NEW VEHICLE CHOICE IN INDIA: HOUSEHOLD CHOICE AMONG MOTORIZED VEHICLE SEGMENTS

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ABSTRACT

Spurred by rapid economic growth, personal vehicle ownership in India is increasing at a fast pace. This is changing the relative popularity of the various vehicle segments in the market. We present a survey of new vehicle buyers in Surat, a representative city in western India, to analyze preferences of consumers in the Indian market. Through this survey, we analyze choices made across new and used motorized two-wheelers and cars, and across different car size segments in a single framework. We control for the preferences of different vehicle attributes by the various socio-demographic groups, and for the attitudes and perceptions of the vehicle buyer. Our analysis quantifies a shift, with increasing wealth, from purchase of motorized two-wheelers to that of cars. We also find evidence of the Indian consumers' preference for smaller vehicles, especially for smaller households. Additionally we find that consumers are highly sensitive to operating cost as compared to purchase price of the vehicle.

The model estimated can explicitly forecast the mix of the motorized personal vehicle fleet, which can inform policy both at the micro and at the macro level. It can facilitate micro-level planning such as estimation of the number of parking spaces of different sizes. It can also facilitate macro-level policy measures such as the computation of taxes and excise on different vehicle segments based on the knowledge of the factors that drive choice and of the sensitivities of the consumer.

Keywords: vehicle choice, vehicle class or size category, survey, attitude & perceptions, factor analysis, Likert scale

INTRODUCTION

India is experiencing rapid economic growth. This is marked by the increased affluence of the burgeoning Indian middle class (Nagaraj, 2008), culminating in a vast growth in private vehicle ownership. A fast-paced shift towards private motorized transport is a substantial change in a country where motorized and non-motorized informal transport serves the majority of the trips overall and public transport serves the majority of the trips in the larger cities. Among private motorized vehicles, motorized two-wheelers were hitherto the most popular (Schipper et.al. 2009). However, the present trend shows that the growth rate of cars has become at par. With manufacturers competing to capture one of the fastest growing car markets in the world, the Indian consumer is being offered increasingly larger set of cars in various sizes and attributes. A nascent market, there are shifts in popularity between the various car sizes, based on the extent to which the attributes of the constituent makes and models meet the consumer's needs.

In a country with a developing road network and relatively low incomes, cars are still a luxury. The Indian consumer is very sensitive to operating cost since the price of gasoline in India is a large fraction of per capita income. Among households with the affordability to own a motorized vehicle, larger household sizes may necessitate ownership of larger vehicles. Yet, as seat belt laws are lax, cars carry passengers that far exceed the capacity of the vehicle. Overloading of motorized two-wheelers is also common. Congestion sometimes necessitates the use of two-wheeler and public transport even by car owners. Consideration of manoeuvrability may thus override the need for capacity in vehicle choice. Many attitudes, perceptions and personal preferences also influence the vehicle purchase decision of a household. Perception of status in owning a specific personal vehicle, negative image of public and non-motorized modes all play their part in a vehicle choice. Decisions are also affected by peer influence.

Being the second most populous nation in the world, changes in India have a global effect. The rapid growth and change scenario, with its potential for affecting the local environment and safety, as well as global fuel use and carbon emissions, underscore the need to study this growth and change phenomenon in the country. Motivated by the fast paced changes in the country, this study aims to assess the needs and aspirations in motorized vehicle ownership of the residents of a rapidly growing city. Studying the customer profile of motorized two-wheelers and the different size categories of cars in the market will reveal useful insights for policy input. Knowing the nature of demand faced by the vehicle market will help formulate policy to direct the growth towards sustainability. For the last few years, sales figures have shown a shift towards bigger cars (CSE, 2008). However, the introduction of the affordable minicar, the Nano by Tata Motors, and the designing of many more affordable small cars by car manufacturers opens up the possibility of a change in the present trend.

We undertook a survey in the city of Surat in western India and surveyed households that had recently bought vehicles. We obtained detailed information on the vehicle bought and the other vehicles owned by the household, information on their socio-demographics, travel

behaviour, and on the attitudes and perceptions of the buyer. In this paper we present the conclusions drawn from the analysis of the survey data. We refer to cars and motorized two-wheelers together as 'vehicles'.

The following section outlines the relevant background of the car market in India until the present year. The subsequent section describes the literature on vehicle choice. Details of the survey and case study location follow this. This is followed by a detailed description of the analysis and summary of results. The final section concludes and outlines possibilities of future work.

BACKGROUND OF THE PRIVATE VEHICLE MARKET

The rapid growth of private vehicles in India is a recent phenomenon. Until the 1980s, industrial production in India was licensed and the car industry comprised of two models together selling 40,000 cars a year. The population of the country was then 684 million. Concurrently, the population of the United States was 226 million and over 8 million new passenger cars were selling in the country (National Transportation Statistics, 2008). Liberalization of the economy and the opening of the market to foreign manufacturers and collaborations in the early 1990s initiated the growth of car sales. The rapid pace of growth of the economy since 2002 became a source of additional stimulus.

Currently, India is the eleventh largest passenger car market having recorded domestic sales of over 1.9 million cars in the country in the year 2009-2010. While in the rest of the world the used car market is double the size of the new car market, these are equal in size in India since consumers hold their cars longer (Roychowdhury, A., 2007). However, with the growth in the new car market, the used car market is also expected to grow; both are studied in this paper.

India is the second largest motorized two-wheeler market in the world being next to Japan in its sales. Its sales have exceeded that of cars by multiples since the seventies with over 9.3 million being sold in year 2009-2010. As with the car market, the growth in the motorized two-wheeler market is also very recent. Many competitors joined the market and many models were introduced since the 1990s. At present, the Indian market carries a wide range of two-wheelers that include scooters, motorcycles, mopeds, electrically operated vehicles and motorcycles with higher volume engines. The possibility of this large consumer base shifting to cars could cause substantial changes in market and mode shares. This paper informs about the possible rate of the change and of the effect of socio-demographic transitions on such change.

Different car size segments

Currently, there are eight different segments of cars in India. Of these, there are six segments segregated on the basis of number of seats and length. The remaining two segments comprise the utility vehicle, equivalent of the sports utility vehicle, and the

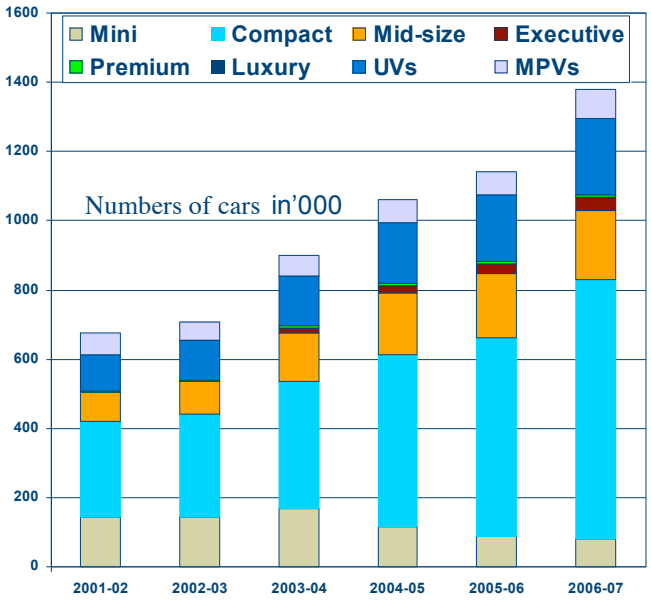
multipurpose vehicle, equivalent of vans. The different car segments are described in Table 1 along with the names of some constituent makes and models.

Table I – Car segments in India

Vehicle	Description	Example
A Passenger Cars	Number of seats including driver not exceeding 6	
A1 Mini	Maximum length 3400 mm	Maruti800, Nano
A2 Compact	Length 3401 – 4000 mm	GM Spark
A3 Midsize	Length 4000 – 4500 mm	Ford Ikon
A4 Executive	Length 4501 – 4700 mm	Honda Civic
A5 Premium	Length 4701 – 5000 mm	Honda Accord
A6 Luxury	Length 5001 mm & above	BMW 7 series
B Utility Vehicles (same as SUV in United States)	B1 Maximum mass 3.5 tonnes, number of seats including driver not exceeding 9 B2 Maximum mass 5 tonnes, number of seats including driver not exceeding 13	Toyota Fortuner
C Multi Purpose Vehicles	Van type; maximum mass not exceeding 3.5 tonnes	Maruti Omni

Source: Society of Indian Automobile Manufacturers 2009.

Figure 1 graphs the sales in the different car segments from 2001 to 2007. The table lists the number of models in, and the five-year compound annual growth rate of each segment. Until 2007, the mini car segment, comprising one model the Maruti 800, had shown a decline in growth with the five-year compound annual growth rate (CAGR) being -11%. The remaining car segments had positive 5 year CAGR with the executive category recording as high as 112%. The decline in the growth of the minicar segment may be attributed to the declining popularity of the Maruti 800. The next size category, i.e. compact cars, is ubiquitous comprising half of the car market.



Vehicle	Number of Models	Five year Compound Annual Growth Rate (CAGR)
A1 Mini	2	-11%
A2 Compact	17	22%
A3 Midsize	17	19%
A4 Executive	10	112%
A5 Premium	9	6%
A6 Luxury	3	33%
B Utility Vehicle/Sports Utility Vehicle	48	16%
C Multi Purpose Vehicle/Van	3	6%

Figure 1 – Trends in Passenger Vehicles Sales

In the number of models constituting the car size categories, we do not consider the variants separately. The 3-series, 5-series, and 7-series in BMW, and the C-class, E-class, and S-

class in Mercedes are each counted as one model. There are few minicar and van models in this nascent market and the comparative lack of demand can be the cause or the effect.

EARLIER STUDIES OF VEHICLE CHOICE

The vehicle choice analysis in the current study builds on the vehicle purchase studies in the literature. Most of these studies are based on new vehicle purchase. Some are based on type choice of the most expensive or frequently used vehicle. The studies either focus on the details of makes, models and vintages or on choices among vehicle classes.

The multinomial logit (MNL) model is commonly used in studies of vehicle type choice. Vehicle attributes such as the purchase price, operating cost, number of seats, luggage space, vehicle weight and age are found to have the most bearing on vehicle type choice (Mannering & Winston, 1985, Berkovec & Rust, 1985, Mannering et.al. 2002). In some of the studies, vehicle attributes are interacted with socio-demographic variables to explore the change in preference of different vehicle attributes with change in socio-demographic characteristics. Most of the studies find income interacted with price to be a significant socio-demographic variable. Some studies capture the effect of the number of household members on vehicle choice (Lave & Train, 1976, Kitamura et.al. 2000). Lave & Train find that increasing household size decreases the probability of owning a sports or a speciality vehicle. Kitamura et. al. find that it has a positive effect on the choice of vans and wagons. They also explore the effect of transit accessibility and find that four door sedans, vans and station wagons tend to be favoured in areas with public transit access while SUVs and trucks are favoured in the metropolitan fringe. Choo and Mokhtarian explore attitude and lifestyle preferences in the form of attributes like subjective and objective mobility, travel liking, attitudes, personality, lifestyle and demographics. They find that owners of cars of different size categories vary in many of attitude and lifestyle preference factors (Choo and Mokhtarian, 2004).

Four studies discuss vehicle choice and use in developing countries. Ni studies motorization pathways, and purchase and use of bicycles, motorized two-wheelers and cars in Shanghai. He conducts a factor analysis study of attitudes and preferences and uses the output to analyze choice of the most expensive vehicle owned. He finds that gender, income, and the perceived effect of status have significant effects on vehicle purchase and use behaviour (Ni, 2008). Joewono, Susilo and Mohamad calibrate an ordered probit model to study the number of vehicles per household. They estimate multinomial logit models for choice of vehicle type and vehicle brand and a regression model for car use in Kuala Lumpur region and its surroundings. They find that lower salary households prefer motorcycles and that households in general have a preference for the national vehicle brand (Joewono et.al., 2008).

Srinivasan et.al. find in their study of Chennai city conducted between 2004 and 2005 that income, presence of female workers and school age children lead to increased probability of households owning a car. Their study of longitudinal data of the current year, and that of five years before, capture many of the transitions in the Indian society, for example, decreasing family sizes and increased participation of women in the workforce. They observe that peer

pressure and credit card holding influence car ownership positively; households with grocery stores or markets nearby are less likely to acquire cars than other households; and the propensity to buy motorized two-wheelers or cars was the largest among households that did not own motorized two-wheelers or cars respectively five years earlier. Given that many households possess a motorized two-wheeler and more than seventy percent of the households do not possess a car, the authors conclude that car ownership may grow faster than motorized two-wheeler ownership in the future (Srinivasan et al, 2007).

Dissanayake and Morikawa, in their study of Bangkok Metropolitan area use a nested logit model in which the upper level represents vehicle ownership types and the lower level represents work trip mode choices for two worker households. They also find that the presence of schoolchildren in households increases the probability of owning cars. (Dissanayake and Morikawa, 2002, 2003).

The literature informs the survey design of the current study by addressing some of the key vehicle choice attributes. The studies conducted in developing economies build a datum with which to compare the findings of the present study. However, none of these studies simultaneously address the choice across different car size segments and across new and used vehicles. Yet, the type choice of cars is the most pressing question in the present context. It is crucial for Indian policy makers to assess the size category of cars that will prevail with the introduction of the Nano and other affordable mini cars like it. This study attempts to answer the vehicle size question with available data.

SURVEY, DATA COLLECTION & CASE STUDY LOCATION

The survey was conducted from August to October 2009 in Surat, India. 128 households that had acquired new or used motorized vehicles since April 2009 were surveyed along with another 67 households who had not acquired motorized vehicles in that year. As the Nano was introduced in the market in April, our sample consists of those households whose choice set included the Nano. However, since the Nano is expected to reach all its customers in the subsequent two years, our sample drawn so close to the date of introduction is not of a size that would enable detailed inferences about the car specifically. The approach developed here could be updated as data on the Nano becomes available, to provide further insight on the impact of the Nano on private vehicle ownership and use in India.

Surat, located in Western India in the state of Gujarat has one of the highest per capita incomes of all cities in India. With an estimated population of 5.4 million, the city is projected to double its population by 2021. Its population density is close to 80 persons per hectare. The vehicle ownership of this city is growing rapidly. At present it has 492 vehicles or 55 cars per thousand persons. New York city records 459 vehicles per thousand persons but a high of 412 cars per thousand. Although the car ownership is low by world standards, it is high for an Indian city being second to Delhi that records 117 cars per thousand (Pai, M. 2009). Having experienced a large growth of private vehicle ownership on account of its economic growth, this city is ideal for the present study. The number of vehicles in the city has grown from 0.29 million in 1991 to 0.98 million in 2005 due to the rapid addition of motorized two-

wheelers and four wheelers. Being comparatively less influenced by globalization, the city preserves many typical Indian characteristics like the traditional joint family system.

Information on households who had bought vehicles in the study duration was obtained from government sources and private businesses. 3000 addresses were compiled from different sources. The addresses were sorted by the seven different municipal zones and by the type of vehicle bought. The number of surveys for all vehicle types conducted in each zone was proportionate to the number of households in that zone. We aimed to get representative surveys of all the vehicle types from each zone. Face-to-face interviews were conducted with the vehicle buyer and his household members in their homes or sometimes in their workplaces. An average interview took 25 minutes. The interviews included questions on the vehicle purchased, other vehicles owned and the residential type. Socio-demographic information and the previous day's travel diary of all persons in the household were recorded. The survey further included a set of Likert scale questions on attitudes and perceptions.

We obtained supplementary data necessary for analysis. The showroom price of the different makes, models and variants were obtained from the vehicle dealers. For used cars, information on prices of different makes, models and variants by the number of kilometres on the vehicle and by vintage for all years since the year 2000 were obtained. Current fuel costs were obtained from local fuel stations. Certified values of average fuel consumption of different makes and models of cars were obtained from an online compilation (SIAM, 2010). Information on city zones and distribution of population were obtained from the Municipal Corporation.

The subsequent sections present the analysis. We begin with a description of the socio-demographic statistics of the households surveyed. We then describe the qualitative analysis obtained from discussions with the survey respondents, vehicle dealers, and government officials of the vehicle registration office. This is followed by preliminary analysis of the data to obtain information on vehicle choice characteristics of different socio-economic groups. Subsequently, we describe the Likert scale attitude questions and the outputs obtained from conducting factor analysis on those questions. Finally we describe the choice model and analyze the various coefficients obtained.

ANALYSIS

We first outline the socio-demographics of the respondents surveyed. The average household size is 5.09, which is close to that obtained for the Indian urban population in the 2001 census. 35.12% of the household members are workers. The income distribution of the sample surveyed is higher than that in the population since the study only includes households who purchased a motorized vehicle in the previous months. 24.7% of the urban population in India own motorized two-wheelers and 5.6% own cars. Our sample represents that minor segment of motor-vehicle owners in the overall urban population.

Qualitative Analysis

The characteristics of vehicle purchase and use was obtained from discussions with survey respondents, vehicle dealers and officials of the vehicle registration office. Such discussions helped modify the survey design and supplemented the information obtained from data analysis.

The traditional three-generation family constitute a sizeable share of the households. They exhibit a unique vehicle ownership and use pattern with the cars and motorized two-wheelers being shared by different members of the household. The highest income earner or the oldest male member of the household is often the main user of the most expensive vehicle. The rest of the vehicles usually have a primary user but are also used by other members of the family.

As discussed, smaller vehicles are preferred for their manoeuvrability and are often overloaded to meet the demand of multi-person trips by larger households. Women drivers are common and most drive motorized two-wheelers or smaller cars. The driving environment is relatively rough with majority of the drivers on the roads being public or semi-public vehicle drivers or paid chauffeurs. These drivers exhibit more competitive and aggressive driving behaviour than road users driving their own vehicles.

In purchasing a vehicle, consumers are often found to make cash payments for vehicle purchase, especially for buying motorized two wheelers. Affluent households sometimes purchase a vehicle on a loan in order to be discrete about their spending capability. In loans, the amount of the monthly payment is an important consideration for medium income respondents, such as salaried people or those running small businesses.

Besides operating cost and price, availability and cost of spares for the vehicle are also important considerations in vehicle type choice. Consumers exhibit a preference for greater interior and luggage space in cars and for comfort for extra passengers in motorized two-wheelers. Younger buyers have some preference for performance like pick up and styling. Many vehicle dealers and survey respondents in Surat believe that car buyers base their purchase decision on the experience of their peers and do not do their own research on the attributes of the choices available.

In the next section we will present the relevant results from the preliminary data analysis.

Data Analysis

Of all the motorized vehicle sales in the nation in September 2009, 83% were motorized two-wheelers and 17% were cars. In comparison, 68% of the respondents in our survey were car buyers and 32% were motorized two-wheeler buyers. The percent distribution over various car size segments of the car buyer respondents closely approximate the percent sales at the national level in those car size segments.

Figure 2 shows the different car segments that were bought by the households surveyed and the placement of the car in their existing fleet. Analysis of the data shows that the compact and the SUV segments are the most widely used, from being a first car to as high as the fourth car in the fleet. There is a substantial presence of second and third car buyers in the small sample of minicar buyers as in the more expensive midsize segment. The sample of minicar buyers mostly comprises buyers of the newly launched Nano. This indicates that the car is attractive to even those buyers who are relatively less price sensitive.

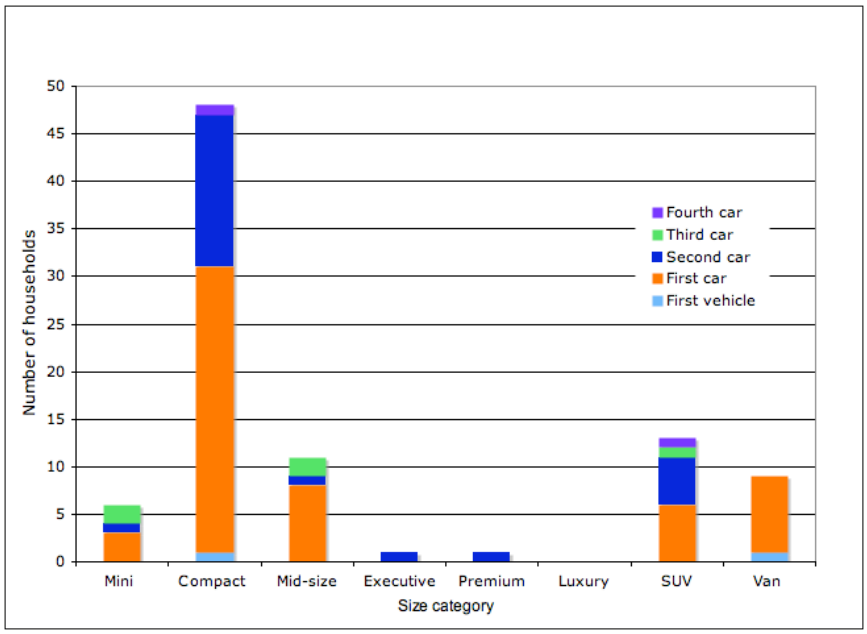


Figure 2 – New car segment & placement in existing fleet

The sample obtained for buyers of cars of the executive and premium class are very small and there is no representative buyer of the luxury class of vehicles. This is indicative of the low affordability, and hence low volume of sales of vehicles in these classes. The few executive and premium car segment buyers sampled were all buying their second cars. The van is always bought as a first vehicle or a first car.

While the sample of third and fourth car buyers is only 4% and 2% respectively in the survey sample, there is evidence of reduction in two-wheeler ownership among those consumer types. 100% of the fourth car buyers and 60% of the third car buyers did not own any motorized two-wheelers compared to only 4% of the first or second car buyers that form the majority of the sample. While congested roads and lack of parking conditions favour use of motorized two-wheelers over that of cars it may be hypothesized that over a certain threshold of income and age, cars dominate over motorized two-wheelers.

With the exception of the van, since the larger cars are also the more luxurious, it is uncertain whether they are bought for their size or for luxury. We address this issue in the section on analysis of coefficients of the choice model.

As mentioned, we intend to capture the set of attitudes and perceptions that shape the vehicle buyers' choices. We hypothesize they affect high value purchases like that of motorized vehicles. A set of Likert scale questions was posed to the survey respondents to assess some of their attitudes and perceptions relevant to vehicle purchase. It is challenging to ascertain the choice-maker in a household and sometimes vehicle choice is a joint decision. The target respondents of the Likert scale questions have typically been the head or other responsible member of the household.

Likert Scale Questions for Attitude Analysis

The Likert Scale questions were motivated by questions posed during similar studies (Ni, 2008). Some questions were added or modified on site to be consistent with the socio-cultural norms of the community. The survey respondents could select one of five responses for a set of 26 statements, the responses being definitely agree, somewhat agree, neither agree nor disagree, somewhat disagree, and definitely disagree. The statements were designed to test the respondents' perceptions in the following categories: perception of status, perceptions about the personal vehicle and other modes, responses to cost considerations, peer influence, and miscellaneous.

Perception of Status

These statements assess the extent to which the respondents agree that a personal vehicle or a car is a status symbol.

Perceptions about the Personal Vehicle and Other Modes

A set of statements pertains to whether the personal vehicle or car improves one's career opportunity and personal life. A second set deals with the issues of expenses in owning a personal vehicle, and the hassle of driving or parking in congestion. A third set of statements deal with whether walk, bike, hired and shuttle three-wheeler services, and buses, are inconvenient. The final set of statements test the respondent's level of comfort in being seen taking any of the modes described.

Responses to Cost Considerations

Different cost-related statements assess the respondents' priorities in buying a vehicle; such as whether the operating cost of a vehicle is an important consideration in vehicle purchase. Some statements assess whether saving is considered a virtue.

Peer Influence

These statements ask the following: whether the respondent liked to be the first among peers to do something new, and whether the respondent felt the need to buy an item that his peer possessed.

Miscellaneous

Some miscellaneous statements assessed the presence or absence of strong national feelings and tendency to buy the national brand. Others assessed attention-seeking behaviour, compulsive shopper behaviour, and the need for some time to oneself.

Factor Analysis on the Likert Scale Responses

Each Likert scale response obtained from the survey come from a set of underlying attitudes that are a mix of one or more of the perceptions discussed. A factor analysis was conducted on these responses to extract the most significant factors that influence the different perceptions regarding private vehicle ownership and use in the city. The analysis was conducted using the statistical software STATA. The method used was principal factors followed by orthogonal varimax rotation. 5 factors were retained that cumulatively explained 88.23% of the variance in the data. The Kaiser-Meyer-Olkin measure of sample adequacy was 0.7, which is rated as 'middling'. The statements with highest loadings for each factor are shown in Table 2.

Table 2 – Statements with highest loadings and names of the factors

Statements with high loadings	**Factor names**
The operating cost considerations are important in my vehicle purchase	Cost and utility considerations: Factor 1 (Variance: 3.59, proportion: 0.28)
Saving is a virtue	
Driving in congestion is a hassle	
Finding parking is a hassle	
The personal vehicle is important for my career opportunities	
The personal vehicle is important for my personal life	
I consider buying a vehicle for infrequent need	Negative image of non-motorized and public modes: Factor 2 (Variance: 2.22, proportion: 0.17)
I don't want to be seen riding a bus or an auto	
I don't want to be seen walking or cycling	
It is inconvenient to be a bus rider	Inconvenience of non-motorized and public modes: Factor 3 (Variance: 2.03, proportion: 0.16)
It is inconvenient to be a pedestrian	
It is inconvenient to ride a bicycle	
When there is something new in the market I have to buy it	Peer influence: Factor 4 (Variance: 1.77, proportion: 0.74)
I have to be the first among my peers to get something new	
When my peers have a certain type of vehicle, I have to own it	
A car is a status symbol	Perception of status: Factor 5 (Variance: 1.72, proportion: 0.88)
A personal vehicle is a status symbol	

The first factor is a composite of monetary and utility considerations. The two monetary considerations are the following: operating cost is important in vehicle choice decision and saving is a virtue. The utility perceptions are that the personal vehicle is useful for the owner's career and personal life. This factor also includes statements on the disutility of driving in congestion and finding parking. The negative image and inconvenience factors deal with two aspects of using non-motorized and public modes. The inconvenience factor

pertains to issues like discomfort and delay in using non-motorized and public modes while the negative image factor pertains to their association with low societal status. Another statement obtaining high loading for the negative image factor is on buying a vehicle even for infrequent need. It expressed the extent of adversity of the respondents towards using all but private motorized modes.

The peer influence factor includes statements expressing both leader and follower behaviour. Some want to be the first among peers to buy a new vehicle while others buy a vehicle when the rest of the peers have it. Finally, the perception of status factor includes statements that the car and the personal vehicle is a status symbol.

Cost and utility considerations explain the biggest proportion of the variance in the data partly because it is a composite of several factors. The negative image or inconvenience of other modes explains very small proportions. This reflects the socio-cultural make-up of the community. Scores for each of the survey respondents were obtained from a product of the loadings obtained from factor analysis and the responses to the Likert Scale questions. These scores are used in the vehicle choice model to assess the role of the various factors in vehicle purchase.

Vehicle Choice

The multinomial logit (MNL) model estimated is used to assess the respondents' choice among 18 classes of vehicles. The choice set includes new and used vehicles including motorized two-wheelers and the eight size segments of cars namely: mini, compact, midsize, executive, premium, luxury, SUV, and van. The model assesses the effects on vehicle choice of different attributes of the vehicle, socio-demographic characteristics of the households, and the respondents' attitudes and perceptions.

Among vehicle attributes, we assess the effect of price, fuel cost and size of the vehicle on vehicle choice. The average price over all makes, models and variants for each vehicle segment is calculated for new vehicles in INR. For used vehicles, the average is also calculated over all vintages since year 2000 and over broad ranges of kilometres travelled. Each car segment consists of vehicles of one or more fuel types: gasoline, diesel, compact natural gas (CNG), liquefied petroleum gas (LPG), and some electric and hybrid vehicles. The average fuel cost per kilometre is calculated for each segment by dividing the cost per litre or kilogram of the fuel by the fuel efficiency (litres per kilometre) of the vehicles. We use the average length of the vehicle class to represent size.

We would like to explore the change in preferences of vehicle attributes with increasing income and decreasing household size of consumers, the two major changes affecting the Indian society. Hence, the two primary socio-demographic variables are income and size of the household. Responses to the questions on household income are few and unreliable. Therefore, we have used different proxies for income such as the type of residence, the number of cars owned and the ratio of the number of vehicles to the number of workers in the household. The number of vehicles to number of workers is the most representative.

The scores for all observations for the five factors extracted from factor analysis represent attitudes.

The number of buyers surveyed in the 18 vehicle segments of the choice set varies. Since some of the segments have inadequate sample to estimate parameters on, we estimate generic parameters across a cluster of those segments. The segments are clustered based on the number of respondents in each and the similarity among the classes as shown in Figure 3. For example, because of the large sample size, the new compact car is considered independently of the cluster comprised of the minicar and the used compact cars. The model is estimated using the open-source software BIOGEME 1.8 (Bierlaire, M. 2003).

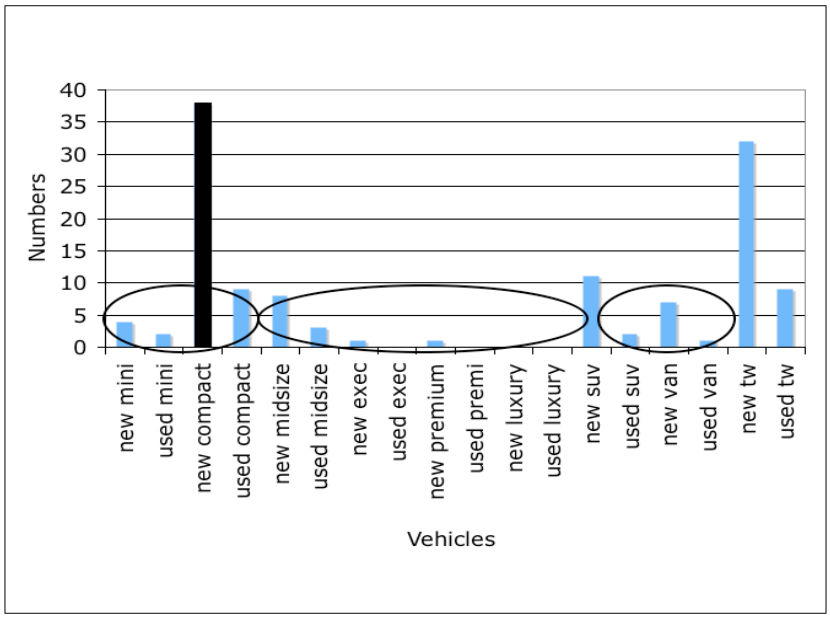


Figure 3 – Distribution of vehicle sizes purchased

Length of the vehicle is divided by the number of members in the household to explore the effect of varying household size on vehicle choice. Generic coefficients are estimated for price of the vehicle, fuel cost per kilometre, length per person, used vehicle dummy and for the natural log of size of vehicle category. The used vehicle dummy explores the nature of preference for used over new vehicles. The natural log of the number of makes and models in each size category is necessary for correct specification of the indirect utility function as the alternatives in this model are aggregations of the different elemental make and model alternatives in a single vehicle size class (Ben-Akiva & Lerman, 1985).

Cluster-specific coefficients are estimated for the income proxy, vehicles per worker, and for the five factors obtained from the factor analysis. Since some of the otherwise complete surveys did not have complete responses to the Likert scale questions, we introduced a Likert scale response dummy to represent those respondents for whom the Likert scale responses were present, instead of removing those observations for which the Likert scale

responses were absent. Use of this dummy enabled use of all socio-demographic data in our limited sample.

The values of the coefficients and their significance are shown in Table 3. Some of the variables have a high p-value, which may be ascribed to the small sample size, noise in the data, possible scope of improvement in specification or lack of significance in reality. The length per person variable has a negative coefficient, which implies that bigger size of a vehicle is a disutility. This is expected because of congestion and the lack of parking space. Given the absence of marked parking slots, vehicles are mostly parked on roads, shoulders and paved or unpaved sidewalks, where it is easier to park a smaller than a larger vehicle. The coefficient for length is the ratio of the coefficient obtained and the number of household members. This reduces in magnitude with increase in the size of the household indicating that larger size of the vehicle allowing more interior space is more attractive for larger households.

Table 3 – Vehicle choice model output

	Value (p-value)	Value (p-value)	Value (p-value)	Value (p-value)	Value (p-value)	Value (p-value)	Value (p-value)
	New compact	Mini, used compact	Midsize to luxury	New SUV	Vans, used SUV	New two wheeler	Used two wheeler
Length per person in household	-1.54(0.2)	-1.54(0.2)	-1.54(0.2)	-1.54(0.2)	-1.54(0.2)	-1.54(0.2)	-1.54(0.2)
Price (in millions INR)	-1.27(0.2)	-1.27(0.2)	-1.27(0.2)	-1.27(0.2)	-1.27(0.2)	-1.27(0.2)	-1.27(0.2)
Fuel cost per kilometer (in INR)	-0.47(0.4)	-0.47(0.4)	-0.47(0.4)	-0.47(0.4)	-0.47(0.4)	-0.47(0.4)	-0.47(0.4)
Used vehicles (dummy)	-1.01(0.0)	-1.01(0.0)	-1.01(0.0)	-1.01(0.0)	-1.01(0.0)	-1.01(0.0)	-1.01(0.0)
Number of vehicles per worker	-	-	-	0.52(0.0)	-	-1.05(0.0)	-0.97(0.1)
Inconvenience of other modes	-	-	0.12(0.3)	-	-	-	-
Negative image of other modes	-	0.11(0.2)	0.21(0.1)	-	-	-	-
Peer influence	-	-1.9(0.2)	-	-	-	-	-
Cost, utility/disutility of private vehicles	-	0.22(0.0)	-	-	-	0.08(0.2)	0.22(0.2)
Status	-	-	-	0.15(0.2)	-	-	-
Ln (number of models in segment)	0.63(0.0)	0.63(0.0)	0.63(0.0)	0.63(0.0)	0.63(0.0)	0.63(0.0)	0.63(0.0)
Likert scale response obtained (dummy)	-	-8.10(0.0)	-3.17(0.0)	-3.55(0.1)	-1.23(0.0)	-3.68(0.0)	-8.35(0.1)

Price and per kilometre fuel cost are negative. This implies that a vehicle becomes less attractive as its price or per kilometre fuel cost increases. The willingness to pay for fuel economy is calculated as the ratio of the coefficient of fuel cost per km to the coefficient of price. Since price is expressed in millions of INR, the coefficient of price expressed in INR is -1.27 x 10 -6. Comparing the willingness to pay for unit reduction of operating cost, with results obtained from a study of two cities of the United States (Martin, E.W., 2009), we

obtain that the willingness to pay of the Indian consumer is 11.43 times that of the United States consumer. In comparison, the ratio of price of gasoline to per capita GDP in India is 5.44 times that in the United States. Assuming an average service life of 10 years with 15000 km of annual kilometres travelled, the Indian consumer is willing to trade INR 2.46 per INR 1 reduction is fuel cost over the life of the vehicle. We infer that the Indian consumer is 2.5 times more sensitive to an INR spent on expected operating costs than on purchase price. The negative coefficient and the low p-value of the used vehicle dummy indicate that used vehicles are not preferred, as is expected when price is controlled for.

The cluster-specific coefficient for the income proxy, the number of vehicles per worker indicates that with increase in income, preference for new SUV increases and preference for motorized two-wheelers decreases relative to the rest of the car segments. This finding supports the hypothesis that with increase in their affordability, the preference of the Indian consumers is shifting from motorized two-wheelers towards cars. The popularity of the new SUV is also evident in Figure 2.

Respondents expressing the opinion that non-motorized, public or shared modes are inconvenient prefer a midsize, executive, premium or luxury (midsize to luxury) car. This results from the higher affordability of the buyers of cars from these classes and consequently their reduced experience of these modes. Those obtaining high scores for the negative image factor are more likely to buy a midsize to luxury car, or a mini or used compact car. While this is expected for buyers of the relatively expensive midsize to luxury cars, it is unexpected for buyers of mini cars and used compact cars. However, as seen in Figure 2, buyers of mini and compact cars often belong to the highest income classes. Peer influence has a negative effect on buying of a vehicle from the midsize to luxury class. This is because the small sample of these car buyers in our sample obtained lower scores for the peer influence factor. The cost and utility conscious respondent has shown a preference for the low cost utilitarian vehicles such as mini, used compact cars, used and new motorized two-wheelers. Finally, those with high scores on the status factor are more likely to buy a new SUV.

The log of the number of constituent makes and models of cars in each size category is included for correct specification. Theoretically, the value of its coefficient is 1. Given that an elemental alternative in the size category would also include variants and vehicles in different combinations of finishes available, the coefficient of 0.625 is a close approximation.

CONCLUSIONS

We study new vehicle choice in the city of Surat as an example of the rapid growth in private motorized vehicle ownership in India. In a market with a large majority of two wheeler buyers and small but growing number of car buyers, we analyze the preference across new and used motorized two-wheelers and cars of different size and price categories.

We quantify the increase in automobile ownership with increasing affordability of consumers. This finding enables forecasting of car-ownership overall and can be used to forecast the

ownership of cars of various sizes. Such forecasts are useful to inform micro-level policies such as calculation of parking space requirements as well as higher-level policy measures for managing fleet composition or peak hour congestion through taxes and excise.

Our preliminary analysis and models outputs both reveal that small cars are preferred in general and that the compact car and the SUV are the most popular. The midsize, executive, premium and luxury cars are exclusive and essentially luxury purchases. In the minicar segment, our limited sample suggests that its main constituent, the Nano, is a preferred choice for some consumers with high affordability as well. The consumers are sensitive to fuel cost and that new vehicles are preferred over used vehicles.

Our analysis of attitude of vehicle buyers confirms its importance in vehicle choice. We obtain that cost and utility considerations override other biases such as perception of status or negative image of other modes in the community surveyed. The cost and utility conscious favour the motorized two-wheelers or the compact cars. Those finding non-motorized and public modes inconvenient prefer the midsize to luxury cars. Status is associated with owning an SUV. The findings conceivably underscore the importance of advertisements and public awareness campaigns in influencing preferences.

The earlier part of conclusions summarized our findings. As future work, we will refine the model presented. We need to better address the sampling method used in the estimation and the model specification. Specification issue is a concern for MNL models due to the independence of irrelevant alternative (IIA) property. Nested multinomial models and mixed logit models have been used in choice model literature to deal with IIA violations and will be explored for our study subsequently. Including the factor analysis outputs in the choice model introduces measurement errors, which can be addressed by conducting factor analysis as a part of the choice model estimation (Ben-Akiva, M., et.al. 2002). We also aim to explore this correction technique in future extensions of this work.

This paper presents the findings obtained from the analysis of a part of the survey data. We will analyze next, the mode choice of the survey respondents and the effect of purchase and ownership of different vehicles on their travel behaviour.

In choosing a vehicle, a consumer selects the make and model that offers the bundle of attributes to best fit her needs. When a consumer chooses a vehicle of a particular size segment, it reflects both the need in the household for a vehicle of that size and also a preference of the other attributes of the specific make and model in that size segment. Studying vehicle choice at the level of the size segment loses much of the resolution of the actual choice process. However, a study at the micro-level of makes and models will be devoid of the panoramic vision that is needed for policy input. This study is the first part of a series of research that the authors will conduct on vehicle choice and travel behaviour in India. The rapid progress of change will need many studies to instigate development that is sustainable both locally and globally.

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