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Empirical Analysis of the Interdependence of Parking Restrictions and Modal Use

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The relation between modal use and parking restrictions was analyzed by examining changes in travel behavior over time during a period of substantial change in parking restrictions, transit service, and transit fares. The situation examined was choice of travel modes to a major trip generator, the campus of the University of Wisconsin-Milwaukee. This area has major parking-congestion problems that have been partially alleviated by special transit services and remote parking lots. These systems have also been developed in conjunction with changes in parking restrictions. From an analysis of modal choices over time, it was found that shifts to transit use have occurred as a result of tighter parking restrictions and that shifts away from transit have occurred as a result of fare changes. Carpoolers seem to be most sensitive to changes, while the drive-along category showed less sensitivity. An analysis of respondents' reactions to probable future situations also indicated similar results.

As cities throughout the United States move toward the development and implementation of transportation system management (TSM) plans, an increasing amount of attention is being given to the relation between parking policy and transit use. Changes in parking policy, such as increasing its price, changing the schedule of rates, removing parking, and increasing parking restrictions, all are seen as potential means of increasing both transit ridership and the efficiency of the existing transportation system. It is felt that by making parking more difficult the relative advantage of the automobile will diminish and the attractiveness of transit as an alternative to it will increase. Given the potential of this strategy, it is surprising to find that the subject has received only limited study.

Mode-shift modeling has been an important part of the transportation planning process for some time, and several recent studies have reported on developing hybrid models to analyze the impact of changes in these variables. One study in particular (1) concludes that subjective preferences are useful for studying travel-mode diversion but that better means of controlling and monitoring changes in modal split through changes in policy-related variables are needed.

Several studies have dealt with short-term changes caused by such things as parking taxes and operator strikes (2, 3), while others have directly addressed the issue of the impact of changes in parking policy on transit use without empirical documentation (4, 5). Some of the literature provides an insight into efforts by our European colleagues to adjust the balance between automobile and transit use, but the applicability of their project conclusions to U.S. urban areas is questionable (6).

Therefore, a review of current literature seems to substantiate the claim that the United States does indeed need to better control and monitor mode-split changes. There has been little work on empirically relating changes in policy variables to mode choice. This current project was intended to help fill the gap and to provide transportation policymakers with a real-world understanding of the interrelationship.

PURPOSE

The purpose of this paper is to provide an analysis of the effects of changes in parking regulations on transit use. This will be done by looking at transit ridership trends and user attitudes in a particular situation over a period of time.

The situation that will be examined is ridership on the UBUS-UPARK, the transit service for the campus of the University of Wisconsin-Milwaukee (UWM). This service has developed over the past few years into a system of nine transit routes serving the campus from throughout the Milwaukee metropolitan area. Paralleling the development of the transit service have been significant changes in the level of parking restrictions in the campus area; the aim has been to make it difficult to commute to the campus by automobile.

This paper will look at (a) the changes in UBUS ridership during the time these restrictions have been implemented and (b) user behavior and attitudes toward these changes as they have occurred. This will be accomplished through the analysis of survey information of the entire market of travelers to the university area. This survey information has been developed to examine how individual travel patterns have changed in relation to changes in parking restrictions, transit service level, and transit prices.

BACKGROUND

Nature of Trip Generator

The UWM campus has many of the characteristics of a major trip generator: high trip-making activity, congested local streets, and severely limited parking supply. The campus is located on the east side of the city of Milwaukee approximately 5 km (3 miles) north of the Milwaukee central business district. The total enrollment of approximately 25 000 students and an additional 4000 faculty and staff yields a total university population of nearly 30 000. As such it is the second largest generator of trips in southeastern Wisconsin. On-campus housing accommodates only 1500 students (6.4 percent of the total), while the remaining students and staff commute to the campus.

The campus, extremely small for a university of this size, covers only 34 hectares (85 acres). Because of this small size, only 1900 parking spaces can be provided on campus for the 10 000 automobiles that are driven to the university each day. This leaves more than 8000 automobiles that must be parked on the surrounding streets.

Transit Service

In response to the severe parking problems in the university area, an extensive system of transit routes has been developed to provide an attractive alternative to the automobile. This service, called UBUS, (a) provides modified urban bus service to the university along bus routes that serve a large portion of the Milwaukee metropolitan area and (b) includes inducements to potential riders, such as direct no-transfer service, convenient schedules, minimum travel times, reduced fares, easily accessible off-street parking, convenient route locations, and a homogeneous rider group.

This service began with one route in September 1973 and carried about 2000 rides/day. It was expanded to a total of nine routes by September 1976 that carried about 6000 rides/day as shown in Table 1. Two types of service are offered: (a) UBUS service, which consists of long, radial transit routes that provide a direct link between many user origins and the campus and (b) shuttle services (UPARK), which directly connect remote parking lots and the campus. When the services came into operation they were free, but later they cost a small fare. Further details on the overall development of the UBUS program are available elsewhere (7-10).

As can be seen in Table 1, transit ridership on the UBUS-UPARK system has fluctuated during its period of operation. Ridership peaked at about 7000 rides/day in the fall of 1975, when UBUS routes operated at a 35-cent fare and shuttle service was provided free. After a fare was imposed in January 1976, shuttle ridership dropped by 1000 rides/day. As will be explained in the following section, these changes in transit service and fares were also accompanied by changes in parking restrictions in the university area.

Parking-Supply Changes

As transit service to the university has been expanded, there have been significant changes in the characteristics of the on-street parking supply surrounding the university. As shown in Figure 1, the number of unrestricted parking spaces has dropped from 2673 or 44 percent of the total available in 1972 to 899 spaces or only 15 percent of the spaces available in 1976. The major drop in unrestricted parking occurred in September 1975, when 1200 unrestricted spaces were changed to 1-h and 2-h parking zones. This was done at the same time that a remote parking lot for 800 cars with a free shuttle service was opened.

The only unrestricted parking that remains in the area is on scattered blocks or far from campus. Enforcement of parking restrictions is quite strict; cars must be moved every hour or two to avoid parking tickets. Furthermore, because of parking congestion, long walks to and from the parking place are necessary.

The net effect of these changes has been to make on-street parking increasingly more difficult both for commuters into the area and for local residents. The basic purpose of this analysis is to determine to what extent these changes in restrictions affected travel behavior in general and transit use in particular. The following sections will describe the analysis procedure and our results.

PROCEDURE

This project is the outcome of a survey distributed to a random sample of 10 percent of UWM's 25 000 students by mail in November 1976. Respondents were offered two options for returning the completed questionnaire: First, to return the completed survey in a postage-paid business reply envelope and, second, to receive a 25-cent cash incentive with the return of the survey to the UBUS ticket window in the student union. The incentive was almost the same as the postage rates for first-class business reply mail, 24 cents.

The survey was designed to obtain necessary personal data and data on value perception, modal preference, and changes in travel patterns from the respondents. Draft forms of the survey were administered to small sample groups for pretesting, and the final survey was printed on buff paper, which will yield a high initial rate of response.

In order to correct for bias in the mail survey, a telephone follow-up of nonrespondents was conducted. With this information, as well as that from previous surveys of the same travel market and ridership counts, it was possible to expand the data to provide a representative sample of the entire student population. Total response to the survey was 671 usable surveys, repre-

senting 2.7 percent of the total population.

The survey can be divided into three general categories of information. The first part of the survey provided personal data about the respondents with regard to geographic dispersion, class standing, enrollment history, family life, and employment. The second part dealt with travel behavior, mode choice, and relative effects of changes in transit service and parking availability. The last section posed hypothetical questions about future changes in the level of transit service and parking supply in an attempt to determine the effect of these changes on modal choice.

ANALYSIS

Student Background

The first portion of the analysis of data generated for this study presents an overview of responses to questions about personal background. The following is a summary of background information; a detailed analysis may be found elsewhere (11).

1. About 70 percent of all students enrolled at UWM are employed. More than half of them work more than 20 h/week and about 28 percent are employed full time.
2. The student population is geographically dispersed. The average home is more than 12 km (7 miles) from campus.
3. Most students travel to UWM more than four days a week.
4. About 65 percent of the student respondents attend daytime classes, 20 percent are exclusively night students, and the remainder have class schedules with both day and night hours.
5. Virtually all students (93 percent) possess a valid driver's license.
6. More than 73 percent of the respondents indicate that they have an automobile available on a regular basis for travel to the UWM campus.

A detailed analysis of the above information corresponds extremely well with demographic information obtained in previous studies undertaken by the Center for Urban Transportation Studies and other agencies.

Changes in Modal Choice Over Time

The survey was developed in such a way as to allow analysis of the different modes of travel used by the respondents in the fall of 1974, 1975, and 1976. The results of this analysis are shown in Figure 2 and indicate that the "drive alone" category increased somewhat in 1976 despite an increase in parking restrictions and a decrease in parking supply in the campus area.

Transit has shown a slight decline in overall use, and a substantial decrease (about 50 percent) appears

Table 1. Transit service to UWM, 1973-1976.

Type of Service	Sept. 1973	Sept. 1974	Feb. 1975	Sept. 1975	Jan. 1976	Sept. 1976
UBUS						
Number of routes	1	4	6	7	7	7
Route kilometers	17	76	113.5	138.5	138.5	138.5
Fare, cents	Free	25	35	35	35	35
Average ridership	2000	4763	4453	4744	4827	4399
UPARK Shuttle						
Number of routes	-	-	-	1	1	2
Route kilometers	-	-	-	4	4	10
Fare, cents	-	-	-	Free	15	15
Average ridership	-	-	-	2377	1338	1610

Figure 1. Changes in parking restrictions.

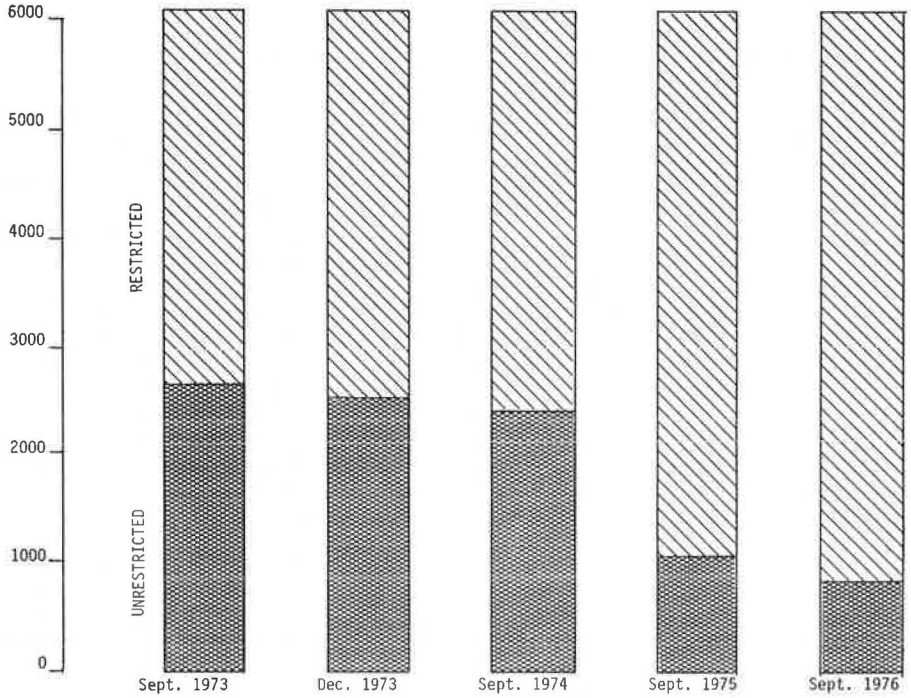

Figure 2. Most frequent travel mode to UWM as a function of time.

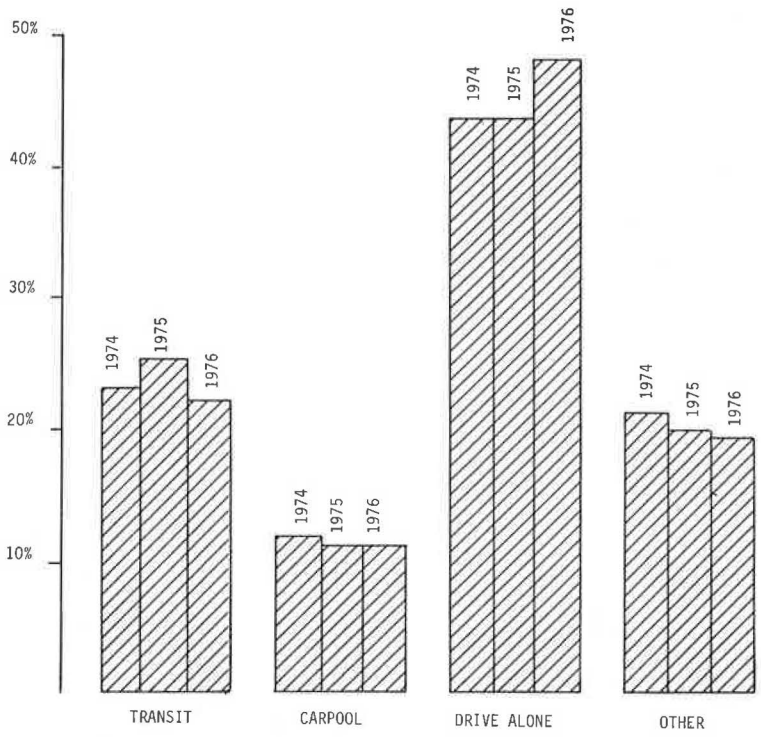

Table 2. Transition matrix for most frequent travel mode for 1974 versus 1975.

Most Frequent Travel Mode 1974	Most Frequent Travel Mode 1975 (%)					
	Transit	Carpool	Drive Alone	Other	Total	Valid Cases (N = 227)
Transit	77	4	17	2	100	53
Carpool	25	57	7	11	100	28
Drive alone	7	3	85	5	100	98
Other	4	6	4	86	100	48

Table 3. Transition matrix for most frequent travel mode for 1975 versus 1976.

Most Frequent Travel Mode 1975	Most Frequent Travel Mode 1976 (%)					
	Transit	Carpool	Drive Alone	Other	Total	Valid Cases (N = 364)
Transit	60	11	22	7	100	103
Carpool	17	46	32	5	100	41
Drive alone	7	6	85	2	100	154
Other	3	2	15	80	100	66

in shuttle-bus use. This decrease in shuttle-bus use is probably attributable to the change in price structure from a free service in 1975 to a 15-cent fare in 1976. Use of carpooling and other categories (chiefly walking, bicycling, and motorcycling) has remained nearly constant over time.

Respondents were asked to explain changes in their most frequent mode of travel, and this information is summarized below. These explanations seem to indicate that most respondents were not adversely affected by changes in parking policy.

Reason for Mode Change	Percentage Responding
Moved	40
Bought a car	15
Change in class times	11
Joined a carpool	7
Additional UBUS service	7
Sold car	5
Quit carpool	5
Other reasons	10
Total	100

A better understanding of the shifts that have occurred over time can be obtained by looking at the intermodal crossover rates in transition matrices as shown in Tables 2 and 3. A transition matrix provides a comparison of the mode of travel used by the respondent in one year with that chosen in the following year. With such a matrix, the portions of travelers that made no modal shifts is shown on the diagonal of the matrix while those that showed modal shifts are shown elsewhere. If there are no modal changes, the matrix would appear as a diagonal with zeros elsewhere. A further explanation of this subject follows.

Understanding the Transition Matrix

This report relies, to a great extent, on the transition

matrix as a means of presenting the analysis of survey data. This transition matrix is used to compare attributes of the study group in two time periods and, as its name implies, illustrates changes (transitions) in respondent behavior as a function of time.

Consider the following example. You and 49 other people are employed by a firm that allows each of its employees and their families a one-week all-expense-paid vacation each year. The company allows only four choices: London, Paris, New York, or Disneyworld. Assuming that each year all employees take advantage of this offer, let us further assume that last year the number of employees vacationing at each location is as listed below.

Location	No.	Vacations (%)
London	15	30
Paris	10	20
New York	10	20
Disneyworld	15	30
Total	50	100

All plan to return to the same location this year. In this instance, since there are no changes from the previous year's choices, the table also represents this year's employee vacation choices.

Table 4 presents a transition matrix that shows that there was no change in location choice in the two time periods: There are entries in the diagonal cells (i.e., London-London, Paris-Paris, etc.) only. If, however, you and your fellow employees had been inclined to vacation in a different city, this decision would be reflected by entries in the nondiagonal cells. The table below represents changes that could have occurred, and Table 5 is a transition matrix of all the information in this table.

Last Year		This Year	
Location	No.	Location	No.
London	15	London	3
		Paris	9
		New York	2
		Disneyworld	1
Paris	10	London	1
		Paris	7
		New York	0
		Disneyworld	2
New York	10	London	0
		Paris	6
		New York	1
		Disneyworld	3
Disneyworld	15	London	2
		Paris	8
		New York	3
		Disneyworld	2

The concise format of the transition matrix helps make it a powerful tool in the interpretation of change-related data. By examining the diagonal entries, consistencies become apparent. In our example, we can see that Paris was a more popular spot (70 percent return rate) than New York (10 percent return rate). The matrix also shows us that those who traveled to New York last year are unlikely to vacation in London this year (0 percent) and that those who traveled to Paris are not attracted to New York (0 percent). Many other observations about the travel preferences can be obtained from the transition matrix, and these observations can be related to experience and expectations surrounding each location.

Study Application of the Transition Matrix

This study uses the transition matrix in a manner similar to that of the above example. Also used, however, was information regarding actual and perceived changes in modal attributes, the availability and cost of parking and transit service, and other factors affecting mode choice. Once the reader has become familiar with the development and interpretation of the transition matrix, he or she will more fully understand the content of this report and perhaps be able to use this concept in similar studies.

In the first of the matrices (Table 2), the travel mode used in 1974 is compared to that used in 1975. This was the period during which substantial restrictions were added to street parking and an attractive alternative (a free shuttle bus from a remote parking lot) was provided to the automobile. This was also a period during which policies were strongly directed to encouraging a shift from automobile to transit. However, as can be seen from Table 2, the transit, drive-alone, and other modes remained relatively stable during this period. Transit experienced some shift in use to the drive-alone category (17 percent) but gained some riders who shifted from carpool to transit use (26 percent). Thus, it appears that most of the gain in transit ridership that occurred during the period was from a shift from carpooling (automobile passenger) rather than from driving alone.

Table 3 illustrates the modal shifts that occurred between 1975 and 1976. During this period a fare of 15 cents/trip was added to the shuttle-bus service, and there were some limited additional restrictions placed on parking. This would be thus characterized as a period when a disincentive to transit use (i.e., a higher fare) was imposed. As can be seen from Table 3, this was a period of instability for transit and carpool users.

Table 4. Transition matrix for unchanged vacation choice.

Place Chosen Last Year	Place Chosen This Year (%)					Valid Cases (N = 50)
	London	Paris	New York	Disneyworld	Total	
London	100	-	-	-	100	15
Paris	-	100	-	-	100	10
New York	-	-	100	-	100	10
Disneyworld	-	-	-	100	100	15

Table 5. Transition matrix for changed vacation choice.

Place Chosen Last Year	Place Chosen This Year (%)					Valid Cases (N = 50)
	London	Paris	New York	Disneyworld	Total	
London	20	60	13	7	100	15
Paris	10	70	0	20	100	10
New York	0	60	10	30	100	10
Disneyworld	13	54	20	13	100	15

Figure 3. Parking location as a function of time.

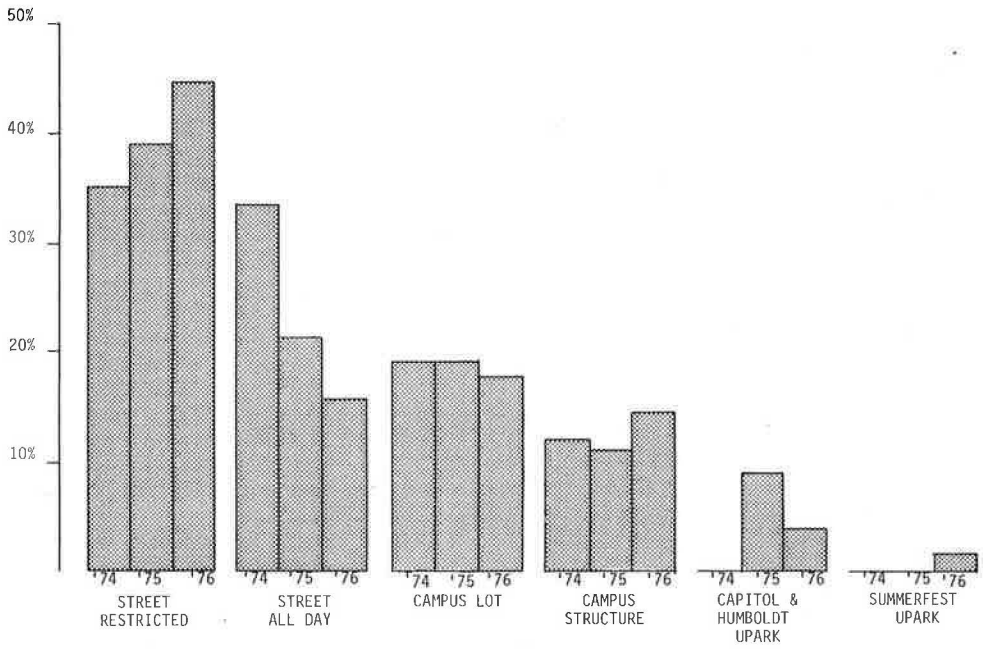

Table 6. Transition matrix for parking location for 1974 versus 1975.

Parking Location 1974	Parking Location 1975 (%) Street Restricted	Street All Day	Campus Facility	UPARK Lot	Total	Valid Cases (N = 157)
Street restricted	84	7	7	2	100	56
Street all day	18	60	6	16	100	50
Campus facility	8	6	84	2	100	51
UPARK lot	-	-	-	-	-	-

Table 7. Transition matrix for parking location for 1975 versus 1976.

Parking Location 1975	Parking Location 1976 (%) Street Restricted	Street All Day	Campus Facility	UPARK Lot	Total	Valid Cases (N = 234)
Street restricted	78	5	14	3	100	94
Street all day	30	51	15	4	100	46
Campus facility	13	6	77	4	100	71
UPARK lot	30	22	22	26	100	23

Former transit users (22 percent) and former carpoolers (32 percent) made fairly substantial shifts to the drive-alone category, but the shift away from transit was partly balanced by a shift from carpool to transit (17 percent).

The policy changes that occurred seem to have had their greatest effect on those who rode with someone else rather than on drivers. There is some limit to the extent to which increases in parking restrictions can lead to a shift to transit use. The respondents seemed to be much more sensitive to price changes than to changes in parking restrictions.

Changes in Parking Location Over Time

Changes in the location of student parking over time are an indication of changes in parking supply and restrictions. Figure 3 graphically summarizes changes in parking location during the 1974-1976 period. This figure illustrates several important points:

1. Use of restricted parking corresponds to increased restrictions on street parking.
2. The Capitol and Humboldt UPARK park-and-ride lot had a much lower rate of use in 1976 than in 1975.
3. The Summerfest UPARK park-and-ride lot is used by only 1 percent of the total market.
4. Campus parking structures are used more now than in the past, despite cost increases.
5. In general, on-street parking has increased by about 10 percent in the 1975-1976 period.

As was the case with mode-choice shifts, the transition matrix is useful for understanding changes in parking locations. Changes in parking location that occurred between 1974 and 1975 are shown in Table 6. Those who parked either in restricted street locations or in a campus facility during 1974 generally did not change locations in 1975. However, there were noteworthy changes in parking location for those who had used all-day on-street parking in 1974: About one-fifth of this group shifted to restricted on-street parking in 1975, and approximately one-sixth began to use the recently completed Capitol and Humboldt UPARK lot.

Changes that occurred between 1975 and 1976 are more dramatic. These changes are shown in Table 7. During this time the fare on the UPARK shuttle bus increased from no charge to 15 cents/ride, and there was a reduction in on-street unrestricted parking. The

table shows that about one-third of those who had parked in unrestricted street spaces began to park in restricted locations and about 15 percent began to use a campus parking facility. There were only minor changes in parking location for those who used on-campus parking facilities or parked on the street in restricted areas.

Those who had been using the UPARK shuttle service in 1975 tended not to do so in 1976. About one-quarter of this group began to use each of the other three parking location categories: street restricted, street all day, and campus facility. Only one-fourth of the 1975 UPARK patrons used the service during 1976, and of those who changed parking location in this period, the UPARK lots were the least likely location to be used in 1976.

Survey respondents were also asked to rank the effect of past changes in parking availability and UBUS routes and schedules. This information is summarized in Figure 4, which shows that more than 70 percent of all respondents were not affected at all by changes in UBUS routes and schedules and that only 6 percent were affected very much.

On the other hand, students appeared to be affected much more by changes in the price and supply of street parking. Almost 45 percent were affected somewhat or very much; 18 percent were affected a little; and 37 percent were not affected. Slightly more than 50 percent of the respondents were affected at least a little by changes in campus parking lots, but about 50 percent were not affected at all.

Future Travel Behavior

The third section of the survey was appropriately entitled "The Future" and was used to determine the effect of changes in transit fares and parking supply on mode choice. This was done by describing a series of hypothetical situations and asking the respondents what they would do in such a situation. Although what one says one will do in the future may not be what one actually does, such information is useful in comparisons of past behavior and other hypothetical futures. Analysis of the data obtained in this portion of the survey is provided in Tables 8-14, which are transition matrices similar to those used earlier.

Changes in Parking Restrictions

Tables 8 and 9 provide a comparison of two extreme alternate futures: one in which all street parking is unrestricted, the other in which student street parking is eliminated. Respondents were asked to select the mode they would most likely use if each of these conditions were to occur in the future. As can be seen from the tables, use of the drive-alone mode would increase somewhat with shifts from transit (primarily shuttle-bus users), carpool, and other categories if parking restrictions were removed. On the other hand, if street parking were eliminated, the transit mode would benefit from substantial shifts by the carpoolers and single drivers. However, it is interesting to note that about half of the drivers (48 percent) and the carpools (52 percent) would continue to use the automobile even if there were no street parking available.

Some insight into what would be done by those who now park on the street if parking were severely restricted can be found by looking at Table 10. Respondents were asked where they would park if all street parking were limited to an hour or less. As the table shows, about one-fifth of those who currently park on the street would no longer use their cars. Another fifth would continue to park on the street, while the remainder would seek parking—campus facilities, UPARK lots, or other locations (friends' garages or along UBUS routes). Nearly all of those who now use campus facilities or UPARK lots would continue to use these locations.

From these analyses, it can be seen that travelers to UWM exhibit some degree of sensitivity to potential changes in parking regulations. A loosening of restrictions would lead to some losses in transit ridership, while a tightening of restrictions would lead to larger shifts to transit. However, there is a tendency to stay with the mode being used in most situations.

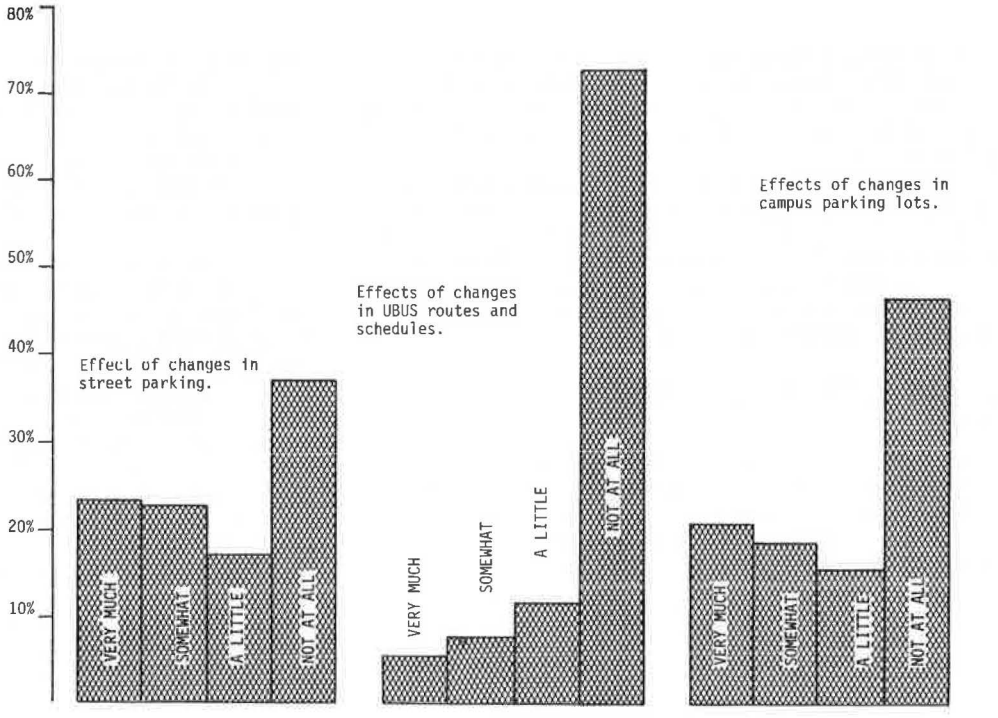

Figure 4. Effects of past changes in parking availability and UBUS routes and schedules.

Thus, the analysis of future conditions generally agrees with that of past changes.

Changes in Transit Fares

Tables 11-14 deal with future changes in UBUS fares and shuttle-bus fares, respectively. In Tables 11 and 12 the effects of two extremes in UBUS fares are analyzed. Table 11 looks at a free-fare service, while Table 12 deals with increasing the present 35-cent fare to 50 cents. If free transit service were provided, there would be a shift from the carpooling, driving alone, and other modes to transit (39 percent, 29 percent, and 15 percent, respectively). This shift is fairly large but not as substantial as the shift to transit if street parking were eliminated. If, on the

Table 8. Transition matrix for effects of all-day parking for present versus future mode.

	Future Mode (%)					
Present Mode	Transit	Carpool	Drive Alone	Other	Total	Valid Cases (N = 537)
Transit	67	8	19	6	100	145
Carpool	10	68	15	7	100	68
Drive alone	7	7	83	3	100	242
Other	1	6	10	83	100	82

Table 9. Transition matrix for effects of no street parking for present versus future mode.

	Future Mode (%)					
Present Mode	Transit	Carpool	Drive Alone	Other	Total	Valid Cases (N = 511)
Transit	91	1	3	5	100	144
Carpool	32	52	5	11	100	65
Drive alone	37	7	48	8	100	222
Other	3	2	3	92	100	80

Table 10. Transportation matrix for effects of 1-h street parking for present versus future location.

	Future Location (%)						
Present Location	Will Not Use Automobile	Street Restricted	Campus Facility	UPARK Lot	Other	Total	Valid Cases (N = 315)
Street restricted	23	20	34	11	12	100	138
Street all day	21	17	13	26	23	100	53
Campus facility	10	10	70	2	8	100	106
UPARK lot	10	0	0	90	0	100	18

Table 11. Transition matrix for effects of free-fare UBUS for present versus future mode.

	Future Mode (%)					
Present Mode	Transit	Carpool	Drive Alone	Other	Total	Valid Cases (N = 548)
Transit	96	0	1	3	100	150
Carpool	39	47	7	7	100	70
Drive alone	29	3	65	3	100	242
Other	15	2	1	82	100	86

Table 12. Transition matrix for effects of 50-cent UBUS fare for present versus future mode.

	Future Mode (%)					
Present Mode	Transit	Carpool	Drive Alone	Other	Total	Valid Cases (N = 534)
Transit	80	5	10	5	100	148
Carpool	14	75	4	7	100	69
Drive alone	5	5	88	2	100	233
Other	2	5	2	91	100	84

Table 13. Transition matrix for effects of free-fare UPARK for present versus future mode.

	Future Mode (%)					
Present Mode	Transit	Carpool	Drive Alone	Other	Total	Valid Cases (N = 510)
Transit	93	1	2	4	100	134
Carpool	29	54	8	9	100	65
Drive alone	17	5	75	3	100	230
Other	4	5	2	89	100	81

Table 14. Transition matrix for effects of 50-cent UPARK fare for present versus future mode.

	Future Mode (%)					
Present Mode	Transit	Carpool	Drive Alone	Other	Total	Valid Cases (N = 495)
Transit	86	2	6	6	100	125
Carpool	16	65	13	6	100	62
Drive alone	6	5	85	4	100	228
Other	1	5	3	91	100	80

other hand, UBUS fares were raised by 15 cents, only minor changes in mode choice would occur, and most people would stay with their present modes.

Tables 13 and 14 deal with changes in UPARK shuttle-bus fares. Again, two extreme futures are considered: one in which UPARK shuttle is changed to a free-fare structure and one in which UPARK shuttle fares are increased to 50 cents. The transition matrices indicate a shift toward transit (which includes the shuttle-service users) by carpoolers and drivers if the shuttle service were free and relatively little change if the shuttle fare were increased. As has been the case in the previous tables, carpoolers tend to exhibit a greater tendency to change modes than others do. Thus, from these analyses, it would appear that cost reductions in transit service will result in shifts toward transit, while increases will have less effect on ridership. Carpool users again seem to be the most sensitive of travelers to changes in price.

CONCLUSIONS

From the preceding analysis of the relation of transit use to parking restrictions and pricing changes, several conclusions can be drawn about the survey respondents.

From the analysis of past changes, it is apparent that shifts to transit use can occur as a result of tighter parking restrictions. They seem to have their greatest effect on those respondents who ride with someone else rather than on drivers or transit users. The respondents were much more sensitive to pricing changes than to changes in parking restrictions.

From an analysis of future situations, similar patterns occurred. Shifts from automobile to transit are likely as parking restrictions increase, again especially for those respondents who ride with someone. However, even with severe restrictions on street parking, many respondents felt that they would tolerate the inconvenience created by the restrictions rather than shift to transit. Decreasing the price of transit can also lead to increased transit use, while an increase in price had less effect on transit use.

It appears from the situation analyzed that the tie to the automobile is strong for many and that disincentives to automobile use will cause shifts to other modes only to a limited extent. This result should serve as a warning to those who expect major changes in mode use as a result of parking-policy changes.

Such disincentives need to be coupled with strong efforts to provide an attractive transit service as an alternative to the automobile. In that way, the two competing modes can be made to function in a complementary fashion for the overall efficiency of the transportation system. Further analysis of this important issue needs to be made so that a better understanding of the phenomenon can be applied in more effective policymaking.

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