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BUYING, RENTING, OR SHARING A CAR: AN ECONOMIC ASSESSMENT BY CONSUMER TYPE, WITH AN APPLICATION TO THE KOREAN AUTOMOTIVE MARKET

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Abstract. *Automotive market is one of the major markets where consumers are offered multiple types of consumption options, including access-based consumption such as renting and sharing. This paper presents an economic assessment model that evaluates the total ownership and operating costs of three consumption options, i.e., traditional buying, renting, and sharing. Reflecting the real data from the Korean automotive market and considering driver type (corporate or individual driver) and driving area (city or long-distance driving), the assessment model helps identify the most affordable option for a specific type of consumer in the Korean market. In this case study, assessment results for four types of consumers are presented, and sensitivity analyses are conducted to provide consumption guidelines that fit each consumer type.*
Keywords: Ownership and operating costs, Rental, Sharing, Automotive market

1. **Introduction.** Recently, access-based consumption is emerging as a new alternative to traditional ownership. Instead of buying and owning things, consumers temporarily use goods and pay for the experience of accessing them [1]. Automotive market is one of the major markets where such non-ownership consumption models proliferate. Consumers are offered a variety of consumption models to choose from, including buying, renting and sharing, and a natural question arises for them: "Which one is the most affordable to me?"

This paper proposes an economic assessment model to answer the question. Focusing on the Korean automotive market, the model evaluates and compares the total ownership and/or operating costs of three consumption options, i.e., buying, renting, and sharing. Although there has been a great deal of research conducted on various consumption models (e.g., [2-6]), only little research has attempted to compare all three options at the same time.

The proposed model identifies the most affordable consumption option for a consumer by considering his/her driving characteristics, such as annual mileage, average speed, and expected duration of consumption. To provide insight and implications on the optimal option, the model is applied to four types of consumers, i.e., Types CC, IC, CL, and IL, representing a wide range of consumers in the Korean market. As shown in Table 1, each consumer type characterizes a specific type of driver as well as driving conditions; for instance, Type CC represents a driver who uses the car for corporate business purposes (in other words, the vehicle is owned and operated by a corporate) in a city area. The assessment by consumer type enables to derive guidelines that fit each consumer type.

The remainder of this paper is organized as follows: Section 2 describes the economic assessment model. Section 3 applies the model to some real cases of the Korean automotive market and suggests choice guidelines for consumers. Section 4 concludes the paper.

TABLE 1. Customer type

Driving type \ Driver type	Corporate	Individual
City driving	Type CC	Type IC
Long-distance driving	Type CL	Type IL

TABLE 2. Nomenclature

Notation	Definition	Notation	Definition
TC_{buying}	Total cost of buying a car	C_{time}	Time-based annual fee for sharing a car
$TC_{renting}$	Total cost of renting a car	$C_{mileage}$	Mileage-based annual fee in sharing
$TC_{sharing}$	Total cost of sharing a car	x	Annual mileage in kilometer (km)
C_{acq}	Initial acquisition cost	y	Average speed in km per hour (km/hr)
C_{maint}	Annual maintenance cost	N	Duration of expected usage in year (yr)
C_{fuel}	Annual fuel cost	$m_{n,k}$	Number of part k replaced over n years
C_{tax}	Annual tax	r_k, c_k	Replacement cycle and unit cost of part k
C_{insur}	Annual insurance price	z	Vehicle fuel economy in km per liter
$V_{salvage}$	Salvage value of a car	c_f	Fuel price in Korean Won per liter (₩/L)
$C_{disposal}$	Disposal cost of a car	s_t	Hourly rate (₩/hr) in sharing
$C_{renting}$	Annual fee for renting a car	s_f	Fuel rate (₩/km) in sharing
$C_{deposit}$	Deposit for renting a car	i	Real interest rate

2. **Economic Assessment Model.** This section proposes an economic assessment model that evaluates the total ownership and/or operating costs of three consumption options, i.e., buying, renting, and sharing. The nomenclature of the model is given in Table 2.

$$\begin{aligned} TC_{buying} = C_{acq} + \sum_{n=1}^{N} (C_{fuel} + C_{maint} + C_{tax} + C_{insur}) \cdot (1+i)^{-(n-1)} \\ - (V_{salvage} - C_{disposal}) \cdot (1+i)^{-(N-1)} \end{aligned} \tag{1}$$

where $C_{fuel} = c_f \cdot x/z$, $C_{maint} = \sum_{k=1}^{K} (m_{n,k} - m_{n-1,k}) \cdot c_k$, $m_{n,k} = \lceil n \cdot x/r_k \rceil$, $V_{salvage} = \max[(-0.032 \cdot N - 0.012 \cdot x/10000 + 0.706) \cdot C_{acq}, 0]$, $C_{disposal} = 0$ (if $V_{salvage} > 0$).

In case of buying, the consumer owns the vehicle and pays for all operating costs. Equation (1) calculates the total cost of buying when it is assumed that the consumer owns a car for N amount of years with the average annual mileage and speed of x and y, respectively. The fuel economy of the car is assumed to be z. The total cost consists of six components: costs due to initial acquisition, fuel consumption, maintenance, tax, insurance, and vehicle salvage. All costs reflect the real data in the Korean domestic market. In the equation, the annual maintenance cost (i.e., C_{maint}) is assessed by considering the expected number of replacement of 10 major parts: engine oil, air filter, transmission oil, teak bracket liquid, front and rear brake pads, fuel filter, air cleansing filter, battery, and coolant. The annual tax is imposed based on the engine displacement (i.e., ₩80/cc for vehicles less than 1,000 cc, ₩140/cc for vehicles between 1,000 and 1,600 cc, and ₩200/cc for vehicles over 1,600 cc). Insurance cost is calculated assuming a plan that meets the minimum coverage required for car-sharing and rental services. It is also assumed that no accident will occur over the consumption duration. At the end of use, the car is assumed to be resold at the price of V_{resale}. To estimate the resale value, a multiple regression was conducted based on 798 used car sales data. The regression equation models the ratio of the resale value to the initial acquisition cost as a function of two variables, the total duration of consumption (or, the vehicle age) N and the average annual mileage x. If the salvage value is negative, the vehicle is expected to be disposed of at a cost of $C_{disposal}$.

The disposal cost is determined based on the vehicle weight.

$$TC_{renting} = C_{deposit} + \sum_{n=1}^{N} (C_{renting} + C_{fuel}) \cdot (1+i)^{-(n-1)} \tag{2}$$

where $C_{deposit} = 0.2 \cdot C_{acq}$, $C_{renting} = 0.0242 \cdot 12 \cdot C_{acq}$.

Equation (2) defines the total cost of renting a car as a sum of three cost components: initial deposit, annual rental fee and fuel. The costs for maintenance, insurance, and tax are all included in the annual rental fee. For brevity, it is assumed that no promotion is applied and the monthly rental fee is constant over the duration of consumption. The initial deposit and monthly rental fee are assumed to be 20% and 2.42% of the acquisition cost, respectively, based on real price data from a major rental service firm in Korea [7].

$$TC_{sharing} = \sum_{n=1}^{N} (C_{time} + C_{mileage}) \cdot (1+i)^{-(n-1)} \tag{3}$$

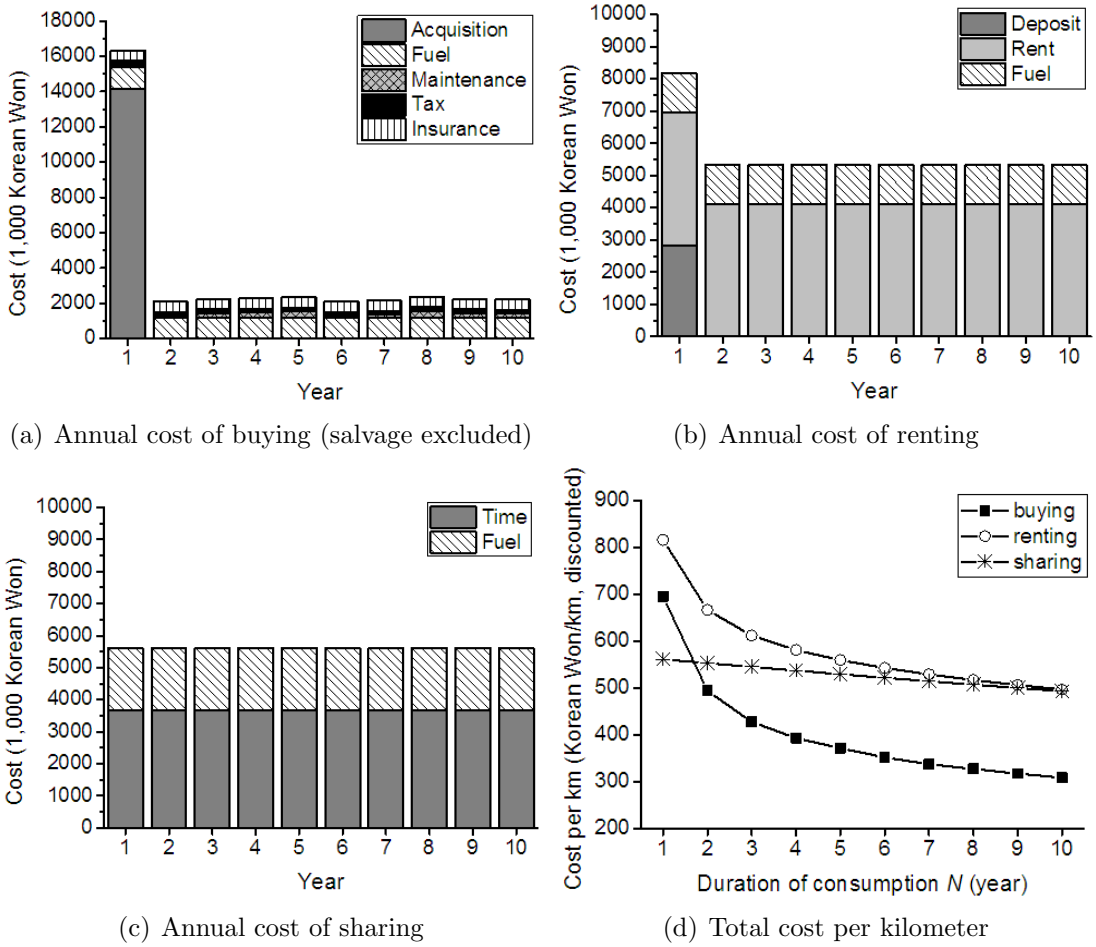
where $C_{time} = s_t \cdot x/y$, $s_t = 0.000672 \cdot C_{acq}$, $C_{mileage} = s_f \cdot x$.

Equation (3) calculates the total cost of sharing. The total cost is affected by two factors, i.e., driving hours and mileage. Sharing is differentiated from buying and renting in that it considers not only fuel consumption (mileage) but also the time the vehicle is used. In this paper, the hourly rate is assumed to be 0.0672% of the initial acquisition cost, based on the price listed by a Korean sharing company [8]. The company also imposes the fuel rate based on both mileage and vehicle size (engine displacement). Here, the fuel rate is assumed to be ₩177/km for vehicles less than 1,000 cc, ₩195/km for vehicles between 1,000 and 1,600 cc, and ₩242/km for vehicles over 1,600 cc.

3. **Case Study.** This section presents a case study to illustrate the application of the proposed model. Four types of consumers (i.e., Types CC, IC, CL, and IL) are analyzed, each of which is characterized by a specific combination of driver type (i.e., corporate or individual) and driving speed (i.e., 26km/hr for city driving; 59km/hr for long-distance driving) [9,10]. Corporate drivers are given a tax relief amounting 10% of the cost, except the initial purchase cost and salvage cost in case of buying. It is also assumed that the consumer is a 26-year-old male, and the vehicle is a small-size sedan produced by a South Korean manufacturer. The annual real interest rate is assumed as 3%.

For each type of consumers, the proposed model estimates the total ownership and/or operating costs of the three consumption options, which allows identifying an optimal option. For instance, Figure 1 shows the results for a Type IC consumer who drives an average of 10,000km every year (i.e., $x = 10,000$). Figures 1(a) through 1(c) present the annual cost of each option (i.e., how much the consumer should pay each year), what it consists of, and how it changes over time. They highlight the pros and cons of each option. In a nut shell, buying requires a relatively high initial investment, but the operating costs are low compared to renting and sharing. Figure 1(d) compares the total costs per kilometer of the three options when the duration of consumption N is given. It implies that sharing has cost advantage over the other options when a shorter duration of consumption (less than two years) is expected. In year 2 and afterwards, buying becomes the most affordable option, while sharing is the next. Although not shown here due to the limited space, it is revealed that the cost advantage of buying becomes more significant as the average mileage increases.

The analysis above suggests that the optimal consumption option changes depending on the duration of usage N and the average mileage x. To better understand the relationship, sensitivity analyses were conducted for a variety of possible combinations of N and x, where N and x are varied between 1-10 years and 0-60,000km of corporate, 0-40,000km of individual, respectively. Figure 2 illustrates the analysis results. It shows how the optimal



(a) Annual cost of buying (salvage excluded)

(b) Annual cost of renting

(c) Annual cost of sharing

(d) Total cost per kilometer

FIGURE 1. Results for Type IC consumer with the average mileage of 10,000km

option for a consumer changes when his driving pattern is varied. (For reference purposes, dash lines show the average mileage of each corporate and individual customer types; according to Seoul traffic statistics data [9], corporate and individual drivers' average annual driving distances are 52,200km and 12,000km, respectively.) For instance, suppose a Type IC consumer who drives on average 10,000km every year in city areas. If he plans to operate the vehicle for one year, then the most affordable option for him will be sharing (see the grey area in Figure 2(b)). If he expects a longer period of use ($N \geq 2$), however, buying becomes superior to sharing. This result also matches with the result shown in Figure 1(d). For corporate driver, who operates the vehicle for 7 years, renting is the most reasonable solution (see the grey area in Figures 2(a) and 2(c)). If he expect a long period of use ($N \geq 7$), buying becomes superior to renting.

Figure 2 implies that sharing is ideal for shorter driving distances, regardless of consumer type. In contrast, buying and renting are appropriate for longer, heavier uses. Renting is especially recommended to corporate drivers whose annual mileage is relatively high. This owes to the assumption of 10% tax relief given to corporate drivers; it makes renting have more cost advantages over buying in corporate-driver cases.

4. **Discussion.** In this study, we proposed an economic assessment model that compares buying, renting and sharing, reflecting the actual data from the Korean domestic market. The proposed model helps identify which consumption option best fits a consumer considering the consumer's driving characteristics.

In the future, the model can be improved by relaxing some assumptions that were applied to simplifying the cost calculation, e.g., no promotion in renting and sharing, no

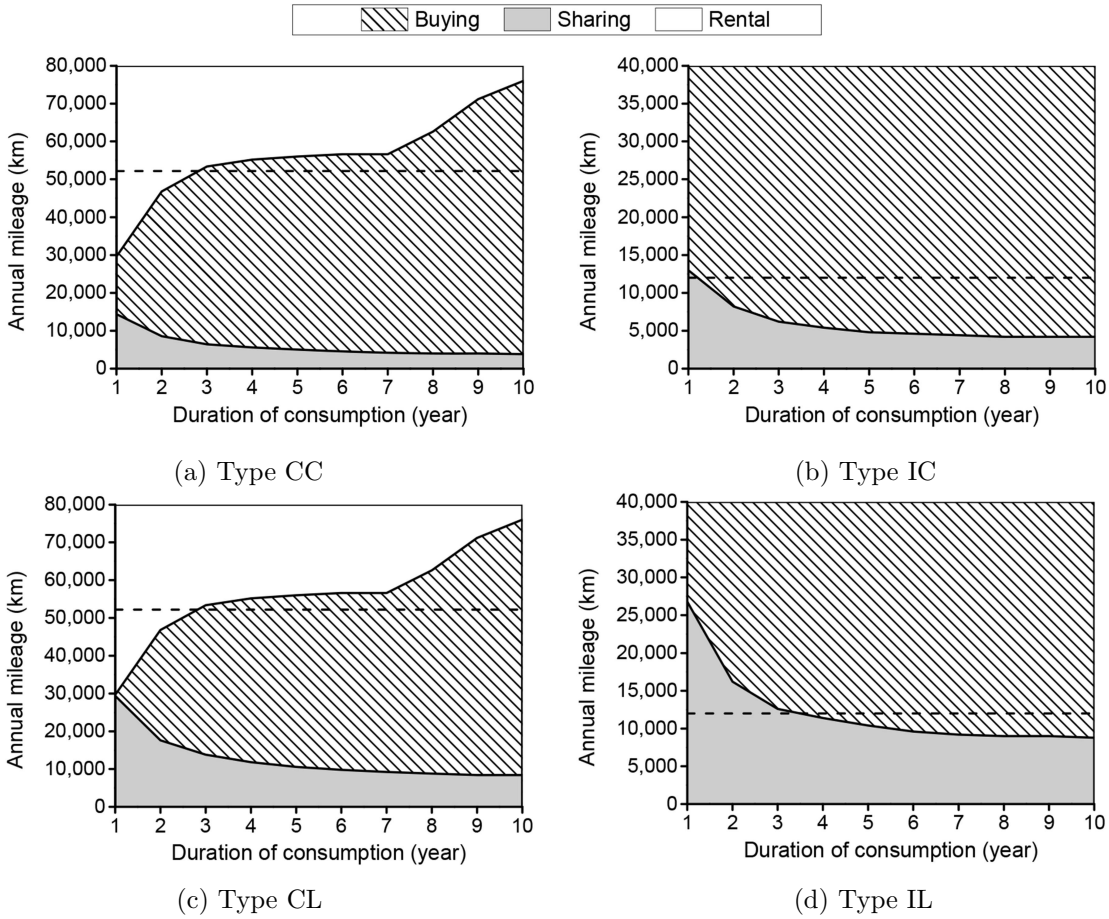


FIGURE 2. Optimal consumption options for different customer types

consideration of differences among the consumption options in terms of vehicle availability, user experiences, parking convenience.

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