

Equity Analysis of the Houston, Texas, QuickRide Project

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The equity considerations involved with the QuickRide program along the Katy Freeway in Houston, Texas, are examined. QuickRide allows two-person carpools to use the Katy Freeway high-occupancy vehicle lane during peak periods for a \$2 fee. Survey data gathered on QuickRide enrollees, along with 1998 QuickRide usage data, were analyzed for potential equity issues that might exist with the QuickRide program. QuickRide usage did not vary significantly by respondent income, occupation, age, or household size. Additionally, the difference between respondents' stated and actual use of QuickRide did not vary significantly by the respondents' income, occupation, age, or household size. However, QuickRide enrollees had significantly higher incomes and were significantly younger than drivers on the Katy Freeway main lanes. Therefore, although income was not an indicator of the amount of QuickRide use among enrollees, it was a significant indicator of whether an individual enrolled in the program. This result raises some equity concerns about the ability or interest of low-income individuals to enroll in the program. However, no drivers were made worse off as a result of the program. Additionally, once enrolled, the QuickRide program is a benefit to most travelers, as long as the occupants of the vehicle value their travel time at a rate that exceeds \$3 per hour each.

Economists have long recognized the potential of value pricing (or congestion pricing) to improve traffic flow (1–3) and reduce the societal costs of congestion. However, not until December 1995, with the opening of the SR-91 express lanes in California, was a value pricing project implemented in the United States. Because value pricing projects implicitly involve adjusting the price of travel, it is important to consider the financial impacts these projects will have on various groups of drivers. Low-income drivers typically spend a higher proportion of their income on transportation (4), so changes in transportation costs tend to affect this group to a greater degree. Additionally, equity concerns—resulting in political opposition—have been a primary reason in the delay or abandonment of many value pricing projects (5–8). Therefore, equity considerations are important both on their own merit and from the standpoint of successful implementation of a value pricing project.

This paper examines, ex post, potential equity issues with the high-occupancy toll (HOT) lane program on the Katy Freeway in Houston, Texas. The analysis examines a combined data set of revealed preference survey data with data on actual HOT lane use. Drivers' perceptions and use of the HOT lane are examined by their socioeconomic characteristics. The difference between stated use and actual use is also examined by socioeconomic characteristics. Finally, the potential costs and benefits to drivers of the HOT lane are briefly examined for additional insight into potential equity impacts.

HOUSTON HOT LANE (QUICKRIDE) PROGRAM

In 1984, a reversible high-occupancy vehicle (HOV) lane was opened along the Katy Freeway in Houston to allow transit vehicles and vanpools to bypass highway congestion. By 1988, occupancy requirements had been reduced to two passengers. Over time, traffic volumes increased on the HOV lane to the point where volumes exceeded capacity during peak periods. Occupancy requirements were then increased to three occupants during peak periods, causing traffic on the HOV lane to return to free flow but creating excess capacity. The peak periods were from 6:45 to 8:00 a.m. and 5:00 to 6:00 p.m. every weekday.

The Houston QuickRide Project was implemented in January 1998 to allow vehicles with two passengers to use the HOV lane during peak periods for a fee of \$2; this type of lane is known as a HOT lane. The objectives of the program were to increase overall person throughput along the Katy Freeway during peak periods, increase travel speeds on the mixed-flow lanes, and efficiently manage demand without adverse operating impacts on the HOV lane or the mixed-flow lanes (9).

QuickRide is one example of value pricing, which harnesses the power of the market—in this case, through tolls—to manage demand and control congestion on transportation facilities. The electronically collected tolls vary with the level of congestion, thereby encouraging drivers to use the facility efficiently. The peak-period tolls provide an incentive to change travel times, change travel modes, or to eliminate low-valued trips (10). Other than the Houston HOT lanes, the number of operational value pricing projects in the United States is limited. They include

- SR-91 express lanes in Orange County, California;
- I-15 HOT lane in San Diego, California;
- Port Authority of New York and New Jersey crossings;
- New Jersey Turnpike Authority facilities; and
- Two bridges in Lee County, Florida.

Several other value pricing projects are currently being considered throughout the United States under FHWA's Value Pricing Pilot Program (11).

Previous studies that examined numerous aspects of the QuickRide program were based on 1998 usage of QuickRide and data from a survey conducted in mid-1998 (9, 12, 13). The main findings from these studies were that

- The total demand for HOV-2 value pricing may be limited in major travel corridors despite large potential time savings;
- Substantial shifts in mode and time are possible with HOV-2 value pricing;

- Household size and income are good indicators, but HOV lane use is a poor indicator of the demand for HOV-2 value pricing; and
- QuickRide users were typically familiar with the Houston HOV system before signing up for the program.

These QuickRide studies only touched on the subject of equity by examining the characteristics of the average QuickRide user: a 38- to 49-year-old professional or manager with a household size of three or four and a household income of more than \$100,000. Survey respondents who participated in QuickRide had demographic characteristics similar to those who did not participate. However, participants were, on average, younger and had slightly higher incomes (9, 13). The issue of equity was never directly addressed.

EQUITY

To perform an equity analysis, the definition of equity must first be established. The 1994 *National Cooperative Highway Research Program Report on Congestion Pricing* defines equity as “the distribution of costs and benefits resulting from a policy decision. Traditionally, distribution has been considered with respect to household income” (14).

In addition, equity can be examined in three different ways (15):

- Horizontal equity is concerned with the fairness of costs and benefits between similar groups,
- Vertical equity with regard to income and social class is concerned with the allocation of costs among income and social classes, and
- Vertical equity with regard to mobility need and ability is concerned with measuring how well an individual’s transportation needs are met compared with those of the community.

This study concentrated on vertical equity issues with regard to income and social class. The impact and use of QuickRide were therefore examined primarily by income level and by occupation.

DATA SOURCES

The sources for this analysis included 1998 QuickRide usage data, 1998 QuickRide enrollee survey data, and the 1998 survey of Katy Freeway drivers who were not enrolled in QuickRide.

QuickRide Usage Data

The original usage data listed the Tag ID (transponder number) of each vehicle using QuickRide, the date the vehicle used QuickRide, and the time (hours, minutes, seconds) that the vehicle passed the QuickRide electronic toll collector. Data-recording errors resulted in the exclusion of 2 days of data (December 22 and 28, 1998), leaving 22,937 individual records of QuickRide usage during 1998 for all QuickRide enrollees (survey respondents and nonrespondents).

QuickRide Participant Survey Data

A survey was mailed to all individuals who registered with QuickRide between January 1998 and March 1998 to collect demographic and opinion data (9). Of the 387 surveys mailed, 190 were returned for a

49% response rate. All survey information was entered into a database, with each entry containing the QuickRide user’s name, a unique Survey ID number, and the responses to survey questions. On one survey, two names were listed, so the survey was removed. Also, not everyone listed in the survey data was also listed in the QuickRide signup data; those who were not listed in the signup data could not be linked to a transponder number or to any of the usage data. Seven surveys were removed because of this discrepancy, leaving 182 usable survey responses.

QuickRide Nonparticipant Survey Data

At the same time that the survey was mailed to QuickRide participants, another survey was mailed to users of the Katy Freeway who did not participate in QuickRide. Of the 2,500 surveys mailed, 289 were returned for a 12% response rate (9). In this survey, the respondents provided their household income, age, occupation, and household size.

For analysis purposes, a table was created that contained all of the survey responses and the corresponding QuickRide usage for those transponder numbers. For 54 QuickRide users who returned surveys, two transponders were listed under their names (because multiple people from a single household could register for the program). Although each user had obtained a unique transponder, only one survey per household was completed. It was assumed that the survey respondent was the one who owned the transponder with the higher usage rate. The database then contained 177 unique respondents who had completed the survey and made a total of 9,525 QuickRide trips during 1998. This selection of data biases results toward additional QuickRide trips per person. However, respondents used QuickRide an average of only 1.2 times per week, which was less than half of what they indicated in survey responses.

ANALYSIS OF DATA

Standard methods of statistical analyses were used to identify significant differences in QuickRide user variables. The Mann–Whitney test was used for two-way comparisons of ordinal data, analysis of variance was used for three- or five-way comparisons of continuous data, and the *t*-test was used for two-way comparisons of continuous data.

Perceived and Actual Usage of QuickRide

All survey respondents were asked to estimate how often they used QuickRide during morning and afternoon peak periods. Their responses were then compared with their actual weekly usage for 1998 (Table 1). Each respondent’s average weekly QuickRide usage was determined by dividing the respondent’s actual number of trips by the number of weeks left in 1998 after that user’s first QuickRide

TABLE 1 Stated and Actual Average QuickRide Trips

	Stated	Actual
Morning Usage (Trips per week)	1.50	0.78
Afternoon Usage (Trips per week)	1.35	0.42
Total Usage (Trips per week)	2.85	1.20

trip. Perceived and actual QuickRide usage during morning (6:45 to 8:00 a.m.) and afternoon (5:00 to 6:00 p.m.) peak periods was significantly different ($P \leq 0.01$). However, respondents' estimated usage correlated ($P \leq 0.01, r = 0.374$) with their actual usage of QuickRide.

The difference between actual and stated QuickRide use by income category, age group, household size, and occupation type (Table 2) was examined for significant ($P \leq 0.05$) differences. It was possible that respondents in low income groups may have predicted a large volume of QuickRide use but, due to the expense, chose not to make many QuickRide trips. However, the difference between stated and actual QuickRide use per week did not vary significantly by income, age, household size, or occupation. (The lack of significant difference could have been caused by the small sample sizes and high variability within groups. A new study of the QuickRide program is under way, and with more QuickRide users now, the problem of a small sample size may be overcome.) Therefore, although survey respondents greatly overstated their use of QuickRide, this overstatement did not vary significantly by socioeconomic characteristics.

Factors Influencing QuickRide Use

The average morning, afternoon, and total QuickRide use were presented in previous studies on the QuickRide survey and usage data (9, 13). The average usage data used in this study differ only slightly because of the method used to calculate average weekly trips, and the method used to determine which transponder records linked to a particular survey in the case of multiple transponders belonging to a single household.

Of the 177 survey respondents, only 10 individuals had household incomes under \$40,000. To ensure adequate sample sizes for a statistical analysis, the income categories were aggregated. A high-income

group (104 respondents with annual household incomes exceeding \$75,000) and a low-income group (48 respondents with annual household incomes below \$75,000) were developed; 25 respondents did not indicate household income. Using this distribution, there were no significant differences by income in morning, afternoon, or total QuickRide usage. Users in both groups had similar usage patterns, suggesting that household income was not a significant factor in a respondent's amount of QuickRide usage.

In the event that the aggregation of household income categories may have hidden significant differences between groups, household income was also split into three groups: low (less than \$40,000), medium (\$40,000 to \$100,000) and high (greater than \$100,000) household incomes. Statistical analysis indicated that, as before, QuickRide usage did not vary significantly by income level.

Respondents listed their ages in one of five categories; morning, afternoon, and total amount of QuickRide usage did not vary significantly with the age of the respondent. Respondents listed their household size in one of four categories; statistical analysis revealed that a respondent's morning, afternoon, and total use of QuickRide did not vary significantly by household size. Respondents were asked to give their occupation, with eight choices, and a ninth choice of "other." Of the 172 respondents who stated an occupation, 94% had a professional, managerial, technical, administrative, or clerical occupation; statistical analysis revealed that a respondent's morning, afternoon, and total use of QuickRide did not vary significantly by occupation.

Other factors were examined to determine whether they significantly affected QuickRide usage. One survey question asked whether the respondent would increase QuickRide usage if the program allowed single-occupancy vehicles onto the HOV lane. Of those who responded, 135 users would increase usage if allowed to drive alone and 42 would not. Those who would increase their usage if allowed to drive alone on the HOV lane used QuickRide significantly ($P = 0.034$) less than those who would not increase usage.

Respondents were also asked how expensive they felt QuickRide was and how much the price factors into their use of QuickRide (both on a scale from 1 to 5). There were no significant differences in the respondents' use of QuickRide based on either of these responses. In summary, there was little difference in QuickRide use among the socioeconomic groups of QuickRide enrollees.

Factors Affecting Opinion of QuickRide Price

Three questions on the QuickRide survey were related to the respondent's opinion of the QuickRide price (\$2 per use). For two of the questions, the respondent was asked how expensive they felt the price was and how much price factored into their decision to use QuickRide (both on a scale from 1 to 5). A third question asked whether the respondent would increase their usage of QuickRide if the price were reduced. For each of these questions, the respondents' answers did not vary significantly based on household income, household size, age, or occupation.

Factors Affecting Opinion Regarding Driving Alone on HOV Lane

QuickRide users were asked whether they would increase their usage of QuickRide if they were allowed to drive alone on the HOV lane. The respondent's opinion regarding driving alone did not vary significantly based on household income, household size, age, or

TABLE 2 Difference in Stated and Actual QuickRide Trips, by Demographic Category

Category	Stated Minus Actual Weekly Number of Trips (Morning)	Stated Minus Actual Weekly Number of Trips (Afternoon)
Household Income		
Under \$75,000	0.70	0.98
Above \$75,000	0.79	0.97
Age		
16 to 25	1.81	1.29
26 to 37	0.39	0.90
38 to 49	0.77	0.97
50 to 64	0.72	0.70
65 and over	1.74	0.60
Occupation		
Professional/Managerial	0.71	1.00
Technical	0.46	1.14
Sales	0.51	0.37
Administration/Clerical	0.69	0.35
Manufacturing	-	-
Retired	2.82	1.75
Student	2.92	-0.04
Unemployed	-	-
Other	-0.41	0.18
Household Size		
1 to 2	0.76	1.07
3 to 4	0.63	0.89
5 to 6	0.98	0.75
7 or more	-0.31	-0.36

occupation. Also, the respondent’s opinion on driving alone on the HOV lane did not vary significantly based on their opinion of the QuickRide price. The only significant finding was that those who used QuickRide with a family member were significantly less likely ($P = 0.032$) to increase their QuickRide usage if they could drive alone in the HOV lane than those who did not ride with a family member.

**Factors Affecting QuickRide Users
Sharing Price of QuickRide**

Survey respondents were asked whether they shared the price of QuickRide with the passenger in their carpool. Of the 173 users who responded to the question, only 27% shared the price of QuickRide. Respondents who shared the QuickRide toll did not vary significantly from those who did not based on household income, household size, age, or occupation. However, respondents who used QuickRide with family members were significantly less likely to share the QuickRide price ($P \leq 0.01$) than those who did not travel with family members. This result seemed intuitive, because most users riding on QuickRide with a family member would consider the \$2 toll as a single charge to the entire household.

QuickRide Users and Nonusers

Socioeconomic data from the survey of Katy Freeway travelers who did not enroll in QuickRide were compared with that of the QuickRide users (Table 3). Those who enrolled in the QuickRide program were younger ($P \leq 0.01$) and had higher incomes ($P = 0.039$) than those who did not enroll.

By making several assumptions, the average age, household size, and household income of the average QuickRide user survey respon-

dent and nonuser survey respondent were roughly estimated. For each age group on the survey, the average age of the group’s range was assumed, and users over 65 years old were assumed to be 70 years old. For household size, the mean household size of each group was assumed, and the “7 or more” group was assumed to be a household size of 8. For household income, the “\$10,000 or less” group was assumed to have an average household income of \$10,000, and the “over \$100,000” group was assumed to have an average household income of \$150,000. The remaining groups were assumed to be the average of their income range.

The average age, household size, and household income of users and nonusers were then calculated (Table 4). These results compare well with results from a 1989 survey conducted by the Texas Transportation Institute on drivers on the main lanes of the Katy Freeway (16). In the 1989 survey, the median age was 40, and the percentage of drivers in each occupation category was very similar to that determined in the 1998 survey.

COSTS AND BENEFITS OF QUICKRIDE

Because the focus of this research was on the equity issues associated with the QuickRide program, this analysis of the costs and benefits of QuickRide was limited to drivers only—users and nonusers. The externalities of the program, as well as the costs and benefits of the program to the operating agency, were not addressed.

The costs of the QuickRide program were charged solely to those who used it. Therefore, nonusers were not disadvantaged in any way; those traveling in the main lanes experienced a small reduction in traffic, and HOV and transit users in the HOT lanes experienced more traffic but still traveled at free-flow speeds. Any free services a motorist using the Katy Freeway had before the implementation of QuickRide remained free after the program began. For users who

TABLE 3 Demographics of QuickRide Users and Nonusers

	Users (N=152)	Nonusers (N=248)
Household Income		
Less than \$50,000	13.2%	23.4%
\$50,001 to \$75,000	18.4%	16.9%
\$75,001 to \$100,000	25.0%	22.6%
Over \$100,000	43.4%	37.1%
Age	(N=174)	(N=283)
16 to 25	2.9%	1.4%
26 to 37	26.4%	23.3%
38 to 49	55.7%	38.5%
50 to 64	12.1%	31.4%
65 and over	2.9%	5.3%
Occupation	(N=172)	(N=285)
Professional/Managerial	77.9%	71.2%
Technical	6.4%	4.9%
Sales	2.3%	5.3%
Administration/Clerical	9.3%	12.3%
Manufacturing	0%	1.1%
Retired	0.6%	1.4%
Student	1.7%	1.1%
Unemployed	0%	0.4%
Other	1.7%	2.5%
Household Size	(N=171)	(N=240)
1 to 2	39.8%	44.2%
3 to 4	46.8%	45.4%
5 to 6	11.7%	9.6%
7 or more	1.8%	0.8%

TABLE 4 User and Nonuser Average Age, Household Size, and Household Income

	Average Age	Average Household Size	Average Household Income
Users	42.1	3.0	\$103,454
Nonusers	46.0	2.9	\$94,194

did enroll in the program, another transportation option was available to them for their morning and afternoon commute. Although the price (both implicit and explicit) of using QuickRide might have prohibited regular use of the HOT lane for some drivers, the option to bypass regular congestion was available for those times when a user’s value of time exceeded the minimum value of time savings offered by QuickRide.

There were almost no significant differences between the perceptions of QuickRide or QuickRide usage among the socioeconomic groups of QuickRide enrollees. The one significant difference that may indicate a potential equity concern was that QuickRide enrollees had significantly higher incomes than drivers on the Katy Freeway who had not enrolled. To better understand why QuickRide users typically had higher incomes, the cost of signing up for QuickRide was examined. To enroll in the program, a \$15 transponder deposit was required, along with a \$40 prepaid account. Each time a transponder was used, a \$2 fee was deducted from the prepaid account. Once the account depleted to a value of \$10, the user’s account was charged to bring the credit back to \$40. A \$2.50 monthly service fee was also charged for each transponder. A credit card was required to enroll in QuickRide. This requirement, along with the fees, could have made QuickRide prohibitively expensive for some users, particularly those with low incomes.

For each QuickRide use, two primary costs were involved: the cost of the toll (\$2.00) and the cost involved in forming a two-person carpool. The \$2.00 toll would seem relatively more expensive to an individual with a lower income than it would to an individual with a higher income. Also, low-income individuals already spend a higher proportion of their income on transportation (4). However, the cost involved with forming a two-person carpool (mainly a time cost) would seem relatively more expensive to an individual with a higher income because of their higher value of time.

A QuickRide trip provided an estimated value of time savings of \$6.00 per hour (9) based on a 20-min average time savings from using the lane. Therefore, it was assumed that if the combined value of time of the two members of a carpool exceeded \$6.00 an hour, then the two individuals would use QuickRide. However, in practice, fewer than 12% of QuickRide participants averaged more than two QuickRide trips per week, despite the users’ high average income.

There were several possible reasons for the infrequent use of QuickRide.

- Enrollees carpooled only occasionally and therefore used QuickRide only occasionally. However, a large number of QuickRide users carpooled frequently, and many took their children back and forth to school. Therefore, this reason does not explain the low frequency of QuickRide use.
- Enrollees used the program only when traffic appeared to be much worse than average. However, from usage records, QuickRide had a fairly consistent number of uses per day and did not fluctuate greatly. Therefore, this reason cannot explain infrequent usage.
- Drivers and passengers simply did not value their time at more than \$6/h (per vehicle) very often. In other words, the QuickRide pro-

gram might have been considered by many drivers to be a rare luxury, used only when saving time was particularly important.

The data gathered about QuickRide users and nonusers suggest that the monetary costs involved with QuickRide are still great enough to deter some people from signing up for the program. However, the top five responses of nonusers asked why they did not enroll in QuickRide were (9)

- Have no one to carpool with (16%),
- Do not know how to sign up (15%),
- HOV lanes should be free (14%),
- Price is too high (12%), and
- Do not want to carpool (12%).

So, although cost is a deterrent for some potential users, there are also many other significant deterrents, including the hassle of forming a two-person carpool.

CONCLUSION

For the QuickRide enrollees who responded to the survey, QuickRide usage did not vary with income, age, occupation, or household size. Opinions on QuickRide price, opinions on driving alone on the HOV lane, and whether a user shared the price of QuickRide did not vary with income, age, occupation, or household income, either. However, QuickRide users who filled out the survey had higher incomes and were younger than Katy Freeway drivers who did not enroll in the QuickRide program.

The price of signing up for and using QuickRide could account for this difference. The QuickRide program could potentially benefit anyone traveling along the Katy Freeway in a two-person carpool with a combined value of time greater than \$6.00 per hour. The cost implied with forming a two-person carpool may also have deterred some individuals from using QuickRide. However, this cost should not prove greater to individuals with a lower household income.

QuickRide increased the number of travel choices along the Katy Freeway for those who enrolled in the program. At the same time, some cars moved from the main lanes to the HOV lane, though not enough to significantly decrease congestion in the main lanes. Those who used the HOV lane for free (three or more person carpools and transit riders) were no worse off due to the program because the HOV lane remained uncongested during peak periods. Therefore, no individuals were worse off due to the program. If the program had any drawbacks in terms of equity, it is the possibility that the price prohibits some individuals with lower incomes from enrolling in the program.

It is recommended that a study be conducted to determine why many individuals choose not to enroll in QuickRide and why those who do use QuickRide so infrequently. A project is currently under way to further investigate equity issues and driver opinion regarding the QuickRide program. With this information, a better understanding

can be developed on the demand for HOV-2 value pricing and on the equity considerations of other HOT lane programs.

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