

ATTACHMENT C:

Quantitative Evaluation of Pay-As-You-Go Pilot

This data analysis considers the quantitative impact of the Pay-As-You-Go (PAYG) Pilot in six areas:

1. End-to-End Travel Times in the ExpressLanes
2. Flow fractions for Non-transponder Trips by time of day
3. Volume of ExpressLanes Trips by Non-FasTrak Users
4. ExpressLanes Revenue
5. On-Time Payments for Trips by Non-FasTrak Users
6. ExpressLanes Access by Infrequent or Occasional Users

END-TO-END TRAVEL TIMES IN THE EXPRESSLANES

In this section, we consider changes in end-to-end travel times on the ExpressLanes.

Data Source: Caltrans Performance Measurement System (PeMS) 5-minute traffic data for all detectors that were at least 70 percent observed (i.e., less than 30 percent imputed in a given aggregation interval). Data were collected for all weekdays in calendar year 2019 and calendar year 2022, with 2019 constituting the “Before PAYG” period and 2022 constituting the “With PAYG” period. These periods were selected to compare the most recent year of data available against the comparable period before the PAYG pilot was implemented in January 2020. Data were collected for the I-10 ExpressLanes between I-605 and Alameda Street. There were insufficient data available in PeMS for the I-110 ExpressLanes to support this analysis, so only I-10 travel times were evaluated.

Additional data were collected from the HOV lanes on the following corridors to function as experimental controls for the I-10 ExpressLanes:

- SR 91 between I-110 (Abs PM 0.5) and I-605 (Abs PM 11)
- I-210 between I-605 (Abs PM 36.71) and SR 57 (Abs PM 44.77)
- I-210 between SR 134 (Abs PM 25) and I-605 (Abs PM 36.71)
- SR 60 between I-605 (Abs PM 11.84) and SR 57 (Abs PM 25.67)

I-105 between I-110 (Abs PM 7.34) and I-605 (Abs PM 18) was also considered as a candidate control corridor, but was found to have insufficient data available in PeMS and subsequently excluded.

Method: In this analysis, travel times are estimated from point measurements along a given corridor (e.g., from inductive loop data) by simulating the progress of virtual vehicles from one end of the corridor to the other. In the case of this analysis, these vehicles are dispatched from the upstream end of the corridor every 5 minutes and their progress is re-evaluated every 45 seconds or every 30 feet along the corridor—whichever occurs first. The time between successive re-evaluations is called the simulation time-step. Generally, the distance threshold will govern, and vehicle progress will be re-evaluated every 30 feet. However, if traffic speeds drop very low, the time threshold of 45 seconds will be reached first, and progress will be re-evaluated after that amount of time. This is included as a protection to ensure that time steps do not grow excessively long when speeds are particularly low. At the start of each simulation time-step, the speed of the vehicle is calculated using the exact location and timestamp of the vehicle at that moment, using linear interpolation between the nearest 5-minute detector data in time and space. The vehicle is then assumed to proceed at that speed for the duration of the simulation time-step.

Due to the expected interaction and correlation between congestion patterns on the I-10 ExpressLanes and one or more of the other managed lanes on nearby parallel routes, a predictive model for I-10 ExpressLanes travel times is built using a linear regression model where the response variable is the end-to-end travel time on the I-10 ExpressLanes in either the eastbound or westbound direction at any given time, and candidate input variables are the travel times on a combination of the control corridors in the same direction as the response variable at that same time. Only data from the “Before PAYG” period were used for model training. Additionally, only data from the peak periods (5-9 AM for westbound travel, 4-7 PM for eastbound travel) were used for model training, to allow for more targeted performance in the area of peak period travel time predictions on the I-10 ExpressLanes—which is specifically what this model will be used for. Model specification was performed by first including all applicable control variables, then incrementally removing those with counterintuitive signs (i.e., those exhibiting an apparent inverse correlation), then incrementally removing those that were not significant at a 95% level starting with the least significant variable, and finally testing all combinations of the remaining significant variables to identify the set that minimizes the Adjusted R-Squared value of the model.

The resultant travel time prediction models for the I-10 ExpressLanes in each direction are specified below.

$$y_{10e} = 5.669 + 0.270x_{210e1} + 0.396x_{60e}$$

$$y_{10w} = 4.165 + 0.305x_{91w} + 0.230x_{210w2} + 0.298x_{60w}$$

where:

y_{10e} = Predicted end-to-end travel time on eastbound I-10 ExpressLanes (weekdays 4–7 PM)

y_{10w} = Predicted end-to-end travel time on westbound I-10 ExpressLanes (weekdays 5–9 AM)

x_{91w} = Calculated travel time on westbound SR 91 HOV lane between I-110 and I-605.

x_{210e1} = Calculated travel time on eastbound I-210 HOV lane between I-605 and SR 57.

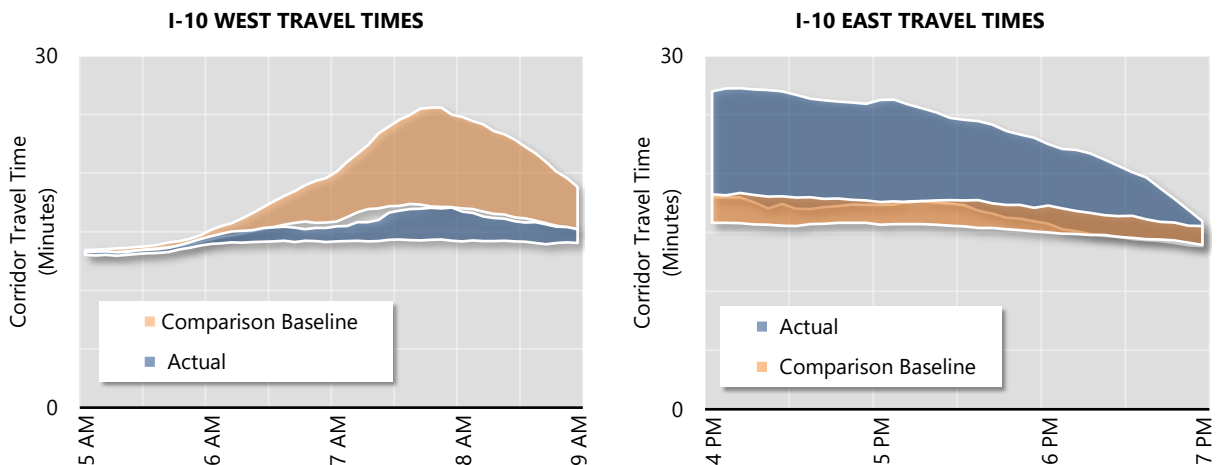
x_{210w2} = Calculated travel time on westbound I-210 HOV lane between SR 134 and I-605.

x_{60e} = Calculated travel time on eastbound SR 60 HOV lane between SR 57 and I-605.

x_{60w} = Calculated travel time on westbound SR 60 HOV lane between SR 57 and I-605.

With these models, it was possible to predict the counter-factual (comparison baseline) travel times in the “With PAYG” period based on the observed performance on the applicable control corridors over the same period. The Adjusted R-Squared value for the westbound AM Peak model is 0.580 (n=10,140), and the Adjusted R-Squared value for the eastbound PM Peak model is 0.230 (n=7,296).

Findings: Observed travel times in the “With PAYG” period were an average of 4.18 minutes higher than the comparison baseline for the eastbound I-10 ExpressLanes between 4 PM and 7 PM, whereas observed travel times were 2.63 minutes lower than the comparison baseline for the westbound I-10 ExpressLanes between 5 AM and 9 AM. Time-of-day distributions are shown in the charts below, represented as inter-quartile ranges for every 5-minute aggregation interval across the applicable peak period for the direction indicated.



Trends in the deviations between the predicted and observed travel times on the I-10 ExpressLanes are attributed to localized changes to the I-10 corridor, including but not limited to the institution of PAYG. These differences may also be influenced by other corridor-specific factors that occurred during the analysis period such as:

- The recent extension of the I-10 HOV lanes east of I-605.

- Changes to transit service along I-10 (i.e., Silver Line, Metrolink) since 2020.
- Pandemic-related changes to commuter patterns that affected the employment centers and industries along I-10 (e.g., downtown LA) differently than employment centers and industries along the control corridors (e.g., Pasadena, West LA, South Bay).

Also note that the eastbound regression model had relatively low prediction accuracy (Adjusted R² value of 0.23), indicating that the eastbound results are not as reliable as the westbound results.

Assumptions: Travel times calculated using spot speed measurements from PeMS detector data are a valid approximation of actual travel times on the corridor.¹

¹ Margulici, J.D; Ban, X. Benchmarking travel time estimates. *Intelligent Transport Systems*, IET, Vol 2, #3, Sept. 2008, p228–237.

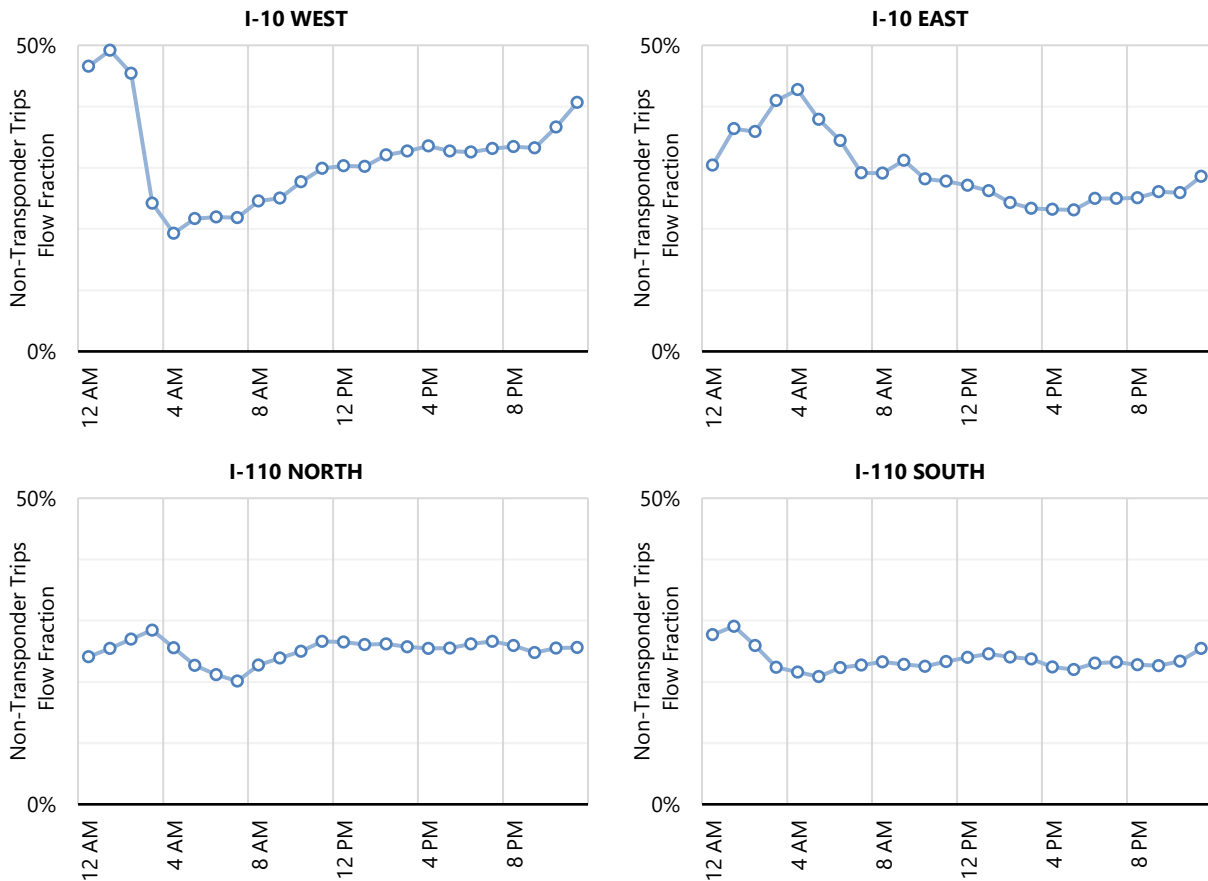
FLOW FRACTIONS FOR NON-TRANSPONDER TRIPS BY TIME OF DAY

In this section, we consider time-of-day patterns in the flow fractions for non-transponder trips in the ExpressLanes to gain insight into the times of day where PAYG travelers are having the greatest proportional impact on trip volumes in the ExpressLanes.

Data Source: Trip records for weekdays in the period between 1/1/2022 and 12/24/2022. This period was selected to characterize non-transponder trip trends because it aligns closely with the "With PAYG" period used for the travel time analysis, which facilitates comparison between the two sets of results.

Method: Trip records are aggregated by hourly bin according to the trip start time. Each is categorized as either a transponder-based trip or a non-transponder trip. Results are examined separately by corridor and direction.

Findings: The overall flow fraction for non-transponder trips during off-peak periods was 25.6%, while the overall flow fraction was 22.5% during peak periods. These findings suggest that non-FasTrak drivers are having a proportionally greater influence on overall trip volumes during non-peak periods.



DATA TABLE

Hour	Transponder Trip Counts				Non-Transponder Trip Counts			
	I-10 East	I-10 West	I-110 North	I-110 South	I-10 East	I-10 West	I-110 North	I-110 South
12 AM	14,504	5,138	39,058	31,690	6,344	4,479	12,402	12,133
1 AM	6,062	3,042	21,129	15,581	3,468	2,944	7,211	6,389
2 AM	4,432	3,137	11,709	13,976	2,480	2,609	4,327	4,895
3 AM	3,255	14,547	13,254	23,092	2,260	4,648	5,275	6,662
4 AM	6,814	132,422	51,663	64,763	5,085	31,670	17,752	17,829
5 AM	19,123	397,899	270,629	160,136	11,676	110,277	79,405	42,196
6 AM	40,158	520,096	534,378	318,511	21,075	146,308	143,488	91,571
7 AM	88,239	560,692	619,670	540,771	36,324	156,746	155,986	159,346
8 AM	108,881	474,946	511,819	458,345	44,687	154,578	150,697	138,988
9 AM	76,325	368,865	444,732	289,321	34,593	123,312	139,677	85,818
10 AM	91,355	241,345	382,753	269,331	35,780	92,513	127,592	78,439
11 AM	126,452	172,394	338,015	292,454	48,718	73,463	122,448	88,935
12 PM	204,290	153,354	336,713	344,746	75,952	66,649	121,371	108,730
1 PM	337,306	144,401	358,039	414,816	120,007	62,563	126,375	135,348
2 PM	490,113	133,524	408,888	550,563	157,106	63,060	145,113	174,432
3 PM	566,454	131,018	432,930	637,376	172,857	63,718	150,147	198,175
4 PM	571,108	135,358	456,705	690,035	172,515	68,383	155,945	199,522
5 PM	566,483	171,070	464,024	673,369	170,322	83,173	158,833	189,897
6 PM	444,222	138,163	374,915	534,404	147,762	66,650	132,910	160,390
7 PM	266,428	69,542	249,743	343,471	88,612	34,486	90,500	103,913
8 PM	159,674	53,417	171,286	216,686	53,488	26,823	59,968	63,929
9 PM	106,699	45,238	140,329	171,888	37,680	22,508	46,198	50,332
10 PM	82,834	25,881	103,757	150,681	28,975	14,956	35,544	46,003
11 PM	43,991	12,270	69,343	81,321	17,602	8,399	23,902	27,756

Assumptions: Non-transponder trip patterns are a reasonable proxy for non-FasTrak trip patterns.

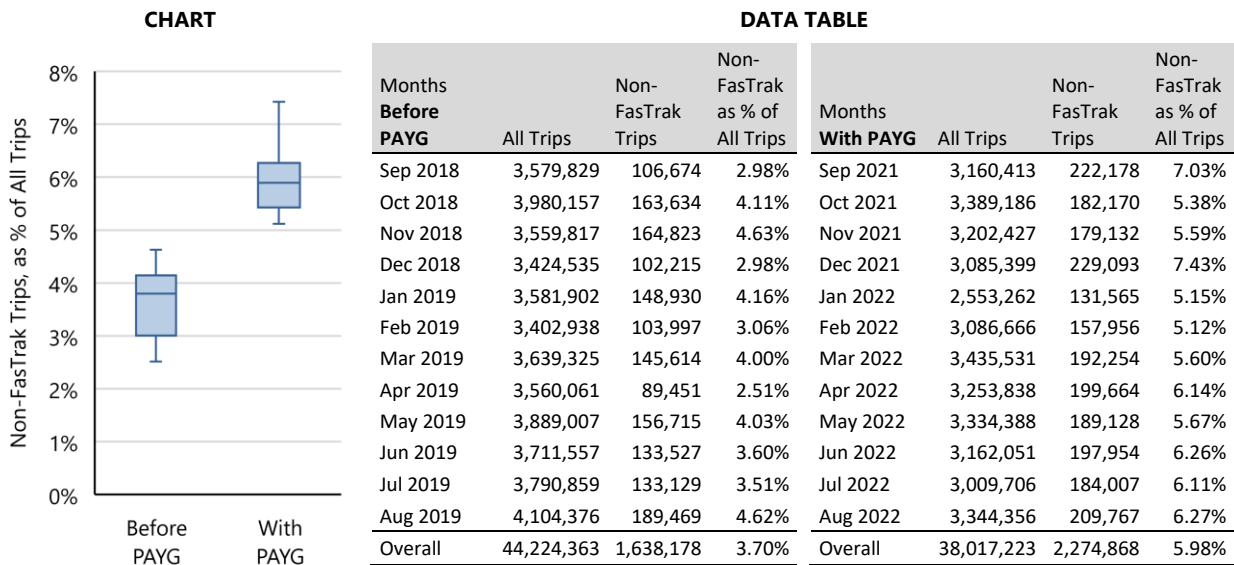
VOLUME OF NON-FASTRAK TRIPS

In this section, we consider changes in trip volume for drivers that do not have FasTrak.

Data Source: Monthly ExpressLanes trip records. The 12 months between September 2018 and August 2019 constitute the “Before PAYG” period. The 12 months between September 2021 and August 2022 constitute the “With PAYG” period. These periods were selected to compare the most recent year of data available against the comparable period before the PAYG pilot was implemented in January 2020.

Method: Data are binned by month, allowing for an evaluation of variance in the overall percentages of non-FasTrak trips before and after the PAYG Pilot began. To control for pandemic-related effects on overall trip volumes, the non-FasTrak trips are reported as a percent of all trips.

Findings: In the “Before PAYG” period, 3.70% of all ExpressLanes trips were made by drivers without FasTrak. In the “With PAYG” period, this percentage increased to 5.98%. This difference was statistically significant at a 95% confidence level (Student’s t-Test, p-value 0.000). Over the same period, FasTrak trip volumes declined 16.1% while non-FasTrak trip volumes increased 38.9%. This translates into an estimated 899,954 additional ExpressLanes trips as a result of the PAYG Pilot in the one-year “With PAYG” period. The data support the conclusion that the PAYG Pilot resulted in more ExpressLanes trips by drivers that did not have FasTrak, and suggest that the PAYG Pilot resulted in a 2.4% increase in ExpressLanes trips.



Assumptions: In the absence of the PAYG Pilot, non-FasTrak trip volumes would have exhibited the same percent change as observed FasTrak trip volumes between the “Before PAYG” and “With PAYG” periods.

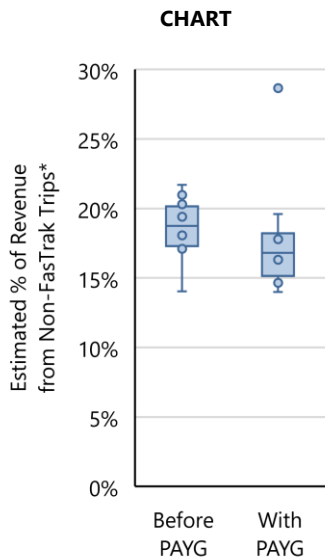
REVENUE IMPACTS

In this section, we consider changes in ExpressLanes revenue that occurred after the PAYG Pilot was implemented, and fees for using the ExpressLanes without FasTrak were reduced from \$25/trip to \$4/trip.

Data Source: Monthly ExpressLanes accounting records. The 12 months between September 2018 and August 2019 constitute the “Before PAYG” period. The 12 months between September 2021 and August 2022 constitute the “With PAYG” period. These periods were selected to compare the most recent year of data available against the comparable period before the PAYG pilot was implemented in January 2020. Supplemental data from FY2018 were used to estimate the revenues associated specifically with all stages of notice escalation prior to DMV hold.

Method: Data are binned by month, allowing for an evaluation of variance in the overall percentages of non-FasTrak trip revenue before and after the PAYG Pilot began. To control for pandemic-related effects on overall program revenues and trip volumes, the revenues originating from non-FasTrak trips paid at any Notice of Toll Evasion Violation escalation stage prior to DMV hold are reported as a percent of all revenues for the program.

Findings: In the “Before PAYG” period, an estimated \$11.7 million in revenue was collected from non-FasTrak users of the Metro ExpressLanes across all Notice escalation stages prior to DMV hold, representing 18.6% of all revenues (\$63.0 million) collected over that time period. In the “With PAYG” period, this percentage fell to 17.1%. Based on these data, the expected revenue in the “With PAYG” period would have been an estimated \$2.6 million higher in the absence of the PAYG Pilot, representing an approximate reduction in revenue of 3.8% as a result of the Pilot. This difference was **not** statistically significant at a 95% confidence level (Student’s t-Test, p-value 0.399). Therefore, we conclude that the data provide no evidence that the PAYG Pilot had any meaningful effect on the total revenue obtained from non-FasTrak trips in the ExpressLanes.



DATA TABLE

Months	Total ExpressLanes Program Revenue	Estimated % of Revenue from Non-FasTrak Trips*	Months	Total ExpressLanes Program Revenue	Estimated % of Revenue from Non-FasTrak Trips*
Before PAYG			With PAYG		
Sep 2018	\$4,483,562	14.0%	Sep 2021	\$5,422,808	19.6%
Oct 2018	\$6,250,025	17.3%	Oct 2021	\$6,061,228	16.8%
Nov 2018	\$5,119,624	19.7%	Nov 2021	\$6,678,266	15.1%
Dec 2018	\$4,758,430	19.4%	Dec 2021	\$6,108,344	16.3%
Jan 2019	\$4,771,775	21.7%	Jan 2022	\$3,751,527	28.7%
Feb 2019	\$5,176,398	17.3%	Feb 2022	\$4,643,542	18.3%
Mar 2019	\$5,075,955	18.1%	Mar 2022	\$6,546,837	15.2%
Apr 2019	\$5,677,222	17.1%	Apr 2022	\$5,409,238	16.8%
May 2019	\$5,561,893	17.4%	May 2022	\$6,380,040	14.7%
Jun 2019	\$5,399,991	20.3%	Jun 2022	\$4,754,852	17.8%
Jul 2019	\$5,024,651	21.0%	Jul 2022	\$4,395,368	18.0%
Aug 2019	\$5,746,192	19.6%	Aug 2022	\$5,913,661	14.0%
Overall	\$63,045,718	18.6%	Overall	\$66,065,711	17.1%

*Includes revenues from all Notice escalation stages prior to DMV hold.

Assumptions: In the absence of the PAYG Pilot, the revenue for non-FasTrak trips would have experienced the same percent change as the observed revenue for FasTrak trips/accounts between the “Before PAYG” and “With PAYG” periods. Also, PAYG revenue impacts would not have affected other program revenue aspects outside of the payments made during notice escalation across all stages prior to DMV hold.

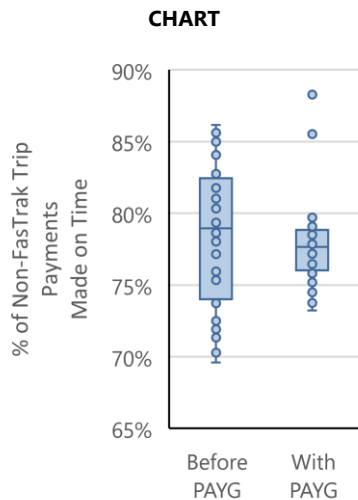
TIMELY PAYMENTS FOR NON-FASTRAK TRIPS

In this section, we consider changes in on-time payments for non-FasTrak trips that occurred after the PAYG Pilot was implemented, and fees for such trips were reduced from \$25 per trip to \$4 per trip.

Data Source: Weekly ExpressLanes payment records. The 53 weeks between 8/26/2018 and 8/31/2019 constitute the “Before PAYG” period. The 53 weeks between 8/29/2021 and 9/3/2022 constitute the “With PAYG” period. These periods were selected to compare the most recent year of data available against the comparable period before the PAYG pilot was implemented in January 2020. Supplemental data from FY2018 were used to estimate the payment volumes associated specifically with all stages of notice escalation prior to DMV hold in 2018 and 2019, as those disaggregate data were not immediately available.

Method: Data are binned by week, allowing for an evaluation of variance in the overall percentages of non-FasTrak trip payments received on time, before and after the PAYG Pilot began. For the purposes of this analysis, an “on time” payment is defined as one that occurred before the notice/fees escalated. To control for pandemic-related effects on non-FasTrak trip volumes and payments, the volume of on-time payments for non-FasTrak trips are reported as a percent of all non-FasTrak trip payments made at any Notice of Toll Evasion Violation escalation stage prior to DMV hold.

Findings: In the “Before PAYG” period, non-FasTrak Notice payments that were submitted on time constituted 78.4% of all payments made at any Notice escalation stage prior to DMV hold. In the “With PAYG” period, this percentage decreased to 77.6%. Based on these data, the expected number of on-time payments in the “With PAYG” period would have been an estimated 6,620 higher in the absence of the PAYG Pilot. This difference was **not** statistically significant at a 95% confidence level (paired Student’s t-Test, p-value 0.104). Therefore, we conclude that the data provide no evidence that the PAYG Pilot had any meaningful effect on the relative frequency of on-time payments for non-FasTrak trips in the ExpressLanes.



DATA TABLE
See full data table at end of this section

Assumptions: In the absence of the PAYG Pilot, the volume of on-time payments made for non-FasTrak trips as a proportion of all non-FasTrak trip payments received would have remained unchanged between the “Before PAYG” and “With PAYG” periods. Additionally, any potential influence of the PAYG Pilot on the total number of non-FasTrak trip payments received in the “With PAYG” period (i.e., 823,401) was assumed to be negligible. Finally, the proportion of payments that occurred after escalation to DMV hold in the “Before PAYG” period is assumed to be consistent from week to week.

DATA TABLE

Weeks Before PAYG, by Start Date	Non-FasTrak Trips Paid*	On-Time Non-FasTrak Trip Payments	Weeks Before PAYG, by Start Date	Non-FasTrak Trips Paid*	On-Time Non-FasTrak Trip Payments	Weeks With PAYG, by Start Date	Non-FasTrak Trips Paid*	On-Time Non-FasTrak Trip Payments	Weeks With PAYG, by Start Date	Non-FasTrak Trips Paid*	On-Time Non-FasTrak Trip Payments
8/26/18	1,625	1,285	3/3/19	7,795	6,082	8/29/21	12,022	9,190	3/6/22	16,228	12,603
9/2/18	6,696	4,661	3/10/19	7,786	5,928	9/5/21	16,802	12,914	3/13/22	15,934	12,402
9/9/18	10,056	7,078	3/17/19	6,388	5,244	9/12/21	18,053	13,858	3/20/22	16,935	13,068
9/16/18	10,576	7,634	3/24/19	3,702	3,189	9/19/21	17,378	13,239	3/27/22	14,259	12,586
9/23/18	11,200	8,119	3/31/19	6,093	4,768	9/26/21	18,056	13,624	4/3/22	16,463	12,749
9/30/18	10,031	7,558	4/7/19	6,520	5,158	10/3/21	17,803	13,619	4/10/22	17,123	13,305
10/7/18	10,030	7,395	4/14/19	8,297	6,443	10/10/21	17,588	13,368	4/17/22	17,267	13,750
10/14/18	12,074	8,951	4/21/19	10,803	8,362	10/17/21	17,760	13,372	4/24/22	16,195	12,920
10/21/18	12,138	8,965	4/28/19	9,793	7,886	10/24/21	18,099	13,552	5/1/22	18,872	14,979
10/28/18	11,711	8,399	5/5/19	10,175	8,585	10/31/21	17,055	12,586	5/8/22	14,983	11,940
11/4/18	9,295	6,533	5/12/19	10,363	8,597	11/7/21	17,503	12,907	5/15/22	13,129	10,378
11/11/18	8,861	6,440	5/19/19	10,354	8,708	11/14/21	18,160	13,527	5/22/22	15,632	12,301
11/18/18	8,549	6,098	5/26/19	7,975	6,812	11/21/21	16,005	11,860	5/29/22	15,036	11,807
11/25/18	10,239	7,401	6/2/19	9,136	7,503	11/28/21	16,659	12,198	6/5/22	15,279	12,083
12/2/18	10,244	7,367	6/9/19	11,933	9,716	12/5/21	17,734	13,483	6/12/22	15,432	12,298
12/9/18	11,466	8,467	6/16/19	10,484	8,572	12/12/21	20,108	15,621	6/19/22	14,452	11,366
12/16/18	11,543	8,765	6/23/19	8,750	6,952	12/19/21	15,171	12,975	6/26/22	15,505	12,212
12/23/18	8,387	6,775	6/30/19	7,734	6,399	12/26/21	9,804	7,422	7/3/22	13,380	10,629
12/30/18	7,457	6,338	7/7/19	8,423	6,996	1/2/22	10,061	7,666	7/10/22	14,121	11,145
1/6/19	8,115	6,176	7/14/19	10,694	9,035	1/9/22	9,424	7,085	7/17/22	15,040	11,739
1/13/19	7,113	5,514	7/21/19	10,933	9,359	1/16/22	10,870	8,240	7/24/22	15,177	11,752
1/20/19	5,714	4,629	7/28/19	10,684	9,009	1/23/22	12,508	9,447	7/31/22	15,202	11,733
1/27/19	5,271	4,074	8/4/19	11,123	9,533	1/30/22	14,181	10,855	8/7/22	16,242	12,649
2/3/19	6,934	5,474	8/11/19	10,618	8,927	2/6/22	17,357	13,542	8/14/22	17,263	13,521
2/10/19	8,982	7,126	8/18/19	11,280	9,183	2/13/22	17,741	13,927	8/21/22	16,831	13,306
2/17/19	10,272	8,077	8/25/19	10,748	8,635	2/20/22	16,493	12,785	8/28/22	7,612	6,009
2/24/19	9,068	6,996				2/27/22	13,414	10,505			

**Includes Notices paid at all escalation stages prior to DMV hold. Numbers are approximate for 2018-2019.*

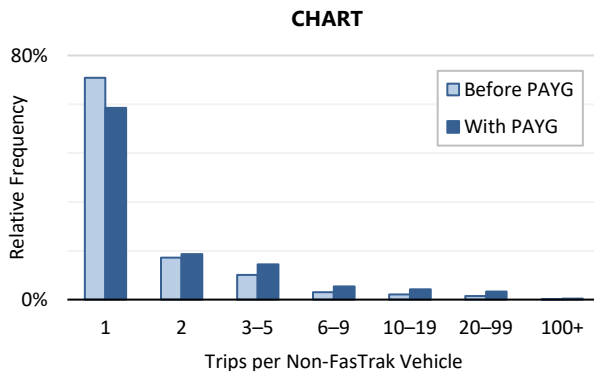
EXPRESSLANES ACCESS BY INFREQUENT OR OCCASIONAL USERS

In this section, we consider changes in the amount of non-FasTrak trips made by infrequent or occasional users of the ExpressLanes after the PAYG Pilot was implemented, and fees for such trips were reduced from \$25 per trip to \$4 per trip.

Data Source: Trip records for the period between 9/1/2018 and 8/31/2019 (constituting the “Before PAYG” period), and trip records for the period between 9/1/2021 and 8/31/2022 (constituting the “With PAYG” period). These periods were selected to compare the most recent year of data available against the comparable period before the PAYG pilot was implemented in January 2020.

Method: Data consider the number of trips made for each non-FasTrak vehicle that appeared at least once in the ExpressLanes during the “Before PAYG” and “With PAYG” analysis periods. These data are aggregated into bins as shown in the “Findings” section. To control for pandemic-related effects on overall ExpressLanes trip volumes, the number of trips made by each vehicle are reported as relative frequencies.

Findings: In the “Before PAYG” period, 73% of non-FasTrak drivers made just one trip in the ExpressLanes, while in the “With PAYG” period this percentage declined to 63%. However, the number of non-FasTrak drivers in every other trip count bin increased in the “With PAYG” period. The average (arithmetic mean) number of trips made per non-FasTrak driver increased from 2.5 in the “Before PAYG” period to 3.7 in the “With PAYG” period. The difference in the two distributions was statistically significant at a 95% confidence level (Chi-Squared Test, p-value 0.000). These findings indicate that non-FasTrak drivers were more likely to continue using the ExpressLanes without setting up FasTrak accounts in the “With PAYG” period compared to the “Before PAYG” period. Conversely, drivers in the “Before PAYG” period were more likely to set up FasTrak accounts or stop using the ExpressLanes altogether after their first trips as compared to the “With PAYG” period.



DATA TABLE

Trips Per Non-FasTrak Vehicle	Vehicle Count Before PAYG	Vehicle Count With PAYG	Relative Frequency Before PAYG	Relative Frequency With PAYG
1	443,473	420,018	72.7%	62.9%
2	83,975	99,449	13.8%	14.9%
3-5	49,309	77,084	8.1%	11.5%
6-9	14,757	29,165	2.4%	4.4%
10-19	10,323	22,828	1.7%	3.4%
20-99	7,367	17,465	1.2%	2.6%
100+	831	2,057	0.1%	0.3%

Assumptions: In the absence of the PAYG Pilot, the distribution of trip counts per non-FasTrak driver in the ExpressLanes would have remained unchanged between the “Before PAYG” and “With PAYG” periods.