COLLEGE OF URBAN AND PUBLIC AFFAIRS
School of Urban Studies and Planning
USP537 – Economics of Urban Transportation

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Winter 2024

KEY Problem Set #2 (Due 02/14/2024 by 10a; hand in on paper at beginning of class; if you cannot attend that day, leave in my mailbox, Urban 350)

For full credit, please show your work!

Costs and Revenue (per boarding ride, adapted from NTD reporting; go there for more actual detail: https://www.transit.dot.gov/ntd/transit-agency-profiles/tri-county-metropolitan-transportation-district-oregon)

	2019	2022
MAX Light Rail boardings	38.8 million	18.6 million
…AVC	$3.25	$6.85
…ATC	$4.30	$8.85
…MC	$1.00	$1.20
…MR=AR (farebox only)	$1.20	$1.05
Scheduled Bus Service boardings	56.5 million	30.8 million
…AVC	$4.10	$7.80
…ATC	$5.45	$10.20
…MC	$2.80	$3.35
…MR=AR (farebox only)	$1.05	$0.95

Based on the short-run cost figures provided above, and what you've learned from class and readings, answer the questions that follow on transit service provision.

1. Calculate the average fixed cost (AFC) per ride and total fixed cost (FC) for each transit mode before and after Covid. Did AFC rise or fall post-Covid? What about total FC? Did AFC and FC move as you expected or not? Briefly interpret the results.

MAX

$AFC_{2019} = ATC_{2019} - AVC_{2019}$
$= \$4.30 - \$3.25$
$= \$1.05$

$FC_{2019} = AFC_{2019} * Q_{2019}$
$= \$1.05 * 38.8M$
$= \$40.74$ million

Bus

$AFC_{2019} = ATC_{2019} - AVC_{2019}$
$= \$5.45 - \$4.10$
$= \$1.35$

$FC_{2019} = AFC_{2019} * Q_{2019}$
$= \$1.35 * 56.5M$
$= \$76.28$ million

(over)

MAX Continued

$AFC_{2022} = ATC_{2022} - AVC_{2022}$

$= \$8.85 - \$6.85$

$= \$2.00$

$FC_{2022} = AFC_{2022} * Q_{2022}$

$= \$2.00 * 18.6M$

$= \$37.2M$

Bus Continued

$AFC_{2022} = ATC_{2022} - AVC_{2022}$

$= \$10.20 - \$7.80$

$= \$2.40$

$FC_{2022} = AFC_{2022} * Q_{2022}$

$= \$2.40 * 30.8M$

$= \$73.92M$

AFC ~~fell~~ rose! for both MAX and Bus from 2019 to 2022. This makes sense, since the costs of vehicles and infrastructure were spread over fewer riders. FC fell slightly, suggesting TriMet was able to adjust some non-variable resources over the period. For example, they might have held off on purchasing new vehicles and/or retired older ones. It's also possible TriMet benefitted from reduced interest rates on debt payments. These FC savings were not directly a result of service cuts or ridership declines.

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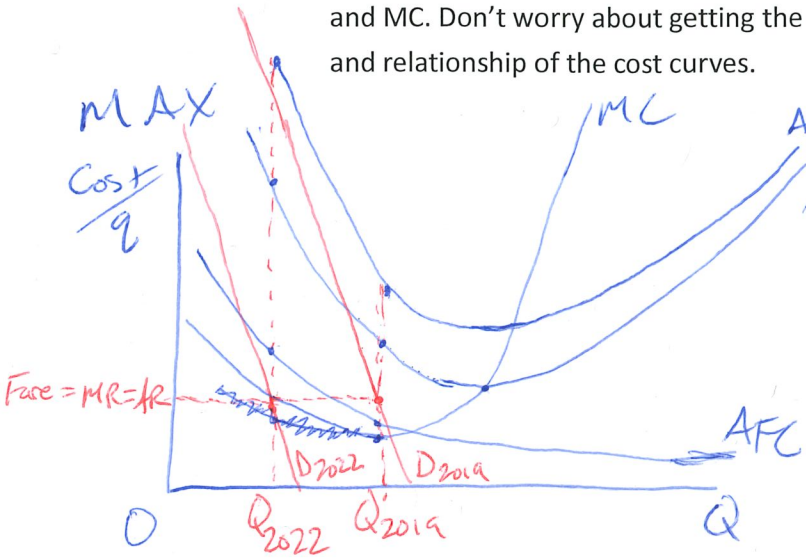
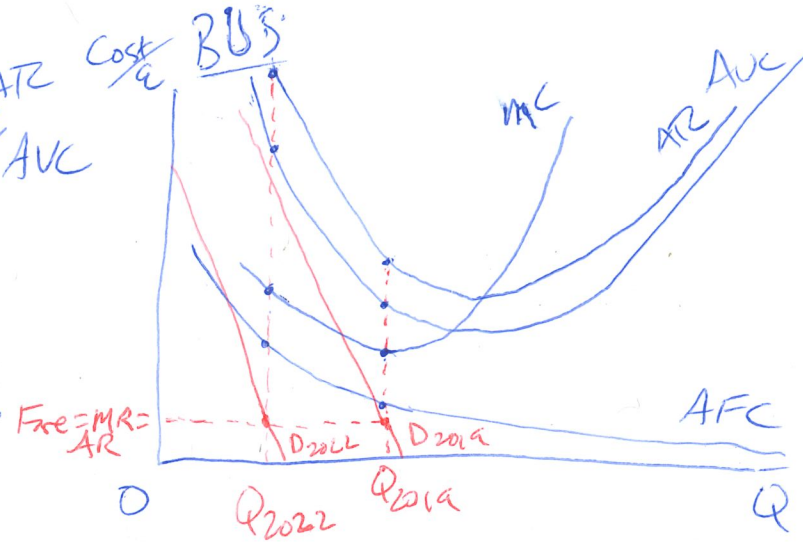
2. Assume (perhaps a big assumption, but…) Trimet's short-run cost structure stayed the same from 2019-2022. Choose Bus **or** MAX, and sketch a graph with a simple set of plausible cost curves for Trimet. Be sure to include AFC, AVC, ATC, and MC. Don't worry about getting the numbers just right; focus on the shape and relationship of the cost curves.





3. Add (or draw a new sketch if needed) the following to your cost sketch:
   a. Add a 2019 demand curve and a fare (use the value of farebox revenue) to your plot. This doesn't need to be precise, but take some care in adding these based on the numbers in the table for your chosen mode.

See above. Key features:
(2022 also shown)

* D_{2019} MAX should intersect fare above MC. D_{2019} BUS should intersect well below MC.

b. Label the resulting Q_{2019}, and draw a vertical line up that intersects the cost curves. Briefly explain what the following represent:

i. Difference between the fare (MR) and MC?

Represents difference between (private) marginal benefit or willingness to pay and (private) cost of providing/serving an additional rider.

ii. Difference between the fare and AVC?

Gap between the average variable cost, the costs that increase with Q, and the average fare revenue per rider.

Note: Fare = MR = AVC would be shutdown point for private provider.

iii. Difference between the fare and ATC?

Gap between the average total cost, including fixed or "sunk" costs and variable costs per rider.

4. Economic efficiency suggests we provide provide a service up to the point MB=MC. Ignoring potential externalities, for your chosen 2019 service (Bus or MAX), should the fare be higher, lower, or stay the same on efficiency grounds only? Briefly explain why.

MAX: Fare is above MC where demand intersects. A lower fare would increase Q_D to a more efficient point where D = MC.

BUS: In the absence of externalities, current fare is below MC, suggesting an increased fare and decreased Q_D would yield a more efficient outcome at D=MC

5. Calculate percent change in ridership from 2019 to 2022 for bus and for MAX.

a. Which declined at a higher rate? Why might that be?

$$\%\text{chg}Q_{Bus} = \frac{(Q_{2022} - Q_{2019})}{Q_{2019}} * 100 = \frac{(30.8M - 56.5M)}{56.5M} * 100 = -45.5\%$$

$$\%\text{chg}Q_{MAX} = \frac{(Q_{2022} - Q_{2019})}{Q_{2019}} * 100 = \frac{(18.6M - 38.8M)}{38.8M} * 100 = -52.1\%$$

MAX declined more sharply, likely due to larger decrease in demand for trip types most served by MAX: commute/peak. Also possible that MAX riders more likely to have options to WFH or travel by car, two substitutes less negatively affected by Covid.

b. How do these compare with the ridership changes reported in the "Cities on three continents..." reading from Week 1?

NYC Bus = −48.2%

NYC Rail = −40.0%

(Granted Heavy Rail ≠ LRT/MAX)

TriMet & NYC Bus declines were very similar, but MAX LRT declined more than Bus and much more than NYC Metro. This could reflect: quicker return to commuting (NYC) or fewer close substitutes (NYC)

6. Add to your sketch from 3 (or draw a new sketch), the demand and fare (assume fare=MR=AR) shifts due to Covid. Label the resulting Q_{2022}, and carry that vertical line up to intersect MC, AVC, and ATC. see #3

   a. Explain what your graphical analysis suggest is happening to AVC and ATC due to the demand shift?

BUS + MAX: Both modes appear to be operating in the decreasing portions of AVC + ATC. Reduced demand/ridership increases cost per rider due to less than efficient use of fixed resources.

   b. Calculate the change in total variable costs for your chosen mode from the table.

MAX: $chg\ VC = (AVC_{2022} * Q_{2022}) - (AVC_{2019} * Q_{2019})$
$= (\$6.85 * 18.6M) - (\$3.25 * 38.8M)$
$= +\$1.31M$

Bus: $chg\ VC = (AVC_{2022} * Q_{2022}) - (AVC_{2019} * Q_{2019})$
$chg\ VC = (\$7.80 * 30.8M) - (\$4.10 * 56.5M)$
$= +\$8.59M$

   c. Your analysis in part (a) above provides part of the answer for the large increase in AVC, but (b) suggests another factor, especially since TriMet did cut service for both Bus and MAX around 15% in response to Qd declines. Total variable costs will always go down with quantity (since MC is always positive). The fact that they went up from 2019-2022 suggests there was also an upward shift in variable costs. Hypothesize what might have driven that shift in VC/Q, remembering some of the key items included in transit variable (operating) cost.

A key factor was likely the labor shortage during Covid. TriMet, like other employers, would have to pay a higher rate to attract operators (and related personnel like maintenance and security). This would be exacerbated for Bus, which requires more operators per rider.

7. Given that there were no fare changes between 2019 and 2022, hypothesize one or more factors that could have led to a reduction in marginal fare revenue per ride. [HINT: think about why the marginal fare revenue is less than a single ride fare, then $2.50].

Many potential factors, among them...
- → remaining riders may have been more likely to have discounted fares.
- → less fare enforcement
- → remaining riders have higher transfer rates, such as longer commutes to essential service or non-WFH jobs.