# An Analysis of Commute Travel Times in an International Context

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**ABSTRACT**

Extreme commuters, defined as those traveling more than 90 minutes each way to and from work, are one of the fastest growing market segments in the United States. The availability of affordable housing, the concentration and specialization of employment, and transportation access are but some of the factors contributing to this phenomenon. This phenomenon is occurring at a time of unprecedented energy and environmental concerns and there is much interest in slowing or even reversing this trend. Who are these people and what are the socio-economic and demographic factors that are associated with long commutes? What is happening in other countries where land use densities are higher and transit systems are more prevalent? This study aims to answer these questions by recognizing that commute lengths are a manifestation of people's residential and work location choices. Using data sets from the United States, Switzerland, and India, international comparisons of commute length market segments are made to better understand the prevalence and socio-economic composition of long duration commuters, defined as those commuting 60 minutes or more each way in this paper. The descriptive statistical comparisons and multinomial logit model estimation results confirm hypotheses that lifecycle stage, personal attributes, and household characteristics are strongly correlated with commute length. More importantly, the study findings raise interesting and important questions regarding the traditional notion that higher densities and levels of transit use are associated with shorter commutes. The percent of long-duration commuters is found to be the lowest in the United States, where land use densities and transit use are among the lowest in the world.

*Keywords*: commuting, land use, travel data, travel time, international comparison, time use, travel behavior.

## INTRODUCTION

The daily commute to and from work continues to be a major component of daily travel in countries around the world. Not only does the commute account for the largest share of daily travel (on average), but many other trips are often linked to or occur in relation to the daily commute. For example, in the United States, the round-trip commute accounts for nearly one-half of the total daily travel time expenditure for commuters (about 45 minutes out of 90 minutes). In a recent May 2006 article, it was reported that "Extreme Commuters", i.e., those who commute more than 90 minutes each way between home and work, constitute the fastest growing commuter market segment in the United States. They number approximately 3.4 million, which is a number twice that seen just 15 years ago *(1)*. This phenomenon is occurring despite rising fuel costs, time-constrained lifestyles, and traffic congestion in many parts of the country. This article, and the literature at large, provide insights into the driving forces behind "extreme commuting". The search for affordable housing (which is often available in distant suburbs), large backyards, peace and tranquility away from the chaotic city scene, and good schools are the oft-cited reasons driving longer commuting patterns in countries around the world. Technology is also playing a role in this phenomenon. Technological innovation has facilitated telecommuting, potentially eliminating the daily grind of the commute, and made travel time more productive (e.g., constant communication via wireless services) and relaxing (e.g., driver-friendly automobile features); in other words, the time spent commuting is no longer a cost to be minimized as the time is used productively *(1-2)*. The increasing trend towards extreme commuting flies in the face of the traditional notion that people attempt to minimize the physical separation between their workplace and residential locations, which has often been the core paradigm underlying transportation planning and policymaking in a wide range of contexts.

Emerging economies such as India are also experiencing rapid suburbanization and dispersion of job and residential locations, similar to that seen in the United States over the past several decades. Growth in population, car ownership, and income are but some of the factors contributing to this phenomenon. In India, where living in a megapolis such as Mumbai is often synonymous to living next to slums, people are increasingly abandoning city life and migrating outwards in search of a better quality of life at the cost of dramatically increasing commute time. It is becoming apparent that the trend towards long distance commuting has started making its appearance in many societies around the world despite socio-cultural differences that may exist between countries.

The primary objective that motivates this paper is a desire to understand the socio-economic composition of the various commuter market segments defined by commute duration. Who are the long commuters? How do they differ from other commuter market segments? What are the socio-economic and demographic factors that are positively and negatively associated with long commuting times? In this paper, the commute length is measured in terms of time as opposed to distance; although there is a high correlation between travel time and distance, one must also note that there may be instances where these two measures of separation are not necessarily aligned with one another. Even a short-distance commuter relying on transit or non-motorized modes may experience a long commute (in duration) due to poor transit service and slow speeds.

In the United States, one may think that long commutes are increasing at a rapid pace due to continued decentralization of jobs and housing (low density development) and excessive reliance on the automobile with poor transit service in most markets. If that is true, then

countries with higher density of development and higher levels of transit service should have a lower prevalence of long commuters. By undertaking an international comparison of commuter market segments, this paper aims to shed light on the hypothesis that countries with higher land use densities and levels of transit service have a lower percent of commuters experiencing long commutes.

The study is based on the paradigm that commute time reflects an individual's decision regarding his/her residential and workplace locations. These location decisions are influenced by socio-economic, demographic, land use, and transportation system characteristics. Through a detailed socio-economic analysis of commuter market segments and the development of multinomial logit models of commute length (defined by discrete categories), this paper purports to shed light on the composition of these market segments and generate hypotheses regarding the role of socio-economics, land use densities, and transportation system attributes in influencing commute lengths. Data sets from the United States, Switzerland, and India are used to facilitate the international comparison. Comparison among the three countries facilitates a better understanding of commute time choice behavior in diverse socio-cultural contexts.

## REVIEW OF LITERATURE

There is a large body of literature devoted to the study of various aspects of commuting behavior. Within the context of this paper, it is not possible to offer a comprehensive literature review on the subject. The commute is a reflection of people's residential and work location choices and much work has been done in trying to model people's residential and work location choices, particularly in the land use modeling context *(3-4)*. This body of literature addresses the connection between urban spatial structure and travel behavior. Numerous economic theories dating back to the 1960s have been based on the notion of a trade-off between commuting cost and housing costs and this trade-off has often been placed at the core of regional science and urban economics *(5-10)*. These papers offer insights into the socio-economic, demographic, and land use-transportation system variables that influence location choices, and hence commuting patterns. More recently, location choice behavior and commuting patterns have been examined in the context of understanding the relationship between transportation and public health. As commutes get longer and increasingly auto-dependent leaving little or no time for physical activity, there are concerns about the adverse effects on people's health, particularly in the wake of rising levels of obesity *(11-14)*.

Pisarski *(15)* identifies several factors contributing to changing commuting patterns over the past few decades including an increase in the number and percent of two-worker households, a boom in long distance travel, and evolving urban form and private vehicle usage that has influenced contemporary commuting characteristics and preferences. At the same time, it is found that average commute times, particularly in the United States, have remained rather stable at a little over 20 minutes each way, with an average increase of about one minute per decade *(16)*. On the one hand, the percent of long distance commuters is increasing and yet average commute times have remained largely stable. These seemingly conflicting trends can be reconciled by noting that small increases in telecommuting (zero-commuters), flexible work hours to avoid the worst peak congestion hours, improved transportation access, and decentralization of jobs (jobs moving to where people live) have helped keep overall average commuting times rather stable.

Commuting duration has played a central role in activity-based analysis and time use research in travel behavior. The time spent commuting is often treated as a mandatory time expenditure that influences the time spent on flexible and discretionary travel and activities. These time use trade-offs and commute time constraints are playing a central role in the specification of new activity-based models of travel demand *(17)*.

Several studies have analyzed the impacts of land use patterns on commuter travel choices including mode choice, vehicle ownership, and trip length with a view to associate commute length, and residential and work locations, with sustainable urban development initiatives *(18-19)*. These studies offer insights into the role that commute reduction strategies can play in decreasing vehicle miles of travel (VMT) that is often seen as critical to achieving more sustainable patterns of development *(20)*.

The discussion in this section demonstrates the central role that commuting behavior, a manifestation of residential and work place location choices, has played in understanding and modeling travel demand and shaping transportation policy. This paper aims to shed additional light on commuting behavior in an international context.

## DATA SETS

The international comparison of commuter market segments is undertaken by utilizing three travel survey data sets from around the world. The three surveys are:

- 2001 National Household Travel Survey (NHTS) of the United States
- 2000 Microcensus Travel Survey of Switzerland
- 2001 Household Travel Survey of the City of Thane, India

While the first two surveys constitute national surveys, the survey from India is from a single metropolitan area in India. Unfortunately, there is no national travel survey available in India that can be used for this study. However, as the City of Thane is a rather representative metropolitan area of India, it was considered suitable to serve as the third international context for this study. Moreover, it comprised a respondent sample of 3,505 households and may therefore be considered statistically valid for model development and estimation.

There are differences and similarities between the surveys that should be noted here. All three travel surveys are based on the trip-diary format in which respondents are asked to provide detailed information about trips undertaken over a 24-hour period in addition to socio-economic, demographic, and other characteristics of households and persons. However, there are differences with respect to the survey administration method. The 2001 NHTS is a combination mail-out/computer-assisted telephone interview (CATI) survey where travel data is retrieved for the household over the phone. The 2000 Swiss Microcensus is a pure mail-out/mail-back travel diary survey. Finally, the 2001 Thane, India survey is a face-to-face in-person survey where field workers actually visit households and interview people in their homes to retrieve travel data. Despite these differences, the survey data offer rather standard information regarding household, person, and travel characteristics and appear worthy of use in an international comparison of this nature. However, the authors caution the reader that differences in results, model estimates, and findings among the three data sets may, in part, be due to differences in survey administration methods.

Table 1 shows the household characteristics of the three data sets. While the US and Swiss data sets are large national samples of 25,000+ households, the India survey sample includes a smaller respondent sample of 3,505 households. As expected, the US and Swiss

survey samples show small household sizes of about 2.5 persons per household and higher levels of licensed drivers with more than 1.5 drivers per household. The US sample exhibits the highest level of car ownership with nearly two cars per household. On the other hand, India is characterized by large household sizes with an average household size of more than four persons. Driver license holding and car ownership levels are very low (less than 0.1 per household) in comparison to the US and Swiss samples. These socio-economic differences offer a rich contrast for comparing commuter market segments across contexts.

## DESCRIPTIVE ANALYSIS OF COMMUTER SEGMENTS

Tables 2, 3 and 4 offer detailed statistical descriptions of commuter market segments for US, Swiss and Indian survey samples respectively. All individuals who made at least one work trip or work-related business trip on the travel survey day are treated as commuters. Three commuter market segments are defined based on the one-way home-work commute travel time: short (15 minutes or less), medium (more than 15 minutes and less than 60 minutes) and long (60 minutes or more). Commuters who reported only non-home-based work trips are excluded from the sample. These definitions are applied consistently to all of the three data sets. Also, the analysis is restricted to only adult commuters who are at least 18 years old for the sake of consistency and to recognize that those under 18 years of ago often do not have the flexibility to exercise their own travel and location choices.

In Table 2, it can be seen that just under six percent of adult commuters in the United States are long commuters traveling 60 minutes or more each way to and from work. The gender split shows that males make up a larger portion of the longer commuter market segment. This finding is consistent with the notion that female commuters attempt to find work closer to the home location (in comparison to their male counterparts) in an attempt to strike a balance between their work and household responsibilities. With respect to age, nearly 20 percent of short commuters are found to be under 25 years of age. The corresponding percent for medium and long commuters is about 12 percent. This finding is consistent with the expectation that those under 25 years are likely to be part time workers seeking work closer to home. Both education and income show consistent trends across the three market segments. Higher education and income levels are associated with longer commutes. Once again, this trend is consistent with the notion that those seeking specialized high-paying jobs must commute farther to access such employment opportunities. Also, higher education and income levels are likely to be correlated with suburban residential location choices further contributing to this phenomenon.

The next series of travel-related variables provide revealing indications. Long commuters are much less single-occupant vehicle (SOV) oriented in their mode choice to work. Less than two-thirds of these commuters report using SOV to work. Nearly 20 percent use bus and rail and another 10 percent are in two-person vehicles. This mode use pattern is consistent with the lower level of driver-license holding among long commuters. Also, as expected, the number of total trips per day decreases as commute time increases. This finding is indicative of two possible phenomena. First, there is a trade-off between commute travel time and overall activity-travel engagement. As commute time increases, total activity-travel engagement decreases due to reduction in discretionary time availability. Second, as commute time increases, commuters may be inclined to be more efficient with respect to their travel pattern and

as a consequence, undertake a greater level of trip chaining (multi-stop journeys). Chaining trips together contributes to lower overall trip frequencies.

Table 3 provides descriptive statistics for the commuter segments in the Swiss sample. Although the context is quite different, many of the trends mirror those seen in the United States. Long commuters comprise about seven percent of the commuter population (slightly higher than, but similar to, the United States). Long commuters are predominantly male. Unlike the US, the age distributions are rather similar across the three market segments. Similarly, employment, education, and income distributions are quite similar across the three market segments for the Swiss survey sample. This is quite different from the US context where clear trends were seen with higher income and education levels associated with longer commutes. One may hypothesize that the mixed land use patterns and socio-economic composition of the population in the European context contribute to this absence of a clear trend. Jobs and housing options are less separated and residential segregation based on socio-economic status is less pronounced in the European context. As a result, the three commuter segments are similar with respect to these socio-economic variables. However, similar to the United States, there are clear differences in trip rates and mode use. Long commuters engage in a smaller number of trips and are far more bus and rail-oriented than short and medium commuters. The average commute time for long commuters in the Swiss sample is considerably higher than that seen in the US sample (111 minutes vs 78 minutes), presumably due to the higher level of rail usage (which is inherently a slower mode). Despite the difference in modal split, the overall commute times are rather similar between the US and Swiss contexts (23.5 minutes vs 25.1 minutes). The higher densities, mix of jobs and housing, and transit service is helping keep commute times in Switzerland comparable to those in the United States.

Finally, Table 4 presents descriptive statistics for the commuter samples in India. Similar to most metropolitan areas in India, Thane is a high density region with a poor transportation infrastructure and high levels of congestion. Reliance on transit service is very heavy for meeting mobility needs, although the transit service is often unreliable. In the India survey sample, it is found that 25 percent of commuters are long commuters, a statistic much higher than that seen in the US and Swiss samples. This is presumably due to the heavy reliance on transit, poor transportation infrastructure, and the poor coordination of jobs and housing. Males constitute more than 85 percent of the commuter sample in India and there is a clear trend with males constituting a higher percent of long commuters. It is also clear that traditional gender roles are an important aspect of life in India.

Several socio-economic trends are found to mirror those seen in the U.S. sample (unlike the Swiss sample, which did not show these trends). In comparison to short and medium commuter segments, long commuters tend to be older, more educated, higher income, and employed in higher paying service (white-collar) jobs. In India, there are phenomena taking place that mirror those seen in the United States. Those seeking specialized high-paying jobs must travel farther to access such job opportunities (they are located in certain pockets) and hence constitute a larger segment of long commuters. Although the land use density is high, the jobs-housing balance is rather poor with higher income and higher educated commuters living in higher status residential enclaves farther away from specialized service employment opportunities.

Auto ownership is still very low in India while two-wheelers are very popular in India as these are more affordable among middle class Indians. An examination of travel-related variables shows that more than 60 percent of short commuters walk to work. The other

predominant modes used are three-wheeled taxis (called autorickshaws) and personal two-wheel transport (motorcycles), besides bus and bicycle to a lesser degree. The mode split shifts heavily in favor of bus and rail as the commute gets longer. Nearly 75 percent of long commuters use rail for the commute to work. Only two percent use the motorcycle or walk. While there is a strong correlation between mode use and commute travel time, the causality that may exist between these two phenomena is unclear. Do people use rail because their commute is very long? Or is the commute travel time high because people are using rail (transit dependent)? Unraveling this causal relationship remains an interesting future research effort that can greatly aid in transportation and land use policy making. If it is the former, then land use policies that bring jobs and housing together should be formulated. On the other hand, if it is the latter, then rail system performance must be enhanced. In reality, it is likely that both causal relationships exist in the population and policies addressing both phenomena are needed. The overall average commute time in India is the highest among the three contexts at 36 minutes.

## MODEL ESTIMATION RESULTS

Multinomial logit (MNL) models *(21-22)* of commute duration choice are presented in this section. These models provide a mechanism for understanding the socio-economic factors contributing to commute length choice in a multivariate analysis context as opposed to the previous section where statistics were examined in along univariate dimensions. Discrete choice models may be considered appropriate for the analysis here because commute length is a manifestation of residential and work location "choices" that people make. Thus, commute length may also be regarded as a choice. Also, MNL models are appropriate for determining the socio-economic factors contributing to commute duration choice. Duration models could also be applied to analyze commute times; however, as the analysis so far has focused on discrete commute market segments, the MNL formulation has been adopted to maintain consistency in the analysis.

Table 5 presents model estimation results for the US survey sample. The alternative-specific constant is positive for the short commute alternative and negative for the long commute alternative signifying that, controlling for all other factors, long commutes are less desirable than short commutes. Note that the medium commute alternative is the base alternative and its utility is set to zero. Being male, working in a professional (presumably specialized) occupation, having a higher income, and living in a large metropolitan area are all positively associated with the long commute alternative. These findings are consistent with expectations and to the descriptive statistical analysis presented in the previous section. Relative to other race groups, whites show a propensity to have shorter commutes. Low income commuters also show a propensity to have shorter commutes. The number of drivers in the household, possibly serving as a proxy for vehicle ownership, is positively associated with a shorter commute. Higher vehicle availability facilitates the use of the personal automobile for the commute and this is usually the faster mode relative to transit and non-motorized options. Commuters living in an urban cluster are more likely to have a short commute due to the higher land use density prevalent in such clusters. Overall, the findings are quite consistent with expectations and easily explained by lifecycle stage factors. For example, as household size increases, the likelihood of being a short commuter decreases; however, as the number of children increases, the likelihood of being a short commuter increases. This may be explained as follows. As child obligations increase, commuters may try to locate their residence and work places so that commute times are

reduced. On the other hand, as the number of adults in the household increases (household size increases), the compromise arising from having multiple commuters in the same household results in a location choice where multiple commuters are commuting farther than they would have otherwise. The findings suggest that household constraints such as fiscal constraints and childcare responsibilities potentially increase the chances of being a short commuter.

Table 6 presents the MNL model estimation results for the Swiss sample. The alternative-specific constants associated with both short and long commute alternatives are negative suggesting that the overall propensity is to adopt a medium commute situation. This finding is different from that seen in the US where the overall propensity is to adopt a short commute. Being male is positively associated with long commutes, similar to the United States. Also similar to the US context, higher household income, education level, and auto ownership reduce the likelihood of having a short commute. Part time and independent employees are likely to have shorter commutes. These findings point to the general pattern worldwide where people seeking higher incomes and specialized occupations need to travel farther (and hence longer) to access such employment opportunities. In contrast to the US context, however, lower income commuters in the Swiss sample are positively associated with long commutes. This is because they have lower auto availability and their reliance on transit leads to longer commutes unlike in the US where car ownership is virtually ubiquitous. Thus, while overall indications appear quite similar to those seen in the US sample model, there are some interesting differences that presumably result from differences in transportation system characteristics.

Finally, Table 7 presents the model for the India sample. The alternative-specific constant is negative for the long commute alternative, suggesting that commuters are least likely to choose this alternative, ceteris paribus. Individuals owning small businesses are likely to be short commuters while those in specialized service occupations are likely to be longer commuters. Commuters with a low income are less likely to be short or long commuters. This is because they are likely to rely heavily on alternative modes (which makes it less likely that they can have short commutes) and work in lower paying jobs closer to home (which makes it less likely to have a long commute). Similar to the US and Swiss contexts, highly educated individuals are likely to have longer commutes, again due to the need to access specialized, high-paying occupations. As expected, young commuters are likely to work closer to home and have shorter commutes while older commuters are likely to access specialized occupations farther away from home. Females with child obligations are likely to be short commuters so that they can take care of household and child responsibilities. Commuters in households with two-wheelers are less likely to be long commuters while those in smaller households are more likely to be long commuters. The former is because two-wheelers are a fast mode of transport in the Indian context and such commuters are likely to be located closer to their work place, and the latter is because such commuters have presumably fewer household obligations that allows them to commute longer. Owning a home, which is often correlated with higher income levels, is positively associated with long commutes.

## CONCLUSIONS

Commuting is a very important aspect of travel as it constitutes the largest share of daily travel distance and travel time expenditure for commuters. Recent trends in the United States suggest that those with commutes of 90 minutes or more (each way) are the fastest growing segment of commuters. This trend has raised several key questions including: How large is this segment of

commuters? What is the socio-economic and demographic composition of this segment relative to other shorter duration commuter segments? Is the United States having a disproportionately large percent of long commuters relative to other countries due to its sprawling low-density land use, absence of mixed land use development, and poor transit service?

In an attempt to answer these questions, this paper presents a comprehensive international comparison of commuter market segments defined by three commute durations: short (less than or equal to 15 minutes), medium (more than 15 minutes but less than 60 minutes), and long (60 minutes or more). Using data sets from the United States, Switzerland, and India, the socio-economic composition of various commuter segments is analyzed and compared across contexts. Multinomial logit models are estimated on the three data sets to better understand the socio-economic factors that affect commute duration, which is considered to be a manifestation of people's residential and work location choices. In addition, the comparison provided a means of assessing the prevalence of long duration commuters in the population in each of the contexts. The analysis revealed that the socio-economic factors contributing to long or short commute durations are remarkably consistent across contexts. Generally, higher income, higher educated, individuals are prone to longer commutes to access specialized occupations paying higher wages. Those using alternative modes of transportation are prone to having longer commutes. Also, individuals with greater household responsibilities and obligations are prone to be shorter commuters. It is interesting to note that these tendencies are generally consistent across the very different socio-cultural, economic, and land use-transportation contexts considered in this paper.

Most interesting, however, is that the study results fly in the face of perceptions that the prevalence of long commutes is smaller in high density, mixed land use settings. In this particular study, it was found that about one-quarter of commuters (compared to only 5-7 percent in US and Switzerland) in the Indian city of Thane (near Mumbai) are commuting 60 minutes or more each way to and from work. This area is one of the densest urban conglomerations in the country. The United States, with its sprawling low density land use and automobile-oriented transportation system, has the lowest percent of long duration commuters (at just under six percent). This finding suggests that mixed high-density land use developments may not necessarily be enough for ensuring modest commute times. In a county like India, the high prevalence of long commute times may be attributable to the poor transportation infrastructure and heavy reliance on slower alternative modes of transportation. Therefore, the development of a mature and high-performance transportation system should be a high priority, along with understanding household residential location choice patterns, to help reduce commute times in rapidly developing counties such as India.

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**TABLE 1 Household Characteristics**

| Characteristic | 2001 US NHTS | 2000 Swiss Travel Microcensus Survey | 2001 Thane, India Household Survey |
|---|---|---|---|
| Sample Size | 26,038 | 27,918 | 3505 |
| Household Size | 2.56 | 2.43 | 4.12 |
| 1 person | 25.82% | 27.5% | 2.0% |
| 2 persons | 32.63% | 35.1% | 12.2% |
| 3 persons | 16.53% | 14.0% | 19.8% |
| ≥ 4 persons | 25.02% | 23.4% | 66.0% |
| No. of Children (under 18) | 0.67 | 0.51 | 0.90 |
| 0 children | 64.4% | 71.3% | 47.4% |
| 1 child | 14.6% | 11.6% | 26.4% |
| 2 children | 13.8% | 12.4% | 16.9% |
| 3+ children | 7.3% | 4.7% | 9.3% |
| No. of Workers | 1.31 | N/A | 1.34 |
| 0 workers | 22.9% | N/A | 9.3% |
| 1 worker | 34.5% | N/A | 57.3% |
| 2 workers | 33.7% | N/A | 25.8% |
| 3+ workers | 8.9% | N/A | 7.6% |
| No. of Licensed Drivers | 1.75 | 1.51 | 0.10 |
| 0 licensed drivers | 5.38% | 12.8% | 91.3% |
| 1 licensed driver | 31.85% | 34.1% | 7.4% |
| 2 licensed drivers | 49.25% | 44.6% | 1.0% |
| 3 or more drivers | 13.52% | 8.5% | 0.3% |
| Annual Income | | | |
| Low income | <$25K(29.1%) | <Fr 48K (20.8%) | <Rs. 60K (42.2%) |
| Medium income | $25-50K (33.3%) | Fr48-96K (35.9%) | Rs. 60-180K (45%) |
| High income | > $50K (37.6%) | >Fr 96K (18.4%) | >Rs. 180K (12.8%) |
| Vehicle Ownership | 1.90 | 1.17 | 0.06 |
| 0 auto | 7.9% | 19.8% | 94.7% |
| 1 auto | 31.4% | 50.5% | 4.9% |
| 2 autos | 37.1% | 24.5% | 0.4% |
| ≥ 3 autos | 23.6% | 5.2% | 0 |
| Residential area type | | | |
| Urban | 79.5% | 78.6% | N/A |
| Non-Urban | 20.5% | 21.4% | N/A |

**TABLE 2 Person Characteristics of Commuter Groups (2001 NHTS, US)**

| Characteristic | | Short Commuters | Medium Commuters | Long Commuters | All Commuters |
|---|---|---|---|---|---|
| Sample Size | | 11876 (47.6%) | 11641 (46.7%) | 1431 (5.7%) | 24948 (100%) |
| Gender | | | | | |
| | Male | 50.5% | 55.1% | 63.6% | 53.5% |
| | Female | 49.5% | 44.9% | 36.4% | 46.5% |
| Age | | | | | |
| | 18 to 20 years | 11.2% | 5.0% | 4.0% | 7.9% |
| | 21 to 24 years | 7.8% | 7.4% | 7.7% | 7.6% |
| | 25 to 44 years | 47.5% | 53.1% | 51.9% | 50.5% |
| | 45 to 64 years | 30.0% | 31.9% | 34.0% | 31.1% |
| | 65+ years | 3.4% | 2.5% | 2.5% | 2.9% |
| Education | | | | | |
| | < High school | 11.3% | 7.3% | 9.2% | 9.3% |
| | High school | 30.7% | 27.9% | 27.5% | 29.2% |
| | Tech. training | 3.5% | 4.0% | 3.8% | 3.8% |
| | College | 19.3% | 18.0% | 14.5% | 18.4% |
| | Associate | 7.1% | 8.9% | 6.7% | 7.9% |
| | Bachelor | 16.3% | 19.8% | 22.8% | 18.4% |
| | Graduate school | 1.9% | 2.0% | 2.1% | 2.0% |
| | Graduate degree | 9.7% | 12.2% | 13.3% | 11.1% |
| Income (USD) | | | | | |
| | <15,000 | 41.0% | 28.0% | 12.0% | 33.2% |
| | 15,000 – 19,999 | 11.0% | 10.0% | 15.9% | 10.8% |
| | 20,000 – 24,999 | 12.3% | 10.7% | 14.7% | 11.6% |
| | 25,000 – 49,999 | 24.3% | 30.7% | 33.6% | 27.8% |
| | 50,000 – 74,999 | 5.5% | 12.7% | 7.5% | 9.0% |
| | 75,000 – 99,999 | 3.7% | 4.6% | 4.1% | 4.2% |
| | ≥ 1000,000 | 2.4% | 3.7% | 12.3% | 3.5% |
| Driver License | | 95.2% | 95.2% | 91.1% | 95.0% |
| Trips/day | | 5.03 | 4.59 | 4.10 | 4.80 |
| Commute Time (min) | | 9.8 | 29.7 | 78.3 | 23.5 |
| Modal Split | | | | | |
| | SOV | 85.3% | 85.7% | 63.2% | 84.1% |
| | HOV2 | 8.4% | 7.8% | 10.4% | 8.2% |
| | HOV>2 | 2.1% | 1.7% | 3.9% | 2.0% |
| | Bus | 0.1% | 1.8% | 9.3% | 1.5% |
| | Rail | 0.0% | 1.5% | 10.0% | 1.4% |
| | Motorcycle | 0.2% | 0.3% | 0.3% | 0.2% |
| | Bicycle | 0.5% | 0.3% | 0.4% | 0.4% |
| | Walk | 3.2% | 0.6% | 0.8% | 1.8% |
| | Other | 0.3% | 0.3% | 1.7% | 0.4% |

SOV: Single occupancy vehicle; HOV2: High occupancy vehicle with occ =2; High occupancy vehicle with occ >2

**TABLE 3 Person Characteristics of Commuter Groups (2000 Swiss Microcensus)**

| Characteristic | | Short Commuters | Medium Commuters | Long Commuters | All Commuters |
|---|---|---|---|---|---|
| Sample Size | | 4272 (52.6%) | 3269 (40.2%) | 586 (7.2%) | 8127 (100%) |
| Gender | | | | | |
| | Male | 58.7% | 57.0% | 67.1% | 58.6% |
| | Female | 41.3% | 43.0% | 32.9% | 41.4% |
| Age | | | | | |
| | 18 to 20 years | 4.3% | 5.9% | 6.8% | 5.1% |
| | 21 to 24 years | 4.34% | 6.1% | 5.5% | 5.2% |
| | 25 to 44 years | 48.0% | 49.7% | 47.9% | 48.7% |
| | 45 to 64 years | 41.2% | 36.9% | 38.1% | 39.2% |
| | 65+ years | 2.1% | 1.4% | 1.7% | 1.8% |
| Education | | | | | |
| | Unknown | 0.4% | 0.4% | 0.5% | 0.4% |
| | < High school | 2.1% | 1.7% | 1.2% | 1.9% |
| | High school | 13.1% | 11.2% | 13.0% | 12.3% |
| | Tech. training | 49.1% | 45.9% | 44.4% | 47.5% |
| | Other college | 19.4% | 21.1% | 18.8% | 20.1% |
| | Bachelor | 5.2% | 8.4% | 7.7% | 6.7% |
| | Masters/PhD | 10.7% | 11.3% | 14.5% | 11.2% |
| Employment | | | | | |
| | Unknown | 0.3% | 0.2% | 0.7% | 0.3% |
| | Full-time | 73.4% | 75.5% | 77.1% | 74.5% |
| | Part-time | 21.3% | 18.8% | 15.7% | 19.9% |
| | Homemaker | 0.7% | 0.3% | 0.3% | 0.5% |
| | Student | 3.5% | 4.9% | 5.5% | 4.2% |
| | Retired | 0.7% | 0.2% | 0.7% | 0.5% |
| | Other situation | 0.1% | 0.1% | 0.0% | 0.1% |
| Income (Swiss Fr) | | | | | |
| | ≤ Fr 2000 | 1.5% | 0.7% | 2.3% | 1.2% |
| | Fr 2000-6000 | 44.7% | 39.1% | 41.1% | 42.1% |
| | Fr 6001-10000 | 37.0% | 38.1% | 38.8% | 37.5% |
| | Fr 10001-14000 | 10.9% | 14.9% | 10.6% | 12.5% |
| | ≥ Fr 14000 | 6.0% | 7.3% | 7.2% | 6.6% |
| Driver License | | 88.8% | 85.5% | 82.9% | 87.1% |
| Trips/day | | 4.98 | 4.25 | 3.90 | 4.61 |
| Commute Time (min) | | 9.2 | 30.5 | 111.4 | 25.1 |
| Modal Split | | | | | |
| | SOV | 49.6% | 54.3% | 30.0% | 50.7% |
| | HOV2 | 5.6% | 5.3% | 4.9% | 5.4% |
| | HOV>2 | 0.9% | 1.1% | 4.1% | 1.2% |
| | Bus | 2.4% | 13.0% | 7.5% | 8.5% |
| | Rail | 0.1% | 9.5% | 41.3% | 8.2% |
| | Motorcycle | 4.8% | 2.9% | 0.7% | 3.5% |
| | Bicycle | 11.9% | 3.5% | 0.7% | 6.6% |
| | Walk | 21.5% | 4.5% | 3.2% | 11.0% |
| | Other | 3.2% | 5.7% | 7.5% | 4.9% |

SOV: Single occupancy vehicle; HOV2: High occupancy vehicle with occ =2; High occupancy vehicle with occ >2

**TABLE 4 Person Characteristics of Commuter Groups (2001 Thane, India Survey)**

| Characteristic | | Short Commuters | Medium Commuters | Long Commuters | All Commuters |
|---|---|---|---|---|---|
| Sample Size | | 1567 (34.0%) | 1923 (41.8%) | 1116 (24.2%) | 4606 (100%) |
| Gender | | | | | |
| | Male | 83.2% | 85.9% | 87.8% | 85.4% |
| | Female | 16.8% | 14.1% | 12.2% | 14.6% |
| Age | | | | | |
| | 16 to 20 years | 5.0% | 4.4% | 3.1% | 4.3% |
| | 21 to 24 years | 11.3% | 10.8% | 10.0% | 10.80% |
| | 25 to 44 years | 56.5% | 57.4% | 57.1% | 57.0% |
| | 45 to 64 years | 26.3% | 26.8% | 29.0% | 27.2% |
| | 65+ years | 0.8% | 0.6% | 0.7% | 0.7% |
| Education | | | | | |
| | Illiterate | 7.4% | 4.6% | 2.9% | 5.1% |
| | Up to SSC | 57.6% | 54.8% | 44.5% | 53.3% |
| | Up to HSC | 12.3% | 11.9% | 13.0% | 12.3% |
| | Graduate | 22.7% | 28.8% | 39.6% | 29.3% |
| Occupation | | | | | |
| | Service | 57.6% | 74.7% | 84.1% | 71.1% |
| | Farmer/Laborer | 8.7% | 7.9% | 3.0% | 7.0% |
| | Professional | 33.1% | 16.9% | 12.6% | 21.4% |
| | Student | 0.30% | 0.3% | 0.2% | 0.2% |
| | Homemaker | 0.30% | 0.1% | 0.0% | 0.1% |
| | Retired | 0.20% | 0.2% | 0.1% | 0.2% |
| Income (INR) | | | | | |
| | No income | 2.6% | 2.7% | 1.6% | 2.4% |
| | ≤ 5,000 | 60.7% | 58.9% | 50.0% | 57.4% |
| | 5,001-15,000 | 34.8% | 36.9% | 45.7% | 38.3% |
| | 15001+ | 1.9% | 1.5% | 2.7% | 1.9% |
| Driver license | | 20.5% | 16.4% | 16.6% | 17.8% |
| Trips/day | | 2.14 | 2.02 | 2.01 | 2.06 |
| Commute Time (min) | | 9.7 | 33.1 | 78.6 | 36.2 |
| Modal Split | | | | | |
| | Car | 2.7% | 1.7% | 2.0% | 2.1% |
| | Bus | 7.8% | 36.8% | 17.2% | 22.2% |
| | Rail | 1.0% | 24.1% | 74.8% | 28.5% |
| | Auto rickshaw | 8.9% | 5.7% | 0.8% | 5.6% |
| | Motorcycle | 11.0% | 6.8% | 1.9% | 7.0% |
| | Bicycle | 4.7% | 3.8% | 0.4% | 3.3% |
| | Walk | 63.2% | 20.5% | 2.6% | 30.7% |
| | Other | 0.7% | 0.5% | 0.3% | 0.5% |

**TABLE 5 MNL Model of Commute Time Choice: USA**

| Variable | Variable Definition | Short Commuters | | Long Commuters | |
|---|---|---|---|---|---|
| | | β-Coeff | t-stat | β-Coeff | t-stat |
| Constant | | 0.3708 | 3.214 | -1.905 | -12.277 |
| Male | Gender: Male | -0.1501 | -5.335 | 0.4375 | 7.084 |
| Age | Continuous Variable | 0.0019 | 1.695 | -- | -- |
| Middle Age | Age: 25-64 years | -0.4387 | -10.526 | -- | -- |
| White | Race: White | 0.1244 | 3.352 | -0.1373 | -1.918 |
| Educated | College Educated | -0.1182 | -3.781 | -- | -- |
| Driver | Licensed Driver | -0.2089 | -2.333 | -0.7740 | -5.749 |
| Professional | Occupation | -0.2398 | -7.998 | 0.2891 | 4.374 |
| Household size | Continuous Variable | -0.1038 | -3.261 | -- | -- |
| Low HH inc | HH income <$15,000 | 0.2077 | 3.241 | -- | -- |
| High HH inc | HH income ≥ $75,000 | -0.1491 | -3.725 | 0.1293 | 1.781 |
| No. of children | Continuous Variable | 0.1392 | 4.343 | -- | -- |
| No. of drivers | Continuous Variable | 0.1399 | 4.517 | -- | -- |
| Area type | Urban Cluster | 0.4672 | 13.984 | -0.3311 | -4.607 |
| Area population | Population ≥ 3 million | -0.5198 | -16.471 | 0.9112 | 14.221 |

| | | |
|---|---|---|
| Log likelihood function at convergence | L(β) = | -19938.7 |
| Log likelihood function with constant | L(C) = | -20690.0 |
| Log likelihood function at zero | L(0) = | -26070.0 |
| | $\chi^2$ [df] = | 1503.4[23] |

**TABLE 6 MNL Model of Commute Time Choice: Switzerland**

| Variable | Variable Type | Short Commuters | | Long Commuters | |
|---|---|---|---|---|---|
| | | β-Coeff | t-stat | β-Coeff | t-stat |
| Constant | | -0.3138 | -3.088 | -2.0206 | -15.076 |
| Male | Gender: Male | -- | -- | 0.4365 | 4.596 |
| Age | Continuous Variable | 0.0092 | 4.811 | -- | -- |
| Young age | Age ≤ 18 years | -- | -- | 0.1776 | 1.674 |
| High HH inc | HH income > Fr. 10,000 | -0.2877 | -4.357 | -- | -- |
| Low HH inc | HH income < Fr. 4000 | -- | -- | 0.2288 | 1.759 |
| Educated | College Graduate | -0.2312 | -3.749 | -- | -- |
| Part-time emp | Employed Part-time | 0.1463 | 2.508 | -- | -- |
| Independent | Occupation: Independent | 0.8043 | 9.914 | 0.6233 | 4.200 |
| Free parking | Free Parking at Work | -- | -- | -0.6505 | -4.915 |
| No reserved parking at the workplace | | -- | -- | -0.2698 | -2.277 |
| Employed in the middle/lower cadre | | -- | -- | 0.2050 | 1.906 |
| HH size | Continuous Variable | 0.0766 | 4.185 | -- | -- |
| Rural resident | Area: Rural | 0.2673 | 4.879 | 0.4017 | 3.962 |
| No. HH autos | Continuous Variable | -0.3472 | -4.496 | 0.3853 | 3.005 |
| HH auto ≥ 2 | 2 or More Autos in Hhld | -0.1588 | -3.056 | -- | -- |

| | | |
|---|---|---|
| Log likelihood function at convergence | L(β) = | -7084.417 |
| Log likelihood function with constant | L(C) = | -8928.422 |
| Log likelihood function at zero | L(0) = | -7265.430 |
| | $\chi^2$[df] = | 362.026[20] |

**TABLE 7 MNL Model of Commute Time Choice: Thane, India**

| Variable | Variable Type | Short Commuters | | Long Commuters | |
|---|---|---|---|---|---|
| | | β-Coeff | t-stat | β-Coeff | t-stat |
| Constant | | -- | -- | -1.0732 | -7.567 |
| Business | Occupation: Business | 0.7376 | 9.815 | -- | -- |
| Service | Occupation: Service | -- | -- | 0.6169 | 6.411 |
| Low income | Income ≤ Rs. 5000 | -0.2593 | -5.353 | -0.3776 | -4.585 |
| Educated | College Graduate | -0.5678 | -7.625 | 0.3608 | 4.139 |
| Young age | Age: 18-30 yrs | -- | -- | -0.2017 | -2.584 |
| Older age | Age: > 45 yrs | -0.1479 | -1.993 | -- | -- |
| Home owner | Own a home | -- | -- | 0.3439 | 3.695 |
| Female with children in the household | | 0.4172 | 3.254 | -0.4711 | -2.811 |
| HH 2-wheelers | Continuous Variable | -- | -- | -0.4879 | -4.941 |
| Smaller HH | Household Size ≤ 4 | -- | -- | 0.1589 | 2.173 |

| | | |
|---|---|---|
| Log likelihood function at convergence | L(β) = | -4754.2270 |
| Log likelihood function with constant | L(C) = | -4951.2752 |
| Log likelihood function at zero | L(0) = | -5060.2082 |
| | $\chi^2$[df] = | 611.96[14] |