Toll Competition Among Congested Roads
by Engel, Fisher, and Galetovic

1. The model in this paper is much more general than just competing toll highways.

2. The social optimum sets marginal benefit equal to marginal private cost plus the congestion externality on all roads.

3. In oligopoly, the tolls are socially too high, meaning congestion is socially too low.
1. More general than roads.

They say: “The paper also suggests a close relation between the economics of franchised roads and the economics of clubs. Roads are subject to congestion, much like standard club goods.” However, they go on that roads are often not symmetric, and free-entry is unlikely.

But also true for oligopoly “clubs” – rinks, theaters

Consider networks for example.
2. Social optimum: $MB = MPC + \text{all externalities}$

*Generalized travel cost* on road $i$ toll plus travel time: $p_i + c_i(q_i)$

Note road 1 could be longer, narrower, etc. ($c_1$ always higher)

Cars flow onto all roads to equalize *market* travel demand with each road’s cost: $B(Q) = p_i + c_i(q_i)$ for all $i$.

Social planner max $S(q_1 \ldots q_n) = \int B(v)dv - q_1 c_1(q_1) - \ldots - q_n c_n(q_n)$, i.e. total benefits to all drivers minus total congestion costs.

FOC is $\frac{\partial S}{\partial q_i} = B(Q) - c_i - q_i c'_i$, note $q_i c'_i$ is toll for all cars on $i$
Oligopoly tolls too high – part 1

Numerical example from pg. 7

Let \( B(Q) = 1 - q_1 - q_2 \)

Let costs be \( c_1(q_1) = 0.3q_1 \) and \( c_2(q_2) = 0.5q_2 \)

Then market “flow” onto roads requires:

\[
1 - (q_1 + q_2) = 0.3q_1 + p_1 \\
1 - (q_1 + q_2) = 0.5q_2 + p_2
\]

Give demand functions

\[
q_1(p_1, p_2) = 0.53 - 1.58p_1 + 1.05p_2 \\
q_2(p_2, p_1) = 0.32 - 1.37p_2 + 1.05p_1
\]
Oligopoly tolls too high – part 2

So each firm maximizes profits \( \Pi_i = p_i q_i \)
– notes costs are for consumers

E.g. reaction function for firm 1 is

\[
p_1(-1.58) + 0.53 - 1.58p_1 + 1.05p_2 = 0 \Rightarrow p_1(p_2) = \frac{0.53 + 1.05p_2}{3.16}
\]

so strategic complements

Optima are: \( p_1 = 0.24 \quad p_2 = 0.06 \quad q_1 = 0.21 \).

The externality on road 1 is then \( q_1 c_1' = 0.21 \cdot 0.3 = 0.06 \).

Thus, the toll is too high, congestion is too low.
Note, \textit{no} product differentiation.
Conclusion

1. The paper presents a general model of competing, congestible goods.

2. The social optimum sets a toll or price equal to the congestion externality.

3. Bertrand competition leads to (surprise) too high a toll, and thus too little congestion.