

# Urban Delivery Industry Response to Cordon Pricing, Time-Distance Pricing, and Carrier-Receiver Policies

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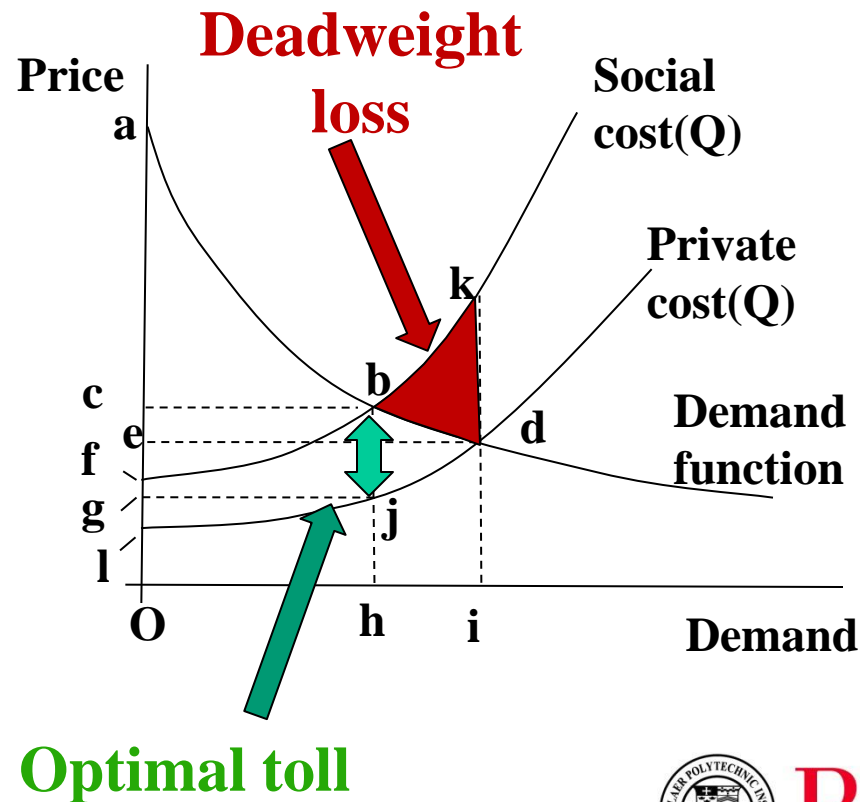
**Presenter: Matthew Brom**



**Rensselaer**

# Rationale for Congestion Pricing

- ❖ If the social costs are not taken into account, there is a deadweight loss, that could be eliminated with a toll (Pigouvian tax)



# The data (from PANYNJ study) indicate that:

- ❖ Changes in delivery time were minimal
- ❖ Carriers implemented other measures, e.g., productivity increases to deal with the toll increase
- ❖ Only 1/9 of carriers passed toll cost to customers
- ❖ Those carriers that passed costs were in industry segments with market power (concrete, electronics, wood/lumber, food)

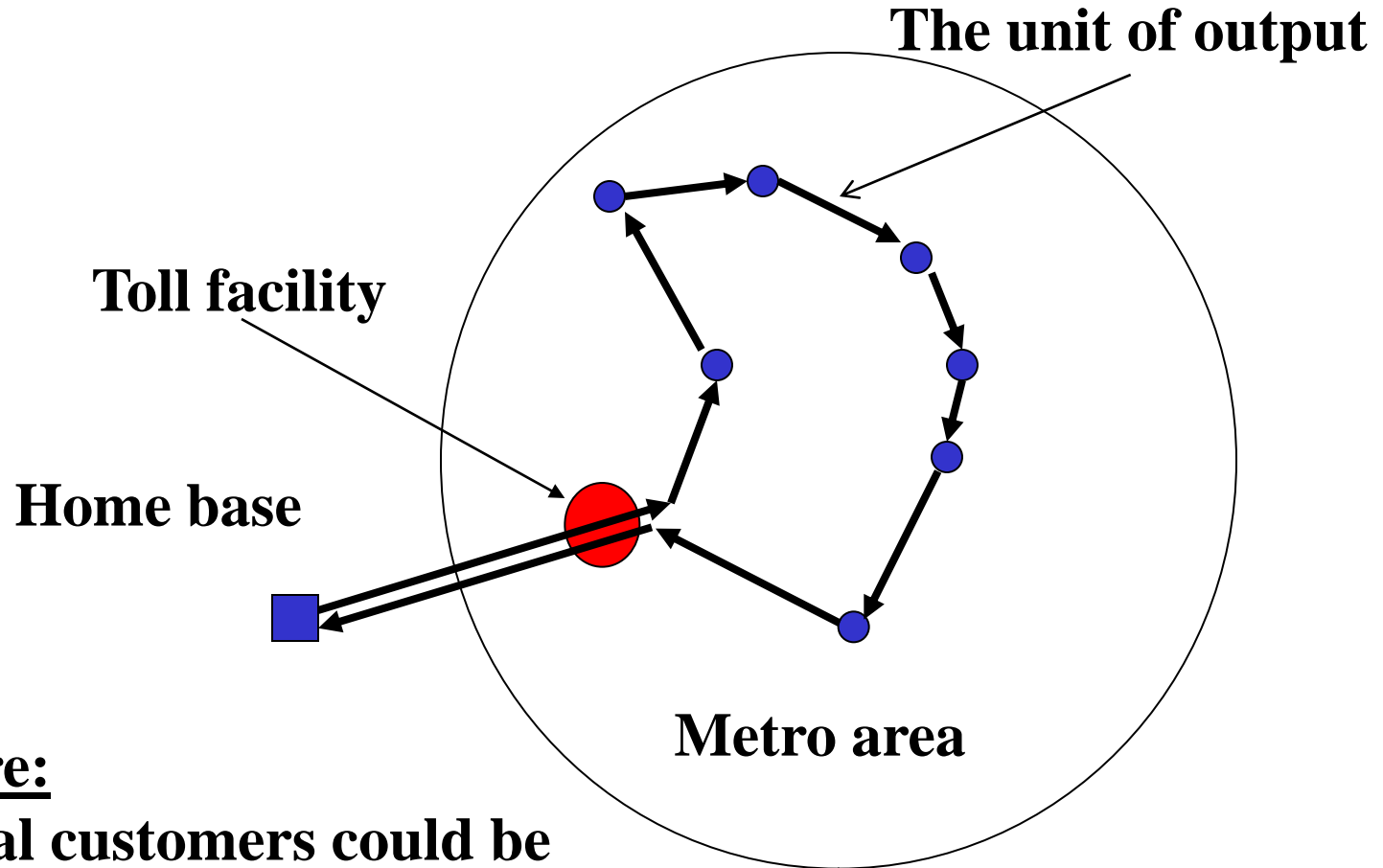


# The objectives of this paper are:

- ❖ To explain this behavior
- ❖ To develop analytical formulations to study carrier-receiver interactions and their joint responses to pricing and comprehensive policies



# The case considered: Urban deliveries (70-80%)



## Key feature:

- Additional customers could be accommodated into existing tours
- A cordon toll is a fixed cost



# The decision about delivery time

- ❖ Is made jointly between receivers and carriers
    - ❖ 40% by receivers, 38% between receivers and carriers and 22% by carriers
  - ❖ Let's take a look at the payoff matrix
    - ❖ The first sign represents the impact on carrier and the second the impact on receiver **(This is the solution preferred by most receivers)**
- (These are non-feasible solutions)**

		Receiver	
		Regular hours	Off-peak hours
Carrier	Regular hours	(-, +) (I)	(-, -) (II)
	Off-peak hours	(-, -) (III)	(+, -) (IV)

**(This is the solution preferred by most carriers)**

# Carrier-receiver interactions

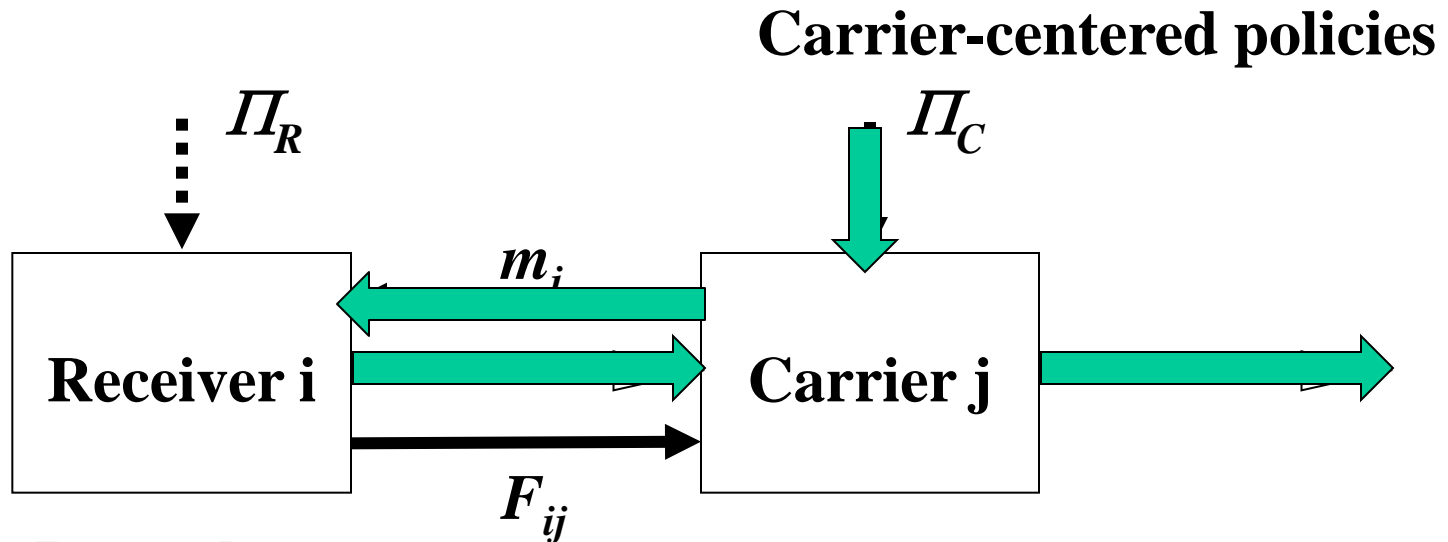
- ❖ Comprehensive policies are needed because it is the only way to move the equilibrium solution from quadrant I to quadrant IV

		Receiver	
		Regular hours	Off-hours
Carrier	Regular hours	(-, +) (I)	(-, -) (II)
	Off-hours	(-, -) (III)	(+, -) (IV)

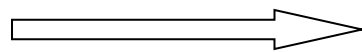
(This is the original solution)

(If proper incentives are provided to receivers, this will be the solution)

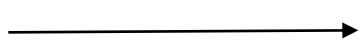
# Carrier centered policies, e.g. freight pricing



## Legend:



**Decision about off-hour deliveries**



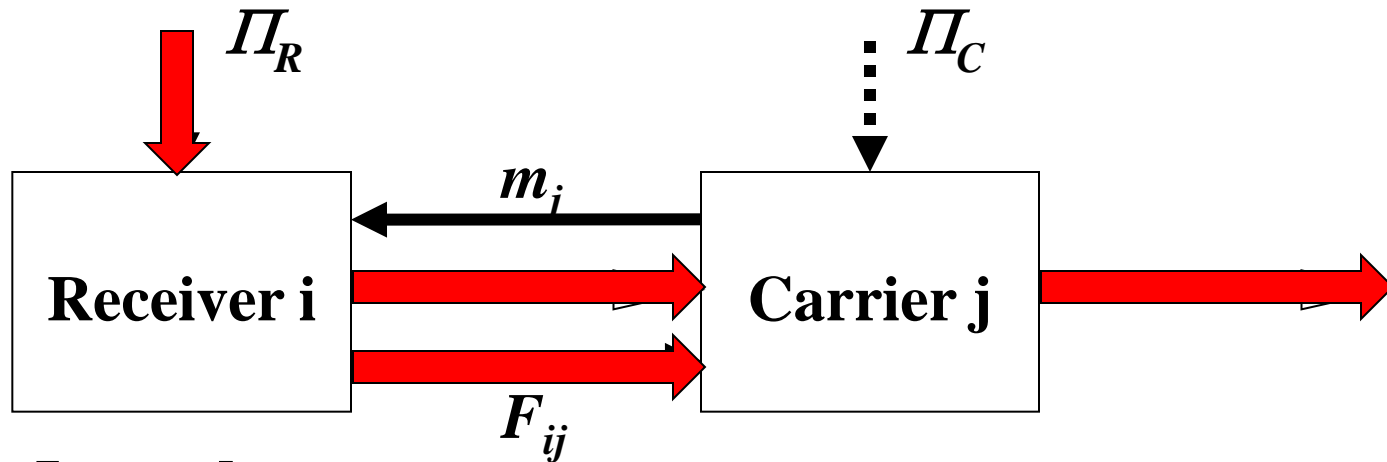
**Price signals**



**External stimuli**

# Receiver centered policies, e.g. incentives

## Receiver-centered policies

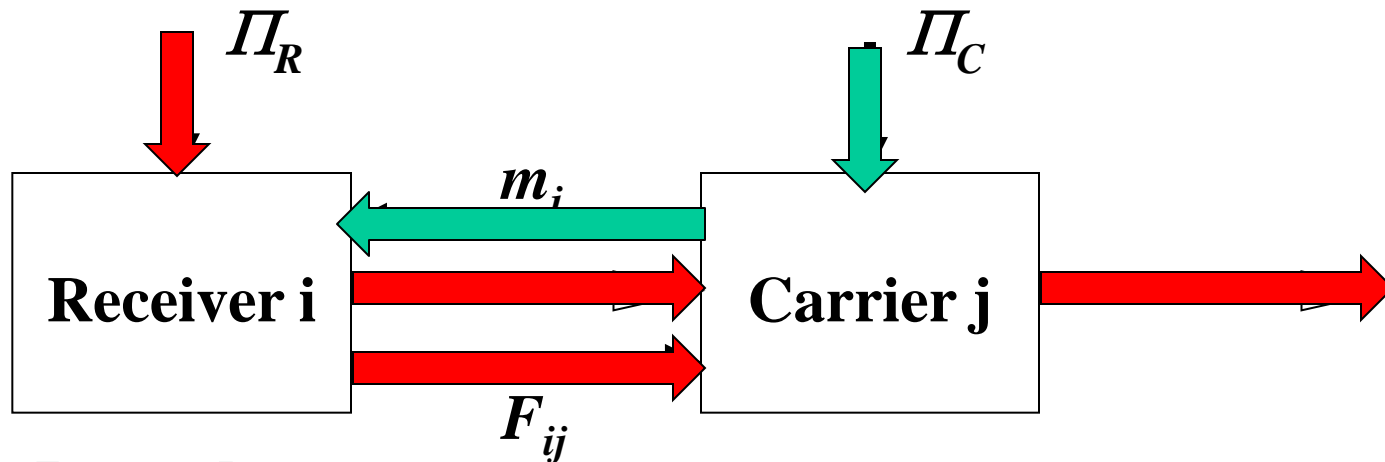


### Legend:

-  Decision about off-hour deliveries
-  Price signals
-  External stimuli

# Comprehensive policies target both agents

## Receiver-centered policies



### Legend:

-  Decision about off-hour deliveries
-  Price signals
-  External stimuli

## ❖ Base case costs

$$C_j^{BC} = (C_{FC}^{BC} + C_{HB}^{BC}) + c_D^{BC} D^{BC} + c_T^{BC} T^{BC} + S^R$$

## ❖ Mixed case (with regular + off-hour deliveries)

$$C_j^M = [(C_{FC}^R + C_{HB}^R) + (C_{FC}^O + C_{HB}^O)] + [c_D^R D^R + c_D^O D^O] + [c_T^R T^R + c_T^O T^O] + S^R$$

## ❖ Necessary condition for carrier to move

$$G_j^M - C_j^M \geq G_j^{BC} - C_j^{BC}$$

$$\begin{aligned} & [(C_{FC}^R + C_{HB}^R) + (C_{FC}^O + C_{HB}^O) - (C_{FC}^{BC} + C_{HB}^{BC})] + [c_D^R D^R + c_D^O D^O - c_D^{BC} D^{BC}] \\ & + [c_T^R T^R + c_T^O T^O - c_T^{BC} T^{BC}] \leq \Delta G_j, \text{ iff } N^O < N^{BC} \end{aligned}$$

## ❖ Key finding: The toll surcharge plays no role! (in the mixed case the carrier also pays the surcharge)



# The paradox of Cordon TOD

- ❖ The results show that in a mixed operation, the toll surcharge plays no role:

$$\begin{aligned} & \left[ (C_{FC}^R + C_{HB}^R) + (C_{FC}^O + C_{HB}^O) - (C_{FC}^{BC} + C_{HB}^{BC}) \right] + \left[ c_D^R D^R + c_D^O D^O - c_D^{BC} D^{BC} \right] \\ & + \left[ c_T^R T^R + c_T^O T^O - c_T^{BC} T^{BC} \right] \leq \Delta G_j, \text{ iff } N^O < N^{BC} \end{aligned}$$

- ❖ If all receivers switch to the off-hours, the surcharge plays a role!:

$$c_T^O T^O - c_T^{BC} T^{BC} \not\leq \Delta G_j, \text{ iff } N^O = N^{BC}$$

- ❖ However, the surcharge is not needed after all!
- ❖ Why?! Because in the off-hours the time related cost savings are so big that provide the incentive needed for the carrier to switch



# Results: Carrier under Time-Distance pricing

- ❖ Tolls per unit time and distance travel are included

$$\Delta C_{F,TDP} \cong \begin{cases} c_D (D_{FC}^O + D_{HB}^O) + c_T (T_{FC}^O + T_{HB}^O), \text{ iff } N^O < N^{BC} \\ 0, \text{ iff } N^O = N^{BC} \end{cases}$$

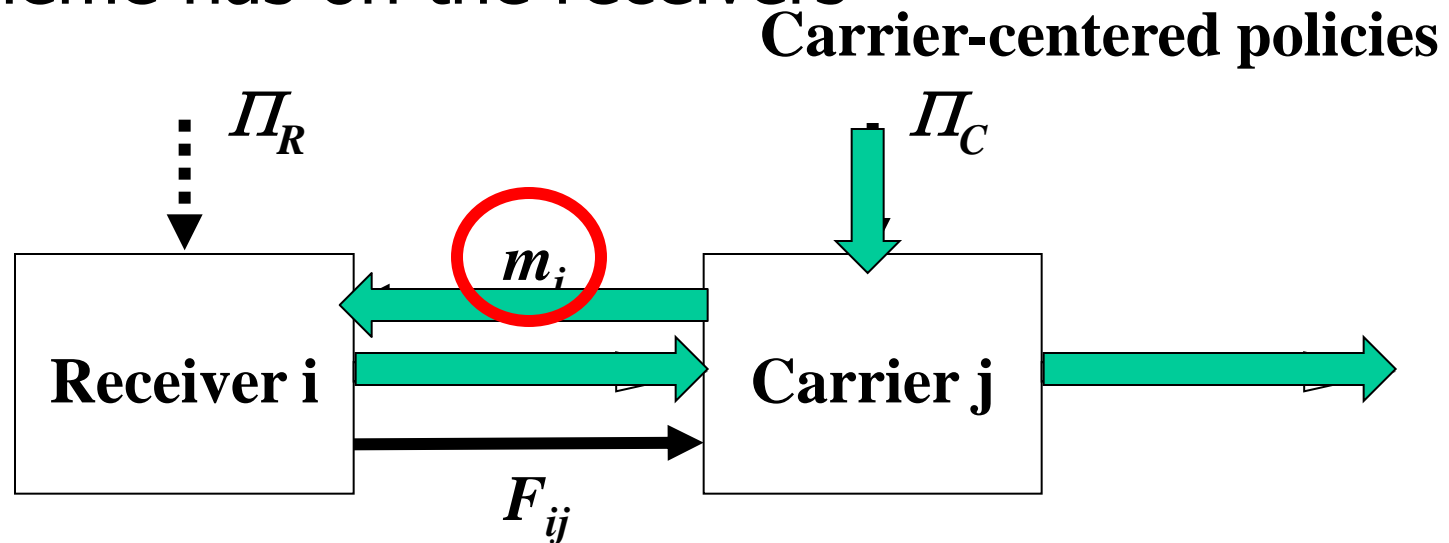
$$\Delta C_{T,TDP} = \begin{cases} (c_T^R + \alpha_T^R)(T^R - T^{BC}) + (c_T^O + \alpha_T^O)T^O, \text{ iff } N^O < N^{BC} \\ (c_T^O + \alpha_T^O)T^O - (c_T^R + \alpha_T^R)T^{BC}, \text{ iff } N^O = N^{BC} \end{cases}$$

$$\Delta C_{D,TDP} = \begin{cases} (c_D + \alpha_D^R)(D^R - D^{BC}) + (c_D + \alpha_D^O)D^O, \text{ iff } N^O < N^{BC} \\ (\alpha_D^O - \alpha_D^R)D^{BC}, \text{ iff } N^O = N^{BC} \end{cases}$$

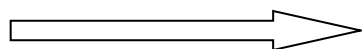
- ❖ Key finding: TDP does play a role regardless of the number of receivers in the off-hours

# Impacts on receivers

- ❖ So far the discussion has centered on the impacts that the pricing scheme has on the carrier
- ❖ Let's focus now on the impacts that the pricing scheme has on the receivers



## Legend:



**Decision about off-hour deliveries**



**Price signals**

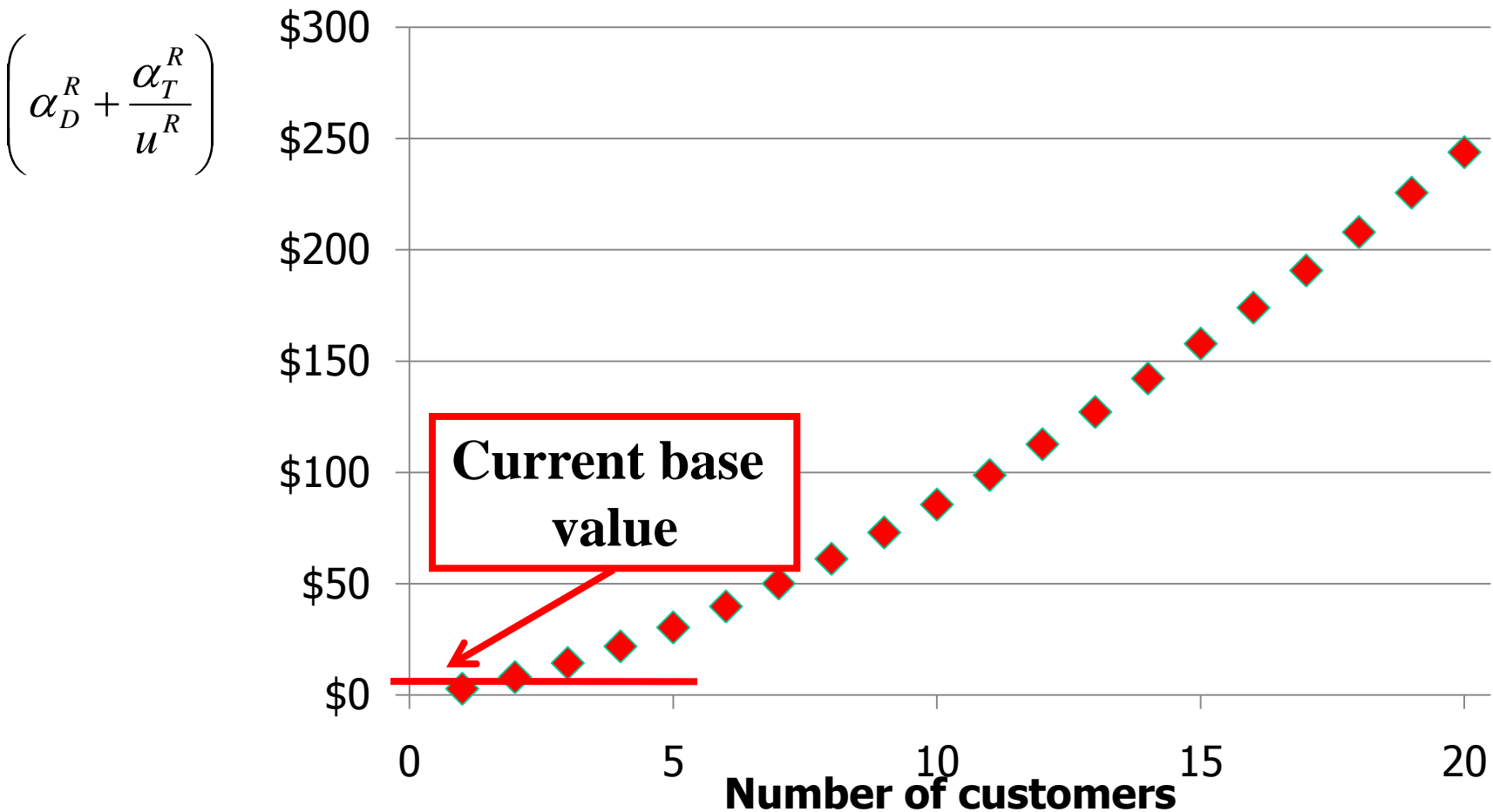


**External stimuli**



**Rensselaer**

# Results: TDP tolls that switch behavior



**These are humongous tolls! (The current value is about \$6/mile)**  
**Implication: TDP could induce a change in very short tours**

# Policy implications

- ❖ We need to rethink the role of freight road pricing in urban areas
  - ❖ Carriers cannot change time of travel unilaterally
  - ❖ Receivers are the key decision makers
  - ❖ Different pricing systems have different impacts
- ❖ Cordon time of day tolls:
  - ❖ Do not work for urban deliveries (that are the majority of truck traffic in urban areas)
  - ❖ Their fixed cost nature forces the carriers to absorb it
  - ❖ No wonder carriers oppose it

- ❖ Time-distance pricing:
  - ❖ Slightly better than Cordon TOD
  - ❖ Carriers can pass it to customers because it is variable
  - ❖ Will not succeed on its own, tolls would need to be huge
- ❖ Comprehensive policies are needed
  - ❖ They target the decision maker
  - ❖ If receivers decide to accept deliveries during the off peak hours, the carriers will (happily) follow suit
  - ❖ Have positive impacts on economic competitiveness of urban areas
  - ❖ Toll revenues → Financial incentives to receivers
  - ❖ Have the support of the carriers!

# References

- ❖ Holguín-Veras, J. (2006). Potential for Off-Peak Freight Deliveries to Congested Urban Areas Albany, NY, Rensselaer Polytechnic Institute.  
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Reactions?

