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Equal Access? Travel Behaviour Change in the Century Freeway Corridor, Los Angeles

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Summary. Construction and operation of the Century Freeway (I-105) created problems for and presented opportunities to the socioeconomically diverse south Los Angeles County area. Early decisions regarding the interstate facility effected economic decline of the area, encouraging disinvestment and forcing dislocation of residents. However, construction and operation provided job and housing opportunities in a depressed area, relieved urban congestion on arterial streets and other highways and provided a direct route to Los Angeles International Airport. In this study, travel behaviour benefits to local residents are analysed. We report modest changes in routes taken to work and shopping, general satisfaction with time and money savings associated with the system and impressive subsistence travel-time decreases for automobile trips. However travel-time benefits are not shared equally across ethnic groups and geographical locations. We discuss these findings in the context of higher percentages of central city-area residents reporting that the Century is not a route to work for them.

Introduction

Social sciences and transport policy research on mobility impacts of highways is equivocal: both costs and benefits are associated with new transport facilities, but they are not equally distributed. One important benefit, travel-time savings, may be differentially experienced by travellers, based on the location and quality of the neighbourhoods around their residences and by socio-demographic characteristics of travellers, including income. In this paper, we report the automobile work and non-work travel behaviour impacts of a new urban freeway and compare automobile travel-time changes of inner-city and suburban residents in southern Los Angeles county. The facility is the Glenn M. Anderson (I-105) Freeway/Transitway. Cities traversed by the Century Freeway differ greatly in terms of neighbourhood quality and the socioeconomic status of their residents. The opening of this facility provides a natural experiment to investigate some of the ways that different populations are affected by new transport infrastructure.

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Travel Behavior Impacts of New Highway Facilities

Impacts of new limited-access roadways on urban areas have been analysed primarily in terms of quantifiable economic benefits to users, both private citizens and commercial or industrial businesses. Decreases in travel times and costs related to increased accessibility have been hypothesised as major local and regional impacts of these roads. In areas previously unserved by highways, benefits are clear: new routes facilitate the movement of goods and services to consumers and open areas to land development. However, travel outcomes in metropolitan areas characterised by a well-developed transport system and a decentralised pattern of land use, such as exist in Los Angeles, are difficult to predict and identified benefits have been small (Giuliano, 1989; Thompson *et al.*, 1993).

Both short- and long-term changes can be expected following an increase in the supply of highways. Changes in route choice, time of travel, mode choice, trip frequency and destination choice are in the former category. Longer-term impacts might include: residential or workplace location change, land development pattern changes and changes in automobile ownership (Dowling Associates, 1994; Kitamura, 1991; Stopher, 1992; DiMento *et al.*, 1997).

Several long-term consequences of increased capacity have been documented. The first is a shift in existing travel behaviour that Downs (1992) terms "triple convergence". Drivers who formerly used alternative routes switch to the improved expressway; drivers who formerly travelled before or after the peak hours start travelling in the peak hours; and drivers who used to take public transport or hesitated to make trips during peak hours switch to driving since it has become faster. That is, the demand rises to meet the supply, so that initial gains in mobility are eventually lost, especially in the peak hours. Therefore, travel-time changes are likely to be most profound closer to the opening of a new facility.

Scholars have also found that trip attributes can vary with the demographic and socioeconomic characteristics of travellers. Among topics studied are race and gender influences on trip distances, mode choice and duration (Gordon *et al.*, 1989). But residential location can also influence trip time. As Johnston-Anumonwo (1997, p. 308) concluded:

> There is widespread agreement in the journey to work literature that travel mode, residential and workplace location, income and occupation all influence work-trip time.

The Study Case: An Introduction to the Century Freeway and its Environs

In 1959, the Century Freeway was formally included in the California Freeway and Expressway System. Property acquisition for the facility began in 1970. In early 1972, after all but two freeway agreements had been signed by the local jurisdictions through which the freeway was to run, the Center for Law in the Public Interest, together with the NAACP, the Sierra Club, the Environmental Defense Fund and the Hawthorne Freeway Fighters, filed a motion for preliminary injunction against officials involved in the construction. They sued on behalf of four couples living in the route of the proposed freeway (DiMento *et al.*, 1991). This suit, *Keith v. Volpe*, sought to prevent the state from acquiring property until environmental impact statements were approved; and it alleged, among other counts, inadequate relocation assistance and denial of equal protection to minorities and low income corridor residents. An injunction was issued on 7 July 1972. It was not lifted until 1979 after federal district court judge Harry Pregerson approved a consent decree negotiated between the attorneys from the Center for Law and the state and federal Departments of Transportation (Consent Decree, *Keith v. Volpe*, 352 F. Supp. 1324 (C.D. Cal. 1980) No. 72-355-HP; Hestermann *et al.*, 1993). The decree mandated creation of an advocacy office for corridor residents, an ambitious housing replacement and replenishment programme, and innovative housing

advisory and minority and women affirmative-action programmes. Groundbreaking for the Century finally occurred in May 1982. The freeway opened to traffic in October 1993 (see DiMento *et al.*, 1991, for a detailed history of the Century Freeway). The facility included 6 lanes for general traffic, 2 High Occupancy Vehicle [HOV] lanes and 10 park and ride facilities. The Green Line, a light rail line in the median, opened on 12 August 1995 (see Figure 1).

There are considerable socioeconomic and demographic differences among residents living along the I-105 route. It begins in El Segundo and ends in Norwalk, along the way traversing Hawthorne, Inglewood, Los Angeles, Southgate, Lynwood, Paramount, Downey and El Segundo. The western and eastern cities tend to have higher median household income and home values. The central portion of the corridor, including the portion within south central Los Angeles and unincorporated Los Angeles County, has higher unemployment, lower median household income and lower owner-occupied home values than the areas that 'sandwich' it (US Bureau of the Census, 1992). It is racially diverse. One community in this area, Watts-Willowbrook, site of the racial disturbances of the mid 1960s and early 1990s, was profoundly affected by the freeway's construction.

The general plans of cities within the central area describe communities with economic, social and physical problems created by increased density and changing demographic and economic trends. Lynwood's general plan (Lynwood, City of, 1990, p. LU-9) states:

> Lynwood and much of the surrounding area are comprised of relatively low income households whose budgets are limited basically to the necessities of life.

Similarly, Los Angeles' South Los Angeles District Plan (Los Angeles, City of, 1991, p. SE-1) describes the area as

> part of Los Angeles' inner city. Numerous physical, economic and social problems ... result in social and economic segregation and private, public institutional disinvestment.

With respect to the parts of unincorporated Los Angeles in the area, County officials hoped to "promote the rehabilitation and revitalisation of deteriorating neighborhoods" (Los Angeles, County of, 1980, p. I-23). The Inglewood general plan notes that the "city is gaining a reputation as being unstable and composed of a transient population" (Inglewood, City of, 1986, p. ii).

In contrast, many of the cities outside this boundary are positioned for development and are optimistic regarding future opportunities. El Segundo officials describe the area as being well maintained with an excellent housing stock (El Segundo, 1992). Downey is "a premier community in the southeast area. It is clean and safe and has a strong sense of community" (Downey, 1992, p. I-17).

Even at the time of route alignment,

> the ethnic breakdown of population in the corridor communities varie[d] greatly. The geographic middle section of the corridor is represented by the communities of South Central Los Angeles, Watts, Florence-Graham, Westmont, Willowbrook, and Compton, which have black majorities: communities on the east and west have white majorities (US Department of Transportation, 1975, pp. 2–11).

Furthermore, "the most (economically) marginal residents along the project appear to be between Western Avenue in Westmont and the Los Angeles River in Paramount" (US Department of Transportation, 1975, pp. 2–11). With respect to the demographic impact of the project on the communities through which the facility was to run, the Final Environmental Impact Statement reported:

> Basically, the poorer and less mobile tend to remain in central and south Los Angeles County, while the more mobile and affluent whites move away. Unfortunately it is not possible to state how much this movement is directly attributable to the

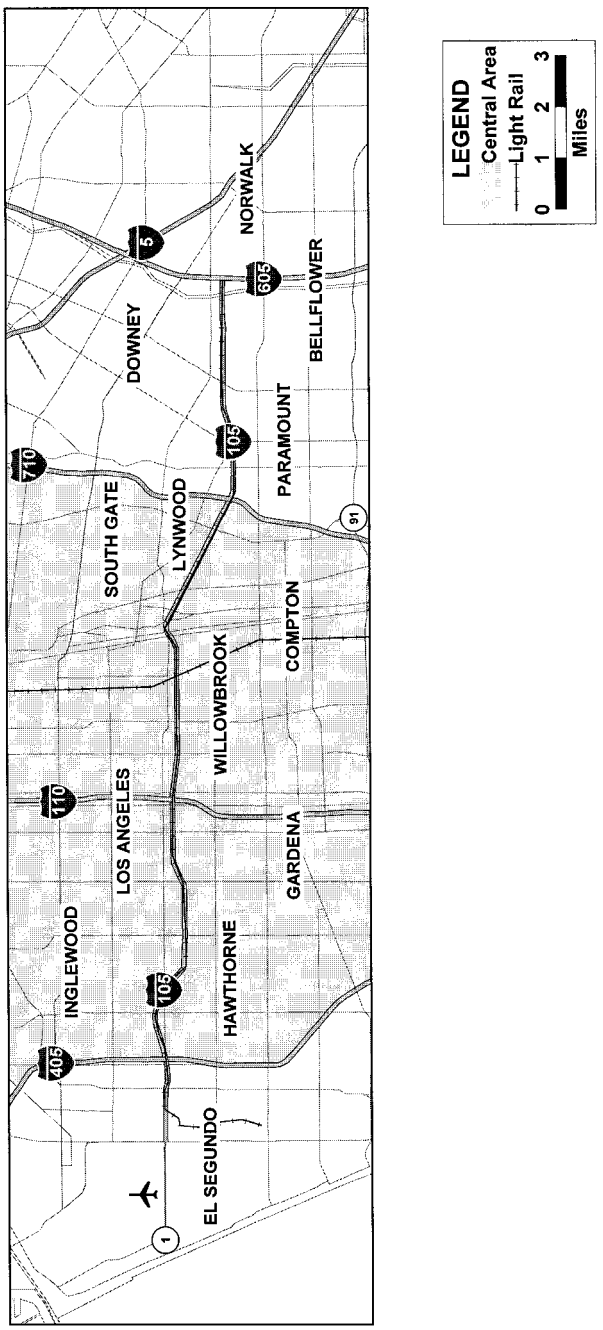

Figure 1. The Century Freeway (I-105) Corridor, Los Angeles: central vs other tracts.

Table 1. Population, housing and travel characteristics of central and peripheral corridor census tracts near the Century Freeway, 1990

	Tracts in central cities	Tracts in eastern and western cities	County average
Percentage white	15.72 (4.46)	43.54** (25.91)	56.81
Percentage black	44.06 (15.1)	26.66 (29.09)	11.20
Percentage Hispanic	53.98 (14.53)	41.36 (21.09)	37.81
Median income ($)	21 950 (6 041)	32 440*** (7 794)	34 965
Percentage unemployment	17.34 (5.14)	8.7*** (4.09)	7.40
Percentage below poverty	26.57 (8.43)	17.07** (9.48)	15.1
Median owner-occupied home value ($)	111 200 (19 690)	173 333*** (56 101)	226 400
Percentage using public transit	8.38 (4.29)	5.14* (3.91)	6.68
Percentage '0' vehicles	17.15 (10.05)	9.24** (6.07)	12.40
Mean work trip travel time (minutes)	27.37 (4.29)	23.62 (2.45)	26.5

Note: Numbers in parentheses represent the standard deviation of the mean.
* t value < 0.10 significance, one-tailed distribution; ** t value < 0.05 significance, one-tailed distribution; *** t value < 0.01 significance, one-tailed distribution.
Source: US Census of Population and Housing, 1990.

> project or how many would have moved from the project area in any case; however the project has caused many people to move sooner than they otherwise would have (US Department of Transportation, 1978).

> improved access to regional commercial, business and public facilities ... parks and recreational areas ... [and] ... improved accessibility to areas of employment opportunities (US Department of Transportation, 1975, S-3).

At an aggregate level, as Table 1 presents, there are significant differences in reported economic and social conditions within the corridor in 1990, three years before the freeway opened. With respect to transport, the US Census shows that significantly more workers in the middle of the corridor are living in carless households and using public transit for the trip to work.

Prior to construction, the environmental impact analysis predicted impacts of the new freeway that included

But impacts were not seen as uniform. The central portion of the corridor was identified as having the potential to be severely affected by the freeway, primarily because this area had a depressed economic character "with some of the lowest-income communities to be found in the county" (US Department of Transportation, 1975, p. 2–11) and a high degree of pedestrian dependence. However, the construction of either the freeway/transitway or exclusive busway alternative would

benefit these areas in the central portion of the corridor by increasing access to health, educational and recreational facilities thus expanding their perceived community (US Department of Transportation, 1978).

For the same origin-destination pairs, this increased road capacity should cause a reduction in travel time.

It is in the context of these community differences that we compare some travel benefits following the freeway's opening.

The Methodology

Data Collection

The corridor study area is defined as the nine cities through which the I-105 Freeway/Transitway passes. The freeway also runs through several parts of unincorporated Los Angeles County. Three cities were added to the study area because they are in close proximity to the freeway/transitway and are impacted by the facility: Gardena, Compton and Bellflower. The study area covers approximately 119 square miles of Los Angeles County, extending approximately 5.25 miles in the north-south direction and 22.75 miles in the east-west direction.

To investigate the travel behaviour of residents near the freeway, a survey and travel diary were administered to a proportionate sample of the study area. A list of 2500 mailing addresses sampled proportionately at random from specified zip code areas of the noted jurisdictions was obtained. From this list, 2000 survey recipients were randomly selected. To counteract panel attrition, the remaining 500 addresses were saved to refresh the sample for the second wave mailing (Murakami and Watterson, 1990; Hensher, 1987; T. F. Golob, personal communication). Attempts to minimise non-response bias included making the survey instrument manageable and maintaining close contact with the sample through postcards and reminder follow-ups.

A mixed panel study methodology was chosen so that changes in individual travel behaviour and attitude could be tracked over time and more conclusively associated with the opening of the freeway. The Century Freeway sample ultimately will be surveyed four times. Each mailout contains a travel diary and personal questionnaire. The travel diary was modelled after those existing in the field (Pas and Koppelman, 1986; Murakami and Watterson, 1990; Kurth, 1986; Clark and Goldstucker, 1986; Axhausen, 1995; Axhausen and Garling, 1992; Brownstone and Golob, 1992).

The travel information on the survey was detailed in a one trip per page travel diary. This was part of a booklet that also asked the respondent to provide demographic information as well as perception of the newly available modes and travel in general. [Representative pages from the diary are appended.] Surveys were distributed two weeks prior to the freeway's opening and approximately six months subsequent to the opening.

The core diary items ask the individual to provide a detailed summary of his or her movement starting with the first trip made after 4 a.m. on the travel day. Included are the start and end times of each trip; each trip purpose; its main mode; the number of passengers in the vehicle; details about the person including age, gender, participation in the labour market, car ownership or availability, and relation to head of household; and household characteristics including income and number of persons. Only the addressee was asked to supply the requested information.

Data Preparation

Preparation of the panel data involved several steps. First, the travel data items were aggregated. Trip frequency, total travel time and average travel time per trip by mode and by trip purpose were calculated for each respondent.[1] Trip purposes were clustered in three primary types: subsistence (work, school or college); maintenance (shopping, personal and appointments); and leisure (visiting and free time activities)—a method proposed by Kitamura and Bovy (1987). The mode choice variable was recoded as: "drive" (which includes either driving alone or driving with a passenger from the origin

of the trip); "carpool" (being or picking up a passenger); "transit" (either bus or train); and "self-propelled" (walk or bicycle). Because of the small number of travellers using the latter three modes, we analyse primarily automobile travel.

Each respondent's address was then matched to the census tract in which his or her home was located using Atlas Geographic Information Systems. The straight-line distance from each address to the nearest interchange on the Century was also calculated. Any respondent who lived further than seven miles from the freeway was not considered a corridor resident and was excluded from further analysis.

We created the CENTRAL variable which identifies residents living in the middle of the corridor study area. The area is delineated by the I-405 and I-710. It also appears to delineate a racial and economic 'boundary'. According to the 1990 Census, close to the freeway itself, the central tracts are 15.7 per cent white compared to 43 per cent outside this central area of the corridor. In the central area, the median home value is 49 per cent of the county median, but it is 76 per cent on the eastern and western edges. This dichotomous variable provides a meaningful method for comparing disaggregate travel characteristics of respondents living within the study area.

All respondents who lived in a census tract located within the southern and northern boundaries of the study area and between the I-405 and the I-710 freeways were assigned a value of 1 for the dummy variable CENTRAL. Respondents living outside the central area were assigned a value of 0 for the CENTRAL variable.

The data were then tested to determine if the sample was drawn representatively from the population in the study area, as we recognised the difficulty of reaching minority populations (Golob and Meurs, 1986; Kitamura and Bovy, 1987). The overall response rate to the first survey of 26 per cent is about average for survey research (Stopher and Meyburg, 1979). It varied from 4.3 per cent in Compton to 36 per cent in El Segundo.[2]

The purchased sampling frame underrepresented residents of particular zip codes within the corridor; a difference in return rate by zip code of residence resulted. A logistic regression was conducted to determine if the return of a survey could be predicted based on place of residence. For the 2000 surveys that were originally distributed, there was a significant difference in probability of return based on zip code of residence (chi-squared $= 60.195$; degrees of freedom $= 28$; significance < 0.01). Weights were consequently assigned to respondents based on the population of the zip code of residence. This first set of weights represents the normalised ratio of the expected proportion to the observed proportion by zip code area. Because the weight was standardised, the effect of this weighting is negligible on the sample size.

The data were tested to determine if the dropouts between Wave 1 and Wave 2 differ in ways relevant to our investigation. Prior studies identified several patterns in panel studies. Households with higher car ownership, interest in the subject, higher education and longer duration of residence are more likely to participate in more than one wave. Low-income households, single adults, smaller households, households of older persons, households without cars and childless couples tend to drop out (Kitamura and Bovy, 1987; Chung and Goulias, 1995; Golob and Meurs, 1986).

We conducted a logistic regression to determine if age, income, education, length of residence in the corridor, trip frequency, intention to use the facility or geographical location of residence improved the prediction that a respondent was likely to participate in both waves of the survey. A statistically significant attrition model resulted. In combination with the sampling weight, the reciprocal of the probability to participate in the second wave survey is used as the Wave 2 attrition weight.[3] These weights are normalised such that the mean of the weights is equal to one.

In the Wave 2 data set, individuals who moved between the Wave 1 and Wave 2

surveys were excluded. Any change in travel behaviour would be difficult to attribute to the freeway after a change in either household or employment location. In order to control for extreme changes in behaviour, any respondent whose trip behaviour change exceeded a reduction by three-quarters or an increase of over 300 per cent of the Wave 1 behaviour was omitted.[4] These differences would also be difficult to attribute solely to the freeway opening. Because the freeway was hypothesised to influence access within local communities, travel originating at the home is most meaningful for our analyses. In order to control for trip origin, analyses were conducted on home-based trips to work or school and shopping or other personal errands.

Data Analysis

The specific survey and demographic items used to describe the respondents and their travel behaviour are listed in Table 2. Baseline travel characteristics of the sample in relationship to residential area are described in Table 3. Mean maintenance and subsistence trip travel time by residence and trip mode are described for all Wave 1 respondents.

First, the stated travel behaviour changes subsequent to the freeway's opening were analysed for all respondents participating in both waves ($n = 249$).[5] As the stated change data are primarily ordinal or categorical, chi-squared analyses were employed for tests of variables reflecting stated change. Paired comparison tests were then conducted to determine if there have been changes in respondents' automobile travel times since the freeway opened, and if they vary by residential area. Paired comparisons were performed for the 196 respondents returning usable travel diaries in both waves.

The Results

Baseline Travel Characteristics

It is notable that a cross-sectional analysis undertaken for all respondents to Wave 1 (regardless of their participation in the second wave) revealed dramatic differences in travel time prior to the Freeway's opening (Table 3). Wave 1 travel times for subsistence and maintenance trips were significantly higher for central-area residents. In south central Los Angeles, there are fewer employment and retail opportunities, so respondents may be travelling to destinations beyond the central areas. This may explain the longer travel times. Mode choice and car ownership have also been used to explain travel time.

Because minority and low-income travellers tend to demonstrate higher transit usage, the longer travel times of transit users as compared to drivers have been used to explain longer travel times for inner-city dwellers (Gordon *et al.*, 1989). The small number of transit users in our panel allowed only a cursory test of this hypothesis. Indeed, seven of the eight transit users live in the central area. However, we find model choice could not explain differences in travel time among our respondents.

Similarly, travel-time comparisons of car owners ($n = 415$) and respondents who did not own cars ($n = 25$) demonstrated that there is an insignificant difference in travel time for these groups before the Century opens. All but two in our sample had cars available regularly, confirming that the data do not lend themselves to meaningful comparisons of changes in travel time among transit-dependent residents in the central area and those on the eastern and western boundaries. Mode of travel is controlled in analyses of changes in travel time by describing only those trips by car where the respondent was the driver.

Analysis of Change in Travel Behaviour Subsequent to the Freeway's Opening

At the time of the Wave 2 survey, 6 months after the freeway facility opened, 66.4 per cent of respondents ($n = 231$) indicated that they had actually used the Freeway within the past week and 34.9 per cent

Table 2. Disaggregate variables and codes

Variable and code name	Type	Wave 1	Wave 2	Specification
[Ethnicity] ETHNIC	categorical	yes	yes	1 = African American 2 = Asian/Pacific Islander 3 = Hispanic 4 = Native American 5 = White 6 = Other
[Car ownership] CAR	categorical	yes	yes	0 = No 1 = Yes
[Mode choice] MODE	categorical	yes	yes	1 = Driver 2 = Carpool passenger 3 = Transit [bus or train] 4 = Walk or bike
EDUCATION	continuous	yes	yes	Number of years in school from 1 to 20 or more
GENDER	categorical	yes	yes	0 = male 1 = female
[Employment status] EMPLOYED	categorical	yes	yes	In wave 1: 0 = no, 1 = yes In wave 2: 0 = no, 1 = yes, 2 = retired
AGE	continuous	yes	yes	Age in years
[Trip duration for subsistence trips by auto] SUBTIME	continuous	yes	yes	Average home-based subsistence trip time in minutes = [SUM (work trip times + school trip times)]/[SUM (work and school trips)]
[Trip duration for maintenance trips by auto] MAINTIME	continuous	yes	yes	Average home-based maintenance trip time in minutes [SUM (shopping trip times + personal trip times + appointment trip times)]/[SUM (shopping, personal and appointment trips)]
[Use of Century on diary day] W2USEDCF	categorigal	no	yes	0 = Did not use Century on travel diary day 1 = Did use Century on travel diary day
[Distance to freeway interchange] DISTANCE	continuous	no	no	The shortest straight-line distance, in miles, between a respondent and a Century Freeway interchange. Data generated using Atlas GIS

had used the carpool lanes. Thirteen per cent indicated that they had changed the location of their shopping place because of the opening of the freeway. Of the 152 respondents who were employed in both waves, 35 per cent indicated that they had changed their route to work because of the Century Freeway.

Table 3. Analysis of variance of baseline auto trip length by residence in central area (Wave 1)

	Outside central area	Inside central area	*F* value; degrees of freedom; probability
Average home-based subsistence trip travel time	23.22 minutes ($n = 71$)	29.62 minutes ($n = 103$)	7.97; 1172; 0.0053
Average home-based maintenance trip travel time	15.60 minutes ($n = 44$)	21.59 minutes ($n = 77$)	6.1; 1120; 0.0149

Overall, 77 per cent of the respondents indicate that the Century Freeway saves them time. Forty per cent of the respondents indicate that the freeway saves them money. On these items, there is no difference between residents of central and peripheral areas. Eighty-six per cent of the overall sample agreed that the Century was convenient (chi-squared = 11.68; degrees of freedom = 1; $p < 0.05$).

For respondents making work or school trips in both waves, mean subsistence travel time decreased by 2.3 minutes (standard deviation-2.8; *t* value = 2.8; degrees of freedom = 50; $p < 0.01$).[6] For maintenance trips, there was an insignificant decrease in average time per trip (3.6 minutes; *t* value = 1.98; degrees of freedom = 26; $p < 0.059$). The total number of trips made on the travel diary day increased insignificantly from an average of 3.53 (standard deviation = 2.09) in Wave 1 to 3.83 (standard deviation = 2.34) in Wave 2. ANOVA tests comparing change in travel by income and gender variables produced results which were not significant. Therefore, these changes are equally distributed across different income and gender groups. The overall *F*-test comparing subsistence trip travel time changes by ethnicity, however, is significant ($F = 2.86$; degrees of freedom = 4, 51; $p < 0.05$). Significantly, change in travel time for non-whites was positive, indicating that this group experienced an increase in travel time for the work or school trip. White respondents experienced a decrease in travel time.

We investigated whether residential location mediated the travel behaviour changes exhibited across the sample. Paired *t*-tests indicate that central-area residents did not experience significant travel-time savings for the subsistence trips (see Table 4). Their neighbours to the east and west of them did. For central-area residents, maintenance trip times decreased significantly. The travel time for this trip purpose for the non-central group was unchanged.

Discussion

Because of the relatively small number of cases in our study, the paired comparisons of home-based trips made by automobile represent the best measure of change in travel subsequent to the freeway's opening.[7] Our conclusions are therefore based on the results of these *t*-tests. First, with respect to subsistence trips: results consistently show that residents outside the central corridor area experience a decrease in travel time. Residents in the central area, an economically distressed and non-white part of Los Angeles, experience no change for this trip purpose. Twenty-six per cent of the overall sample indicated that the Century Freeway "does not go to the place I need to go" for the work trip. But this number rose to 40 per cent when central-area residents were considered separately. This difference may partially explain why there is no concomitant decrease in overall trip length with the freeway opening.

Secondly, with respect to maintenance trips, central-area residents exhibit a decrease in travel time not shared with peripheral-area

Table 4. Paired *t*-tests of auto trip lengths by residence in central area

	Subsistence trips		Maintenance trips	
Central area resident?	0 = no	1 = yes	0 = no	1 = yes
n	27	24	8	19
Wave 1				
Travel time (minutes)	21.70	23.3	15.15	22.71
Mean (standard deviation)	(10.81)	(11.12)	(9.36)	(14.87)
Wave 2				
Travel time (minutes)	18.83	21.65	13.91	18.13
Mean (standard deviation)	(10.03)	(7.62)	(9.69)	(13.5)
Correlation				
Wave1/Wave 2 travel time	0.896***	0.794**	0.243	0.827**
Mean travel-time savings between Wave 1 and Wave 2 (minutes)	2.87	1.65	1.24	4.58
Mean (standard deviation)	(0.931)	(1.41)	(4.2)	(1.95)
t value; p	3.09; 0.000	1.17; 0.253	0.3; 0.776	2.36; 0.03

** = $p < 0.05$.

residents. We speculated that maintenance trip destinations changed between Waves 1 and 2. Paired *t*-tests revealed a low correlation between maintenance trip travel times for non-central residents between waves. This type of trip varies from day to day and it is likely that the same destinations were not visited on each of the travel days. Destinations for the non-work trip are not fixed in the same manner as most work trip destinations.

Where there is a high correlation between travel times before and after the freeway opening, there has also been a significant reduction in travel time. Possibly these residents are visiting the same locations for their maintenance trips and are experiencing travel-time savings. However, logistic regression estimates of shopping trip destination changes revealed that central residents were more likely to indicate making a change. A detailed analysis of the maintenance trip destinations would be required to understand fully the change in non-work travel between waves. At the level presented here, it is impossible to distinguish whether travel-time changes resulted from changing destinations, improved mobility, or inter-day variability in maintenance needs. This result does provide some support for the argument that the freeway increased access of a particular and potentially very important kind for residents in the central area: to quality stores and services.

Conclusion

Overall decreases in the work and school trip length were seen for residents of the more advantaged areas, outside the central portion of the corridor. The comparison is, however, somewhat difficult to interpret because there are several possible sources of variation between the groups. In addition to differences related to the freeway, there may be differences from other events between waves or errors of measurement in the measuring instrument. Moreover, the freeway opening might affect members of the population differently based on characteristics unaccounted for by the grouping variables. Perhaps, for some, locations of job sites may change from day to day in a manner that is not discernible from the travel diary data.

Why travel times to work did not change for residents in the central area is a question of significance for transport planning. The correlation of travel times between time-

periods was quite high, indicating that these residents were probably travelling to the same jobs. Perhaps the freeway opening did not facilitate movement for these groups of people. Either they do not use the new freeway, or the freeway did not ease congestion on the routes they continued to take after its opening.

Thus, the subsistence travel times of those residents hypothesised to be most impacted by the freeway's construction did not change in a manner comparable to residents in less-affected areas. Two questions emerge. Were these residents 'compensated' for the impacts of freeway construction in a manner not captured by this study? What characteristics of respondents in the disadvantaged areas prevent them from garnering the travel-time savings accruing to other urban residents?

An important direction for future research is analysis of whether the freeway opening has in any way caused a convergence in travel times for residents of more and less advantaged areas. In addition, more detailed analyses of maintenance trips will allow for a fuller understanding of opportunities available for inner-city residents. An analysis of subsequent waves (3, 4) of the present panel will address impacts of another mode of travel on the Century, that of the light rail Green Line.

The debate over the mobility impacts of new transport facilities continues. The pattern of changes in travel time in this study indicates that even though access, measured in terms of reduced travel time, may be improved for some individuals, these benefits are not uniformly distributed. In particular, the residents with the longer subsistence trip travel times prior to the freeway opening are not experiencing significant travel-time savings. This unfortunate combination of findings suggests inequity in the results of transport policy: this new transport infrastructure, placed in sensitive urban areas, provides small travel benefits while imposing considerable environmental and socioeconomic costs. Furthermore, those incurring these costs may not be receiving their proportionate share of benefits.

Notes

1. Because we did not ask respondents to indicate if they made no trips on their travel day, all respondents with empty travel diaries are recoded as missing for the purpose of travel behaviour analyses.
2. Also, because racially and economically different groups in Los Angeles tend to be isolated by geographical location (Allen and Turner, 1993) and the hypotheses suggest that geographical location and the dependent variables of interest are related, a logistic regression analysis was conducted on the sample to determine if zip code of residence had any significant effect on the correct completion of the survey. There was no difference in quality of survey returned by zip code of residence. That is, the less carefully completed surveys could not be isolated from the more carefully completed surveys based on residence.
3. The Wave 2 weight fully utilises the information that the survey results offer. It is based on both a sampling distribution weight and attrition behaviour observed at the disaggregate level. Its use may be preferable to the more typical approach of weighting observations based on sample distributions across cells defined by a few socioeconomic or demographic variables (Kitamura and Bovy, 1987). This new combined weight was computed for use in Wave 2 by dividing the expected over the observed proportions of the mailing list by the probability of staying in the panel.
4. A second analysis of respondents indicated that the direction and magnitude of change were similar when those whose travel changes exceeded 50 per cent and 200 per cent were omitted.
5. The Wave 2 data are weighted to be representative of the Wave 1 sample; however, some small differences in pre-freeway-opening travel behaviour exist between this subset of the Wave 1 sample and the complete sample.
6. Travellers who exhibited extraordinary changes in travel were excluded from analyses in order to minimise the effects of outliers.
7. The two waves of data do not provide a sample size sufficient to analyse meaningfully change in travel behaviour using regression estimates.

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Appendix. Representative pages of travel diary

THIS IS YOUR PERSONAL

ONE-DAY

TRAVEL DIARY

In the next section of the survey, we are asking you to record each trip you make on one day.

By telling us where you go and how you travel, we will learn about the transportation needs of the people in your area.

THIS IS HOW YOU DO IT:

FIRST, choose one day during the week that you think will be convenient for you to record your travel. You can choose any day of the week as long as it is BEFORE MONDAY, OCT 11TH, 1993.

THEN, begin the travel diary with your first trip after 4 a.m. on the day you've chosen. Anytime you drive, take the bus or train, ride a bike or walk to get from one place to another, you've made a trip. Driving to work, walking to the movies, picking someone up, or going to the bank are all examples of trips.

IT'S EASY! WE ONLY NEED TO KNOW FOUR THINGS:

- Where did you go during the day?
- What was the general reason for going there?
- How long did it take you to get there?
- How did you travel on your way there?

TRAVEL DIARY

***CHOOSE* Your Travel Diary Day**

(Please Circle)

Mon. Tues. Wed. Thurs. Fri. Sat. Sun.

NOW, LET'S GET STARTED!

REMEMBER—A TRIP OCCURS EVERY TIME YOU LEAVE ONE LOCATION TO GO TO ANOTHER LOCATION.

First we need to know where you were at the BEGINNING of your travel diary day (4 am)

1. Where did your first trip begin on your travel diary day?

☐ Home ☐ Work

☐ Other Location (Please fill in address)

_____

(Place name)

_____

(Address or nearest intersection)

_____

(City) (Zip, if known)

FIRST TRIP

1. Where did you go on your first trip?

(Please fill in the address or nearest cross-streets)

_____

(Place name)

_____

(Address or nearest intersection)

_____

(City) (Zip, if known)

2. What was the purpose of this trip?

☐ Work ☐ Work-related

☐ School ☐ Pick up or drop off someone

☐ Shopping ☐ Recreation

☐ Eating out ☐ Banking/personal business

☐ Return home ☐ Other (please specify)_____

3. How long did it take to get there?

I left at ____:____ ☐ am ☐ pm I got there at ____:____ ☐ am ☐ pm

4. How did you get there?

☐ Drive alone ☐ Driver with passengers

☐ Passenger in car/truck ☐ Bus

☐ Train ☐ Walk

☐ Bicycle

5. If you were a driver or a passenger, which freeways did you use? (please list)

____ ____ ____ ____ ____ ☐ none

6. If you were a driver or a passenger, did you use any carpool lanes?

☐ Yes ☐ No

7. If you used the bus, which routes did you use (please list)

____ ____ ____ ____ ____

8. If you used the train, which lines did you use?

☐ Red Line ☐ Blue Line ☐ Amtrak ☐ Commuter train

9. Was this the last thing you did today?

☐ Yes (Finished! Go to last page.) ☐ No (Go to next page to tell us where you went after this.)