Working Paper 168

Auto Nonavailability As a Component of Transportation Disadvantage:

A Pre-BART Review of the Bay Area Situation and the National Context

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March 1972

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INTRODUCTION

Lack of access to an automobile may be triply disadvantageous to residents in an American metropolis like the San Francisco Bay Area. The availability of an automobile permits the resident convenience and flexibility -- and hence a positive sense of mobility. Nonavailability of an automobile reverses this situation, denying the resident these very qualities. In a very direct sense, then, we may presume that the availability or nonavailability of a car is a key factor in determining the extent to which a resident can match his real or potential travel needs with a corresponding capacity for mobility.

As more and more residents come to depend on auto use and as the transportation system becomes a preponderantly highway-auto-dominated one, alternative modes of public transportation tend to suffer in quality and their level of service tends to decline. Thus the resident living among households in which auto availability is the rule is likely to find himself without fully adequate public transportation.

In addition, the resident without auto availability is in any event limited in choice of transportation mode. If both auto and transit were available, the resident would have options open and, depending upon the circumstance, might in fact vary his choice. With the auto not available, he becomes a "captive" of public transit, of riding with others in their cars, or of depending on walking or a two-wheeled conveyance. He may be forced to accept a mode which is by no means optimal from his own point of view or from that of society as a whole.

Thus it appears that to lack access to an auto in an auto-dominated world suggests some degree of involuntary immobility. In short, auto nonavailability spells both absolute and relative deprivation for a substantial number of persons. It is our intent to explore how serious is this deprivation.

It follows that the major purpose of this working paper is to summarize existing data as to levels of auto availability, differentials in auto availability as related to other variables (such as income, age, and race), geographic patterns of auto availability within the Bay Area, and the relationship between auto availability and transit use. We make some exploratory forays into some correlates of auto availability. Since 1970 census data on auto availability have not yet been released, our analysis utilizes 1960 census data and other survey information. In several cases, where data from the Bay Area did not exist in the form we sought, we drew upon relevant data at the national level. Some directions for future research are also suggested.

In the course of further studies of BART impact, much additional information will be forthcoming on questions relating to automobile availability and the relative use of auto and transit. The present working paper provides some background and establishes the rudiments of a framework within which to pursue subsequent research. Some findings from Bay Area Survey No. 1, conducted in the summer of 1971, will be introduced, but the main analyses of the survey results remain to be conducted.

In subsequent research, we shall be dealing more broadly with the concept of transportation disadvantage. At this juncture, it may suffice to define a disadvantaged household as one in which the transportation needs of its members are not fully satisfied by the combination

of private and public transport services available to that household. Under this definition, few households exist that are not in some way disadvantaged, but obviously many households are still relatively much better off than others.

This is not the place to undertake any detailed discussion of this definition of disadvantage with respect to transportation. One problem with the definition is that it must be measured in terms of the resources possessed by each household and its specific transportation needs. Because there are always costs (in both money and time) involved in the consumption of transportation, it would be misleading to assume that these costs can be reduced beyond some minimum level. Efficiency considerations, given a minimum real cost for transportation, would suggest a focus on the extent to which actual costs reflect the social costs of transport, or, in other words, to what extent transport services are efficiently priced. Equity considerations, on the other hand, would suggest a focus on the amount of mobility which each household should possess, accepting the necessity for at least partial public subsidy of transportation for households disadvantaged with respect to mobility. This, in turn, would lead one to consider alternative forms of subsidy -- whether to the households or to the transportation system.

AUTO AVAILABILITY IN THE BAY AREA

A first measure of auto availability, and the one on which we shall mainly rely in this working paper, takes advantage of empirical data collected by the decennial census, the major transportation studies, and certain other sources. The common form is to classify households as to their ownership or regular use of autos:

a) No auto
b) 1 auto
c) 2 or more autos

If we accept for our purposes this three-fold breakdown and presume that it is conveniently expressed in percentage form, we are given a set of three percentages and two degrees of freedom. It would be convenient to express these three figures as a single index. This would permit, for example, the use of such an index as one variable in multivariate analysis.

After some experimentation we decided upon the following Auto Availability Index (AA Index):

$$\text{AA Index} = \frac{\%\ \text{Households}_{1\ \text{auto}} + 2\ (\%\ \text{Households}_{2\ \text{or more autos}})}{2}$$

This is a simple weighted average that sums the percent of households with one auto and twice the percent of households with two or more autos. This thus uses the built-in assumption that households with two or more autos are twice as well off as those with only one. The index indirectly also takes into account the percent of households with no autos, even though given a weight of zero, since the three

percentages comprise a closed system adding to 100 percent. It should be readily apparent that this index greatly oversimplifies the situation, not only because individual utility functions cannot be directly compared, but also because there is no control for household size or for any other household characteristics. And, of course, it does not take into account land-use patterns or the availability of public transit service so that it cannot be accepted as a direct measure of transportation advantage. Nonetheless, this AA Index provides a direct empirical measure of a feature that very importantly differentiates urban households.

The AA Index ranges from 0 to 100. A residential district in which no autos were available to any of the households would score 0. A residential district in which every household had two or more autos would score 100. In very rough terms, the following equivalents pertain:

AA Index	No. of autos per household
0	0
25	0.5
50	1.0
75	1.5
100	2.0

Further, the figures in the right-hand column should be read " -- or more," since the third percentage is "2 or more autos." Using the 621 census tracts of the six-county San Francisco-Oakland SMSA and data from the 1960 census, we found a total range of AA Index values from 3.3 for San Francisco census tract A-14 to 91.7 for Contra Costa County census tract 26. The AA Index for the six-county San Francisco-Oakland SMSA in 1960 was 51.2.

Table 1 picks out selected census-tract AA Index values so as to provide a sense of variation within the Bay Area. At one extreme is

TABLE 1

AA Index and Percentage of Households with No Car, One Car, or Two or More Cars, Selected Ranked Census Tracts, San Francisco-Oakland SMSA, 1960

Individual Census Tracts	AA Index	% Households owning or having available - No Car	One Car	Two or More
San Francisco's lowest (C.T. A-14)	3.3	93.4	6.6	0
Oakland's lowest (C.T. 23)	12.3	77.3	20.9	1.9
Berkeley's lowest (C.T. 5-A)	26.3	53.8	40.0	6.2
San Francisco's highest (C.T. 0-7)	68.2	6.7	50.2	43.1
Berkeley's highest (C.T. 3-E)	73.8	4.1	44.2	51.6
Oakland's highest (C.T. 72)	82.1	0.7	34.4	64.9
Alameda County's highest (C.T. 22)	83.5	0	32.9	67.1
San Mateo County's highest (C.T.54)	90.0	0	18.3	81.7
Contra Costa County's highest (C.T. 26)	91.7	0	16.6	83.4

Source: Derived from 1960 Census.

San Francisco census tract A-12, an apartment house district on the southern slope of Nob Hill, in which 93.4% of the households had no car available and not a single household had two or more cars available. At the opposite extreme is Contra Costa county census tract 26, in suburban Pleasant Hill, where 83.4% of the households had two or more cars available, 16.6% had only one car available, and no households were carless. Overall, the census tracts having the lowest index values were inner, often low-income, districts and those having the highest values were either suburban, often remote areas, or upper-income urban, as in the Oakland or Berkeley hills.

Table 2 shows the average AA Index values for counties and various major cities in the Bay Area. The most striking AA Index figure is the index value of 34.5 for San Francisco, markedly lower than the averages for the other counties. Oakland and Berkeley, on average, also have AA Index values lower than that for the SMSA as a whole. The

TABLE 2

AA Index and Percentages of Households with No Car, One Car, or Two or More Cars, Counties and Main Cities of the San Francisco-Oakland SMSA, 1960

County	City	AA Index	% Households owning or having available - No Car	One Car	Two or More
SMSA - TOTAL		51.2	22.4	52.9	24.7
ALAMEDA		53.9	18.6	55.1	26.3
	Oakland	47.7	26.5	52.6	20.9
	Alameda	51.7	18.0	60.6	21.4
	Berkeley	49.4	21.8	57.6	20.6
	Castro Valley	70.6	5.8	47.3	47.0
	Fremont	68.4	3.3	56.7	40.0
	Hayward	65.1	6.5	56.8	36.7
	San Leandro	62.6	7.7	59.3	33.0
CONTRA COSTA		64.2	8.7	54.2	37.1
	Concord	62.8	5.7	63.0	31.3
	El Cerrito	65.3	9.0	51.5	39.5
	Richmond	56.6	15.2	56.4	28.4
MARIN		62.9	9.0	56.3	34.7
SAN FRANCISCO		34.5	42.1	46.8	11.1
SAN MATEO		64.2	7.9	55.8	36.3
	Daly City	60.2	9.3	61.0	29.7
	Menlo Park	63.9	8.3	55.5	36.2
	Redwood City	62.9	9.0	56.2	34.8
	San Bruno	61.8	10.2	55.9	33.9
	San Mateo	62.2	9.2	57.2	33.6
	So. San Francisco	62.3	6.3	62.9	30.8
SOLANO		59.3	9.2	63.0	27.8
	Vallejo	55.3	15.0	59.5	25.5

Source: Derived from 1960 Census.

highest city indexes were Castro Valley (unincorporated) and Fremont (incorporated), both in southern Alameda County. Contra Costa and Marin counties had the highest county-wide indexes. For the SMSA as a whole, the average AA Index of 51.2 means that households averaged slightly more than 1 car per household. This is spelled out in the percentage distribution: 22.4% with no car available, 52.9% with one car available, and 24.7% with two or more cars available.

In Table 3 we show a similar geographic breakdown, by counties and by main cities. The table reveals that something over a third of all the census tracts in the San Francisco Bay Area averaged less than an AA Index value of 50 (i.e., one automobile per household) in 1960, while slightly less than two thirds of all census tracts averaged an AA Index value of 50 or more (one or more cars per household). In San Francisco, however, fully 87% of the census tracts (106 out of 123 tracts) averaged less than one car per household and in Oakland more than three-fifths of the tracts (60 out of 99 tracts) averaged less than one car per household. Over half of the census tracts in Alameda and Berkeley had less than one car per household. On the other hand, Castro Valley, Fremont, Hayward and San Leandro in Alameda County; Concord, El Cerrito, and Richmond in Contra Costa County; all the major cities in San Mateo County; and Marin and Solano Counties all had significantly more than half of their census tracts containing an average of one or more cars per household. More than 85% of all census tracts in the Bay Area scored index values between 25.0 and 74.9 (representing between 0.5 and 1.5 cars per household); only 6.0% averaged less than 25.0 (representing 0.5 vehicles per household) and only 8.4% averaged more than 75 (representing 1.5 vehicles per household).

TABLE 3

Distribution of Census Tracts by AA Index, Counties and Main Cities of the San Francisco-Oakland SMSA, 1960

County	City	Total Tracts	Tracts with AA Indexes of - 0-24.9	25-49.9	50-74.9	75-100
SMSA - TOTAL		621	37	179	353	52
(Percentage distribution		100.0%	6.0%	28.8%	56.8%	8.4%)
ALAMEDA		223	7	81	125	10
	Oakland	99	7	53	35	4
	Alameda	14	0	8	6	0
	Berkeley	28	0	16	12	0
	Castro Valley	7	0	0	4	3
	Fremont	6	0	0	6	0
	Hayward	18	0	1	17	0
	San Leandro	13	0	1	12	0
	Remainder of county	38	0	2	33	3
CONTRA COSTA		104	0	8	76	20
	Concord	13	0	1	11	1
	El Cerrito	7	0	0	6	1
	Richmond	17	0	2	13	2
	Remainder of county	67	0	5	46	16
MARIN		33	0	4	25	4
SAN FRANCISCO		123	29	77	17	0
SAN MATEO		104	0	6	83	15
	Daly City	8	0	2	6	0
	Menlo Park	9	0	1	5	3
	Redwood City	12	0	0	12	0
	San Bruno	5	0	0	5	0
	San Mateo	16	0	1	14	1
	So. San Francisco	8	0	0	7	1
	Remainder of county	46	0	2	34	10
SOLANO		34	1	3	27	3
	Vallejo	19	1	3	14	1
	Remainder of county	15	0	0	13	2

Source: Derived from 1960 Census.

We have also prepared two large-scale maps, based on 1960 census tract data, showing (a) the AA Index and (b) the percentage of households with no car available. These are available for inspection or use, but

were not reproduced as part of this working paper. These maps, of course, show intra-city and fairly detailed patterns of auto availability-nonavailability well beyond the summary reporting in our tables here. San Francisco, for example, has a considerable range of auto availability -- from the largest areal bloc of low availability centering near downtown and running into the Mission to a considerable but irregular bloc of intermediate availability in the southwesterly portions of the city. Oakland, too, shows a very considerable range. Some areas of high availability also show up on these maps at scales too fine to be shown adequately in our tables in this present paper.

With the completion of the Bay Area Survey No. 1, conducted during the summer of 1971, an updated view of auto availability is provided. Table 4, with its summary for the five-county Bay Area, shows differentials in auto availability for the main BART-corridor catchment areas, broadly defined, and for other areas not directly served by BART. Three rough levels of auto availability become clear: the highest AA Index values are for the Concord-Orinda and the Fremont-San Leandro corridors and for Marin County and San Mateo County; the intermediate values show up for Oakland and for the Richmond-Berkeley corridor; the lower values, indicating the lowest level of auto availability, are found in San Francisco.

Particularly with the recent Bay Area Survey No. 1 findings at our disposal it became possible to seek out earlier comparable data so as to present a time series showing changes in auto availability during the past dozen years or so. Rather than relying on a single overall series, however, it seemed wise to pay close attention to certain variations in definition of auto availability and to recognize that different geographic boundaries might be employed. Four definitions have been used;

TABLE 4

AA Index and Percentages of Households with Various Numbers of Cars, BART Corridors and Non-BART Areas, San Francisco-Oakland SMSA, 1971

Geographic Areas	AA Index	% Households owning or having available -				
		No Car	1 Car	2 Cars	3 Cars	4 or More
SMSA - TOTAL	58.9	17.1	49.3	26.7	5.5	1.5
BART Corridors						
Richmond-Berkeley	53.7	20.1	52.6	20.7	4.1	2.6
Oakland	55.4	18.4	52.4	25.7	2.6	0.9
Fremont-San Leandro	72.3	7.1	41.2	38.6	11.1	2.0
Concord-Orinda	73.2	5.5	42.4	44.4	6.5	1.1
Daly City-Mission	48.8	26.8	48.9	21.5	2.8	0
S.F.:Central & Other	49.7	33.0	54.6	10.5	1.9	0
Outside BART Areas						
East Bay	62.8	10.5	53.4	26.5	9.6	0
San Mateo County	70.3	6.3	47.0	34.4	9.3	3.1
Marin County	71.8	6.9	42.7	39.9	5.3	5.2

Source: Bay Area Survey No. 1, Summer 1971.

Note: In calculating AA Index, households with 2 or more cars are treated as a single group in order to maintain comparability with certain earlier Census sources.

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we placed them into three groupings as follows:

1) Autos owned, the definition used in the Current Population Reports.

2) Autos owned or available, including company cars that can be taken home or cars available from other sources, the definition used by the decennial census and the BAS 1.

3a) Motor vehicles, including pickup trucks (but not motorcycles), owned or available, the definition used by the Bay Area Transportation Study Commission (BATSC).

3b) Motor vehicles, including pickup trucks and motorcycles, owned or available, the definition used by the BAS 1.

Definitions 3a and 3b were thought to be sufficiently comparable to be employed together.

Table 5 shows several time series, reflecting these various definitions of auto accessibility and geographic coverage. Whichever series one looks at, it is apparent that auto availability has been rising significnatly. Overall, for the five-county Bay Area, for example, the AA Index based on cars owned and available rose from 50.9 in 1960 to 58.9 in 1971. Except for the separate figures for San Francisco, where the AA Index rose by only about 8 Index points, the larger Bay Area and the East Bay showed Index rises of about 9 points whichever AA Index is employed. Table 5 also shows that the AA Index figures obtained from rather divergent sources are generally consistent. We might expect some sampling variability, but the figures seem to be very convincing. It will be important to see whether the 1970 census figures further corroborate the picture we have thus far depicted.

TABLE 5

AA Index and Percentages of Households with Varying Numbers of Cars or Motor Vehicles, San Francisco Bay Area, 1960 to 1971

Date	AA Index	% Households with - None	One	Two or More
CARS OWNED: SIX-COUNTY SAN FRANCISCO-OAKLAND SMSA				
1960-61 average[a]	47.9	24.0	56.2	19.8
1969-70 average[a]	56.5	19.9	47.3	32.8
CARS OWNED OR AVAILABLE: FIVE-COUNTY SAN FRANCISCO-OAKLAND SMSA				
1960[b]	50.9	22.9	52.4	24.7
1971[c]	58.9	17.1	49.3	33.7
CARS OWNED OR AVAILABLE: SAN FRANCISCO				
1960[b]	34.5	42.1	46.8	11.1
1971[c]	42.5	31.2	52.7	16.1
CARS OWNED OR AVAILABLE: ALAMEDA AND CONTRA COSTA COUNTIES				
1960[b]	53.8	15.8	54.8	29.4
1971[c]	62.5	13.2	48.7	38.1
MOTOR VEHICLES OWNED OR AVAILABLE: FIVE-COUNTY S.F.-OAKLAND SMSA				
1965[d]	59.7	16.7	45.0	37.2
1971[c]	62.8	16.6	41.2	42.2
MOTOR VEHICLES OWNED OR AVAILABLE: SAN FRANCISCO				
1965[d]	41.7	34.1	48.6	17.4
1971[c]	43.9	31.2	49.8	19.0
MOTOR VEHICLES OWNED OR AVAILABLE: ALAMEDA AND CONTRA COSTA COUNTIES				
1965[d]	67.0	10.9	44.2	44.9
1971[c]	68.3	12.5	38.4	49.1

Sources: [a]Current Population Reports, Series P-65, No. 33 (Oct. 16, 1970), Table 3.

[b]1960 census.

[c]Bay Area Survey No. 1.

[d]Bay Area Transportation Study Commission.
See also definitions in text above.

AUTO AVAILABILITY IN NATIONAL PERSPECTIVE

Up to this point we have presented figures for the San Francisco Bay Area and selected component areas. We obtain a better grasp of the Bay Area levels and trends by presenting several comparative tables showing changes in auto availability for regions of the U. S., for selected SMSAs, and for certain household categories by drawing upon Current Population Reports published by the Census Bureau and based on national samples. We may conveniently compare changes from 1960-61 averages to 1969-70 averages, the latest available.

Table 6 shows variations among regions and among major SMSAs and indicates changes for the nine-year period utilized. For the entire country, the AA Index was at 46.5 in 1960-61 and rose by 7.9 points to 54.4 in 1969-70. Note, however, that the San Francisco-Oakland SMSA started at 47.9 in 1960-61, only slightly above the national (despite California's reputation for high auto ownership), but rose by 8.6 points to 56.5 in 1969-70. With suburbanization, the Bay Area has been moving rapidly toward higher auto availability. San Francisco, clearly, has come to hold a decreasing relative importance in its own SMSA with the passage of time. The table shows that the San Francisco-Oakland SMSA at the beginning of the 1960s had an AA Index not greatly exceeding AA Index values for the Boston, Philadelphia, Pittsburgh and St. Louis SMSAs. By the end of the 1960s, the San Francisco-Oakland SMSA had left the Boston and Pittsburgh SMSAs well behind in auto availability and had outdistanced the Philadelphia and St. Louis SMSAs. Within California,

TABLE 6

Changes in AA Index, Geographic Regions and Selected Large SMSAs of the U. S., 1960-61 and 1969-70 Averages

Regions	AA Index 1960-61	AA Index 1969-70	Changes	SMSAs	AA Index 1960-61	AA Index 1969-70	Changes
TOTAL U.S.	46.5	54.4	+7.9				
New England	47.3	56.1	+8.8	Boston	42.1	42.6	+0.5
Middle Atlantic	40.7	46.8	+6.1	New York	36.0	38.6	+2.6
				Philadelphia	43.0	50.4	+7.4
				Pittsburgh	44.9	45.2	+0.3
East N. Central	48.9	56.4	+7.5	Chicago	38.7	46.7	+8.0
				Detroit	52.3	60.4	+7.4
				Cleveland	53.1	57.1	+4.0
West N. Central	49.1	57.3	+8.2	St. Louis	42.5	51.4	+8.9
				Minneapolis-St. Paul	n.a.	63.9	n.a.
South Atlantic	42.9	52.2	+9.3	Washington	44.0	53.2	+9.2
East South Central	41.4	53.9	+12.5				
West South Central	47.4	55.7	+8.3				
Mountain	53.5	62.1	+8.6				
Pacific	53.6	59.5	+5.9	Los Angeles-Long Beach	56.6	60.3	+3.7
				San Francisco-Oakland	47.9	56.5	+8.6

Source: Current Population Reports, Series P-65, No. 33. (Oct. 16, 1970). Derived from Table 3. AA Index calculated for cars owned by households.

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the San Francisco-Oakland SMSA had come close to closing the gap with the Los Angeles SMSA, reaching in 1969-70 the AA Index, 56.5, held by Los Angeles in 1960-61.

In interpreting Table 7 we must bear in mind that an inflationary decade has altered the purchasing power of the income groups employed. It must also be recognized that the inclusion of the entire United States introduces regional heterogeneity and even some rural-urban heterogeneity (although rural areas are becoming a smaller and smaller proportion of national population). Nevertheless the figures are revealing. They show, first, that the only intra-group gains are for the two income groups over $10,000. We may infer that the bulk of the 8.8 points national gain is due to upward shifts in the proportions of households in the various income groups -- i.e., more in the upper income groups and fewer in the lower income groups in 1970 than in 1960.

TABLE 7

Changes in AA Index, U. S. Households by Income of Primary Family or Primary Individual, 1960 to 1970

Income	AA Index 1960	AA Index 1970	Change, 1960-70
Total - All Incomes	45.7	54.5	+ 8.8
Under $3,000	24.1	23.5	- 0.6
$3,000 - 4,999	44.9	41.3	- 3.6
$5,000 - 7,499	55.7	54.3	- 1.4
$7,500 - 9,999	63.3	63.2	- 0.1
$10,000 - 14,999	69.1	72.2	+ 3.1
$15,000 and over	76.5	79.7	+ 3.2

Source: Current Population Reports, Series P-65, No. 33. (Oct. 16, 1970). Derived from Table 1. For cars owned.

By 1970 the spread in difference in availability of the auto has become more pronounced than was the case ten years earlier. Without

any doubt, auto availability is highly correlated with income.

Table 8, as a national summary, shows that by 1970 there were roughly three levels of auto availability: the highest for households whose heads were 35 to 54; the next highest for the age groups on either side, 25 to 34 and 55 to 64; and the lowest for households whose heads were under 25 or were 65 and over. The table also shows that those age groups already associated with the highest levels of auto availability in 1960 had the greatest point gain in the AA Index from 1960 to 1970, thus further reinforcing previous differentials.

TABLE 8

Changes in AA Index, U. S. Households by Age of Household Head, 1960 to 1970

Age of Household Head	AA Index 1960	AA Index 1970	Change, 1960-70
Total - All Ages	45.7	54.5	+ 8.8
Under 25	42.3	43.7	+ 1.4
25 - 34	49.0	58.7	+ 9.7
35 - 44	53.2	64.9	+11.7
45 - 54	51.8	64.7	+12.9
55 - 64	44.4	54.1	+ 9.7
65 and over	28.4	32.0	+ 3.6

Source: Same as for Table 7. For cars owned.

We now present in Table 9 a detailed cross tabulation of change in auto availability, with households simultaneously broken down by income and by age of head. In other words, Tables 7 and 8 above, constitute the marginals for Table 9, except that in Table 9 two income

TABLE 9

Changes in AA Index, U. S. Households by Income and by Age of Household Head, 1960 to 1970

	Under $5,000			$5,000-9,999			$10,000-14,999			$15,000 and over		
Age of Head	1960	1970	1960-70	1960	1970	1960-70	1960	1970	1960-70	1960	1970	1960-70
Under 25	39.5	39.8	+ 0.3	50.6	52.2	+ 1.6	n.a.	60.5	n.a.	n.a.	n.a.	n.a.
25 - 34	39.8	37.9	- 1.9	56.2	57.5	+ 1.3	64.1	69.4	+ 5.3	n.a.	83.8	n.a.
35 - 44	40.3	39.3	- 1.0	60.2	61.9	+ 1.7	69.0	75.7	+ 6.7	76.8	81.6	+4.8
45 - 54	32.6	30.8	- 1.2	61.3	67.5	+ 6.2	72.2	75.8	+ 3.6	77.6	81.9	+4.3
55 - 64	32.7	32.5	- 0.2	50.8	58.4	+ 7.6	68.8	71.1	+ 2.3	79.7	79.6	-0.1
65 and over	22.1	24.8	+ 2.7	n.a.	45.3	n.a.	n.a.	58.9	n.a.	n.a.	68.5	n.a.

Source: Same as for Table 7. For cars owned.

groups below $10,000 replace four income groups in the previous tables. Some cells are not reported, apparently reflecting the dearth of households in these cells in the national sample surveyed. Nevertheless, several findings may be emphasized. First, if household income exceeds $15,000, the AA Index is high for virtually all households regardless of the age of the head. Second, if household income is under $5,000, the AA Index is generally low and falls sharply with increasing age of household head. Not unexpectedly, we find that older households with low income have the lowest auto availability of any households. Third, persons 65 and over seem particularly to gain in the availability of autos as their household income rises. It is households with older household heads, even as young as the 45 - 54 group, that turn out to be particularly disadvantaged in the nonavailability of autos.

Table 10 presents such additional breakdowns as are available: namely for metropolitan-nonmetropolitan locational status, and for tenure. The utility of these breakdowns is limited, since each is but a marginal distribution. But certain differentials are suggested: The metropolitan suburbs along with farms have had the largest increases in the AA Index this past decade. Owner households have had larger increases than renter households.

TABLE 10

Changes in AA Index for U. S. Households, by Metropolitan-Nonmetropolitan Status and by Tenure, 1960 to 1970

Selected Characteristics	AA Index 1960	AA Index 1970	Change, 1960-70
U. S. - All Households	45.7	54.5	+ 8.8
Metropolitan Areas - Total	41.3	54.2	+12.9
Central Cities	36.0	43.9	+ 7.9
Outside Central Cities	51.7	63.1	+11.4
Nonmetropolitan Areas - Total	49.3	55.0	+ 5.7
Nonfarm	49.9	54.8	+ 4.9
Farm	46.4	57.2	+10.8
Owner Occupied	52.2	62.3	+10.1
Renter Occupied	35.2	40.5	+ 5.3

Source: Same as Table 7. For cars owned.

Table 11 provides one further national comparison, black households and white households, but covers only the three-year period, 1967 to 1970. The table shows that black households, on average, have an AA Index of only about three-fifths of the average AA Index for white households. And certainly black households, for this brief period at least, did not seem to be catching up; if anything, the gap seems to be widening (although perhaps not at a level of statistical significance).

TABLE 11

Changes in AA Index for Black and White Households, U.S., 1967 to 1970

Race	AA Index 1967	1970	Changes 1967-70
Black households	31.1	32.1	+ 1.0
White households	55.6	57.0	+ 1.4

Source: Current Population Reports, Series P-23, No. 38 (July 1971). Derived from Table 77. For cars owned.

We now turn to a brief analysis of the relationship between auto availability (or nonavailability) and reliance upon public transit.

TRANSIT USE AS RELATED TO AUTO AVAILABILITY

The use of public transit is influenced in large part by the availability of an auto. Household members in households lacking any auto are often forced to rely on public transportation for work, shopping, recreation, and other purposes. Most households, even though at least one auto is available, do not have available as many autos as active adults. In such cases some household members find themselves without an auto for all or some of their trips. Some household members, especially the elderly, may also be unable or unwilling to drive because of ill health, physical limitations, or timidity.

In general, census data and evidence from other sources bear out the inverse relationship between auto availability and transit use. Table 12 invites a visual comparison between the reliance on transit for work trips and the AA Index. Such a comparison is an "ecological" one in the sense that we are comparing average characteristics for entire cities or counties rather than a direct comparison, household by household.

For the SMSA as a whole, about 20% of all trips to work were by public transit in 1960. The figure is pulled this high by San Francisco where over two-fifths of work trips were by transit. Next in transit use are two classes of cities: first, Oakland, Berkeley and Alameda as East Bay central cities where transit service is fairly intensive and, second, a number of San Mateo County cities where available transit service to San Francisco and a large volume of San Francisco workers boost

TABLE 12

Percent Transit Travel of Total Work Trips Compared with AA Index, Counties and Main Cities of the San Francisco-Oakland SMSA, 1960

County	City	% Transit Trips of All Work Trips	AA Index
SMSA - TOTAL		19.6	51.2
ALAMEDA		11.4	53.9
	Oakland	17.1	47.7
	Berkeley	15.1	49.4
	Alameda	12.2	51.7
	San Leandro	5.3	62.6
	Castro Valley	4.3	70.6
	Hayward	1.9	65.1
	Fremont	0.7	68.4
CONTRA COSTA		4.7	64.2
	Richmond	7.0	56.6
	El Cerrito	6.7	65.3
	Concord	2.8	62.8
MARIN		10.4	62.9
SAN FRANCISCO		42.4	34.5
SAN MATEO		12.6	64.2
	Daly City	17.7	60.2
	San Mateo	14.8	62.2
	San Bruno	10.5	61.8
	So. San Francisco	10.4	62.3
	Menlo Park	10.0	63.9
	Redwood City	9.3	62.9
SOLANO		2.6	59.3
	Vallejo	3.2	55.3

Source: Derived from 1960 Census.

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transit usage. Exceptionally low transit usage is found in southern Alameda County where, in fact, below Hayward, transit service is non-existent.

Within the San Francisco Bay Area the direct relation, household by household, of auto availability and trip patterns and mode was analyzed by the Bay Area Transportation Study Commission in their 1965 Bay Area Transportation Study. The results are shown in Table 13.

TABLE 13

Trips per Household, Trips per Person, and Mode of Travel, by Auto Availability, Nine-County Bay Area, 1965

Car Availability	Trips per - Household	Person	% Distribution, Mode of Travel Total	Auto	Transit	Walk or Other
TOTAL - ALL HOUSEHOLDS	8.4	2.7	100.0	75.7	7.9	16.4
No Car Avail.	3.9	2.0	100.0	17.9	30.5	51.5
One Car Avail.	8.1	2.7	100.0	73.1	7.5	19.5
Two Cars Avail.	11.4	3.1	100.0	80.4	4.6	15.0
Three or More Cars Avail.	14.2	3.4	100.0	85.5	3.5	11.0

Source: Bay Area Transportation Report (May 1969), Tables 3-6, 3-2. Trips per household and per person for total Bay Area derived from data on pp. 27 and 41. For cars available.

Auto usage rises markedly and transit usage falls abruptly with the increase in car availability. The difference is particularly prominent as between households with no car available and households with one car available. Differences persist as households move to two- and three-or-more car status, but at a slackening rate of change. The increase in the number of cars available is also associated with an increase in the trips per person. Households with two cars available average more than half again as many trips per person as households

with no car available (as well as nearly three times as many trips per household). Some mix of two possibilities seems likely: members in households with more cars are able to take trips they otherwise could not and households may get more cars because they are active and ordinarily take more trips per person. This table also shows a sharp drop in walk trips as cars become available.

It is essential to keep in mind the distinction between households with cars available and household members with cars available. As we have already stressed, most households have fewer cars than adults, meaning that some of these household members may not have an auto available for a given trip. This is well summarized in Table 14. This table reflects transit riders on A. C. Transit buses in the East Bay and bus or streetcar riders in San Francisco. In each half of the table it is the third column that is of particular significance: the percent of the transit riders who did not have an auto available to them at the time they made that particular transit trip. The first column on each half of the table shows that almost two-thirds of the transit riders canvassed came from households in which at least one auto was owned. The authors of the report from which the table was drawn point out that of the 47% of the transit riders from households owning one auto, more than half did not have an auto available at the time of the transit trip, and thus were "captive" riders. Riders from two-auto households are captive to a lesser extent -- about two-fifths had no auto available -- but even riders from households owning three or more autos were captive to a remarkable degree -- almost two-fifths had no auto available.

TABLE 14

Availability of Auto to East Bay and San Francisco Transit Riders at Time of Transit Trip, by Household Ownership of Auto, 1965

Autos Owned by Household	East Bay Transit Riders			San Francisco Transit Riders		
	% of Riders	Auto Availability % Available	% Not Avail.	% of Riders	Auto Availability % Avail.	% Not Avail
TOTALS	100.0	31.9	68.1	100.0	33.3	66.7
No auto	37.9	3.6	96.4	34.7	3.3	96.7
One auto	47.4	45.7	54.3	47.3	44.6	55.4
Two autos	12.9	59.7	40.3	14.9	61.2	38.8
Three or more	2.4	61.8	36.2	3.0	62.0	38.0

Source: Simpson and Curtin, Coordinated Transit for the San Francisco Bay Area - Now to 1975 (Oct. 1967), Table 9.

Up to this point we have stressed auto availability as a direct factor related to use or nonuse of public transit. We may also consider a complementary factor, the availability of the transit service itself. We do not have data on this for the Bay Area, but can present two informative cross tabulations from a study based on a sample of metropolitan areas in the United States. The upper tabulation shows that transit (common carrier) usage is correlated both positively with frequency of transit service and negatively with auto availability. The lower tabulation shows that auto usage is correlated both positively with auto availability and negatively with frequency of transit service. Thus, each tabulation depicts a surface that tilts perceptibly from lower left to upper right.

TABLE 15

Percent Usage of Common Carrier or of Auto as Way to Get to Work, by Variations in Auto and Common Carrier Availability, U.S. Metropolitan Areas, 1963

Availability of Auto: Household has --	Availability of Common Carrier: Total	No Service	Infrequent Service	Frequent Service
A. % Who Sometimes or Always Use Common Carrier				
No Auto	53	a	59	83
Fewer Autos than Adults	11	*	18	62
As Many Autos as Adults	5	*	10	a
B. % Who Always Go by Auto				
No Auto	24	a	29	*
Fewer Autos than Adults	80	90	78	38
As Many Autos as Adults	92	97	89	a

[a]Too few cases to percentagize.

*Less than 0.1%.

Source: John B. Lansing and Gary Hendricks, Automobile Ownership and Residential Density (June 1967), Table 12, p. 49.

One further view of the public transit situation in the Bay Area is provided in Table 16, based on data from Bay Area Survey No. 1. This shows the distribution of work trips by selected transportation modes, the percent of employed persons who work in San Francisco, the percent of households with bus stop within two blocks of home, and AA Index. The breakdown is for BART Corridors and for certain non-BART areas.

TABLE 16

Percent Work Trips by Public Transit, Percent Bus Stop Within Two Blocks, and AA Index, BART Corridors and Non-BART Areas, San Francisco-Oakland SMSA, 1971

Geographic Areas	% Work Trips by - Bus (or Street Car)	Train or Ferry	Auto or Car Pool	% Bus Stop within Two Blocks	% Work in San Francisco	AA Index
SMSA - TOTAL	14.7	0.9	68.6	53.0	36.1	58.9
BART Corridors						
Richmond-Berkeley	8.0	0	73.1	67.6	12.8	53.7
Oakland	15.2	0	73.1	76.4	14.1	55.4
Fremont-San Leandro	3.1	0	89.2	26.9	2.5	72.3
Concord-Orinda	10.4	0	74.2	13.1	13.9	73.2
Daly City-Mission	28.1	0	61.2	75.4	87.5	48.8
S.F.: Central & other	38.7	0	34.5	90.0	88.0	49.7
Outside BART Areas						
East Bay	0	0	77.5	11.6	1.2	62.8
San Mateo County	1.5	4.8	81.3	25.6	27.3	70.3
Marin County	7.8	1.8	77.6	17.5	34.3	71.8

Source: Bay Area Survey No. 1 (Summer 1971). AA Index based on cars available.

From Table 16 one can by visual inspection recognize some rough sense of negative correlation between percent of work trips by transit and the AA Index. One can also recognize some positive correlation between nearness of bus stops and use of transit. Let us test a cross-tabular approach resembling the Lansing-Hendricks cross tabulations reported above in our Table 15. Our table is very grossly based only on average figures for entire geographic sectors and hence represents at best merely a test of ecological correlation in contrast to their direct cross tabulation at the household level. Furthermore, we do not have frequency of transit service as an available variable and substitute the percent of households having bus stops within two blocks. As our main dependent variable we use the number of transit work trips (including bus, streetcar, train or ferry) per 100 work trips by auto (as driver, rider, or car pool driver or member).

TABLE 17

Transit Work Trips per 100 Auto Work Trips, by Nearness of Bus Stop and by AA Index, Residential Sectors of the San Francisco Bay Area, 1971

AA Index	Percentage of Households Within 2 Blocks of Nearest Bus Stop -- Less than 40%	40 - 69.9%	70% and Over
Less than 50	Note: The figure after each area (e.g., 11 after Richmond-Berkeley) = the number of transit work trips per 100 auto work trips.		Daly City-Mission 46 S.F.: Central and Other 112
50 - 59		Richmond-Berkeley 11 5-COUNTY BAY AREA TOTAL 23	Oakland 21
60 and over	Concord-Orinda 14** Non-BART: Marin Co. 12** *Non-BART: East Bay 0	*Fremont-San Leandro 4 Non-BART: San Mateo 8	

*Sectors with unusually low percentage working in San Francisco.
**Level of transit use higher than might be expected from its tabular position.
Source: Derived from Bay Area Survey No. 1.

We can also explore the relevance of place of work. We assume that work in the metropolitan center has a two- or three-way association with transit usage: first, the metropolitan center is more likely to have a good transit system in it and radially directed to it than are the other employment centers in the metropolitan area. Second, it is the metropolitan center that draws the long-distance commuters, and long-distance commuters may be more prone to take transit. And, third, long-distance commuters to the metropolitan center tend to come from

higher-income suburban areas. We offer a further cross tabulation in Table 18. Since San Francisco is the more important center but Oakland is a twin, but secondary, center, we arbitrarily weighted San Francisco employment 3 to Oakland's 1 and took a weighted average.

TABLE 18

Transit Work Trips per 100 Auto Work Trips, by Percent Working in San Francisco or Oakland and by AA Index, Residential Sectors of the San Francisco Bay Area, 1971

AA Index	Percentage Working in San Francisco (Weighted 3) and Oakland (Weighted 1) as Weighted Average -- Less than 10%	10 - 24.9%	25 - 49.9%	50% and over
Less than 50	See note in Table 17 re measure of transit use.			Daly City-Mission 46 S.F.: Central and Other 112
50 - 59		Richmond-Berkeley 11	Oakland 21 5-COUNTY BAY AREA 23	
60 and over	Fremont-San Leandro 4 Non-BART: East Bay 0	Concord-Orinda 14** Non-BART: San Mateo 8	Non-BART: Marin 12	

**Level of transit use higher than might be expected from its tabular position.
Source: Derived from Bay Area Survey No. 1.

Tentative and crude as the two cross tabulations (Tables 17 and 18) may be, they are suggestive of factors that bear on the amount of transit use over and beyond a negative relationship with the AA Index. In short, auto availability or nonavailability can be but one of a number of factors bearing on transit usage. Similarly, auto availability is but one component -- though presumably an extremely significant one -- of transportation disadvantage.

DIRECTIONS FOR FURTHER RESEARCH

This paper has endeavored to examine levels and differentials of auto availability, with particular emphasis on those Bay Area counties that will be served by BART. We have suggested a single measure, the AA Index, and have proceeded to employ that index to show geographic variation, changes over time, and some possible correlates. We offered some empirical evidence as to the inverse relation between auto availability and transit usage. We identified some of the differences in measures of auto availability that have been employed in the past, so as to be on guard against confusing them.

We have sought to communicate some sense of the pre-BART background situation. As BART comes into operation and the future unfolds it will be essential to monitor the levels of auto availability, and perhaps refinements of our index will prove helpful.

We propose to work on several modifications. With data from Bay Area Survey No. 1 and further surveys we should be able to document far more precisely the relation between the number of autos available and the number of active adults in the household. We should also provide more accurate data as to which household members do and do not have an auto available for specific types and timing of trips. Most households have one or more cars but fewer cars than adults. We must work to understand this situation with greater clarity.

Fortunately, we have a 1970 census that should become fully available during the coming year or so. And data grouped by small

geographic areas or political units will be supplemented by important Public Use Sample tapes providing a 1-in-100 sample in which one can get down to the individual household or person rather than depending upon already grouped data.

We are eager to be able to tap data and analysis provided by the group studying modal split. Their work on choice of travel mode will aid us in understanding features of transportation disadvantage. Perhaps some of our interest in level of auto availability will be helpful to them as well.

With our emphasis on transportation disadvantage, our future work may well focus more pointedly on those residential sectors and those population categories for which the auto is the least available. These questions persist: (a) How do household members manage to get along without autos in a world increasingly oriented to auto use? (b) How effectively do BART and other forms of public transit offer convenient, workable alternative transportation service?

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