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Freight Road Pricing: Empirical Evidence and Comprehensive Policies

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We all know that …

If prices go up, transportation demand goes down

In freight road pricing:

1. Tolls are imposed on truck traffic
2. Carriers pass the toll to the receivers / shippers
3. Receivers / shippers / carriers react by either:
   - Move operations to the off hours
   - Disappear from the face of the Earth
   - Change routes and bother someone else

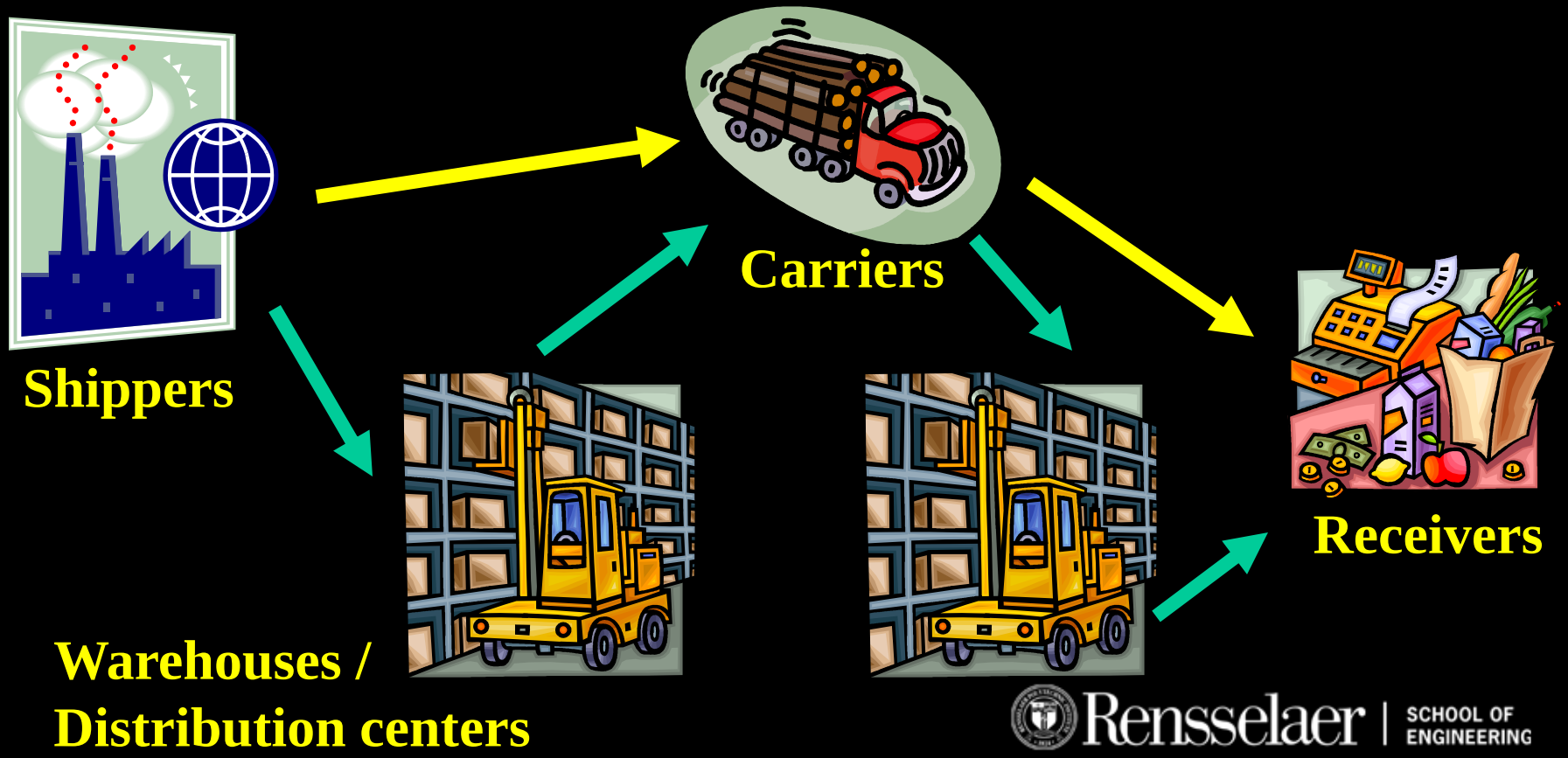
Right?

Not quite….. Reality is more complex than we think

We need to understand the system's economic foundations

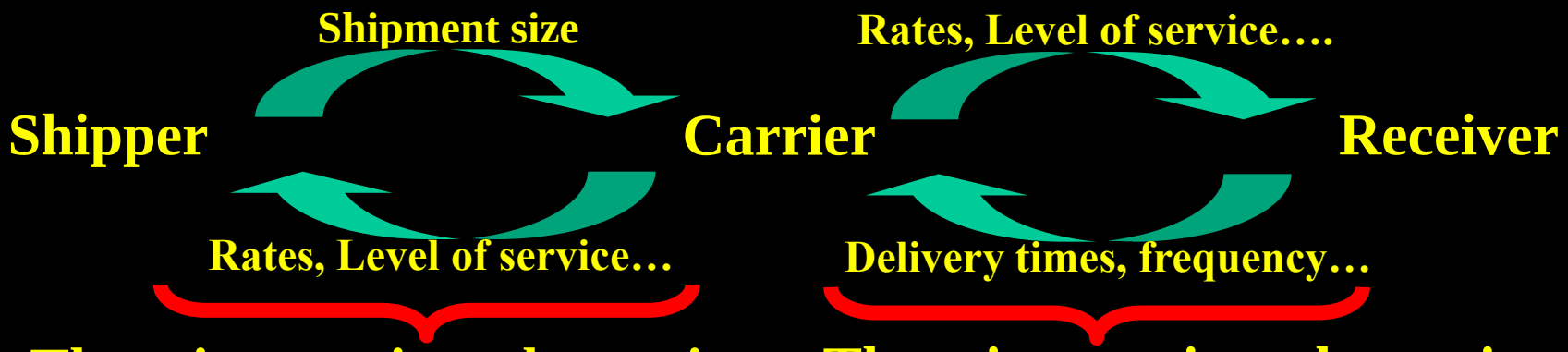
Supply chain 101

- Interactions among players determine truck traffic patterns (Shippers, warehouses, distribution centers, carriers and receivers, 3PLs, 4PLs)



In a simplistic view: Three key players

- The shipper, the one who ships
- The carrier, the conduit between shipper-receiver
- The receiver, the one who consumes/receives
- The nature of their interactions determine their response to pricing, freight mode choice, etc. etc.



These interactions determine <u>freight mode choice</u> as part of a cooperative game

These interactions determine <u>delivery times</u> as part of the Battle of Sexes game

What is the bottom line?

- Freight carriers are nothing more than:
  - A conduit between shippers and receivers
  - The weakest element of the link
- Truck traffic is the physical manifestation of these interactions
- Most of the irritating aspects of truck traffic are the result of the behaviors of the other agents
  - Congestion during the peak hour
  - Idling trucks
- Truckers are, more often than not, hard to love

Who produces the truck traffic?

- Simply stated, us!
- Truck traffic and the real economy are intertwined
  - Economic transactions fuel the economy
  - Freight flows travel on the opposite way

	Commodity Type																			
Number of Employees	Agriculture, Forestry, Fishing	Food	Non-alcoholic Beverages	Alcohol	Tobacco	Textiles / clothing	Furniture	Wood / lumber	Paper	Chemicals	Metal	Machinery	Computers / Electronics	Household goods /various	Stone/concrete	Office supplies	Jewelry/art	Printed material	Medical supplies	DK/ref
0 - 15	1.1	3.5	2.1	1.1	1.1	2.5	6.6	5.6	1.1	1.1	2.8	3.1	2.1	1.5	1.1	1.3	2.5	6.3	2.3	22.6
15 - 30	2.4	4.8	3.4	2.4	2.4	3.8	7.9	6.9	2.4	2.4	4.1	4.4	3.4	2.8	2.4	2.6	3.8	7.6	3.6	23.9
30 - 45	0.9	3.4	1.9	0.9	0.9	2.4	6.4	5.4	0.9	0.9	2.7	2.9	1.9	1.3	0.9	1.1	2.4	6.1	2.2	22.4
45 - 60	2.4	4.9	3.4	2.4	2.4	3.8	7.9	6.9	2.4	2.4	4.1	4.4	3.4	2.8	2.4	2.6	3.8	7.6	3.6	23.9
60 - 75	1.8	4.2	2.8	1.8	1.8	3.2	7.3	6.3	1.8	1.8	3.5	3.8	2.8	2.1	1.8	1.9	3.2	7.0	3.0	23.3
> 75	6.5	9.0	7.5	6.5	6.5	8.0	12.0	11.0	6.5	6.5	8.3	8.5	7.5	6.9	6.5	6.7	8.0	11.7	7.8	28.0

We need to understand the system's complexity

Misconceptions abound…

- Frequently, observations of behavior are extrapolated to cases for which they are not valid…
- If we do that, the empirical evidence seems to contradict itself:
  - Ohio Turnpike vs. PANYNJ
- Is there a contradiction? or, Are we misreading the conclusions?

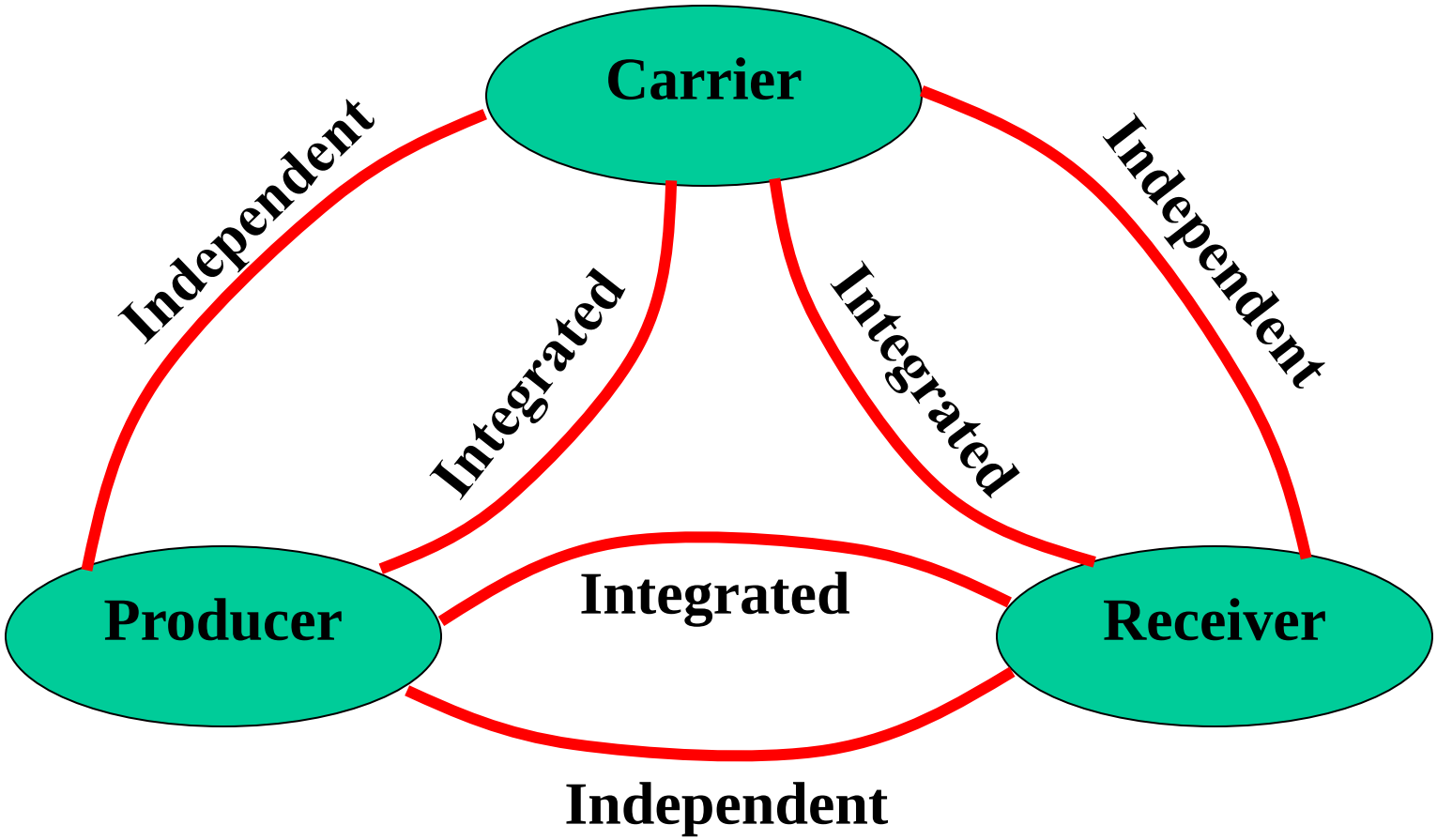
The trucking industry is very heterogeneous

However, there are some basic principles:

1. Carriers must be responsive to customer needs
2. Carriers' response is shaped by:
   - The carrier's market power
   - Economic linkages among shippers, receivers, carriers
   - The availability of substitutes
   - The characteristics of the carrier's operation
     - Type of commodity transported
     - Company size
     - Geographic scale
     - Type of operation (intermodal, urban deliveries, etc.)

Role of economic linkages

- In the case of producers-shippers-receivers



Empirical evidence

- Behaviors exhibited by Integrated vs. Independent tend to be similar
- However, the constraints imposed on independent agents are tighter
- Example: Flexibility to change the time of delivery

Type of operation	Late Arrival Flexibility	Early Arrival Flexibility
Integrated Carrier-Receiver	79.0	55.1
Independent Carrier-Receiver	26.1	23.7
All users	48.8	37.3

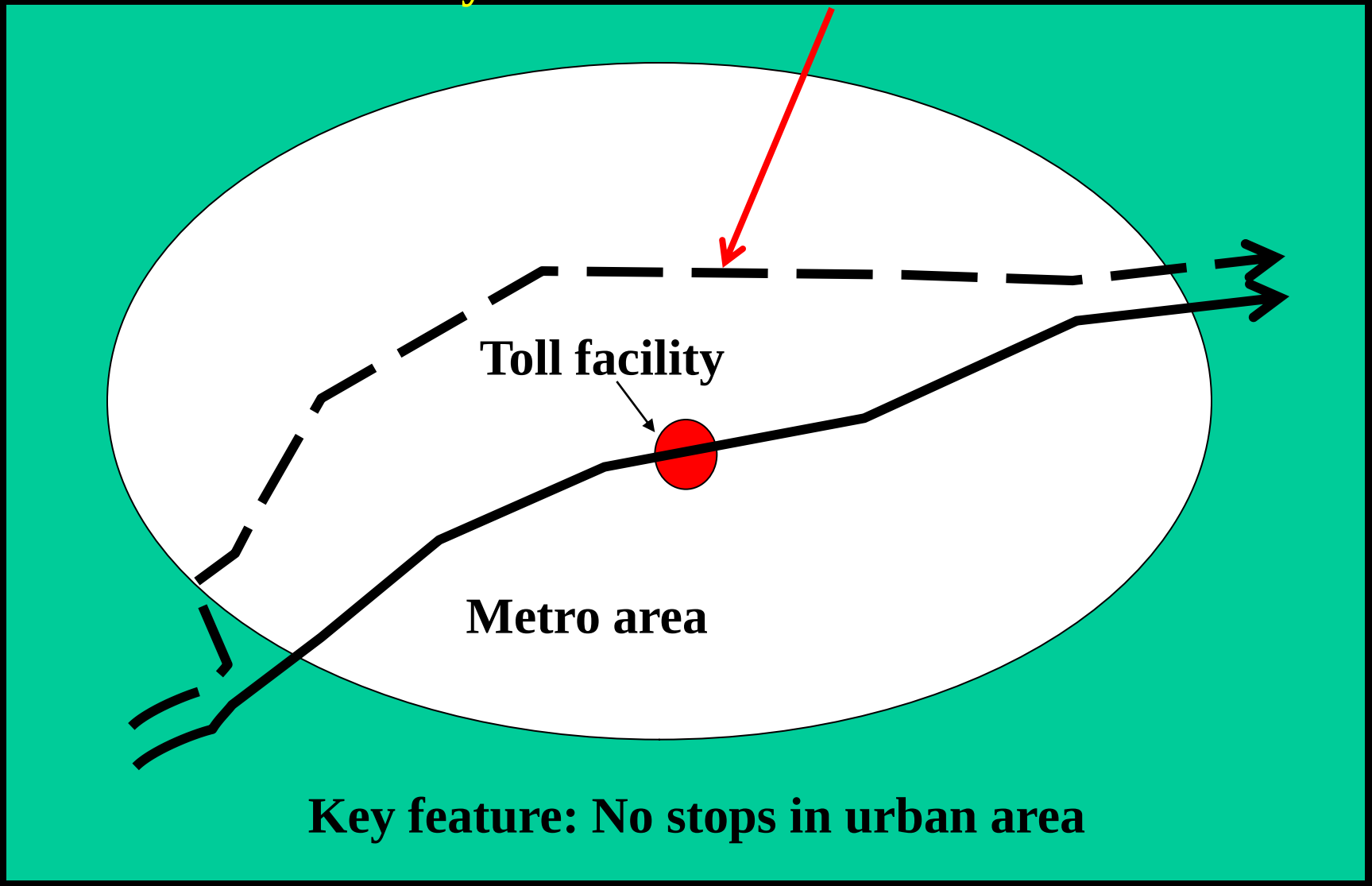
Holguín-Veras, J., Q. Wang, N. Xu, K. Ozbay, M. Cetin and J. Polimeni (2006). "The Impacts of Time of Day Pricing on the Behavior of Freight Carriers in a Congested Urban Area: Implications to Road Pricing." Transportation Research Part A: Policy and Practice 40 (9): 744-766.

Role of trip type

- There are many different truck-trip types
- Commodity related:
  - Intra-regional (urban, suburban) trips: both ends inside the area, multiple delivery stops
  - Inter-regional trips (with one end in the area)
  - Thru trips (traversing area en route to other places)
- Empty trips (20-30% urban, 30-40% intercity)
- Service trips: main purpose is to service, though they transport cargoes (10-20% ?)

Thru trips (1-3% urban, 30-60% intercity)

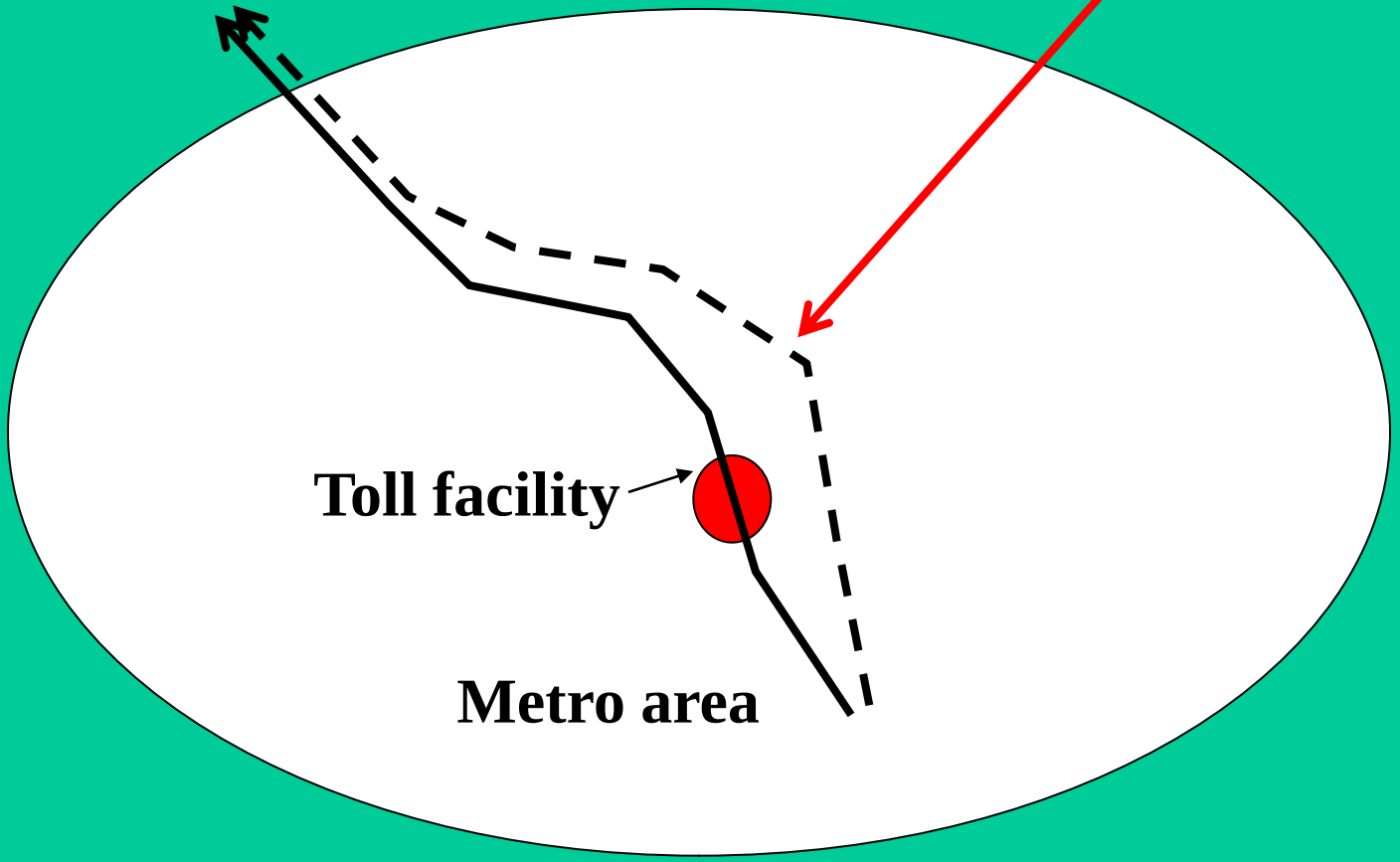
They could bypass the toll facility as long as they meet delivery constraints



Key feature: No stops in urban area

Inter-regional trips (20-25% urban, intercity)

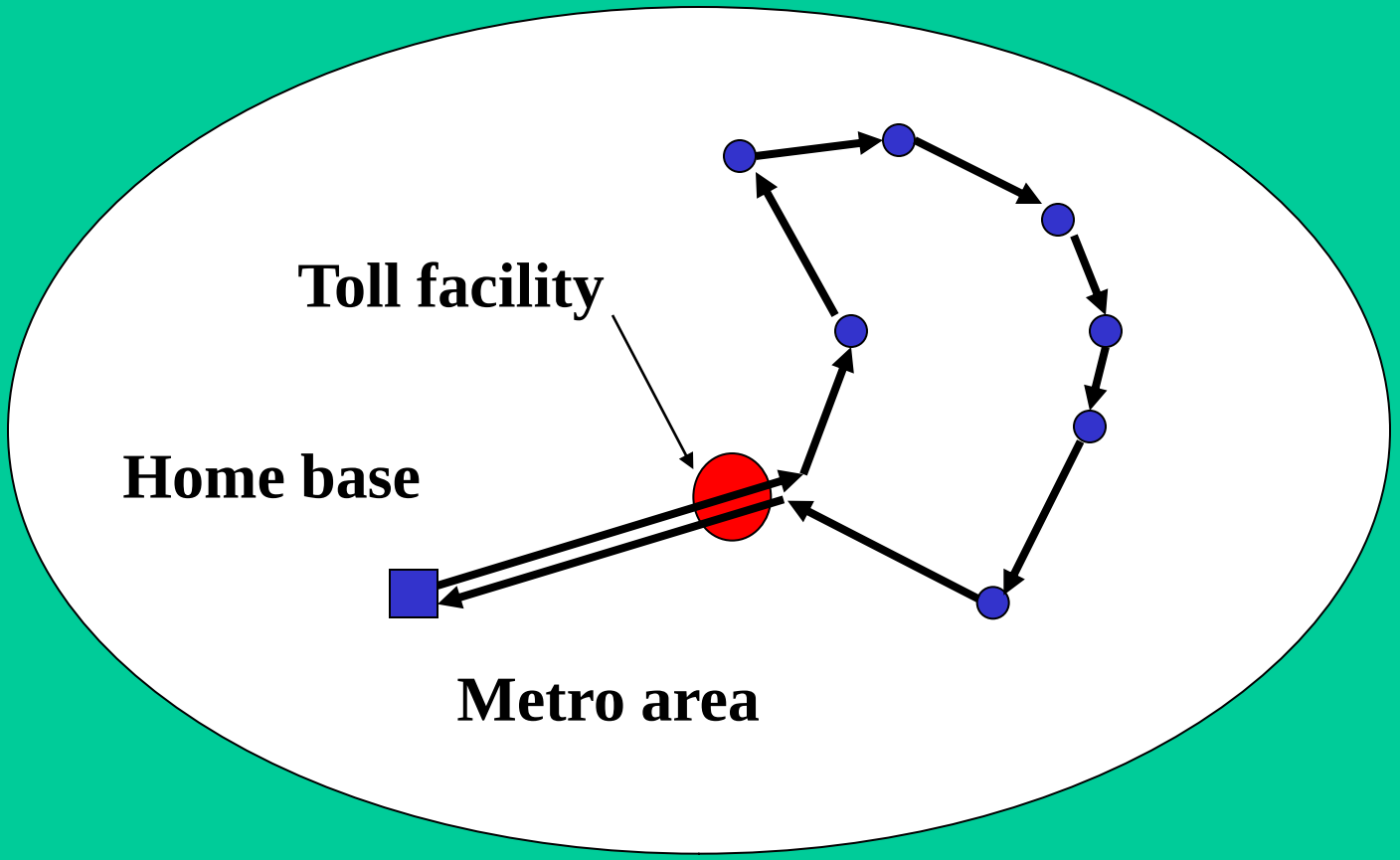
They may have some ability to bypass the toll facility



Key feature: Very few stops in urban area

Internal trips (70-80% urban,10-20% intercity)

Not possible to bypass toll facility, only change of time of travel



Key feature: A lot of stops in urban area

What does the empirical evidence show?

Do observations and theory match?

- Yes, conclusively
- Examples to discuss:
  - Ohio Turnpike
  - Port Authority of New York and New Jersey's Time of Day Pricing Initiative

tbi The Ohio Turnpike

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- Case study: The Ohio Turnpike
  - Truck tolls increased in the 1990s to finance construction
  - Trucks shifted routes and began using local routes
  - Communities complained about surge in truck traffic
  - Truck tolls were lowered to attract truck traffic
- Tolls
  - Before 1983: $21.50
  - 1983-1994: $23.25
  - 1995-2005: Gradually increased to $42.45
  - after 2005: $31.00 (due a subsidy from the state)

- Swan and Belzer (2008) found statistical evidence of a route shift
- Demand is inelastic though
- Revenue maximizing tolls at about $0.25-0.30/mile

Table 3
OLS Results

Independent Variables	Model 1 Coefficients	Model 2 Coefficients
U.S. Truck (billions)	5.1328***	5.2659***
Nominal_Rate x US Truck	-0.029099***	
Real_Rate x US Truck		-0.04642***
Speed x US Truck	0.038145*	0.02946
Constant		
F	4,215***	3,817***
N	16	16
Adjusted R-squared	0.9987	0.9986

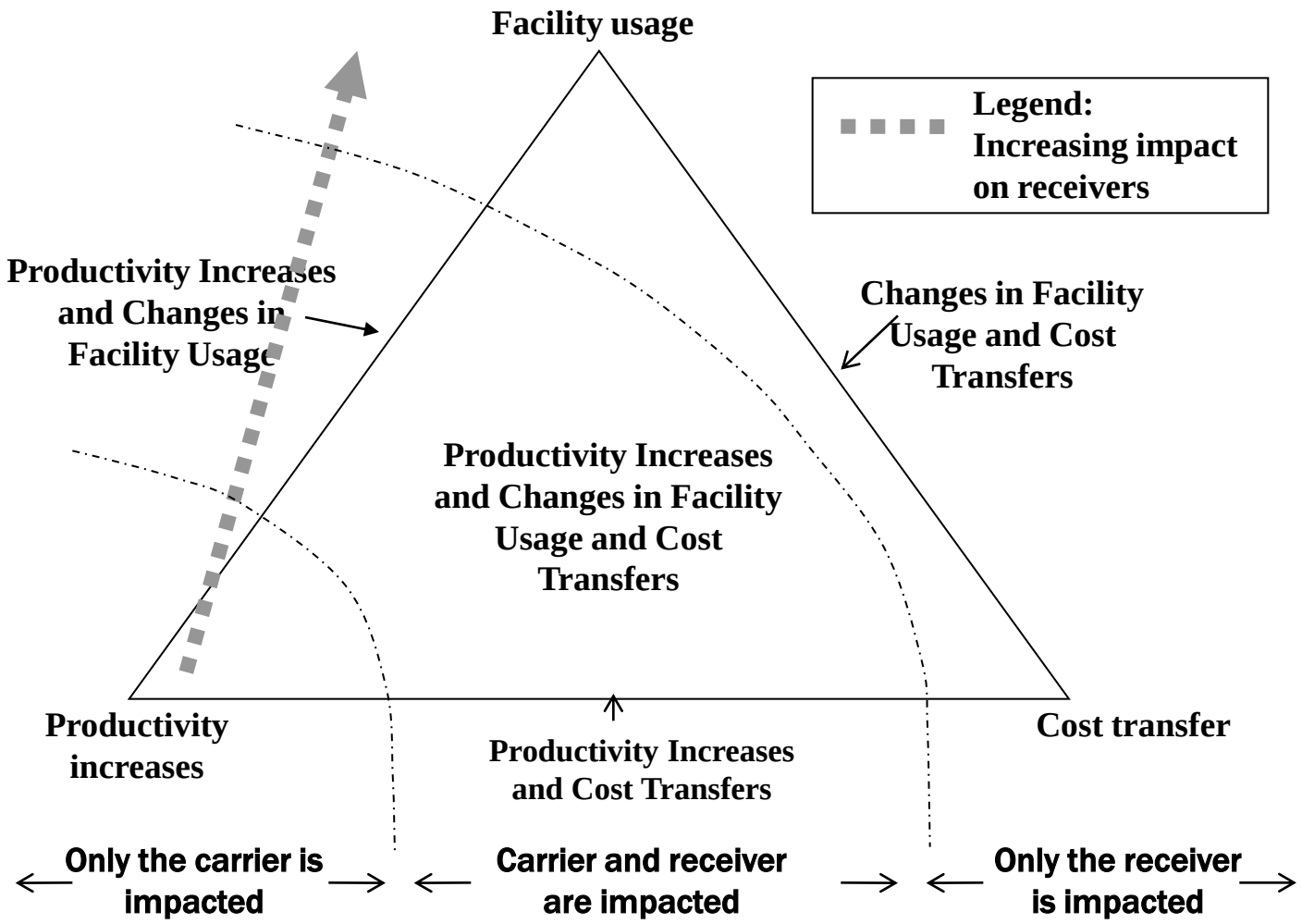
The PANYNJ 2001 time of day pricing initiative

- Implemented a time of day pricing policy
- Unique opportunity to assess behavioral impacts
- RPI conducted the evaluation study for FHWA
- Collected data about behavior before/post pricing

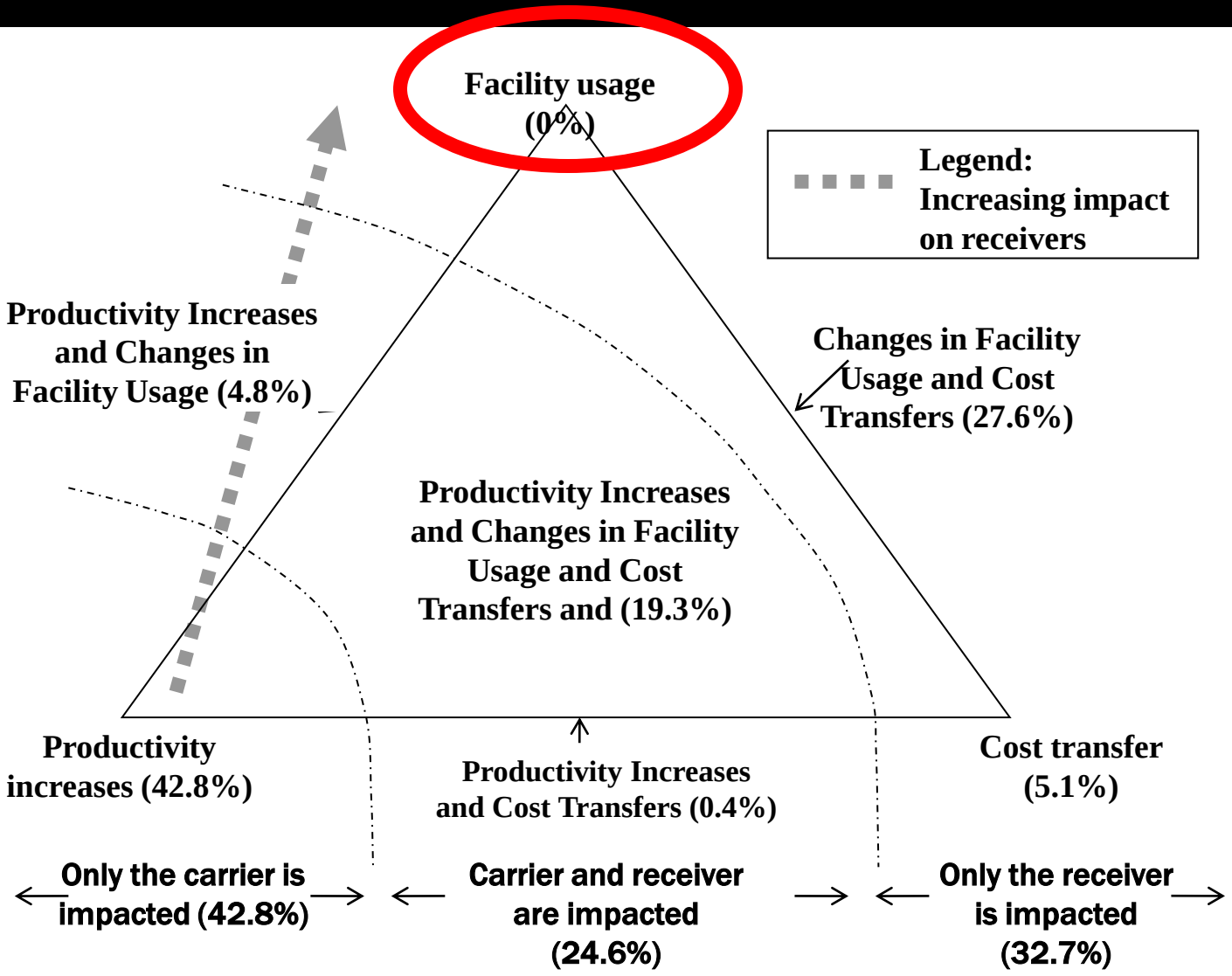
Carriers that changed behavior vs. that did not

Characteristic:	Carriers that changed behavior	Carriers that did not change behavior	Statistically different at 5% level?
% of FTL operators	73.6%	25.3%	Yes
Interstate drivers (mean)	[illegible] drivers	39.3 drivers	Yes
% of carriers transporting shipments from areas other than New Jersey and New York	28.0%	9.9%	Yes
% of carriers transporting shipments to areas other than the Mid-Atlantic region	30.4%	16.2%	Yes
Fleet size (mean)	51.6 trucks	54.5 trucks	No
Interstate drivers/truck (mean)	0.7 drivers/truck	0.7 drivers/truck	No

The PANYNJ 2001 time of day pricing initiative



Behavioral Changes Reported by Carriers (cont.)



Empirical evidence: Summary

- 20.2% of the sample changed behavior (implementing productivity increases, changes in facility use, and cost transfers)
- 69.8% of the carriers that did not change behavior indicated it was due to "customer requirements"
- Only 9.0% of the sample increased rates
  → cost transfers were relatively small, about 15%
- The bulk of carriers that changed behavior are doing long haul FTL
- Urban delivery carriers did not change behavior in a significant way

In summary

- The segments that changed behavior in both OH Turnpike and PANYNJ are pretty much the same
- However, because of the different mix of industry segments the total amount of truck traffic that changed behavior is different
- Perfectly consistent with theory

The need to think SYSTEM

- Toll facilities have been / are / will be, a small component of the network
- What really matters are the systemwide impacts of trucking, not only the impact on the tolled facility
  - OH turnpike case shows importance of external effects
  - Skaneateles NY case
  - This is the norm, not the exception
- Carriers that increase productivity, for instance, are helping achieve sustainability goals even though they may not change facility usage

In closing

- We need to rethink the role of freight pricing:
  - Carriers cannot always to reduce truck trips
  - Carries cannot change time of travel unilaterally
  - Carriers are constrained by contractual agreements
  - Carriers that could pass costs, pass a diluted price signal
  - Carriers that could react to tolls are either doing thru trips or transporting low value commodities
  - Carriers' route switch could create other externalities
- In urban areas comprehensive policies targeting receivers and carriers seem the way to do it
  - If receivers decide to accept deliveries during the off peak hours, the carriers will (happily) follow suit

Did I muddy the waters?

- Questions?

- Acknowledgments: This research has been partially funded by three pioneering projects:
  - FHWA's Evaluation Study of the PANYNJ Time of Day Pricing Initiative
  - NYSDOT's Off Peak Delivery Study
  - USDOT's Integrative Freight Demand Management in the NYC Metropolitan Area

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Role of trip type: In a typical urban area

- Intra-regional (urban): (70-80%)
- Inter-regional trips: 20-25% of truck trips
- Thru trips: 1-3%
- Empty trips: 20-30%
- Service trips: 10-20%

Role of trip type: In an intercity freight corridor

- Intra-regional trips: 10-20%
- Inter-regional trips: 20-25% of truck trips
- Thru trips: 30-40%
- Service trips: small to negligible
- Empty trips: 30-40%