IMPACTS TO TRANSIT FROM LOS ANGELES CONGESTION REDUCTION
DEMONSTRATION

TRB PAPER 15-1590

Brian Pessaro, AICP
Senior Research Associate
Center for Urban Transportation Research (CUTR)
University of South Florida
4202 E. Fowler Avenue, CUT-100
Tampa, FL 33620-5375
Phone: 813-974-5113
Fax: 813-974-5168
pessaro@cutr.usf.edu

Word Count: 3,386 (body) + 2,000 (8 tables) + 1,500 (6 figures) = 6,886 words
ABSTRACT
The Metro Los Angeles Congestion Reduction Demonstration (CRD) converted the carpool lanes on I-110 and I-10 into dynamically priced managed lanes. A significant share of the CRD funds was used to improve the Metro Silver Line express bus on I-110 and the Foothill Transit Silver Streak express bus on I-10. The purpose of this research paper is to highlight some of the transit evaluation findings.

In the I-110 corridor, ridership on the Silver Line increased 52 percent in the morning peak period and 41 percent in the afternoon peak period. After tolling began, ridership increased another 29 percent in the morning peak period and another 25 percent in the afternoon peak period. In the I-10 corridor, service was added to the Silver Streak concurrent with tolling. Ridership increased 59 percent in the morning peak period and 15 percent in the afternoon peak period.

The data suggests that implementing variable tolls has had little or no negative impact to bus travel times. On I-110, the Silver Line’s average travel time after tolls increased less than a minute in the morning and was virtually the same in the afternoon. On I-10, the Silver Line’s average travel time decreased 4 percent in the morning and 14 percent in the afternoon. That 14 percent reduction equated to a 2.6 minute reduction. The Silver Streak’s average travel time on I-110 decreased 22 percent in the morning and 17 percent in the afternoon. This amounted to a 4.7 minute and 3.8 minute reduction respectively.
INTRODUCTION

The Metro Los Angeles Congestion Reduction Demonstration (CRD) converted the carpool lanes on I-110 and I-10 into dynamically priced managed lanes. The locations of these express lanes are shown in FIGURE 1 Location of I-110 and I-10 Express Lanes. Tolling on the I-110 Express Lanes commenced first on November 10, 2012. Tolling on the I-10 Express Lanes commenced on February 23, 2013. The Metro L.A. CRD included multiple transit-related improvements. However, this paper focuses only on two of them: the Metro Silver Line and the Foothill Transit Silver Streak. Both are express bus routes. The latter operates in the I-10 Express Lanes, and the former operates in both the I-10 and I-110 Express Lanes. CRD funding was used to improve the Silver Line’s headways on I-110 from every 30 minutes to every 10 minutes in two phases. The first phase occurred in June 2011 when the peak period headway was improved from 30 to 15 minutes. The second phase occurred in June 2012 when the headway was improved from 15 to 10 minutes. Both of these improvements occurred before tolling commenced on I-110 in November 2012. The service frequency of the Silver Line’s I-10 segment was already at 10 minutes and remained the same. Service on the I-10 Silver Streak was improved in December 2012, two months prior to the February 2013 start of tolls.

FIGURE 1 Location of I-110 and I-10 Express Lanes
LITERATURE REVIEW
Congestion (or value) pricing, according to the Federal Highway Administration (FHWA), is a way of harnessing the power of the market to reduce the waste associated with traffic congestion. FHWA lists four types of congestion pricing strategies: variably priced lanes, variable tolls on entire roadways, zone-based or cordon charges, and area-wide or system-wide charges (1). In the United States, the dominant form of congestion pricing has been high occupancy toll (HOT) lanes. With HOT lanes, toll exemptions are granted to HOVs and transit buses. Nearly all HOT lanes in the U.S. are converted HOV lanes. Travelers in the corridor can continue to drive toll-free in the general purpose lanes or they can opt to use the HOT lane. To use the HOT lane, they have several options: pay the toll if they do not meet the minimum vehicle occupancy; meet the minimum vehicle occupancy and drive toll-free; or take a transit bus that uses the HOT lane.

While HOT lanes have been in existence in the United States for nearly two decades, there has not been much formal evaluation of the actual impacts of HOT lanes to transit performance. A 2008 study by Geoffrey Chum and Mark Burris sought to predict what percentage of bus passengers would switch to driving alone after a hypothetical HOV to HOT conversion. The study relied on surveys of bus passengers at the park and ride lots for two Houston, Texas freeways, which were used to calibrate a mode choice model. The model predicted that very few bus riders would shift to driving alone in the HOT lane (2). However as late as 2009, Matthew Hardy reported in the Journal of Public Transportation that there was still an overall lack of formal evaluation in this area (3).

In 1996, the San Diego Association of Governments (SANDAG) and Caltrans converted the HOV lanes on an 8-mile stretch of I-15. From 1996 to 1998, single occupant drivers were charged a monthly fee for unlimited usage of the I-15 Express Lanes. In 1998, the switch was made to variable dynamic pricing. The Inland Breeze was the name of the bus service initiated on the I-15 Express Lanes and was funded by the toll revenues. This congestion pricing project was formally evaluated by San Diego State University (SDSU). The evaluation reported that ridership on the Inland Breeze increased by 9 percent during the study period while ridership in the entire region increased 23 percent. Surveys showed that most of the Inland Breeze passengers were captive riders who had switched from other bus routes and were traveling in the reverse commute direction (4). The report did not include any specific information on other impacts to transit service such as bus travel times, speeds, and on-time performance.

Another early HOT project was the I-394 MnPass lanes in Minneapolis. They opened in 2005, and like the I-15 Express Lanes were an HOV to HOT conversion. Lee Munnich from the Hubert H. Humphrey Institute of Public Affairs at the University of Minnesota and Kenneth Buckeye from the Minnesota Department of Transportation reported on nine issues and outcomes of the I-394 MnPass project. Issue 8 was the concern that transit riders and carpoolers might suffer due to the adaption from HOV to HOT if there was a level of service (LOS) degradation. They reported that the I-394 MnPass project had no negative impacts on transit riders or carpoolers. The preliminary data indicated that transit usage in the I-394 corridor had improved more than that of the control corridor on I-35W. They reported also that transit users supported the idea of allowing solo drivers into the lane for a fee (5).

The formal evaluation of the UPAs has provided the most up to date research on the impacts to public transit from congestion pricing. In 2010, early results of transit user perceptions of the I-95 HOT lanes in Miami were reported in the Journal of the Transportation Research Board. Pre- and post-deployment surveys of the bus riders showed that the I-95 bus service was already highly rated when the Express Lanes were HOV and that the service ratings...
increased even further after the HOT conversion. Furthermore, the surveys showed that the 
ratings for travel time and service reliability improved by margins that were statistically 
significant at the 99 percent and 95 percent confidence levels, respectively (6). More recent 
transit results from the UPA evaluation will be reported in a forthcoming issue of the Journal of 
the Transportation Research Board. The article, Impacts to Transit from Variably Priced Tolls 
Lanes by Pessaro, Turnbull, and Zimmerman, reported several findings from the Miami, 
Minnesota, and Atlanta projects. In Miami and Minneapolis where speed data was available, 
buses speeds increased by 37 mph and 29 mph respectively. Ridership (a.m. peak period) 
increased in each of the corridors after tolling: 57 percent in Miami, 8 percent in Minneapolis, 
and 21 percent in Atlanta. The overall perception of the HOT lanes by bus riders has been 
positive. In Miami, 53 percent of new riders said they were influenced to take transit because of 
the HOT lanes. In Minneapolis, it was 23 percent. In Atlanta, it was 45 percent (7).

METHODOLOGY
All data for the transit analysis was provided by the Los Angeles County Metropolitan 
Transportation Authority (Metro). The data focus was on peak period and peak direction. The 
peak periods were defined as 6:00 to 9:00 a.m. and 3:00 to 7:00 p.m. The peak direction on the I-
110 is northbound in the morning and southbound in the afternoon. The peak direction on the I-
10 is westbound in the morning and eastbound in the afternoon. Ridership on the I-110 Express 
Lanes was measured between the Harbor Gateway Transit Center on the south end and the 37th 
Street Station on the north end. Ridership on the I-10 Express Lanes was measured between El 
Monte Transit Station on the east end and Union Station on the west end. The ridership figures 
were taken from automated passenger counter (APC) data, boardings in the morning and 
alightings in the afternoon. A copy of the Silver Line’s schematic map is shown in FIGURE 2. 
The stations on I-10 (Union Station, LAC/USC Medical Center, Cal State LA, and El Monte) are 
also used by the Foothill Transit Silver Streak.

For the analysis of ridership, three analysis periods were used: March – May 2011; 
March – May 2012 and; March – May 2013. The logic for the analysis period is illustrated in 
TABLE 1. The intent was to compare data from the same times of year in order to control for 
seasonal variation. The reason why the months March to May were chosen was because no key 
CRD events occurred during those times.
Bus travel times were derived from the bus vehicle’s automated vehicle location (AVL) system. The Silver Line runs through downtown Los Angeles in addition to running in the I-110 and I-10 Express Lanes. The Silver Streak begins its route to the east beyond the I-10 Express Lanes. The analysis wanted to isolate the impact of the express lanes on changes in bus travel times. Therefore, the travel time data that was collected was limited to when the buses were in the express lanes. For I-10 this meant collecting AVL data between El Monte and Union Station. For I-110, the AVL data was collected between Harbor Gateway Transit Center and Slauson Station. The one-year pre-toll average was compared to the one-year post-toll average. Since the start date of tolls on I-110 was different from the start date of tolls on I-10, the months used in the calculation for the two corridors was different also. For I-110, the pre-toll bus travel time average was calculated using data from November 2011 to October 2012. The post-toll bus travel time average was calculated using data from November 2012 to October 2013. For I-10, the months used to calculate the pre-toll average were March 2012 to February 2013, and the months used to calculate the post-toll average were March 2013 to February 2014. February 2013 was included as a “pre-toll” month since the I-10 tolls did not begin until the end of the month on the 23rd.

RESULTS

Silver Line Ridership

TABLE 2 and TABLE 3 show the change in average daily ridership for the Silver Line on I-110 and I-10 respectively. The data shown is for peak period, peak direction. The peak periods were defined as 6:00 to 9:00 a.m. and 3:00 to 7:00 p.m. The peak directions on I-110 are northbound in the morning and southbound in the afternoon. The peak directions are westbound in the morning and eastbound in the afternoon.

On I-110, the number of average daily Silver Line riders increased 52 percent in the morning peak period and 41 percent in the afternoon peak period after the first phase of CRD service was added. It increased another 29 percent in the morning peak period and another 25 percent in the afternoon peak period after the second phase of new service was added and after tolling began (TABLE 2). The main conclusion to be drawn from the I-110 data is that the CRD-
funded service improvements to the Silver Line had a greater impact on ridership than the tolls alone.

**TABLE 2 Silver Line Average Daily Riders (I-110 Express Lanes)**

<table>
<thead>
<tr>
<th></th>
<th>Morning Peak Period</th>
<th>Percent Change</th>
<th>Afternoon Peak Period</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar-May 2011</td>
<td>596</td>
<td></td>
<td>680</td>
<td></td>
</tr>
<tr>
<td>Mar-May 2012</td>
<td>907</td>
<td>52%</td>
<td>957</td>
<td>41%</td>
</tr>
<tr>
<td>Mar-May 2013</td>
<td>1,175</td>
<td>29%</td>
<td>1,199</td>
<td>25%</td>
</tr>
</tbody>
</table>

Source: Metro

There were no service changes to the Silver Line’s I-10 segment. Consequently, there was not the same dramatic change in ridership as on I-110. **TABLE 3** shows that the number of average daily riders on the I-10 segment of the Silver Line increased by only 15 percent in the morning peak period and 7 percent in the afternoon peak period between 2011 and 2012. It then dropped 5 percent in the morning peak period and stayed the same in the afternoon peak period between 2012 and 2013. It should be pointed out that while the percentage changes on the I-110 segment of the Silver Line were larger, the I-10 segment carries a larger absolute number of riders.

**TABLE 3 Silver Line Average Daily Riders (I-10 Express Lanes)**

<table>
<thead>
<tr>
<th></th>
<th>Morning Peak Period</th>
<th>Percent Change</th>
<th>Afternoon Peak Period</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar-May 2011</td>
<td>1,434</td>
<td></td>
<td>1,528</td>
<td></td>
</tr>
<tr>
<td>Mar-May 2012</td>
<td>1,642</td>
<td>15%</td>
<td>1,629</td>
<td>7%</td>
</tr>
<tr>
<td>Mar-May 2013</td>
<td>1,568</td>
<td>-5%</td>
<td>1,637</td>
<td>0%</td>
</tr>
</tbody>
</table>

Note: There were no service improvements to this segment of the Silver Line during the evaluation
Source: Metro

Ridership on the Silver Line was compared to Metro’s system-wide ridership. The purpose was to test whether the trend on the Silver Line was similar or different to what was occurring on Metro as a whole. **TABLE 4** shows that monthly boardings on Metro system-wide were flat while monthly boardings on the Silver Line increased by 27 percent between 2011 and 2012 and by another 15 percent between 2012 and 2013. The monthly boardings on the Silver Line from February 2011 to February 2014 are shown in **FIGURE 3** and further illustrate the steady growth.
TABLE 4  Monthly Boardings Silver Line vs. Metro System-wide

<table>
<thead>
<tr>
<th></th>
<th>Silver Line</th>
<th>Percent Change</th>
<th>Metro System-wide</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar-May 2011</td>
<td>216,029</td>
<td></td>
<td>30,014,784</td>
<td></td>
</tr>
<tr>
<td>Mar-May 2012</td>
<td>273,502</td>
<td>27%</td>
<td>29,724,628</td>
<td>-1%</td>
</tr>
<tr>
<td>Mar-May 2013</td>
<td>315,661</td>
<td>15%</td>
<td>30,057,352</td>
<td>1%</td>
</tr>
</tbody>
</table>

Source: Metro

FIGURE 3  Silver Line Monthly Boardings

Notes: (1) June 2011, Peak period service on Silver Line increased from 30 to 15 minutes on I-110.
(2) June 2012, Peak period service on Silver Line increased from 15 to 10 minutes on I-110.
(3) November 2012, I-110 ExpressLanes open; tolling begins.
(4) February 2013, I-10 ExpressLanes open; tolling begins.
Source: Metro
Silver Streak Ridership

Foothill Transit introduced their CRD service enhancements to the Silver Streak just two months before tolling on I-10. The CRD service was added on December 16, 2012 and the I-10 Express Lanes opened on February 23, 2013. Because the new service began so close to the start of tolls, it is difficult to parse how much of the change in ridership was due to the CRD-funded service changes and how much was due to the tolls.

Average daily ridership on the Silver Streak increased 59 percent in the morning peak period and 15 percent in the afternoon peak period (TABLE 5). It is unknown why there is such a difference in results for the morning and afternoon peak periods. It is possible that the Silver2Silver Program played a role. The Silver2Silver program, which began in October 2012, allows riders of the Silver Line and Silver Streak to ride either route at the same fare. This resulted in a fare decrease for Silver Streak riders. It is possible that some riders may take the Silver Streak into Los Angeles in the morning but make their return trip in the afternoon on the Silver Line.

TABLE 5 Silver Streak Average Daily Riders (I-10 Express Lanes)

<table>
<thead>
<tr>
<th></th>
<th>Morning Peak Period</th>
<th>Percent Change</th>
<th>Afternoon Peak Period</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar-May 2011</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
<td>n/a</td>
</tr>
<tr>
<td>Mar-May 2012</td>
<td>505</td>
<td></td>
<td>681</td>
<td></td>
</tr>
<tr>
<td>Mar-May 2013</td>
<td>804</td>
<td>59%</td>
<td>783</td>
<td>15%</td>
</tr>
</tbody>
</table>

Source: Metro

Ridership on the Silver Streak was compared to Foothill Transit’s system-wide ridership to test whether the trend on the Silver Streak was similar or different to what was occurring on Foothill Transit as a whole (TABLE 6). The Silver Streak’s ridership did increase by a greater percentage than the rest of Foothill Transit though the contrast was not as stark as the one observed between the Silver Line and Metro. The trend in monthly boardings is shown in FIGURE 4.

TABLE 6 Monthly Boardings Silver Streak vs. Foothill Transit System-wide

<table>
<thead>
<tr>
<th></th>
<th>Silver Streak</th>
<th>Percent Change</th>
<th>Foothill System-wide</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar-May 2011</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Mar-May 2012</td>
<td>108,709</td>
<td>1,077,114</td>
<td>22%</td>
<td>15%</td>
</tr>
<tr>
<td>Mar-May 2013</td>
<td>132,612</td>
<td>1,240,167</td>
<td>22%</td>
<td>15%</td>
</tr>
</tbody>
</table>

Source: Metro
Changes in bus travel times were examined using the automated vehicle location (AVL) systems of the Silver Line and Silver Streak buses. The data points were restricted to when the buses were in the express lanes so as to isolate the impact of the latter on the former. AVL data for the year prior to tolling was compared to the year after tolling.

The data suggests that implementing variable tolls has had little or no negative impact on bus travel times on the I-110 Express Lanes and has had a positive impact to bus travel times on the I-10 Express Lanes. FIGURE 5 shows that bus travel times on the I-110 Express Lanes were relatively flat while FIGURE 6 shows a noticeable decrease in travel time on the I-10 Express Lanes. In terms of actual percentages, the Silver Line’s average travel time on the I-110 Express Lanes increased 6 percent in the morning peak period after tolling, which amounted to less than a minute increase. There was virtually no change in the afternoon peak period (TABLE 7). On the I-10 Express Lanes, bus travel time for the Silver Line decreased 4 percent in the morning peak period and 14 percent in the afternoon peak period. That 14 percent reduction amounted to a 2.6 minute reduction. On the Silver Streak, the decrease was stronger. Travel time decreased 22 percent in the morning peak period and 17 percent in the afternoon peak period (TABLE 8). This amounted to a 4.7 minute and 3.8 minute reduction respectively. Besides the variable tolls, a likely contributor to the stronger travel time reductions on I-10 is the fact that a second HOT lane...
was created via restriping with no loss of general purpose lanes on I-10 from I-605 to I-710. This means the I-10 Express Lanes have more capacity than the I-110 Express Lanes.

FIGURE 5 Silver Line Average Travel Time I-110 Express Lanes

TABLE 7 Silver Line Average Travel Time I-110 Express Lanes

<table>
<thead>
<tr>
<th></th>
<th>A.M. Peak Northbound (minutes)</th>
<th>P.M. Peak Southbound (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Toll</td>
<td>14.0</td>
<td>12.5</td>
</tr>
<tr>
<td>Post-Toll</td>
<td>14.8</td>
<td>12.4</td>
</tr>
<tr>
<td>Percent Change</td>
<td>6%</td>
<td>-1%</td>
</tr>
</tbody>
</table>

Pre-Toll = the 1-year average from Nov. 2011 to Oct. 2012
Post-Toll = the 1-year average from Nov. 2012 to Oct. 2013
Source: Metro
FIGURE 6 Silver Line and Silver Streak Average Travel Time I-10 Express Lanes

TABLE 8 Silver Line and Silver Streak Average Travel Time I-10 Express Lanes

<table>
<thead>
<tr>
<th></th>
<th>Silver Line</th>
<th></th>
<th>Silver Streak</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A.M. Peak</td>
<td>P.M. Peak</td>
<td>A.M. Peak</td>
<td>P.M. Peak</td>
</tr>
<tr>
<td></td>
<td>Northbound</td>
<td>Southbound</td>
<td>Northbound</td>
<td>Southbound</td>
</tr>
<tr>
<td>Pre-Toll</td>
<td>17.3</td>
<td>17.9</td>
<td>21.3</td>
<td>21.7</td>
</tr>
<tr>
<td>Post-Toll</td>
<td>16.6</td>
<td>15.3</td>
<td>16.6</td>
<td>17.9</td>
</tr>
<tr>
<td>Percent Change</td>
<td>-4%</td>
<td>-14%</td>
<td>-22%</td>
<td>-17%</td>
</tr>
</tbody>
</table>

Pre-Toll = the 1-year average from Mar. 2012 to Feb. 2013
Post-Toll = the 1-year average from Mar. 2013 to Feb. 2014
Source: Metro

CONCLUSIONS

The Metro Los Angeles Congestion Reduction Demonstration (Metro L.A. CRD) was one of five cities that implemented tolled managed lanes through the U.S. Department of Transportation’s Congestion Reduction Demonstration and Urban Partnership Agreement Programs. The other cities were Miami, Minneapolis, Atlanta, and Seattle. The USDOT sponsored evaluation of the Metro L.A. CRD is the last one to be conducted. As such, it will add to the body of knowledge on managed lanes. Unlike the other UPA/CRD sites, the Metro L.A.
CRD provided a unique opportunity to compare the effects of tolled managed lanes on transit in two different corridors. The results of the transit analysis confirm some of the findings from the other UPA/CRD evaluations. Namely, that improving transit service is an important component to the success of a managed lane project. On the bus routes where CRD funds were used to improve service (the Metro Silver Line on I-110 and the Foothill Transit Silver Streak on I-10) there was a large increase in ridership. Furthermore, there was a larger percentage increase in ridership on the I-110 segment of the Silver Line after the new service went into effect than there was after tolling began. Finally, the L.A. CRD evaluation provided further confirmation that implementing variable tolls does not negatively impact bus operations. In fact, on the I-10 Express Lanes where capacity was added in the form of a second HOT lane, bus travel times improved.
ACKNOWLEDGMENT

The author would like to acknowledge and thank Ms. Megan Nangle from the Los Angeles County Metropolitan Transportation Authority for all of her assistance providing the necessary data for the evaluation.
REFERENCES


