SOME OBSERVATIONS ON CAR AVAILABILITY AND CAR USE, AND IMPLICATIONS FOR TDM POLICY

Christo Venter

Department of Civil and Biosystems Engineering, University of Pretoria, Pretoria, 0002,
christo.venter@up.ac.za, Tel (012) 420-2184

ABSTRACT

Car availability and use for household purposes is analysed, based on data from the National Household Travel Survey (2003). Car availability varies significantly across provinces, cities, and communities within the same metropolitan area. By far the single most important factor explaining such variation is household income, while other demographic variables such as education, dwelling type, and race are also significant. Many of these factors, while essentially outside of the ability of government policy to influence, are currently changing in ways that would tend to reinforce accelerating car ownership in the near future. Evidence is found, however, that the proximate provision of public transport (especially taxi) services and shorter work trip distances are associated with lower car availability and use, suggesting some land use and transport strategies that might reduce car use. However, 70% of persons in car-owning households never use public transport, leaving about 2.3 million people with a demonstrated willingness to respond to such interventions. A more in-depth understanding of potential car users' attitudes, habits and desires, is needed to enable the crafting of more effective TDM responses.

1. INTRODUCTION

1.1 Background and objectives

Public and political pressure is rising to deal with the increasing traffic congestion on our roads. Finding more effective ways of doing so requires policy makers and programme implementers to understand trends and patterns of car use better. Who owns cars; how, why, and how much do they drive; and which mobility needs can be satisfied by some other means? Apart from allowing us to craft more effective strategies to respond to these needs, insights into these questions could also help us understand the limits of present policies and programmes, and maybe point the way towards different approaches needed.

This paper aims to make a contribution towards understanding car availability and car use patterns in South Africa by analysing aggregate household-level data obtained from the National Household Travel Survey (NHTS) of 2003[1]. Cross-tabulations and multivariate analyses are used to pursue the following questions:

[1] The paper is partly based on analyses performed for the Department of Transport in developing a strategic framework to guide the implementation of Travel Demand Management strategies. The permission of the DOT to publish the findings of this project is gratefully acknowledged. Marina Lombard assisted with the data analysis.

- How does car availability differ by geographical area and income?
- In what ways are households with car access systematically different from households without car access? Which household characteristics tend to be associated with a tendency to acquire a car?
- Once a car is available, who gets to use it, and how much?

The advantage of using a large national survey database is its efficiency in identifying and characterising population sub-groups (e.g. households with and without access to cars), and understanding the differences between them. However, with data at one point in time it is not possible to infer causality nor trends over time. The analysis therefore paints a picture of car access and use in South Africa for 2003, while acknowledging that much further in-depth analysis, both statistical and qualitative, is needed to understand the *why?* behind the patterns observed here.

After a brief note on the data, the paper proceeds to investigate each of the questions listed above, and concludes with some observations on the likely trajectory of car ownership growth in SA and the implications for Travel Demand Management (TDM) and transport interventions into the future.

1.2 Data

The National Household Travel Survey (NHTS), undertaken in 2003, collected demographic, travel, accessibility, and perception data from 52 376 households nationally. The first national travel survey of its kind in SA, it produced a rich dataset for a statistically representative sample of households across the entire country (DOT, 2005). Of the complete dataset, 42 795 households provided all information (including income), and could be used for the multivariate analysis.

With regard to the analysis, it is important to note that the NHTS questionnaire asked respondents to indicate the number of "… motorised vehicles in running order [that] this household ha[s] available for private use". It thus groups together households who physically own vehicles, with households who are non-car owning but who have access to vehicles (for instance those of neighbours and other family members). Company-owned vehicles are also included. Other data sources indicate that car *ownership* is typically about 2 to 4% lower than car *availability* as defined above, so the difference is thought to be minor.

2. CAR AVAILABILITY: HOW DOES CAR ACCESS DIFFER BY AREA AND INCOME?

Nationally, 2.7 million households (23% of the total) have one or more cars available for personal use. Car availability differs significantly across provinces, with Western Cape and Gauteng having the highest (45% and 33% of households respectively) and Eastern Cape the lowest (15% of households) average car availability (Figure 1). Figure 2 shows the geographical variation in car availability across SA. Households in metros and larger cities tend to have relatively high car access, with Cape Town leading (411 000, or 49% of households, have car access), and Johannesburg second (369 000, or 32% of households). About 56% of the national household vehicle stock is concentrated in the nine largest metros and cities. Interestingly, Figure 3 indicates also that some smaller towns with high-income populations (probably in the commercial farming or tourism sectors) also have high relative car access, such as Makhado (Louis Trichardt) and towns along the Cape south coast.

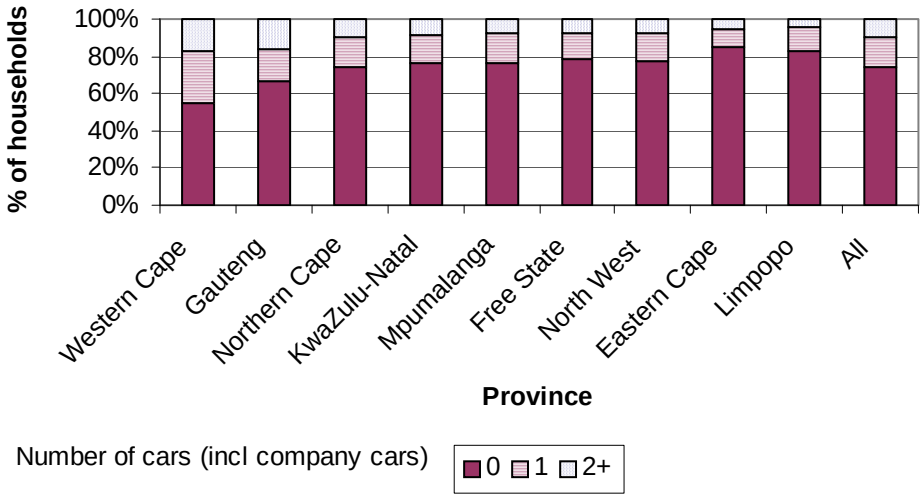

Figure 1. Car availability by province and RSA
(Source: NHTS data, 2003)

In the aggregate there is a very strong relationship between household income and car availability (Figure 4). Below a monthly household income of R1000, car access is virtually zero; above R3000 per month the majority of households have car access. Almost 80% of the highest income households (above R16000 per month) have access to more than one car – typically in two-income families.

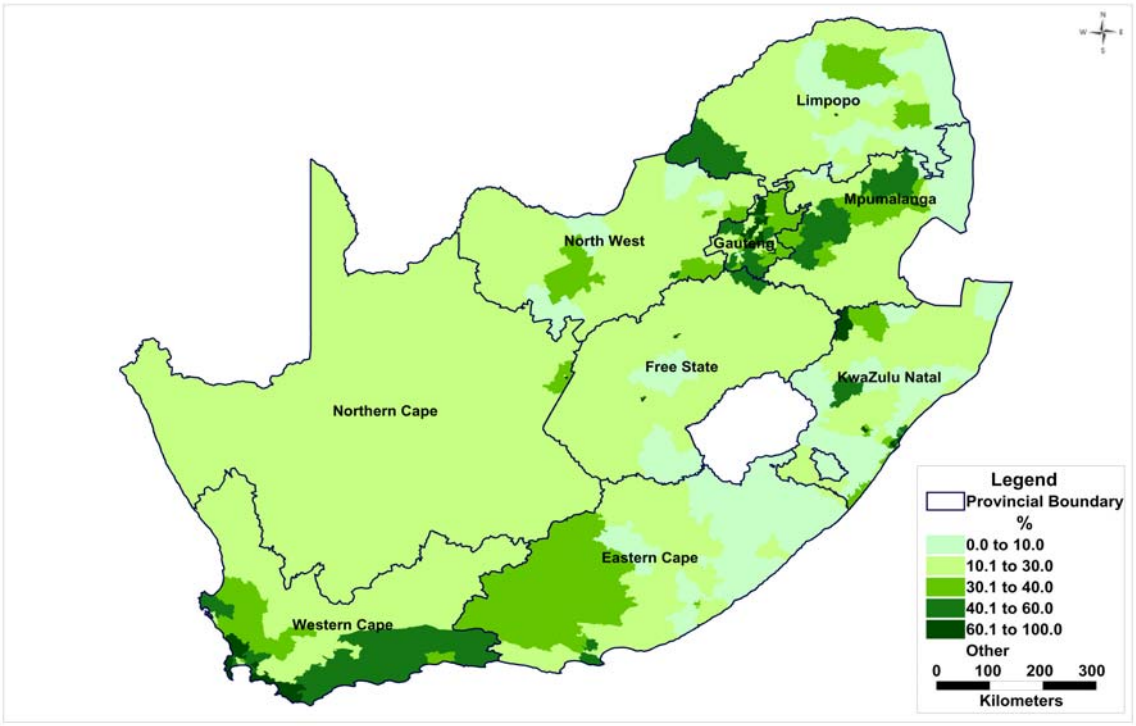

Figure 2. Percentage households with 1+ cars available per transport analysis zone
(Source: DOT, 2005)

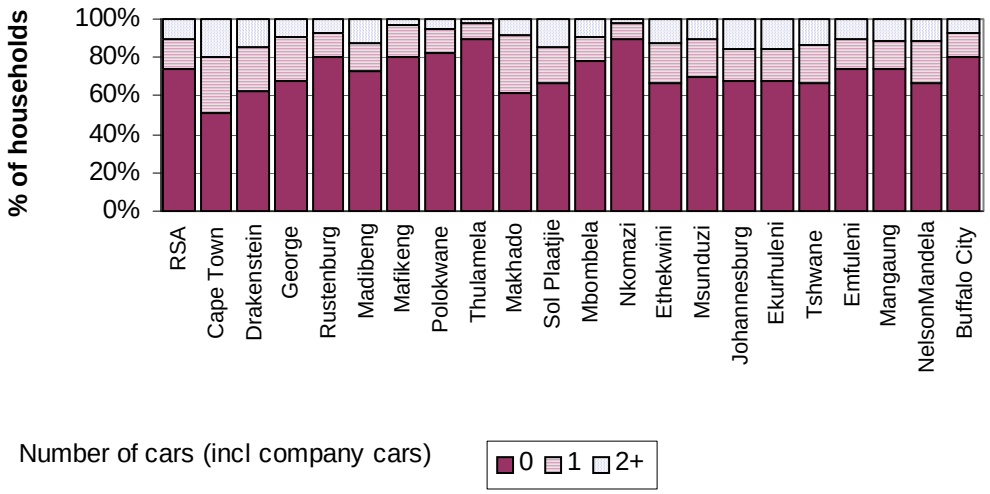

Figure 3. Car availability for some metros, cities and towns
(Source: NHTS data, 2003)

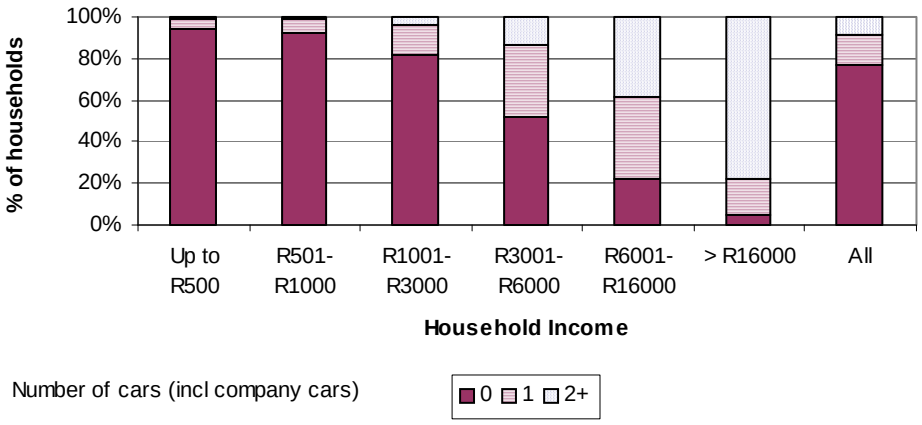

Figure 4. Car availability by monthly household income
(Source: NHTS data, 2003)

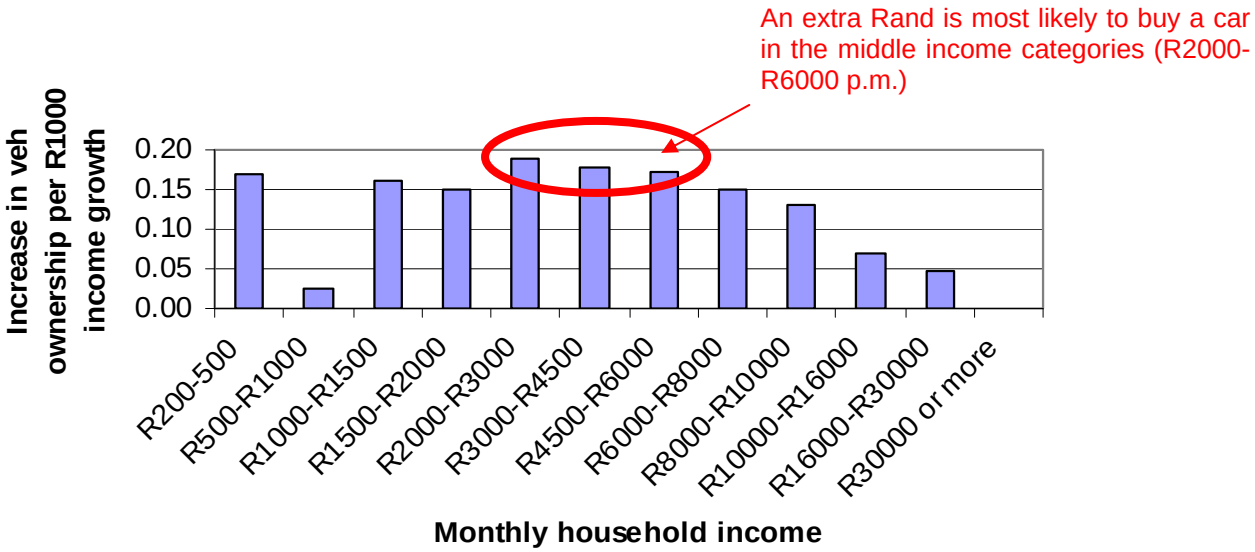

Figure 5.Marginal vehicle ownership versus marginal income
(Source: NHTS data, 2003)

Looking more closely at the elasticity of car access with respect to income, it is clear that the income band between R2000 and R6000 can be thought of as a transition zone, where an extra Rand is most likely to go towards buying a car (Figure 5). It is evidently in this "middle income" group where economic and social transformation is happening fastest, and where some TDM programmes aimed at prospective car owners may be targeted.

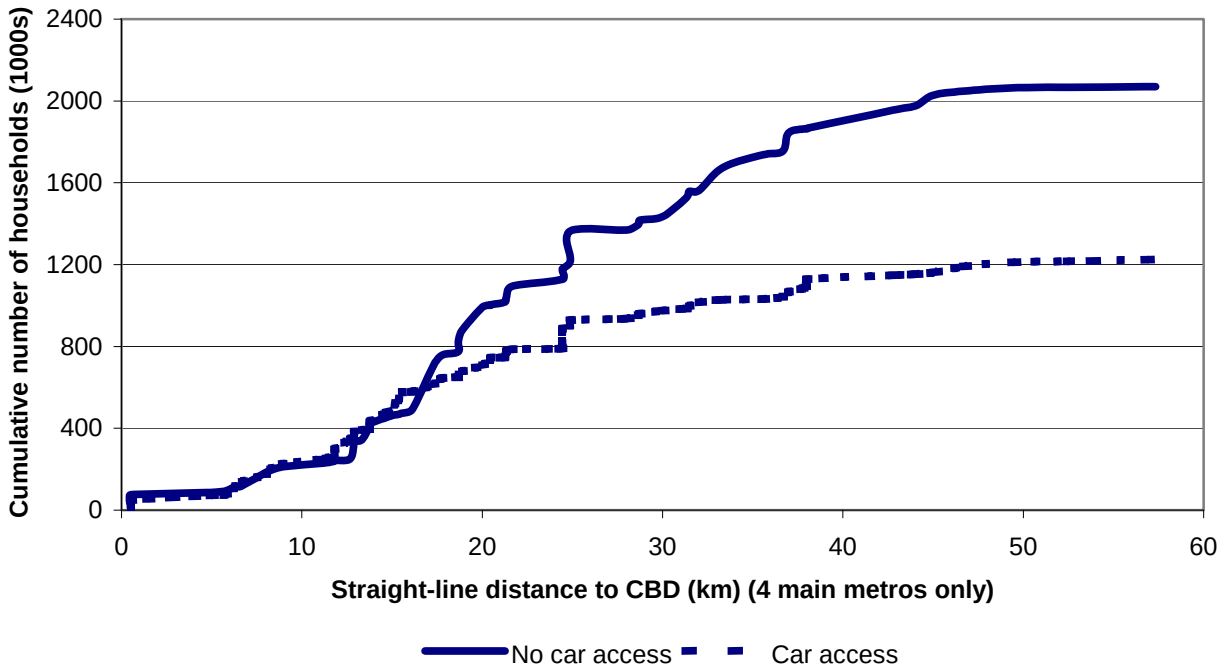

Figure 6. Car access and distance from the CBD (for Cape Town, Johannesburg, Ekurhuleni, and Tshwane)

(Source: NHTS data, 2003)

How is car access distributed within cities? Zonal car access figures were plotted against distance from the CBD for four large metro areas, to give a sense of the spatial distribution of car access. Figure 6 indicates that up to about 15km from city centres the numbers of car-access and carless households are roughly equal, but much larger numbers of carless families live further away, as compared to car-access families. About 700 000 carless households (21% of the total) live beyond 25km from the respective city centres, compared to 300 000 car-access families (9% of the total). The general picture that emerges is one of more central areas catering for both car-owning and car-less families (through better provision of public transport, inter alia); of some higher-income suburbs and secondary business nodes with high car ownership; and of large areas of low-car access, lower-income areas (including mostly former townships and newer RDP settlements) located further away from the main urban cores. Clearly, the distribution of car access across the urban landscape is very uneven.

3. MULTIVARIATE ANALYSIS: HOW DO HOUSEHOLDS WITH CAR ACCESS DIFFER FROM HOUSEHOLDS WITHOUT IT?

A multivariate analysis of NHTS data was performed to identify factors that help explain systematic differences between households with and without access to cars. The objective was broadly to find out if there are demographic or spatial factors that systematically predispose certain households to obtaining a car (without necessarily inferring strict causality). This would provide some insight into, firstly, how demographic and spatial

development trends can be expected to impact on car ownership growth in future, and secondly, whether there are any policy interventions that might affect car ownership indirectly, via their impacts on the covariates.

A multiple linear regression was performed on the entire dataset on a household basis, using car access as the dependent variable, and a list of potential independent variables that could be obtained from the NHTS database. Some experimentation lead to a final set of independent variables, shown in Table 1.

Table 1. Final set of variables used in multiple linear regression analysis

Category	Explanatory variable	Description
Household Income	INCMIDPT	Monthly Household Income
Household Structure	HH-RETIRED	All HH members retired (D)
	HH-SINGLE	Single person household (D)
	HH-SINGLEPARENT	Single adult with children (D)
	HH-ADULTS	Multiple adults, no kids (D)
	HH-NUCLEAR	Multiple adults with children (D)
Other Household Attributes	HHSIZE	Household size (persons)
	DWELL-RETIRE	Dwelling type: Retirement village (D)
	DWELL-FORMAL	Dwelling type: Townhouse, house or flat (D)
Demographics of Household Head (HHH)	HHH-MALE	HHH is male (D)
	HHH-AGE	Age of HHH (yrs)
	HHH-EDUCATION	HHH has Grade 10 or more (D)
	HHH-RACE	HHH is white, coloured, Indian (D)
	HHH-LICENCE	HHH has driver's licence (D)
	HHH-EMPLOYED	HHH is formally employed (D)
	HHH-PERSINC	Personal income of HHH
Location variables	PROVINCE	Household living in WC, KZ, MP (D)
	METRO	Household living in metro area (D)
	URBAN	Household living in non-metro urban area (D)
	HHH-DIST2WORK	Travel distance to HHH's place of work
Public transport access	TAXI-AVAIL	Taxi is available within 30 minute walk (D)
	TRAIN-AVAIL	Train is available within 30 minute walk (D)

*(D) = included as dummy variable

Many previous studies of travel behaviour have shown the importance of household structure in determining travel needs, choices and constraints that, it is hypothesised, could also affect car availability. Dwelling type was shown in previous work in SA to be a predictor of zonal car ownership (Mokonyama and Venter, 2007), by acting as a potential proxy for lifestyle choice and housing density. Demographic variables were included with reference to the socio-economic and personal information of the nominal household head (HHH), who was defined for these purposes as either the highest-earning adult, or (absent any earners) the eldest adult in a household. The implied hypothesis is that it is not only average household characteristics, but also the characteristics of a single “primary” individual in a household that determine the need for and ability to obtain a car. Location-wise, the province of residence was represented by a dummy variable for three provinces that showed different results from others. Relative accessibility of the household was indicated by the distance travelled to the HHH’s place of work (if they had one), the data for which was inferred from the stated travel time, travel mode, and average travel speed of each mode. Lastly, the effect of public transport access on car access was tested with two dummy variables inferred from self-reported walk access times.

It is important to note that, barring significant correlations among the explanatory variables, the results of the model shows the independent effect of each variable, taking account of all the others. A correlation analysis confirmed that all correlations were acceptable at below 0.4 except for higher correlations between HHSIZE and some of the household structure variables.

The results of the regression analysis are shown in Table 2. Positive estimates indicate a positive correlation with having car access; significant variables are shown in bold.

Table 2. Results: Households-based multiple linear regression analysis

Category	Explanatory variable	Estimate	t-statistic	p-value
Household Income	**INCMIDPT**	1.75E-05	44.00	0.000 ***
Household Structure	**HH-RETIRED**	0.044	5.73	0.000 ***
	HH-SINGLE	-0.030	-6.99	0.000 ***
	HH-SINGLEPARENT	-0.025	-3.62	0.000 ***
	HH-ADULTS	0.013	2.54	0.011 ***
	HH-NUCLEAR	3.43E-04	0.10	0.920
Other Household Attributes	HHSIZE	-2.64E-04	-0.26	0.793
	DWELL-RETIRE	-0.030	-0.78	0.435
	DWELL-FORMAL	0.049	14.76	0.000 ***
Demographics of	**HHH-MALE**	-0.011	-3.52	0.000 ***
Household Head (HHH)	**HHH-AGE**	1.80E-04	3.43	0.001 ***
	HHH-EDUCATION	0.065	18.72	0.000 ***
	HHH-RACE	0.152	35.66	0.000 ***
	HHH-LICENCE	0.445	104.54	0.000 ***
	HHH-EMPLOYED	-0.005	-1.29	0.198
	HHH-PERSINC	6.44E-08	5.81	0.000 ***
Location variables	**PROVINCE**	0.009	2.97	0.003 ***
	METRO	-0.030	-4.85	0.000 ***
	URBAN	0.008	1.41	0.159
	HHH-DIST2WORK	9.38E-04	10.81	0.000 ***
Public transport access	**TAXI-AVAIL**	-0.029	-7.39	0.000 ***
	TRAIN-AVAIL	-8.66E-04	-0.21	0.836
Intercept	**Constant**	0.005	0.87	0.383

*** = Coefficient is significant at 99% level

n=42795, R^2 = 53%; Stand error of model = 0.29; F-value =3023.8 (p=0.000***)

The R^2-value indicates that the variables together explain about half of the observed variation in car access across households. The high F-value indicates relatively high confidence in the overall results. Relating to individual variables, interesting findings include:

- Personal and household demographic variables are by far the most important factors explaining car availability. These include household income (the strongest factor), whether the household head has possession of a driver's licence, education, and personal income. The significant race variable indicates that, even taking account of income and all other factors, black households are on the average less likely to have car access than other households. This may suggest the existence of a legacy/cultural effect that is independent of current income level, but needs more probing.
- Less important, but still significant, are some other variables relating to household structure and attributes. All else being equal, households of retired or adult persons are more likely to have car access, while single-person households and single-parent households are less likely, as compared to the traditional nuclear family. This may

reflect the trend towards earlier nucleation of families, with younger people forming their own households before eventually acquiring a car. The presence of children does not of itself seem to promote car ownership. Households living in formal dwellings are more likely to gain car access, compared to those in informal dwellings, even controlling for income differences. There may be factors related to the permanence and asset accumulation possibilities of living in formal housing that also promote investment in a mobility asset such as the car.

- Location-wise, the (counterintuitive) negative METRO coefficient and insignificant URBAN coefficient suggest that locational differences are explained by other variables (notably income), rather than metro/urban/rural indicators *per se*. The very significant HHH-DIST2WORK variable suggests that, again controlling for everything else, people become more likely to buy a car the further away they live from their work. This is important as it suggests a link between jobs/housing location and car ownership at the level of the individual household.
- Public transport provision, specifically access to taxi services, is strongly associated with lower car ownership (while access to train is not associated with less car ownership, suggesting that this mode is mostly used by captive users who have no option of car access).

Overall, the multivariate analysis shows there are systematic differences between households with and without car access – although the underlying reasons for many of the differences are not yet clear at this aggregate level of analysis.

4. INTRA-HOUSEHOLD DIFFERENCES: WHO USES THE CAR (AND WHO DOESN'T)?

Of course, mere *access* to the car is not as important, from a sustainable transport and mobility point of view, as *use* of the car. The following analysis attempts to gain an understanding of how car use differs within households that indicated they have access to one or more cars. The question is also relevant from an equity point of view, as intra-household distribution of (mobility) resources has implications on, amongst others, gender and child welfare.

People residing in car-access households were divided into three categories depending on the modes they indicated they used within the last week. "Car use" therefore refers to day-to-day use rather than occasional use (such as for holiday trips). Table 3 shows the three categories, labelled for our purposes as *car-dependent*, *car-deprived*, and *car-discriminating*. About 70% of people in car-owning households use only the car (the *car-dependent*), indicating that, once a household acquires a car, most people in it are unlikely to consider using public transport. The remaining 30% of people in car-access households still use public transport, although, of these, 4 out of 5 never get to use the car (the *car-deprived*). Only about 420 000 persons in the country indicated they live in households with car access, but use both the car and public transport some of the time (the *car-discriminating*).

Table 3. Categories within households with access to at least one car

Modes used in the last week	Number	%
Private transport, no public ("*Car-dependent")*	5 740 388	70.3
Public transport, no private ("*Car-deprived")*	1 994 343	24.4
Both private and public transport ("*Car-discriminating")*	426 804	5.2

(Source: NHTS data, 2003)

To get a sense of who typically falls in each of the three categories, they are broken down by demographic status and car access ratio (Figure 7), and by access to public transport services from the home (Figure 8).

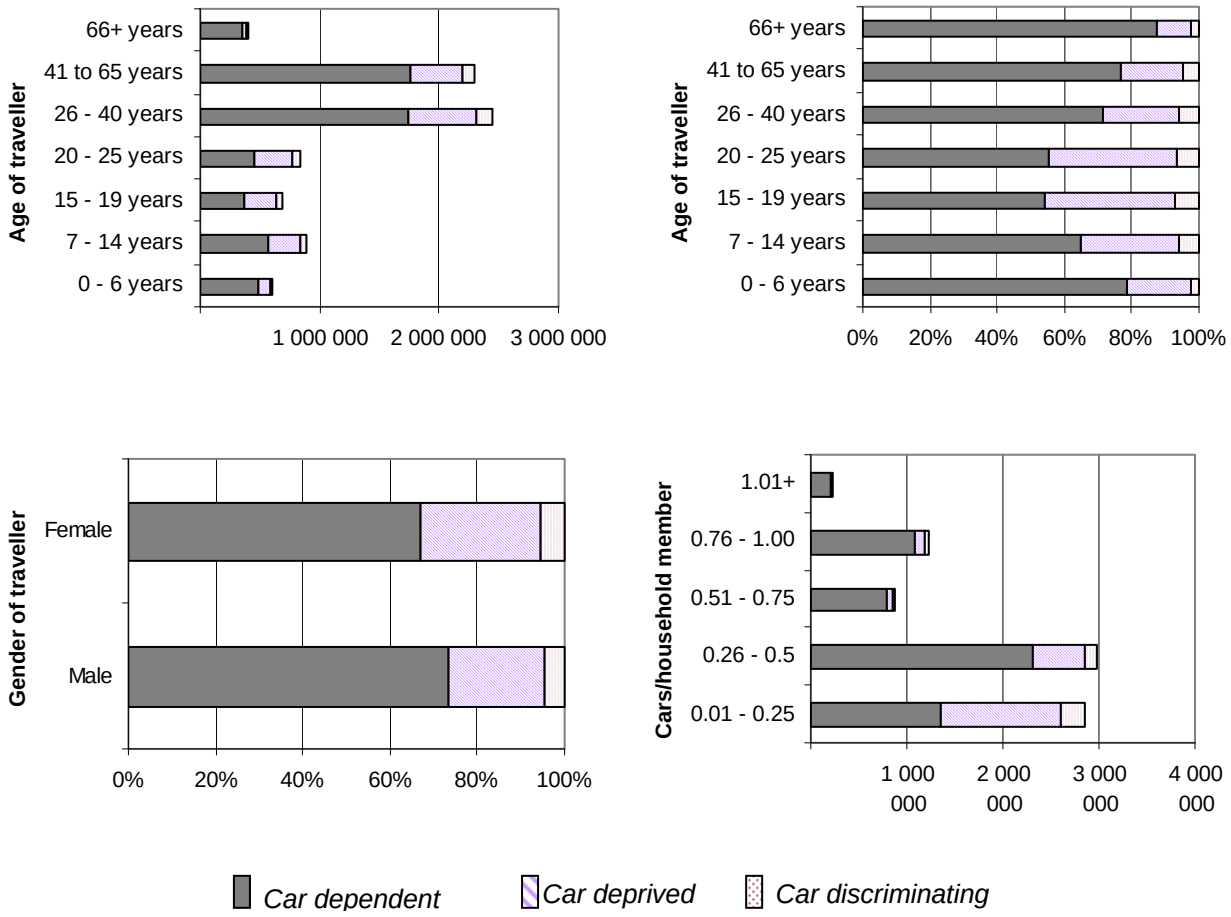

Figure 7. Car user groups versus demographics, within car-access households
(Source: NHTS data, 2003)

The *car-dependent* tend to be more male, and either older (over 40) or very young (suggesting that parents with young children are more likely to become car-dependent than other adults in car-owning households). Conversely, people in car-access households most likely to use public transport are in their late teens or early twenties, and female. Women in car-access households are more likely to be *car-deprived* than men, suggesting that the male "breadwinner" often gets precedence in using the car, perhaps leaving women household members without that option. The ratio between cars and household members is also very important: below one car for every four persons, public transport use is high, while households with more than about one car per two persons are almost entirely car dependent.

Public transport provision also seems to play a role. In households located closer to either bus or taxi services, the proportion of *car-dependent* people decreases slightly, suggesting that improving public transport service coverage (on its own) could have a (modest) impact on car use in car-available households. The analysis does not consider other qualitative, site-specific aspects of public transport – such as the quality of infrastructure or safety issues – that are probably more important in determining the likelihood of public transport use among car-owners.

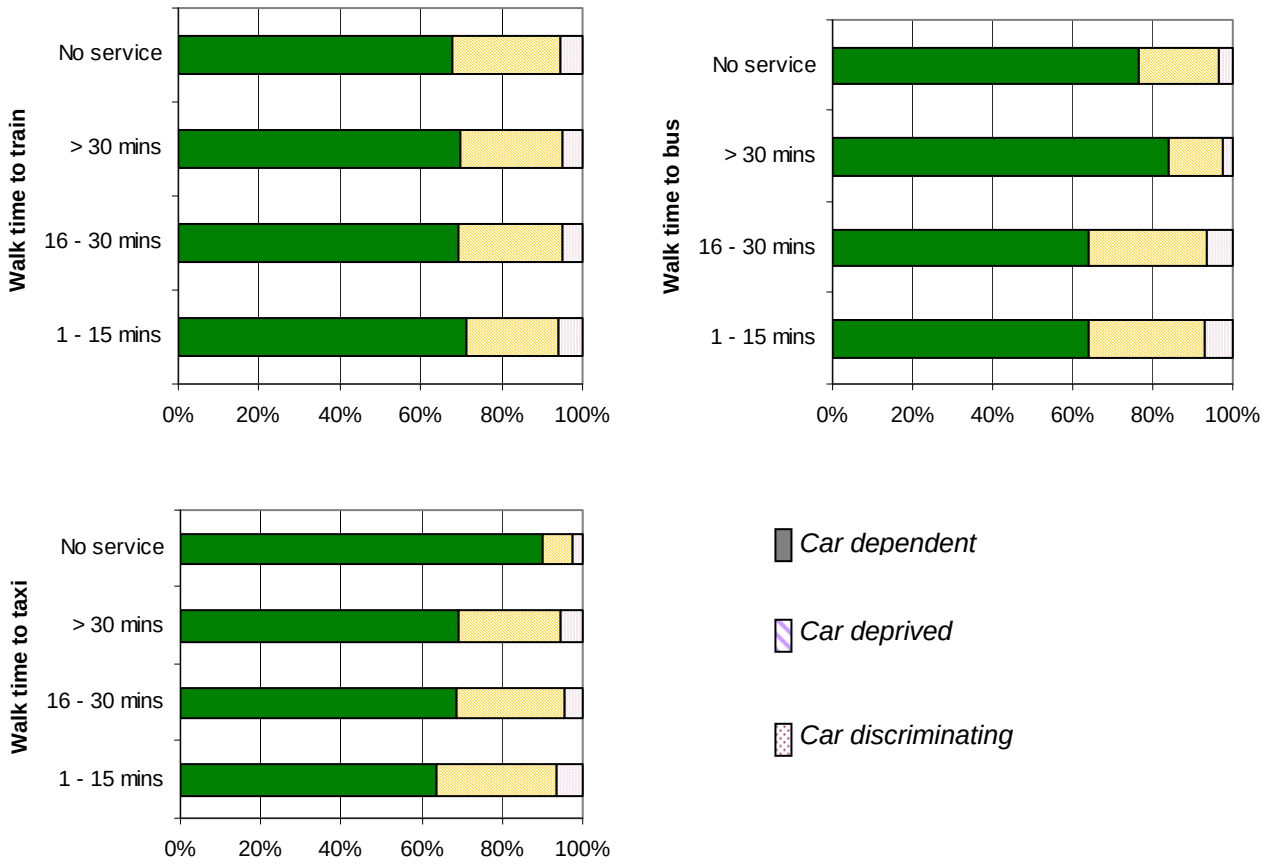

Figure 8. Car user groups versus access to public transport from home, within car-access households

(Source: NHTS data, 2003)

5. CONCLUSIONS: LIKELY TRAJECTORIES FOR CHANGE, AND IMPLICATIONS FOR TDM POLICY AND IMPLEMENTATION

Car availability varies significantly across provinces, cities, and communities within the same metropolitan area. By far the single most important explanatory factor for such variation is household income, supporting international evidence that households purchase the benefits (real and perceived) of personal car ownership as soon as they can afford to do so.

What is more, international and local historical trends, socio-economic changes, spatial factors, and improving affordability in the car industry all point towards accelerating car ownership in certain sectors of the SA population in the short to medium term (Mokonyama and Venter, 2007). Several demographic variables that this study found to be associated with higher car availability rates are currently changing in ways that would tend to reinforce accelerating car ownership. These trends include growing numbers of older/retired people, especially in higher income categories; fast growth in the emerging middle-income groups in urban areas; emergence of a more educated population; growing personal incomes through work, welfare, and remittances; and more households living in formal housing. A possible exception is the growth in single adult and single parent households, which is associated with lower car ownership.

What is important is that most of these factors lie outside of the control of government policies, especially in the transport sector, which severely limits the ability of public sector planners to effect a meaningful change in the magnitude of car ownership in the country, at least in the immediate future. The resultant likely rise in the *use* of personal vehicles suggests significantly increasing traffic demand pressures on our road systems, with resulting growth in traffic congestion and its accompanying environmental and economic impacts.

Does this mean government's policy intentions and (hitherto largely ineffectual) actions in the public transport and travel demand management arenas are doomed to perpetual failure? This work suggests that policies and programmes that ignore the strong role of personal attitudes, expectations, and lifestyles in shaping people's mobility (and car use) choices will continue to have marginal results. Income as a prime predictor of car ownership points towards the high importance of underlying lifestyle and expectations issues. We clearly need to start from a better understanding of people's attitudes, habits and desires, to understand which lifestyle expectations are (currently or potentially) satisfied by the car, before setting policy targets for public transport use or designing TDM programmes that are mere "shots in the dark". Future studies need to delve deeper into the underlying expectations and decision mechanisms at the micro level, and how these change over time, to supplement aggregate cross-sectional studies such as this one.

The study did identify at a very high level some spatial and transport-related factors showing a statistical association with car ownership and use, that could form the basis for potential policy levers.

In general, once a household owns a car, the majority of its members never use public transport. Pre-empting the car purchase decision may thus be an effective way of ultimately reducing car travel. By focusing TDM marketing or incentive programmes on emerging households in the "middle income" group, where economic and social transformation is happening fastest, the highest prospects of success may exist. Everything else being equal, shorter travel distances to work reduce the likelihood of purchasing a car. Land use restructuring interventions that affect the proximity of employment opportunities to housing may thus, on the whole, help reduce car ownership (although only in combination with other lifestyle-enhancing measures). Perhaps such restructuring should be prioritised towards middle-income families (rather than towards low-income households exclusively) to reap mobility benefits.

There is evidence that the right kind of public transport improvements may help reduce car ownership and use. Improved public transport availability (especially of the minibus-taxi type which appears to offer the most competitive service to the car) is associated with reduced car ownership, suggesting that the right combination of service design and targeting of specific user markets (maybe through more innovative services more closely matching the requirements of car-aspirant or car-discriminating persons, such as car sharing), could have a modest impact on car ownership. The types of innovative services needed to be effective in this market may be quite different from the improved mass transport services needed to better serve low-income, carless populations.

Changing the car usage patterns of people that already have car access is perhaps most effectively done through targeting the approximately 5% of people in car-available households who demonstrate most willingness to use public transport, and providing the sort of mobility alternatives that suit their needs. At present not enough is understood of their demographic characteristics, activity patterns and mobility needs, and decision criteria, to enable effective design of interventions. A further 25% of people in car-available

households always use public transport, and mobility management interventions (that may be similar to or different from the previous case) may be focused on reinforcing the desirable travel habits of such persons. The focus here may be particularly on public transport users in their teens or early twenties, who are familiar with public transport and who are also forming habits into the future. Lastly, more restrictive or interventionist approaches are likely needed to affect the car usage of the remaining 70% of car-available persons. Whether the expected pay-offs of pursuing this market is worth the considerable political and economic costs remains to be decided.

6. REFERENCES

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[2] Mokonyama, M and C Venter, 2007: *Forecasting household car ownership in South Africa: Alternative models and future trends*, Journal of the South African Institute of Civil Engineers, South Africa (forthcoming).