# *Land use and Port Infrastructure: Evaluating the Impact of Road Pricing and Congestion Costs on Port Drayage Markets*

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# What is the cheapest distance between two points?

- This is the question that freight carriers and shippers are always asking themselves.
- Road tolling is but one of many components of total carrying cost that freight haulers are constantly seeking to minimize.
- Can the cost of tolling be high enough to change cheapest distance significantly?
- If so, what economic consequences might this have?

# Tolling: passenger vs freight

- Tolling (road pricing) in theory is a good way to internalize the cost of the use of the road on to the road user, resulting in more efficient facility usage.
- However not all road usage may be alike economically.
- Freight haulage in particular is a key input into economic output more generally and tolling may have significant second order effects that could detract from optimal road usage.

# Freight tolling issues

- Distortion of route choices
- Distortion of business location choices
- Freight shipping market structure and toll burden
- Use of toll revenues – reinvestment or diversion
- Distortion of mode choice

# The Natural Experiment

- There is an area in the United States where there is a lot of tolling to study: the New York City metropolitan area. Tolls here are numerous and for some particular crossings (e.g. the George Washington Bridge) very high, especially for trucks.
- The area is also the site of one of the largest ports in the country – the Port of New York/New Jersey – a major final product destination and a major trucking hub.
- NY Metro thus offers an opportunity for a full-bodied empirical analysis to consider the second order economic effects of tolling on freight traffic.
- This paper conducts an exploratory empirical analysis, using some fine grained data; this appears to be relatively rare in the existing literature on freight tolls.

# Data

- **Major data source:** In response to the Port Authority of New York/New Jersey (PANYNJ) toll increases in July 2011, the operators of New York City Terminals (NYCT) in partnership with the PANYNJ (their landlord) commissioned a joint study of the impact of these tolls and their recent increase on the competitive position of the NYCT.
- The survey contained 6,740 observations collected from February 27 to March 2 2012 at two facilities – the Global Marine Terminal in Hudson County and the New York Container Terminal in Richmond County (the Borough of Staten Island).
- There is a significant amount of information regarding the origin/destination pairs of regional freight movements at the New York Metro port facilities and roughly 40% of the truck freight activity occurring at these facilities during the sample week are captured.

# Methods

- These core data were taken and geo-coded and analyzed spatially using ArcGis.
- The origin/destination data were also combined with other existing information on tolling and freight rates and carrier shipping costs to impute per-mile shipping costs to and from the two NY freight terminals, comparing the toll cost component with other components.
- Other secondary sources were drawn in and combined with the primary analysis to reach some preliminary conclusions about the effect of tolling on freight movements and costs within the NY metropolitan area specifically and possible implications for the elements of efficient freight road pricing more generally.

# New York State: a heavily tolled region

| Revenue Source | US Per Capita | NYS Per Capita |
|---|---|---|
| •Federal Fuel Taxes – | $123.30 | $73.78 |
| •State & Local Fuel & Other - | $208.23 | $115.93 |
| •Tolls (AKA Road Pricing) – | $23.45 | $105.39 |
| •Total | $354.98 | $295.10 |

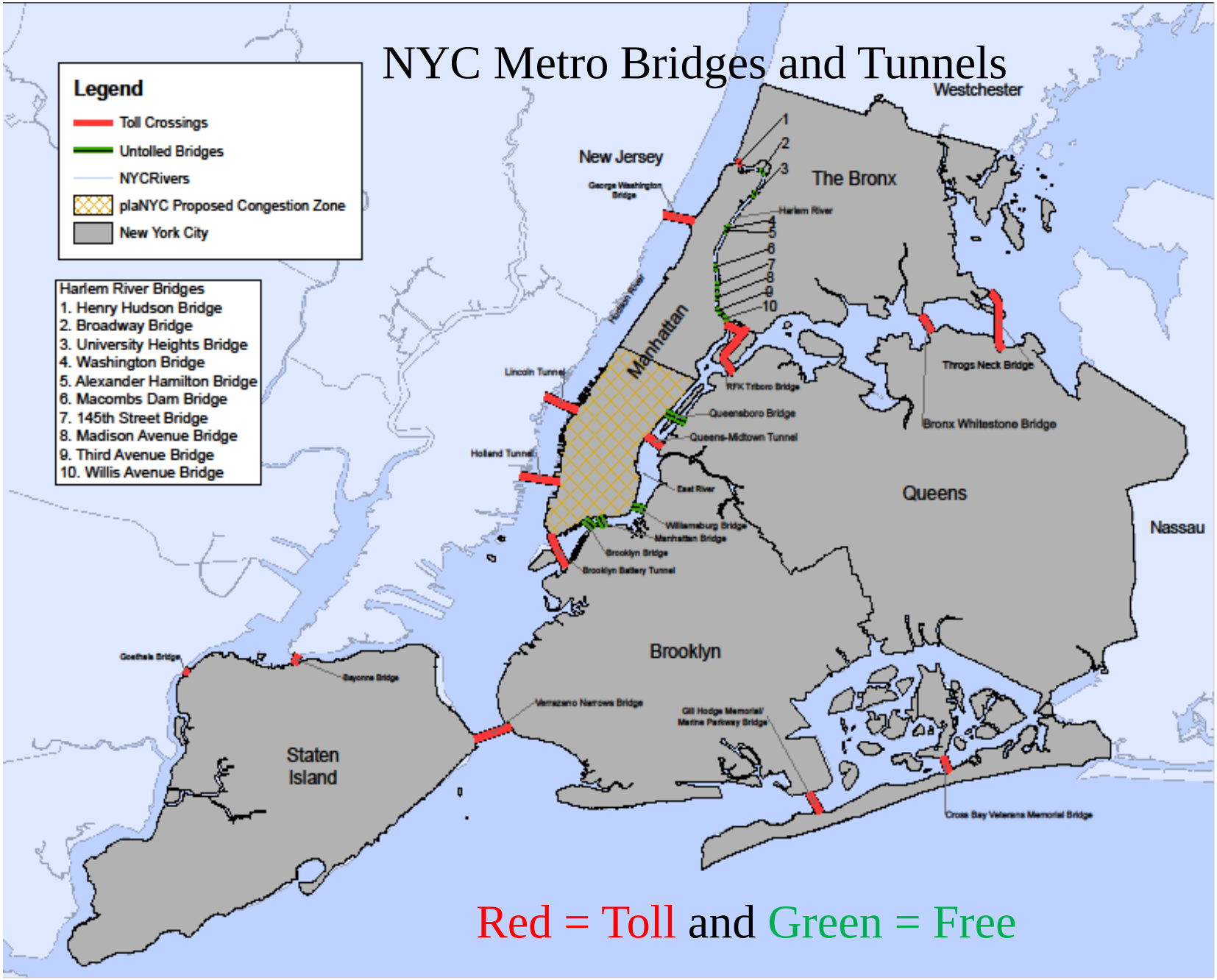
Year 2000 Fuel Tax and Tolls

FHWA Statistics

| STATE | $(000) STATE AND LOCAL FUEL AND VEHICLE TAXES | $(000) STATE AND LOCAL TOLLS | Percent of U.S. Tolls | Rank | Cumulative Percent |
|---|---|---|---|---|---|
| New York | 2,193,452 | 1,987,071 | 30.12% | 1 | 30.1% |
| New Jersey | 1,173,185 | 711,611 | 10.79% | 2 | 40.9% |
| Florida | 3,254,862 | 614,959 | 9.32% | 3 | 50.2% |
| Pennsylvania | 2,559,311 | 534,789 | 8.11% | 4 | 58.3% |
| California | 7,554,477 | 450,378 | 6.83% | 5 | 65.2% |
| Illinois | 2,341,302 | 390,002 | 5.91% | 6 | 71.1% |
| Texas | 6,886,299 | 376,313 | 5.70% | 7 | 76.8% |
| Massachusetts | 951,183 | 229,267 | 3.48% | 8 | 80.3% |
| Ohio | 2,085,499 | 177,310 | 2.69% | 9 | 82.9% |
| Maryland | 1,641,212 | 148,909 | 2.26% | 10 | 85.2% |
| Delaware | 200,269 | 146,627 | 2.22% | 11 | 87.4% |
| Oklahoma | 927,994 | 132,344 | 2.01% | 12 | 89.4% |
| Virginia | 1,854,916 | 112,944 | 1.71% | 13 | 91.1% |
| Washington | 1,473,561 | 97,914 | 1.48% | 14 | 92.6% |
| Indiana | 1,284,492 | 85,325 | 1.29% | 15 | 93.9% |
| Kansas | 524,601 | 61,198 | 0.93% | 16 | 94.9% |

# New City Metropolitan Tolls

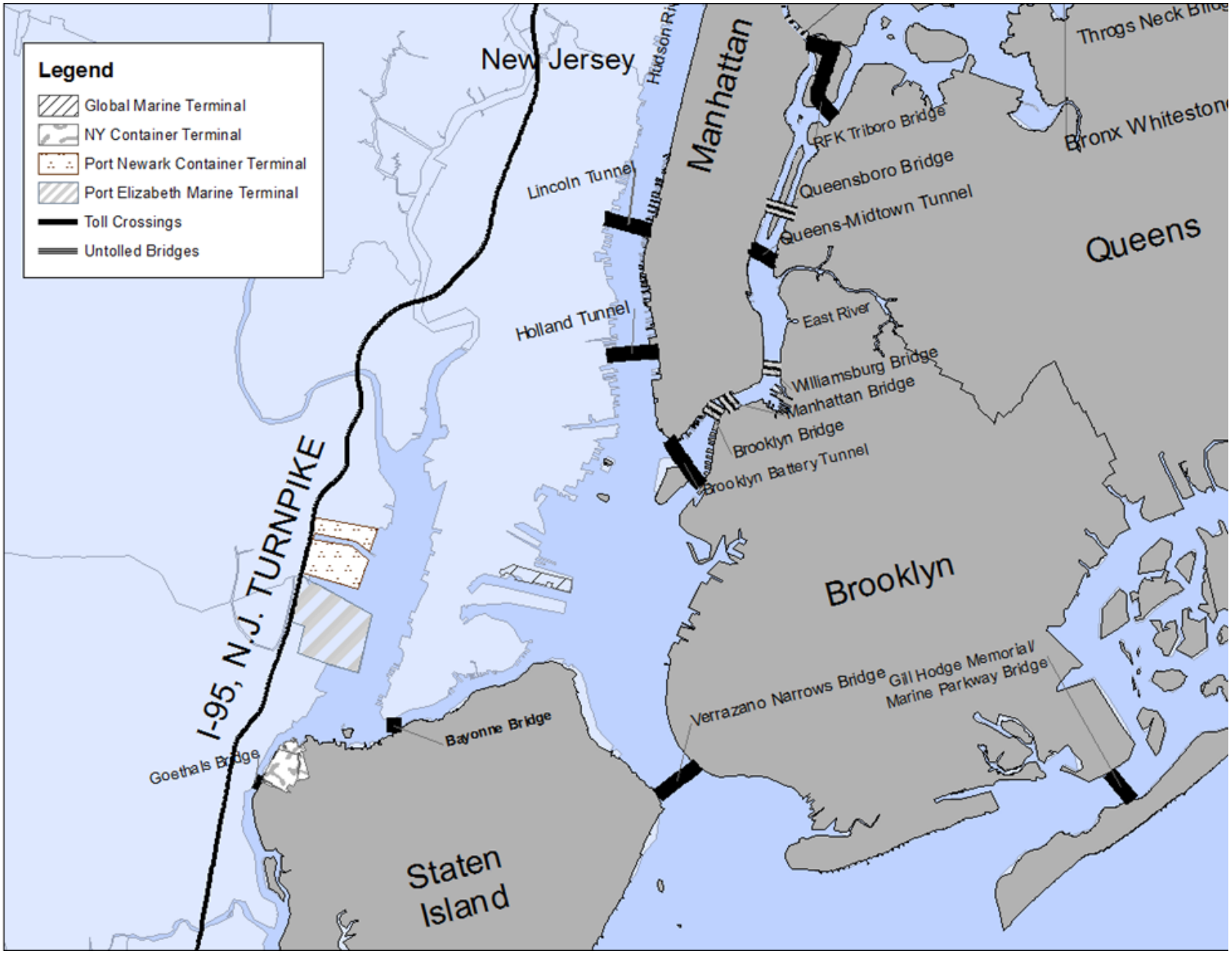
- Much of New York State tolling takes place in the New York Metro Area, which leads the Northeast region and the Nation in road pricing levels and total toll revenues.
- Being surrounded by water, there are a high number of bridges and tunnels and most of these are tolled.
- There are high prices on most toll facilities and the highest levels fall on multi-axle vehicles.
- There have also been major road price increases in the last ten years to cover major rehabilitation and renewal (with most of the major facilities being built during the first half of the twentieth century).


NYC Metro Bridges and Tunnels
Legend
Toll Crossings
Untolled Bridges
NYCRivers
plaNYC Proposed Congestion Zone
New York City
Harlem River Bridges
1. Henry Hudson Bridge
2. Broadway Bridge
3. University Heights Bridge
4. Washington Bridge
5. Alexander Hamilton Bridge
6. Macombs Dam Bridge
7. 145th Street Bridge
8. Madison Avenue Bridge
9. Third Avenue Bridge
10. Willis Avenue Bridge
Westchester
New Jersey
The Bronx
Manhattan
Queens
Brooklyn
Staten Island
Nassau
George Washington Bridge
Harlem River
Hudson River
Lincoln Tunnel
Holland Tunnel
RFK Triboro Bridge
Queensboro Bridge
Queens-Midtown Tunnel
East River
Williamsburg Bridge
Manhattan Bridge
Brooklyn Bridge
Brooklyn Battery Tunnel
Throgs Neck Bridge
Bronx Whitestone Bridge
Goethals Bridge
Bayonne Bridge
Verrazano Narrows Bridge
Gil Hodge Memorial/ Marine Parkway Bridge
Cross Bay Veterans Memorial Bridge
Red = Toll and Green = Free

# The freight market in New York

- The New York region boasts nearly 20 million residents and sits at the center of the Northeast Corridor megalopolis region that features about 18 percent of the U.S. population and 20 percent of the nation's Gross Domestic Product (GDP).
- Transport and delivery of goods in and out of New York and New Jersey represents about eight percent of total employment growth in recent years, and 1 in 13 jobs in New York State is being supported by the trucking industry.
- 405 million tons of freight annually leave, arrive and move through the ten-county region within the New York Metropolitan Transportation Council (NYMTC 2014) jurisdiction and had a total economic value of $1.34 trillion in 2007, and most of this freight arrived at and left the ports by truck.

- In 2012, the bridges and tunnels between New York and New Jersey had 105,895,000 vehicles crossing, including 7,401,000 trucks (PANYNJ 2012).
- At the core of this freight traffic is the third largest maritime port district in the United States. The maritime commerce activities of the Port of New York and New Jersey are mainly located around the perimeter of the deep water port of the Upper New York Bay.
- Since the advent of containerization for goods shipping in the 1960's, the port freight facilities have concentrated in five major container facilities around the Upper Bay – three in New Jersey, one in Staten Island and two minor facilities in Brooklyn.


Legend
Global Marine Terminal
NY Container Terminal
Port Newark Container Terminal
Port Elizabeth Marine Terminal
Toll Crossings
Untolled Bridges
New Jersey
Hudson Ri
Manhattan
Throgs Neck Brid
Bronx Whitestone
RFK Triboro Bridge
Queensboro Bridge
Queens-Midtown Tunnel
Queens
Lincoln Tunnel
Holland Tunnel
East River
Williamsburg Bridge
Manhattan Bridge
Brooklyn Bridge
Brooklyn Battery Tunnel
Brooklyn
I-95, N.J. TURNPIKE
Bayonne Bridge
Goethals Bridge
Verrazano Narrows Bridge
Gil Hodge Memorial/
Marine Parkway Bridge
Staten
Island

- Table 1 shows outbound truck traffic from two of the major maritime container terminals in the area, the Global Marine Terminal and the New York Container Terminal (NYCT), drawn from the primary data source described above.
- These data confirm what is well known about the general nature of the New York freight market: the vast majority of trips out of Global Terminal and the NYCT are to and from NY and NJ.

Table 1: Outbound Freight Destinations from the Port of New York and New Jersey

| | Port | | | |
|---|---|---|---|---|
| Destination | Global | | NYCT | |
| | Trips | Share | Trips | Share |
| Canada | 90 | 2.5% | 14 | 0.4% |
| Alaska | 1 | 0.0% | 0 | 0.0% |
| Connecticuit | 41 | 1.1% | 32 | 1.0% |
| Delaware | 7 | 0.2% | 6 | 0.2% |
| Georgia | 0 | 0.0% | 1 | 0.0% |
| Illinois | 1 | 0.0% | 0 | 0.0% |
| Massachusetts | 81 | 2.3% | 56 | 1.8% |
| Maryland | 10 | 0.3% | 6 | 0.2% |
| Maine | 6 | 0.2% | 3 | 0.1% |
| Missouri | 1 | 0.0% | 0 | 0.0% |
| New Hampshire | 1 | 0.0% | 0 | 0.0% |
| New Jersey | 2813 | 78.6% | 2607 | 82.5% |
| New York | 311 | 8.7% | 211 | 6.7% |
| Ohio | 13 | 0.4% | 6 | 0.2% |
| Pennsylvania | 125 | 3.5% | 180 | 5.7% |
| Rhode Island | 4 | 0.1% | 6 | 0.2% |
| Tennessee | 1 | 0.0% | 0 | 0.0% |
| Texas | 2 | 0.1% | 0 | 0.0% |
| California | 0 | 0.0% | 7 | 0.2% |
| Wisconsin | 2 | 0.1% | 0 | 0.0% |
| Missing | 69 | 1.9% | 25 | 0.8% |
| Total | 3579 | | 3161 | |
| | | | | |
| NY& NJ | 3124 | 87.3% | 2818 | 89.1% |

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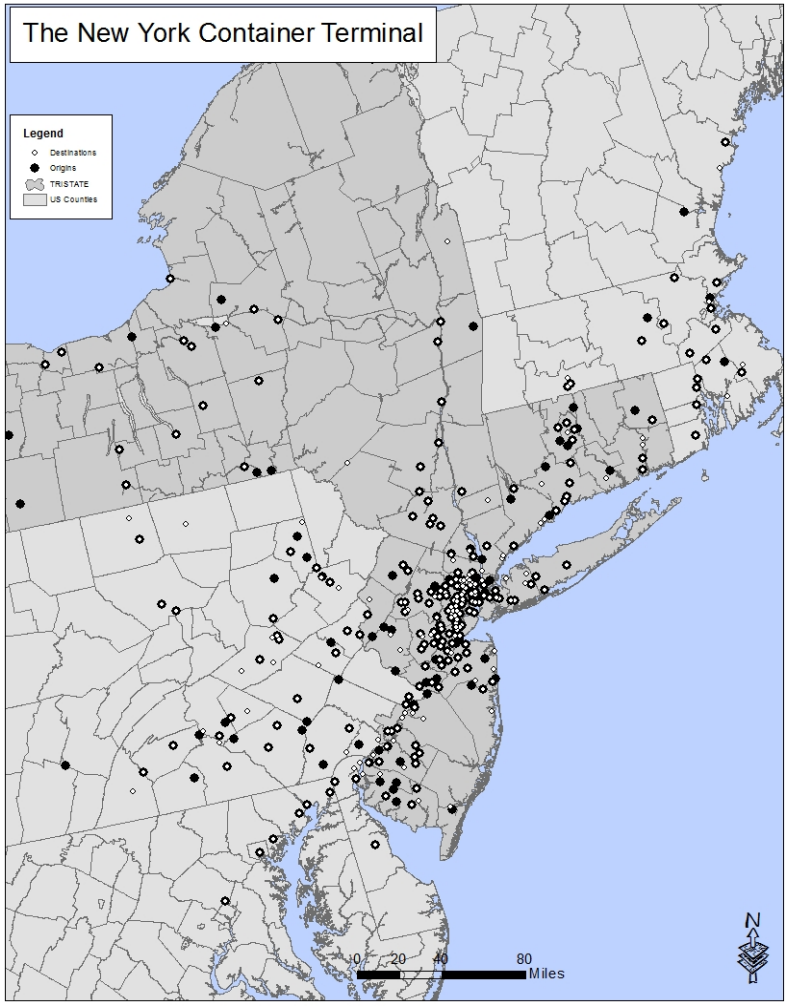
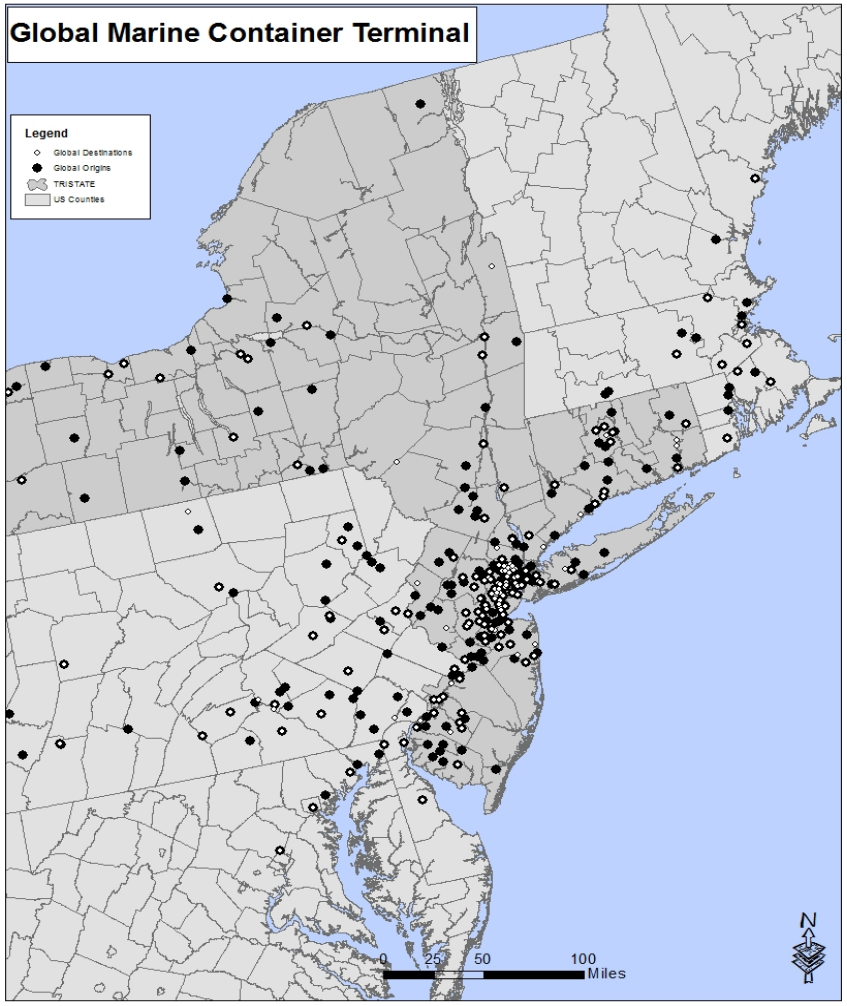



- The mappings of the origin-destinations for the two terminals shows how local most of the traffic to and from there is.
- What is behind this and what is its economic significance?

# Tolls and Trucking Market Structure

- The trucking market is generally split into large fleet/long haul and small/fleet drayage segments (with in-between combinations of course).
- Tolls affect these market segments differently.
- Large long-haul carriers generally can absorb tolls and/or pass them on and their burden is fairly small for the carrier. These carriers can also more easily avoid tolls through route alteration.
- Small drayage firms tend to find these tolls, especially high ones, more burdensome both as a percentage of total costs and because these firms often must take specific facilities into local markets (and, indeed, large haulers often outsource drayage to small firms in part so they can avoid the tolls themselves).

# Tolls and New York Freight

- Available evidence shows that the high tolls in the New York area are having a material effect on decisions carriers make in route selection and shift of burden across different industry segments.
- The American Transportation Research Institute reports tolls were 2 cents of the $1.71 average per mile operating costs of trucks in the US – or about 1% of costs.
- But where carriers have to go into NYC, the burden of tolls can be higher. An NCFRP study (Wood (2011)) reported that one trucking firm has a policy of charging a flat amount of $130 to shippers to go anywhere in Manhattan and to include the toll for crossing the George Washington Bridge explicitly to any shipper whose goods required passage across that bridge ((Wood 2011), p. 13).
- Drayage firms, however, can be stuck with the bill. One firm in Wood's study reported 15% of toll invoices were unpaid and had to be written off

# A measure of toll cost in NYC

- To get a more precise measure of the percentage of total freight carrying costs accounted for by tolls in the NY metropolitan region, the authors utilized the highway network from the National Transportation Database (NTD) and loaded the data into the Transcad® software to calculate road network distance by county centroid for every county in the United States from the Ports of Baltimore, Norfolk and New York/New Jersey.
- For New York/New Jersey port activity, we further subset the distance data for the major container terminals in the region: Port Elizabeth/Newark, Global Terminal (Hudson County), New York Container Terminal (Richmond County) and Brooklyn Container Terminal (Kings County).

- Trips were then priced based on the reported average ton mile cost for freight as reported by Delcan Corporation based on the Cass Freight Index for freight movements into the ports of New York, Baltimore and Norfolk.
- Based upon the distance traveled and the rates for rail and truck transport, the authors were able to estimate the cost of delivery to counties either by rail or truck from the three ports in general.
- These data suggest that the New York area ports are substantially more expensive than other ports along the Atlantic for both rail and truck movements.

Table 2: Ton Mile Rates from Cass Freight Index

| Port Area | Rail Cost | Truck Cost |
|---|---|---|
| New York Metro | $ 0.79 | $ 1.36 |
| Baltimore | $ 0.56 | $ 0.66 |
| Norfolk | $ 0.52 | $ 0.66 |

- We then further developed a general toll pricing algorithm to more accurately reflect the regional variation in toll prices on freight movements in and around the Port of New York.
- Toll prices are based on an estimated blended rate of travel due to some level of variation in price by method of payment (cash versus electronic toll payment).
- In addition, some additional variation in price would be driven by axle count as well as time of day price variation on Port Authority Bridges and Tunnels for electronic toll payers. Rates were applied as surcharges to the calculated Cass Freight Index cost to more accurately reflect the regional variation in prices by area for various port destinations.
- The toll costs per trip were pro-rated on a ton mile basis for trips in the region and applied to the various port facilities. Toll burden was priced based on origin/destination point relative to a particular port facility.

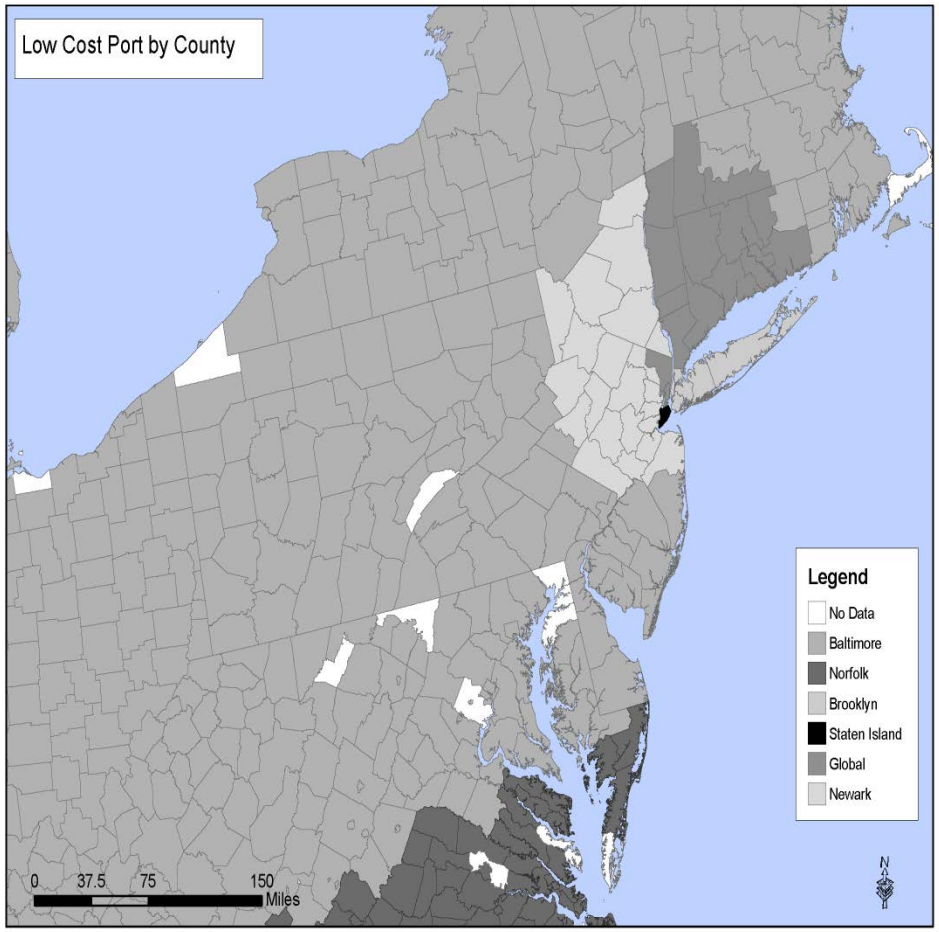
- Port moves that reflected no marginal toll costs were priced accordingly (say from the Brooklyn Container Terminal to Suffolk County in Long Island – $0 toll cost) and moves that faced multiple toll barriers were re-priced as well (for example Brooklyn Container Terminal to Monmouth County, New Jersey - $115 dollars in toll cost).
- Table 3 provides the local toll costs for 5 axle trucks for each major NY/NJ terminal.

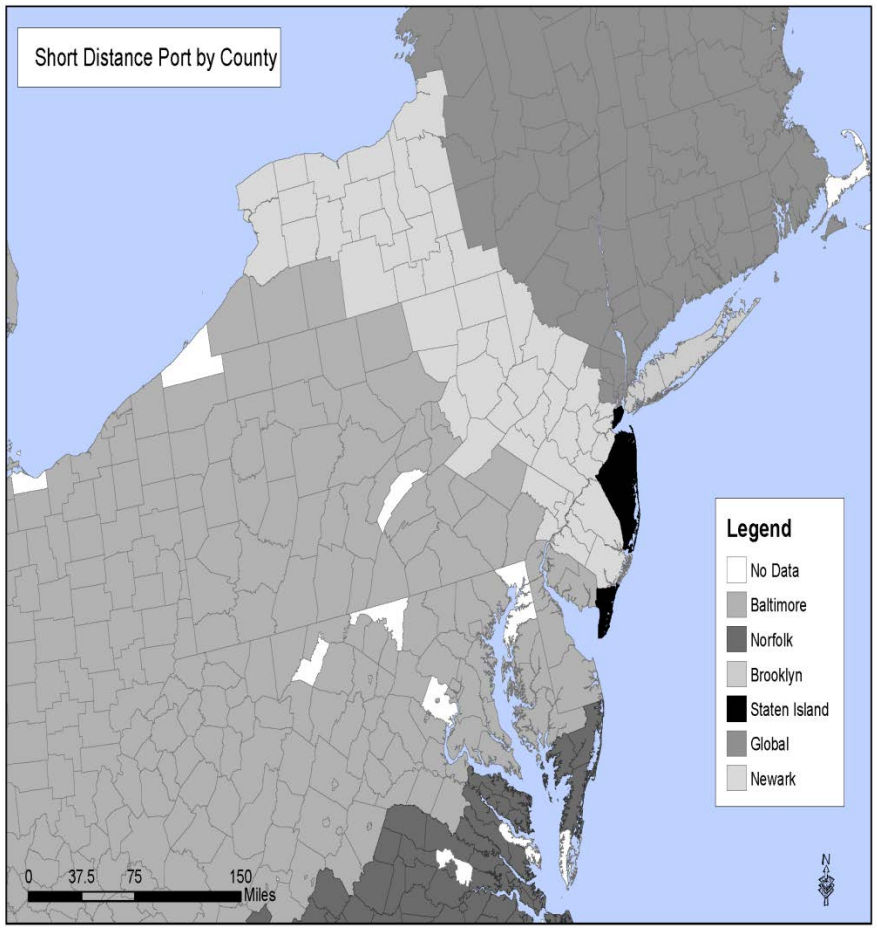
Table 3: Toll Rates from Select New York and New Jersey Port Facilities to Mainland

| Port | PANYNJ | MTA Bridges | NJ Turnpike | Total | $ per Ton |
|---|---|---|---|---|---|
| Brooklyn | $ 55.00 | $ 60.00 | $ - | $ 115.00 | $ 4.60 |
| NYCT | $ 55.00 | $ - | $ - | $ 55.00 | $ 2.20 |
| Global Terminal | $ - | $ - | $ 11.25 | $ 11.25 | $ 0.45 |
| Port Elizabeth/Newark | $ - | $ - | $ - | $ - | $ - |

# Route selections

- This modeling exercise has some interesting results. As the next maps show, based on the detailed (though partial) data set used here, there is significant diversion of traffic away from the New York City terminals in many cases, to ports much farther away.
- In other words, optimal routes into and out of New York City often covered significant additional distance and it appears that avoiding high tolls in the area was partly the reason for this.




The first figure shows optimal ports/terminals by minimum total cost for carriers given O/D pairs (by county). The second figure shows optimal ports/terminals by minimum distance.

# Interpretation

- The areas shaded in dark and light grey in the first figure are counties served via minimum total cost from Newark and Global ports, respectively. For example the area shaded in medium grey is best served in terms of minimum cost via the port of Baltimore, which is approximately 180 miles southwest of Newark.
- The second figure provides the minimal distance port for each county in the Mid-Atlantic region. On this basis, for example, the port of Elizabeth/Newark should optimally serve the Northern Tier of New York State as well as most of New Jersey.  Global Terminal is in a dead heat with Port Newark to serve Western New England.

# Cost distortions

- Taken together, the figures suggest that road tolls dramatically alter the lowest cost trucking routes for destinations throughout the Northeast US, and that when accounting for road tolls the Ports of New York and New Jersey are competitive within the metro area but substantially less so for truck trips outside the region.
- Adding freight tolls to the mix reduces the low cost shipping shed for New York Metro Ports to basically the Greater New York Metro region and Southern Connecticut. The New York Container Port and Brooklyn Container Terminal are basically made uncompetitive by the toll facilities, with NYCT having a single low cost county (Richmond – only 480,000 people in terms of population) as compared to other terminals and the Brooklyn Container Terminal having competitive truck price advantage only for freight destined for New York City (excluding Richmond County) and Long Island.

# Local Tolls = Local Costs

- This insight is reinforced by another set of calculations based on two port areas –New York Container Terminal (Howland Hook) and Global Marine Terminal based on data from the American Transportation Research Institute (see (Institute 2012)).
- The cost of tolling for the NYCT trips represents over 50% of the overall cost of operating a 20 mile trip for a regional freight trip, and nearly double the cost of a similar trip from a New Jersey port facility to the mainland of the U.S.
- While this estimate is based on a naïve model of a truck trip in and out of the container port, they do represent a useful preliminary analysis of the impact of tolling on regional business decisions.

Table 4: Toll and Operation Cost Estimates for 20 Mile Trip from New York Area Ports, 2011

| Cost of Operations | Average Cost per Mile | U.S. Average Total Costs | U.S. Average % of Costs | To and From Global Total Costs | To and From Global % of Costs | To and From NYCT Total Costs | To and From NYCT % of Costs |
|---|---|---|---|---|---|---|---|
| **Vehicle Based** | | | | | | | |
| Fuel and Oil | $ 0.59 | $ 11.80 | 35% | $ 11.80 | 27% | $ 11.80 | 14% |
| Truck/Trailer Lease or Purchase | $ 0.19 | $ 3.78 | 11% | $ 3.78 | 9% | $ 3.78 | 5% |
| Repair and Maintenance | $ 0.15 | $ 3.04 | 9% | $ 3.04 | 7% | $ 3.04 | 4% |
| Truck Insurance Premiums | $ 0.07 | $ 1.34 | 4% | $ 1.34 | 3% | $ 1.34 | 2% |
| Permits and Licenses | $ 0.04 | $ 0.76 | 2% | $ 0.76 | 2% | $ 0.76 | 1% |
| Tires | $ 0.04 | $ 0.84 | 2% | $ 0.84 | 2% | $ 0.84 | 1% |
| Tolls: General | $ 0.02 | $ 0.34 | 1% | $ 0.34 | 1% | $ 0.34 | 0% |
| Tolls: Bridges | | | | $ 8.97 | 21% | $ 48.22 | 59% |
| **Driver-based** | | | | | | | |
| Driver Wages | $ 0.46 | $ 9.20 | 27% | $ 9.20 | 21% | $ 9.20 | 11% |
| Driver Benefits | $ 0.15 | $ 3.02 | 9% | $ 3.02 | 7% | $ 3.02 | 4% |
| Total Costs | $ 1.71 | $ 34.12 | 100% | $ 43.09 | 100% | $ 82.34 | 100% |

Note: Estimates are of overall cost of a 20 mile trip. General operating costs from 2012 ATRI Average Carrier Costs per Mile.

# Port Commerce in New York

- Port Commerce has been a key part of the economic prosperity of New York State and New York City
- Currently the Port Authority of New York/New Jersey runs the ports. But they also run many of the toll road facilities.
- It appears at least notionally that their road pricing policies may be at odds with their port commerce policies. The high cost of moving across toll barriers is expected to undermine the competitive position of these port facilities as maritime shipping firms as well as major freight customers operate on a global scale with complex ship and cargo movements coordinated across nations and regions.
- There have been significant threat from other ports, e.g. Norfolk, VA, for some time now and high tolls may be unintentionally increasing this threat.

# Warehousing and Storage

- Tolling may also be changing the geographical shape of the region's warehousing and storage sector.
- There are a limited number of firms in this sector in New York City – 152 Firms and 3306 employees in 2006.
- Toll bridges may well function as a barrier to the growth and location of this sector in New York City
- The tolls can be a significant cost to shippers when carriers pass them on (as large ones certainly do, directly or indirectly).
- And passing tolls on may not be an option for drayage firms. And more generally competing storage options regionally may be leading to a significant shift in spatial location of this sector.

# Warehousing – New Jersey

- Interestingly the sector is much larger in neighboring New Jersey:
- 128 Firms with 6,330 Employees in Middlesex County in 2006.
- 41 Firms and 1730 Employees in Union County.
- 49 Firms and 1194 Employees in Essex County.
- 20 in Somerset County with 655 Employees.
- Overall 25,405 Employees in 634 Firm in New Jersey.
- So we are located adjacent to a hot spot in terms of Warehousing – Middlesex County.
- But why not New York City? Of course there are many factors such as high land costs but tolling is also likely playing a role.

# Conclusions

- Road tolls in theory are a very important tool in managing road use and recovering facility cost.
- In the freight context however, they can have significant secondary economic effects that need to be considered.
- In the New York City area, the size and location of the tolls seems to be economically bending certain household and business activities in response to this pricing but without necessarily according to clear policy aim.

# Conclusions II

- In NY Metro Road Pricing Policy is set by various agencies for various reasons.
- There is a multilayered impact of all tolls by agency on households and businesses.
- Pricing policies are not coordinated or aligned with overall national/regional goals and investments.
- In NY Metro, a significant amounts of revenue is diverted from the toll road network for a number of purposes.

# An unintentional industrial policy?

- Industrial policy – government incentives and subsidies to pick ‘winners and losers’ from various industries in various locations – is generally not seen as efficient for advanced economies.
- However this work suggests that tolls in the New York metropolitan region may be, in effect, a sort of unintentional ‘shadow’ industrial policy that is affecting business location decisions in some sectors (e.g. port commerce and warehousing) and freight carriage route and mode selections more generally.
- More analysis of various sorts is indicated.

# Questions?

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