Engel, Fischer, and Galetovic, “Toll Competition Among Congested Roads.”

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Main Points

• Show a simplified, linear version of the model.

• Discuss conclusion: in oligopoly, tolls are socially too high, meaning congestion is socially too low.

• Discuss some other applications beyond competing toll roads.
Social Optimum:
MB = MPC + all externalities

- *Generalized travel cost* on road $i$ = toll plus travel time: $p_i + c_i(q_i)$
- Note road 2 could be longer, narrower, etc. ($c_2$ would be 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 $i$
Assignment: Demand

• 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 the roads implies
  \[ 1 - (q_1 + q_2) = 0.3q_1 + p_1 \]
  \[ 1 - (q_1 + q_2) = 0.5q_2 + p_2 \]
• Solve simultaneously for demand functions
  \[ q_1(p_1,p_2) = 0.53 - 1.58p_1 + 1.05p_2 \]
  \[ q_2(p_2,p_1) = 0.32 - 1.37p_2 + 1.05p_1 \]
Assignment: Oligopoly Tolls

- Each firm maximizes profits $\Pi_i = p_i q_i$
  - Note that costs are for consumers
- Firm 1 reaction function is
  
  $p_1(p_2) = (0.53 + 1.05p_2)/3.16$
  
  - Note, strategic complements
- Optima are $p_1 = 0.24$, $p_2 = 0.21$, $q_1 = 0.37$, $q_2 = 0.28$
- So TMC on road 1 is $p_1 + 0.3q_1 = 0.24 + 0.11 = 0.35$
Social Optimum

- A social planner would maximize
  \[ \int B(v)dv - q_1c_1(q_1) - q_2(c_2) \]
  i.e. total benefits to all drivers minus total congestion costs
- Social planner FOCs are
  \[ B(Q) - c_1(q_1) - q_1c_1' = 0 \Rightarrow B(Q) = 0.3q_1 - q_1 \times 0.3 = 0 \]
  \[ B(Q) - c_2(q_2) - q_2c_2' = 0 \Rightarrow B(Q) = 0.5q_2 - q_2 \times 0.5 = 0 \]
- So at oligopoly equilibrium with \( q_1 = 0.37 \), the external congestion cost on road 1 is \( q_1 \times 0.3 = 0.111 \).
- Thus, the toll is too high, and congestion is too low.
Other Applications

- Are competing toll roads likely?
- Other infrastructures where people/goods “flow” based on congestion
  - Railroads, airlines, electric grids, pipelines, communication networks
- Facilities where people dislike congestion
  - Golf clubs, swimming pools, beaches, amusement parks, nature parks, etc.
- Maybe some natural resources like fisheries, oil patches where overuse/overextraction raises everyone’s cost
- Maybe some medical and other public service facilities where waiting is a big part of the cost