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Observed Traffic Pattern Changes Due to Variable Tolls

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In August 1998 the Midpoint and Cape Coral Bridges in Lee County, Florida, began charging variable tolls based on the time of day. Traffic data collected at these two bridges are examined, including the number of vehicles, by transaction payment type and by time of day. These data were analyzed to determine if variable pricing toll discounts have changed traffic patterns at the toll bridges. Data collected from January through July 1998 (before the implementation of variable pricing) were compared to data collected from August through December 1998 (during variable pricing). The data were examined in both aggregate and half-hour time increments throughout the day. This allowed for initial analysis of ways that traffic volumes have shifted by time of day due to discounted tolls. Data were also collected on the payment methods of all bridge users. This information is critical, since only those users paying their toll electronically (approximately 23 percent of transactions) are eligible for the variable pricing toll discounts. Therefore, two groups were examined separately—eligible users (the test group) and ineligible users (the control group). Variable pricing was found to have caused significant changes in the travel behavior of eligible users. On the Cape Coral and Midpoint Bridges, the number of eligible users increased significantly during the discount periods and decreased significantly during the peak periods. In contrast, changes in the traffic patterns of ineligible users were found to be statistically insignificant.

In an effort to better understand driver responses to variable tolls and, to a lesser extent, to manage traffic congestion, variable pricing began August 3, 1998, on the Midpoint and Cape Coral toll bridges in Lee County, Florida. As of that date, bridge travelers could receive a 50 percent discount on their toll by traveling during specific discount periods—from 6:30 a.m. to 7:00 a.m., from 9:00 a.m. to 11:00 a.m., from 2:00 p.m. to 4:00 p.m., and from 6:30 p.m. to 7:00 p.m. This project is one of four variable tolling projects operating in the United States and is part of the FHWA Value Pricing Pilot Program. As such, user response to variable pricing and the resulting impacts on traffic are being carefully monitored.

Lee County, located along Florida's southwest coast, has a population of 400,000 citizens, the majority of whom reside in or near the cities of Cape Coral and Fort Myers. These two cities are separated by the Caloosahatchee River (see Figure 1). The majority of employment is on the Fort Myers side and, therefore, the four bridges connecting Cape Coral to Fort Myers accommodate a great deal of the commuter traffic in the county. Two of these bridges, the Cape Coral and the Midpoint, are tolled, and variable pricing was implemented on these two bridges only.

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This geography is beneficial to the study of variable pricing since applying variable tolls on these two toll bridges could affect traffic throughout much of the county. Additionally, Lee County does not suffer from severe congestion. Levels of service in 1998 during the peak hour of the peak season on the four bridges crossing the Caloosahatchee River were as follows: Caloosahatchee, C; Edison, B; Midpoint, C; and Cape Coral, C. Therefore, any traffic changes resulting from variable pricing will likely be due to economic factors (toll savings) and not to congestion (reduced travel time outside the peak period). These factors greatly increase the likelihood that any observed traffic changes are due to the toll savings offered by the variable pricing program.

The Midpoint Bridge opened in October 1997. In 1994 tolls were raised from $0.75 to $1.00 on the Cape Coral Bridge to help finance the construction of the Midpoint Bridge. At that time the Lee County Commission promised citizens it would not raise bridge tolls for the foreseeable future. This led to the current variable pricing toll discount program, in which tolls are discounted by 50 percent in the periods just before and just after the morning and evening peak periods (6:30 a.m. to 7:00 a.m., 9:00 a.m. to 11:00 a.m., 2:00 p.m. to 4:00 p.m., and 6:30 p.m. to 7:00 p.m.) for those patrons paying the toll electronically.

The opening of the Midpoint Bridge significantly altered traffic in the region, particularly trips across the Caloosahatchee River. Therefore, no data from before January 1998 were analyzed in this study. The majority of the data comparisons presented in this paper compare data collected from January to July 1998 (before the implementation of variable pricing) with data collected from August to December 1998 (during variable pricing.)

As in many cities in the United States and around the world, traffic in Lee County fluctuates by time of year. Generally, more traffic is seen from January to April than at any other part of the year because of tourists in the county. Fortunately, the Midpoint and Cape Coral bridges are minimally affected by tourist traffic. In fact, of the nearly 50 year-round traffic count sites (covering most of the county's roadways) in Lee County, only one location has less seasonal traffic fluctuation than do these two bridges.

HYPOTHESIS

Due to the discounted toll available from 6:30 a.m. to 7:00 a.m., 9:00 a.m. to 11:00 a.m., 2:00 p.m. to 4:00 p.m., and 6:30 p.m. to 7:00 p.m., people are expected to alter their time of travel to pay this lower toll. The full toll is either $1.00 or $0.50 [most electronic toll collection (ETC) patrons have a discount program that allows them to pay only $0.50 per trip instead of the full $1.00 fare]. The variable pricing discount fare is 50 percent of the full fare, either $0.50 or $0.25. However, not all bridge patrons are eligible for this discounted toll rate. Only those patrons paying the toll electronically (23 percent

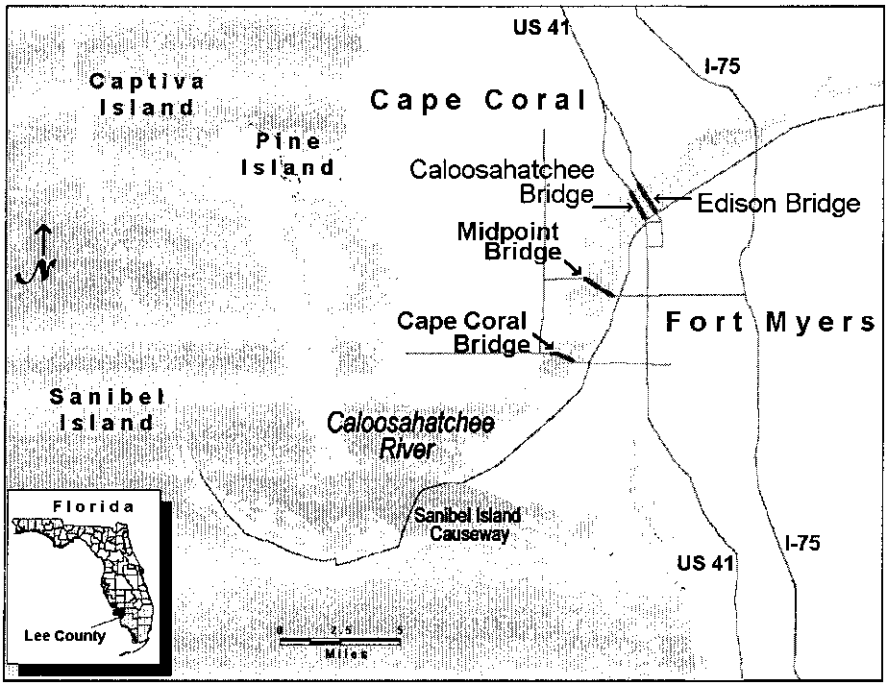

FIGURE 1 Lee County, Florida.

of transactions) are eligible for variable pricing discounts. Those patrons not eligible for the discount are not expected to alter their time of travel and will be examined separately from those patrons who are eligible to receive the discount.

Therefore, the null hypothesis states that no significant change in time of travel has taken place for both eligible and ineligible bridge patrons. To determine if a significant change has occurred, researchers will compare the mean number of vehicles traveling during specific half-hour increments (e.g., 6:00 a.m. to 6:30 a.m.) for the months before variable pricing with those for the months with variable pricing. If variable pricing is working as expected, this hypothesis will be accepted for ineligible patrons but rejected for eligible patrons (because a significant change has occurred).

Finally, since the discounted tolls are only available to bridge patrons who pay their tolls electronically, variable pricing could possibly influence more bridge users to obtain electronic toll accounts. The null hypothesis states that no significant change has occurred in the percentage of tolls paid with accounts eligible for discounted tolls. Again, if variable pricing is inducing the expected impacts on trip making, this hypothesis would be rejected. Of course, this is not the only reason for bridge travelers to purchase an ETC account. However, in a recent telephone survey performed on 400 frequent bridge travelers in Lee County in November 1998, over 50 percent of respondents indicated that variable pricing was one of their main reasons for purchasing an ETC account. Of the 139 respondents with ETC, 75 (54 percent) indicated that the variable pricing toll discounts were one of their main reasons for obtaining ETC.

DATA COLLECTION EFFORT

The data required to accept or reject the above hypothesis are collected automatically at the toll plazas. For each vehicle, equipment at each toll plaza records the time of transaction and the method of toll payment. This information, for all vehicles crossing the three toll bridges in 1998, is analyzed and presented in this paper.

As discussed previously, not all traffic that crosses the toll bridges is eligible for the variable pricing discount. Only those patrons using LeeWay PrePay (paying the toll electronically) are eligible for variable pricing discounts. In fact, only 23 percent of Midpoint and Cape Coral traffic is currently eligible for discounts.

All Saturdays, Sundays, and certain holidays (New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving, and Christmas) were excluded from the data, because variable pricing discounts are not offered on these days. Additionally, the week of September 21 was excluded due to the abnormal traffic patterns caused by Hurricane Georges.

First, traffic at the Midpoint Bridge was examined. Figures 2 and 3 indicate the percentage change in the average half-hourly traffic from before variable pricing to during variable pricing for eligible and ineligible vehicles, respectively. The half-hourly traffic volumes from the pre–variable pricing period were increased by 8 percent across the day to account for the lower average daily traffic during that time frame. If the data are altered in this way, no change in total traffic is seen throughout the day, but differences in traffic in each half-hour period are easier to see graphically. Figures 4 and 5 display similar data obtained from the Cape Coral Bridge.

Since only 23 percent of the traffic stream is currently eligible for variable pricing, the numbers of vehicles altering their travel times are not as dramatic as the percentages. As the number of eligible patrons continues to increase, the impact of variable pricing will grow. Table 1 lists the differences in the average number of vehicles per day that have traveled during the times listed.

The payment method used by bridge travelers was also examined. Figure 6 indicates the payment method used by travelers on the Midpoint and Cape Coral Bridges. Eligible users are those patrons that pay their toll electronically using their LeeWay tag. This includes users that pay the full ($1.00) fare and users that pay

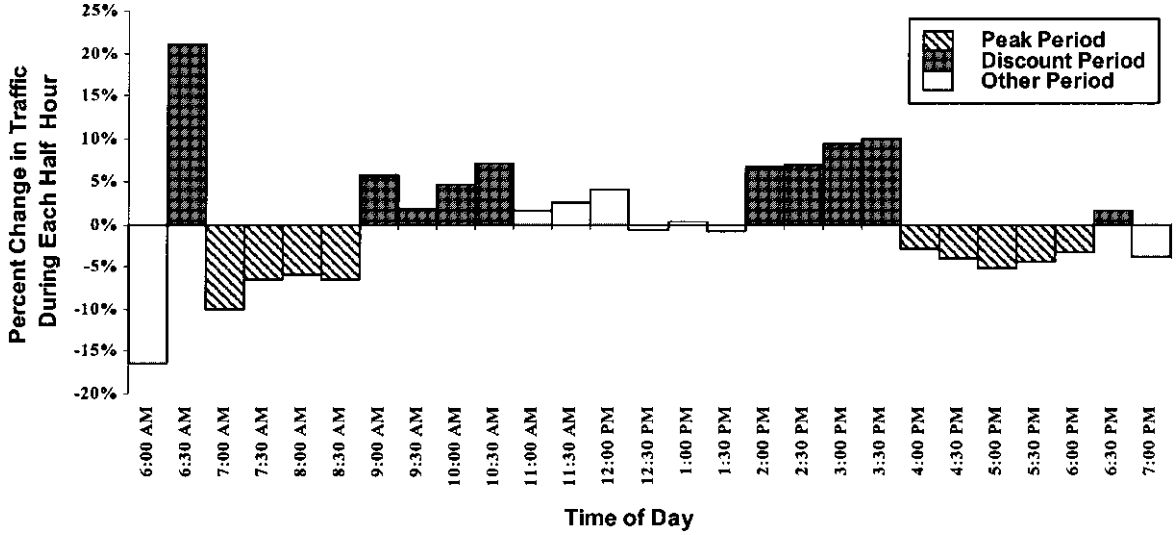

FIGURE 2 Traffic changes of eligible users on Midpoint Bridge.

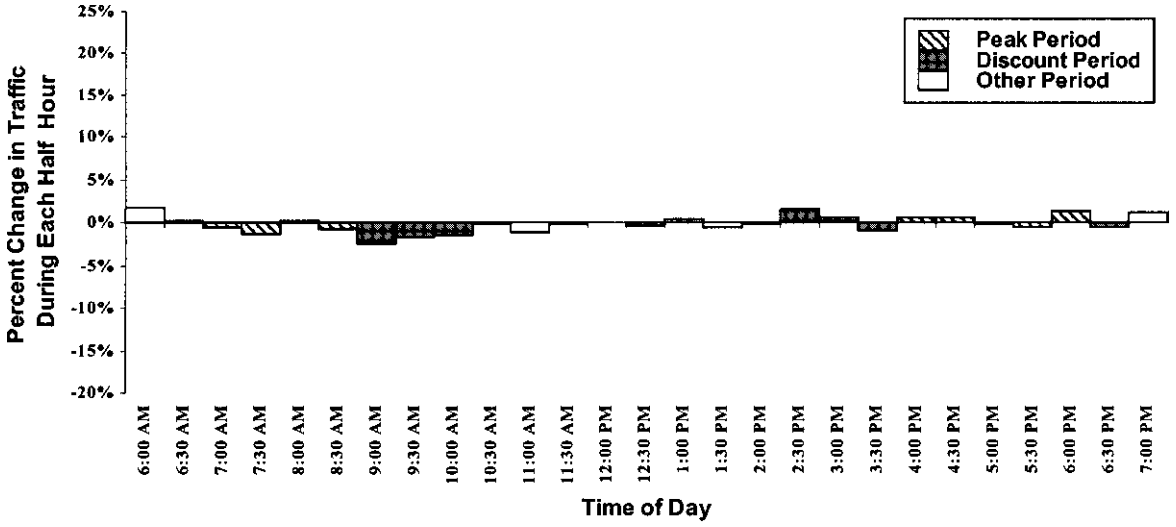

FIGURE 3 Traffic changes of ineligible users on Midpoint Bridge.

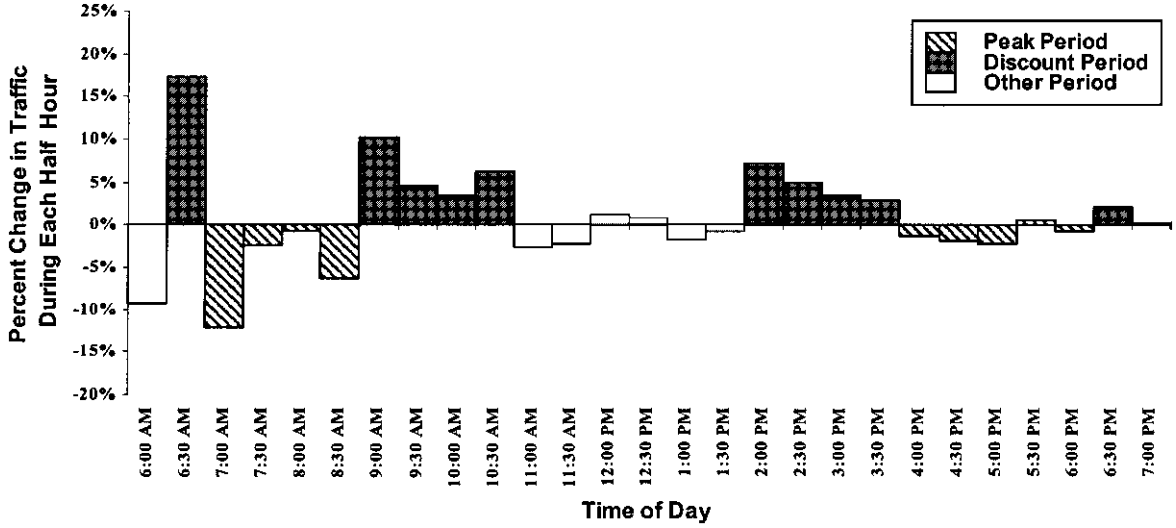

FIGURE 4 Traffic changes of eligible users on Cape Coral Bridge.

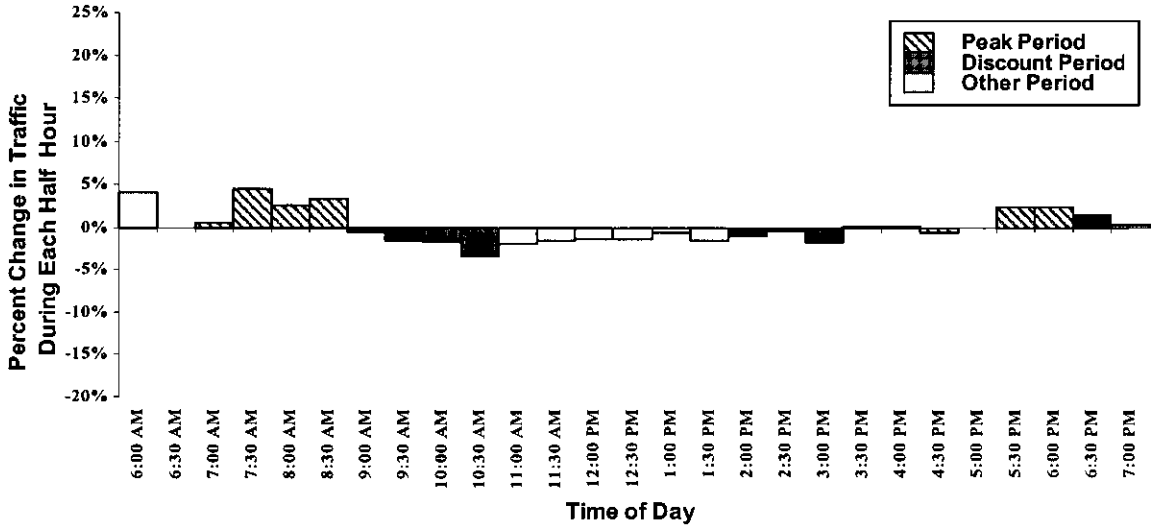

FIGURE 5 Traffic changes of ineligible users on Cape Coral Bridge.

$0.50 during nondiscount hours. All other bridge travelers are counted as ineligible users.

DATA ANALYSIS AND DISCUSSION OF RESULTS

First, eligible and ineligible traffic volume changes were examined separately. Review of Figures 3 and 5 indicates that little change has occurred in the driving times of bridge travelers not eligible for variable pricing discounts. On the Midpoint Bridge, only one half-hour period (9:30 a.m. to 10:00 a.m.) showed a significant change (at the 95 percent confidence interval) in traffic volumes. On the Cape Coral Bridge, nine half-hour periods showed significant changes. These changes appear to follow typical seasonal fluctuations in Lee County caused by tourists in the spring and are all less than 5 percent.

To determine if changes in traffic volumes during each half-hour period are statistically significant (at the 95 percent confidence level), a one-way analysis of variance test was performed. This test compares each adjusted half-hourly traffic volume for a specific half hour from before the implementation of variable pricing with the half-hourly traffic volumes recorded for the period with variable pricing. A total of 149 days of pre–variable pricing data were used, as well as 101 days of data from during variable pricing. If the means of these two values are significantly different at the 95 percent level of confidence, then the null hypothesis (H_0) must be rejected. The null hypothesis states that the mean values of the two streams of numbers are the same.

Next, researchers examine the travel-pattern changes of patrons eligible for the variable pricing discount tolls (approximately 23 percent of bridge traffic) in order to see if traditional peak period travelers are moving their travel times outside the peaks (one of the goals of the project.) Figures 2 and 4 clearly show that variable pricing has caused a significant positive impact on traffic patterns of eligible patrons on both the Cape Coral and Midpoint bridges. Most half-hour time periods during discount hours experienced a significant increase in traffic, whereas traffic decreased significantly during peak periods. With these data, changes greater than approximately 4 percent are statistically significant at the 95 percent confidence level.

During other periods of the day (defined as time periods other than peak and discount periods), few significant changes in traffic occurred. However, one significant change occurred at both the Cape Coral and Midpoint Bridges. This was a decrease in traffic from 6:00 a.m. to 6:30 a.m. Most likely these vehicles switched their travel time to the first discount period at 6:30 a.m. to 7:00 a.m. Although the percent change is significant, the number of vehicles traveling at this early hour is relatively small (approximately 100 eligible vehicles during this time period on each bridge) and therefore does not cause congestion during the first discount period of the day.

These changes to traffic patterns clearly show that variable pricing is meeting its goal and that drivers are altering their travel behavior

TABLE 1 Changes in ADT

Time	Midpoint	Cape Coral
Morning Peak (7 to 9 am)	-101	-70
Morning Discount (6:30 to 7 am) and (9 to 11 am)	+89	+94
Afternoon Peak (4 to 6:30 pm)	-67	-20
Afternoon Discount (2 to 4 p.m.) and (6:30 to 7 p.m.)	+70	+50
Total (of the above times)	-15	+54

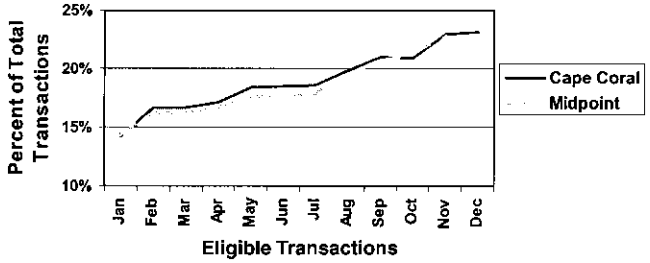

FIGURE 6 Payment method of Midpoint and Cape Coral Bridge users, 1998.

TABLE 2 Summary of Results

Hypothesis	Result
Ho: Traffic patterns for all vehicles on the Midpoint Bridge did not change.	Fail to reject. For almost all periods of the day, total traffic on the Midpoint Bridge did not significantly change.
Ho: Traffic patterns for eligible vehicles on the Midpoint Bridge did not change.	**Reject**. For peak and discount periods statistically significantly changes in traffic were observed.
Ho: Traffic patterns for ineligible vehicles on the Midpoint Bridge did not change.	Fail to reject. For all periods of the day, ineligible traffic on the Midpoint Bridge did not change significantly.
Ho: Traffic patterns for all vehicles on the Cape Coral Bridge did not change.	**Reject**. For many periods of the day, traffic on the Cape Coral Bridge did significantly change. However, this appears to be due to seasonal fluctuations and not variable pricing.
Ho: Traffic patterns for eligible vehicles on the Cape Coral Bridge did not change.	**Reject**. For peak and discount periods, statistically significant changes in traffic were observed.
Ho: Traffic patterns for ineligible vehicles on the Cape Coral Bridge did not change.	Fail to reject. For most periods of the day, ineligible traffic on the Cape Coral Bridge did not change significantly.

because of variable pricing. Eligible bridge travelers are responding to variable pricing as predicted, shifting their travel times from peak periods to discount periods. The preliminary data showed significant changes during most of the discount and peak time periods. These data will be updated as the project continues, and they will be supplemented with telephone and travel survey data to determine why people have altered their travel times, along with the sociodemographic and commute characteristics of those people who have altered their travel times.

Examining total bridge traffic, of both eligible and ineligible patrons combined, results from the Midpoint Bridge indicate a 7 percent increase in traffic during the early morning discount period (6:30 a.m. to 7:00 a.m.). Traffic showed no significant change (with these data, changes less than approximately 2.5 percent were not statistically significant at the 95 percent level of confidence) in the remainder of the half-hour periods throughout the day. This analysis is based on the mean traffic volume. As expected, almost all peak period traffic experienced a relative decrease after the start of variable pricing. However, these changes were too small to be statistically significant at the 95 percent level of confidence. Therefore, although the trends in traffic changes correspond to what was expected to happen with variable pricing, changes to total traffic on the bridges were not statistically significant in most cases.

Cape Coral Bridge results were not as clear. Several half-hour time periods throughout the day experienced significant changes in traffic volumes. These changes did not all correspond to the peak and discount periods. Rather, the pattern of traffic change at the Cape Coral Bridge was indicative of the impact of additional tourists in the traffic stream during the early part of the year (January to March). Therefore, comparison of 1998 traffic with 1999 traffic will be necessary before the impact of tourists can be factored out of this particular analysis. A summary of these findings is included in Table 2.

CONCLUSIONS

To date, the traffic impacts of the Lee County variable pricing project have been basically as researchers expected. During the first few months of the project, a steady increase has been seen in the number of patrons eligible for variable pricing discounts. A significant shift in traffic from the peak to discount periods has also occurred. The largest shift in traffic has been during the early morning discount period, when 7 percent increase in total traffic has been seen at the Midpoint Bridge. A corresponding decrease in traffic during the morning rush hour has occurred.

As researchers examine eligible and ineligible traffic volumes separately, they see that variable pricing toll discounts have significantly changed traffic patterns on the two bridges. Little change has occurred in the travel times of ineligible patrons, whereas significant changes in travel times have occurred in eligible patrons since the start of variable pricing. As expected, significant increases in traffic have taken place during discount periods and significant decreases in traffic have taken place during peak periods.

This paper presents findings from data obtained through December 1998. A great deal more research is planned for this variable pricing pilot project. An important aspect of future research will focus on gaining a better understanding of the motivations and socioeconomic characteristics of users of the program and determining whether toll discounts are inducing additional travel across the bridges. This future analysis will be based on traffic data collected from the toll plaza computers and from a mail-back survey of 3,500 bridge travelers performed in May 1999.

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