Revenue Impacts of Proposed Changes to TriMet's Transfer Policy

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BACKGROUND

This study was commissioned by TriMet to obtain an estimate of the effects on revenues of a proposed change in transfer policy. In the context of public transit, the word "transfer" has two different meanings. As a verb, it means to change from one line to another within a transit trip. As a noun, it means the physical receipt for payment, which allows additional boardings until it expires. In this report we will use the term "transfer receipt" when using the noun to avoid confusion.

Current Transfer Policy

TriMet's transfer policy is to allow two hours from validation for light rail tickets and two hours from boarding for transfer receipts issued on buses. Transfer receipts allow boarding through their expiration, so paid travel may extend beyond the expiration time.

TriMet's transfer policy is intended to ensure that users can travel from their origin to any single destination within the service area on one fare. An unintended consequence of the policy is that users making shorter trips can make additional, free trips before their transfer receipt expires. These additional, free trips usually are return trips back to the user's origin, but may take the form of trips to second or third destinations. These additional, free trips are allowed under TriMet's fare policy, but they are not the purpose of the policy.

Proposed Changes to Transfer Policy

OPAL has proposed changing TriMet's transfer policy to allow three hours for all transfers issued before 7:00PM. They also propose that transfers issued after 7:00PM would remain valid through the end of the service day. The primary effect of these changes would be to significantly increase the number of additional, free trips allowed and taken by users.

This report also examines the effects on revenue of some variations on OPAL's proposed changes to TriMet's transfer policy.

REVENUE IMPACTS OF PROPOSED CHANGES

The proposed changes in policy would affect TriMet's revenues in two ways. The direct effect would be a decrease in revenue from fares that would otherwise be collected on additional trips that would become free under the changed policy. An indirect effect would be increased sales of fares for initial trips, which would be expected since the cost of a set of sequential transit trips would be reduced for those users whose itineraries include additional trips within the extended transfer period, making transit a more attractive option.

Revenue Effects of Trips That Would Become Free

Those who use monthly passes, 30-, 14-, seven-, or one-day passes would be unaffected, though some who purchase one-day passes may instead purchase single fares if they expect to begin their third trip within the extended transfer period. We separately estimate the reduction in revenue from one-day passes, which are now priced equal to two cash trips.

Of those who purchase single fares, some would be unable to use an additional, free trip within the extended transfer period. These include most users who take transit to work, school, or other activities with long durations, as well as users who use other modes for other trips (e.g., one-way trips to or from the train station, bus terminal, or airport).

Number of Trips

TriMet uses the term 'origination" to describe the first boarding on a trip from the traveler's origin to their destination. If the trip includes transfers between the origin and destination, those subsequent boardings do not count as originations. But the beginning of a new trip is counted as an origination, even if the boarding is made with an unexpired transfer receipt.

Data from TriMet show that on a typical weekday there are 68,384 cash and ticket originations (27.6% of all weekday originations) and on a typical weekend day there are 50,096 cash and ticket originations (36.6% of all weekend originations). Weekends have different service schedules and travel characteristics (e.g., fewer work or school trips), so are tracked separately.

Within a day, different time periods also have different service schedules and travel characteristics. For example, morning and afternoon peak travel periods are dominated by travel to or from work and most lines have more frequent service during these periods to accommodate the additional travelers. Travelers in different time periods have different distributions of times until they are available to travel again and different likelihoods of having another trip to make that day. To

Daily Cash and Ticket Originations		
Time period	**Number**	**Percent**
Weekday AM Peak (before 9:00 AM)	10,992	16.1%
Weekday Mid-Day (9:00 AM to 4:00 PM)	30,249	44.2%
Weekday PM Peak (4:00 PM to 7:00 PM)	17,324	25.3%
Weekday Evening (after 7:00 PM)	9,819	14.4%
Weekday Total	**68,384**	**100.0%**
Weekend Day (before 7:00 PM)	39,325	78.5%
Weekend Evening (after 7:00 PM)	10,771	21.5%
Weekend Total	**50,096**	**100.0%**

estimate the number of users who might benefit from the proposed extended transfer period, we divided the weekday service day into four time periods and made separate estimates for each, and we divided weekends and holidays into before and after 7:00 PM. TriMet provided data on the numbers of originations by time period. All originations data is from the Fall 2012 fare survey.

Revenue per Paid Trip

TriMet reports that they receive an average of $830,661 of cash and ticket fare revenue per week and that there are an average of 442,111 paid cash and ticket trips per week. The average revenue per paid cash and ticket origination is therefore $1.88.

Number of Free Trips Under Current and Proposed Transfer Policies

To estimate the number of free trips, we used data from Metro's most recent travel survey, which followed travelers in the Portland metro area through entire days, recording the origin and destination of each trip, the travel mode(s) used, beginning and ending times for each trip, and the duration and nature of the activities undertaken between trips. For transit trips, the method of payment and number of transfers also were recorded.

To predict the number of people who could get a free trip, we need to understand the time it takes between the first boarding for the first trip (when the transfer receipt is issued) and the first boarding for the next trip (when the transfer receipt from the first trip must still be valid). That time includes all of the in-vehicle time on the first trip, transfer wait time(s), if any, on the first trip, walk time from the end of the first trip, dwell time at the activity between trips, walk time for the second trip, and wait time for the second trip. We called the sum of these times "time until available" or TUA.

For each trip by a traveler who had at least one subsequent transit trip on the same

day, we calculated the time between the start of the first trip and the start of the subsequent trip. We made the assumption that the walk and wait times for the two trips are, on average, the same, so this duration measures the time until available. The distribution of these durations was examined and, as expected, did not correspond to a normal distribution. A normal distribution extends below zero and has an equal number of observations above and below the average (the median is equal to the mean). The distribution of actual times does not include any observations below zero and the mean is significantly higher than the median because the longest times are much farther from the median

could make those trips with an unexpired transfer receipt. We made the additional assumption that nobody would lose their transfer receipt and multiplied the estimated number of additional, free trips by the average fare revenue per cash or ticket trip to estimate the per-day revenue impact and then scaled those estimates to annual estimates by multiplying by the number of such days in a year.

Results

The Metro survey data indicate that few people who travel before 9:00 AM on weekdays make subsequent trips before their transfer receipts expire, even though over 80 percent have another trip to make in the same day. These people are mostly

	Weekday Before 9AM	Weekday 9AM-4PM	Weekday 4PM-7PM	Weekday After 7PM
Mean of TUA (minutes)	542	345	521	430
Mean of log of TUA	5.88	4.91	5.26	5.50
Variance in log of TUA	0.83	1.87	2.00	1.12
% less than 120 minutes	11.5%	46.5%	36.9%	24.9%
% less than 180 minutes	22.5%	58.2%	48.1%	38.4%
% less than end of service	100.0%	100.0%	100.0%	100.0%
% Not Last Trip of the Day	82.3%	57.1%	17.7%	12.2%
% Free Under Current Policy	9.5%	26.5%	6.5%	3.0%
% Free Under Proposed Policy	18.5%	33.2%	8.5%	12.2%

time than are the shortest times. The distribution of times does correspond well to a lognormal distribution, in which the natural logarithm of the observations is normally distributed. We fit a lognormal distribution to the distributions of time until available for each time period.

We used the properties of the lognormal distributions to estimate the proportion of travelers in each time period who had subsequent transit trips to make who

traveling to work or school, and those activities tend to have long durations Extending the transfer duration to three hours would add 996 free trips, out of almost 11,000 daily cash and ticket trips before 9:00 AM. Annual revenue losses from weekdays before 9:00 AM would total $484,917.

Mid-day travelers, traveling between 9:00 AM and 4:00 PM, are more likely to be able to take advantage of the extended

transfer policy. 57 percent of these travelers have another trip to make in the same day. 26.5% of mid-day travelers can get a free trip under the current transfer policy and 33.2% would be able to get a free trip under the proposed policy. The number of free trips would increase by 2,032 per weekday and would result in annual revenue losses of $989,425.

Travelers in the PM peak period, from 4:00 PM to 7:00 PM, are mostly traveling back home, and only 17.7% of them have another transit trip to make in the same day. Of those who do have another trip to make, though, 37% make it within two hours and 48% make it within three

hours. The number of free trips would increase by 343 per weekday and would result in annual revenue losses of $167,177.

Of travelers who begin a trip after 7:00 PM on a weekday, 12.2% have another transit trip to make in the same day and 24.9% of those get their next trip for free under the current transfer policy. Under the proposed policy, all would get their next trip for free. The number of free trips would increase by 896 per weekday and would result in annual revenue losses of $436,481.

The Metro survey data did not include weekend or holiday travel. We assumed

Calculation of Revenue Losses	Weekday Before 9AM	Weekday 9AM-4PM	Weekday 4PM-7PM	Weekday After 7PM	Weekend Before 7PM	Weekend After 7PM
Cash and Ticket Originations	10,992	30,249	17,324	9,819	39,325	10,771
% Free Current Policy	9.5%	26.5%	6.5%	3.0%	26.5%	3.0%
Number Free Current Policy	1,043	8,025	1,131	297	10,433	326
% Free Proposed Policy	18.5%	33.2%	8.5%	12.2%	33.2%	12.2%
Number Free Proposed Policy	2,039	10,057	1,474	1,194	13,075	1,309
Additional Free Trips per Day	996	2,032	343	897	2,642	983
Number of Days per Year	259	259	259	259	106	106
Additioanl Free Trips per Year	257,935	526,290	88,924	232,171	280,025	104,224
Average Revenue per Trip	$1.88	$1.88	$1.88	$1.88	$1.88	$1.88
Change in Revenue	**$ (484,917)**	**$ (989,425)**	**$ (167,177)**	**$ (436,481)**	**$(526,448)**	**$(195,940)**

Total Over All Time Periods	**$(2,800,388)**
From Before 7PM	$(2,167,967)
From After 7PM	$ (632,421)

that travel patterns on weekend days before 7:00 PM would be similar to mid-day travel on weekdays and weekend travel patterns after 7:00 PM would be similar to weekdays after 7:00 PM. We applied these patterns to the numbers of trips on weekend days to estimate the number of additional free trips. We estimated that on weekend days before 7:00 PM there would be 2,642 additional free trips, resulting in annual revenue losses of $526,448. After 7:00 PM, there would be 983 additional free trips, resulting in annual revenue losses of $195,940.

In total, annual revenue losses from additional free trips would amount to $2,800,388, of which $2,167,967 is attributed to the before-7:00 PM change to three-hour transfers and $632,421 is attributable to the after-7:00 PM change to unlimited transfers through the end of the service day.

POTENTIAL ADDITIONAL REVENUE LOSSES FROM ONE-DAY PASS USERS

Under current TriMet policy, riders may purchase a one-day pass for the cost of two cash fares and take as many trips as they like until the end of the service day. Of all one-day passes sold, 64.4 percent end up being used for only two trips. If transfer times were increased, some of the people now purchasing one-day passes would be able to complete their traveling with one cash fare and it is likely that some of those would no longer pay for one-day passes.

When deciding whether to purchase a one-day pass or two cash fares, which cost the same, the traveler must decide whether it is more likely that they will be able to start their return trip before the

transfer expires (making the cash fare cheaper) or it is more likely that they will have occasion to make another, extra trip later in the day (making the pass cheaper). Changing the length of time until the transfer expires will change that trade-off, but some people may still place a higher value on the option of being able to make additional trips later in the day. We don't know how people value that option, so our estimates of additional revenue losses represent the high end of a reasonable range. The low end would be zero.

Assuming the same distributions of times until available and the same proportions of last trips of the day in each time period as for all transit users in the Metro survey, we estimate that the proposed transfer policy changes would result in additional revenue losses of $1.3 million, of which $1.1 million is attributed to the before-7:00 PM change to three-hour transfers. If some of the people who could take advantage of the extended transfer period to get free return trips choose not to because they value the option to make additional trips later in the day with the one-day pass, revenue losses would be less than estimated here.

OFFSETTING REVENUE EFFECTS OF ADDITIONAL SALES

For some potential users who would not choose to use TriMet for particular trips under the current transfer policy, the proposed change in policy would result in a sufficient probability that their fare cost would be reduced by half or more that they would choose to use TriMet for those trips under the proposed policy. These users would pay fares that TriMet would not otherwise receive, offsetting fare losses from additional free trips.

Potential Revenue Change from One-Day Passes	Weekday Before 9AM	Weekday 9AM-4PM	Weekday 4PM-7PM	Weekday After 7PM	Weekend Before 7PM	Weekend After 7PM
Number of one-day pass originations	6,475	13,971	8,239	5,246	19,482	5,447
% with two one-way trips	82%	64%	65%	62%	58%	68%
Number of 2-trip 1-day pass originations	5,310	8,941	5,355	3,253	11,369	3,707
% Half-Free Under Proposed Policy	12.4%	22.0%	17.8%	18.0%	22.0%	18.0%
Free Trips Under Proposed Policy	330	983	476	293	1,250	334
Number of Days per Year	259	259	259	259	106	106
Additional Free Trips per Year	85,581	254,565	123,253	75,836	132,466	35,369
Average Fare Revenue per Trip	1.88	1.88	1.88	1.88	1.88	1.88
Change in Revenue	(160,893)	(478,583)	(231,716)	(142,571)	(249,037)	(66,494)

Total Over All Time Periods	(1,329,295)
From Before 7PM	(1,120,229)
From After 7PM	(209,066)

Method

To estimate the potential number of additional fares sold, we need to know the relationship between the price of fares and the quantity of fares sold. This relationship is expressed as an elasticity, or proportional change in quantity resulting from a proportional change in price.

Several studies have been conducted in the US and elsewhere to determine the price elasticity of demand for transit services. All of these studies concluded that the demand for transit is price-inelastic, i.e., a change in price results in a less-than-proportionate change in quantity demanded. The studies also concluded that peak-period travel is even less sensitive to price changes than off-peak travel. The average price elasticity of demand across the studies was -0.20 for peak-period travel and -0.33 for off-peak travel. These numbers mean that a one-percent increase in fare price would result in an approximately 0.2 percent reduction in peak-period travel and an approximately 0.33 percent reduction in off-peak travel.

When the change in price is more than one percent, the percent change in quantity must be calculated using a formula that takes into account the properties of the elasticity relationship, so with an elasticity of 0.20, a 100% increase in price would result in a 14.9% decrease in quantity, not a 20% decrease. A 50% decrease in price would result in a 14.9% increase in quantity.

In the case of the proposed policy, not all potential transit users would perceive a reduction in the cost of travel. We assumed that those who could use transit, but choose not to at current fares, have the same distribution of travel patterns as those who currently do use transit. The same proportions of potential transit users therefore could get free additional trips under the proposed policy as of actual transit users. Those who could get a free trip would perceive a fare reduction of 50 percent on the paid trip. In the peak period, with an elasticity of -0.20, sales to those who could take advantage of additional free trips would increase by 14.9%. In the off-peak period, with a price elasticity of -0.33, sales to those who could take advantage of additional free trips would increase by 25.7%.

It is not clear that all travelers would be able to know in advance whether they will complete their activities after their first trip in time to get a free subsequent trip. If that is the case, the responsiveness to the cost reduction would be less than estimated here. Assuming that all travelers know how much they could save under the proposed policy, we estimate that additional sales would increase revenues by $649,106 per year. Of that amount, $486,565 is attributed to the before-7:00 PM change to three-hour transfers and $162,541 is attributable to the after-7:00 PM change to unlimited transfers through the end of the service day.

Potential Revenue Change from Additional Fares	Weekday Before 9AM	Weekday 9AM-4PM	Weekday 4PM-7PM	Weekday After 7PM	Weekend Before 7PM	Weekend After 7PM
Paid Trips That Would Come With Free Subsequent Trip	257,935	526,290	88,924	232,171	280,025	104,224
Average Cost of Two Trips Under Proposed Policy	$1.88	$1.88	$1.88	$1.88	$1.88	$1.88
Average Cost of Two Trips Under Current Policy	$3.76	$3.76	$3.76	$3.76	$3.76	$3.76
Ratio of Proposed Cost to Current	0.5	0.5	0.5	0.5	0.5	0.5
Assumed Price Elasticity of Demand	-0.20	-0.33	-0.20	-0.33	-0.33	-0.33
Percent Change in Quantity Demanded	14.9%	25.7%	14.9%	25.7%	25.7%	25.7%
Additional Paid Trips Demanded	38,354	135,264	13,223	59,671	71,970	26,787
Average Revenue per Paid Trip	$1.88	$1.88	$1.88	$1.88	$1.88	$1.88
Change in Revenue	$72,106	$254,296	$24,859	$112,182	$135,304	$50,359
Total Over All Time Periods	$649,106					
From Before 7PM	$486,565					
From After 7PM	$162,541					

NET EFFECT ON REVENUE

The net effect on revenue consists of the direct effect of additional free trips, the potential additional effect of one-day pass users switching back to cash fares to gain free trips, and the potential offsetting effect of additional cash fares sold to people who currently don't use transit. We are reasonably confident in our estimate of the direct effect. We are less confident in our estimates of the other two effects. In both of those cases, our estimates rely on the assumption that travelers can predict whether they will be able to get a free trip later in the day and that they will value the potential for that free trip as if it were a certainty. If that assumption does not hold, the true values for those effects will be closer to zero than our estimates.

The direct effect of OPAL's proposal is estimated to be $2.8 million per year of revenue losses. Additional losses of $1.3 million might accrue from one-day pass users. And offsetting gains of $0.65 million might accrue from additional sales. The low estimate would be $2.15 million (full effect of additional sales and no effect from one-day passes). The high estimate would be $4.1 million (no effect from additional sales and full effect from one-day passes. Counting half of each of the uncertain effects results in an estimate of $3.125 million in losses; counting all of each yields $3.45 million in losses.

Sensitivity Analysis

In addition to the changes to TriMet's transfer policy that have been proposed by OPAL, we examined the effects on revenue of three-hour transfers all day long, two-and-a-half-hour transfers before 7:00 PM (with unlimited after 7:00 PM), and two-and-a-half-hour transfers all day long. As expected, these options reduced the estimated revenue losses.

Cost to Users of Service Cuts

This analysis does not attempt to estimate the cost to users of the reduction in service that would be necessitated by the loss of revenue caused by the proposed change in policy.

Proposed Transfer Time		Low or High	Estimated Change in Revenue		
Before 7PM	After 7PM	Estimate	Before 7PM	After 7PM	All Day
180 Minutes	Until End of Service	Low	(1,681,402)	(469,881)	(2,151,283)
		High	(3,288,196)	(841,487)	(4,129,683)
150 Minutes	Until End of Service	Low	(905,086)	(469,881)	(1,374,967)
		High	(1,777,918)	(742,726)	(2,520,644)
180 Minutes	180 Minutes	Low	(1,681,402)	(84,600)	(1,766,003)
		High	(3,288,196)	(322,931)	(3,611,127)
150 Minutes	150 Minutes	Low	(905,086)	(44,636)	(949,722)
		High	(1,777,918)	(170,380)	(1,948,298)