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## Social-Cost Pricing in Freight Transportation

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Economic Competitiveness

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*The information in this presentation is preliminary and is being circulated to stimulate discussion and critical comment as developmental work for analysis for the Congress.*

# This Research Addresses the Following Question:

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- If the external costs of freight transport were taxed, how would the choice of mode of transportation (truck vs. rail) be affected?

# Typical External Costs May Be Eight Times Higher for Truck Than for Rail

(2014 cents per ton-mile)

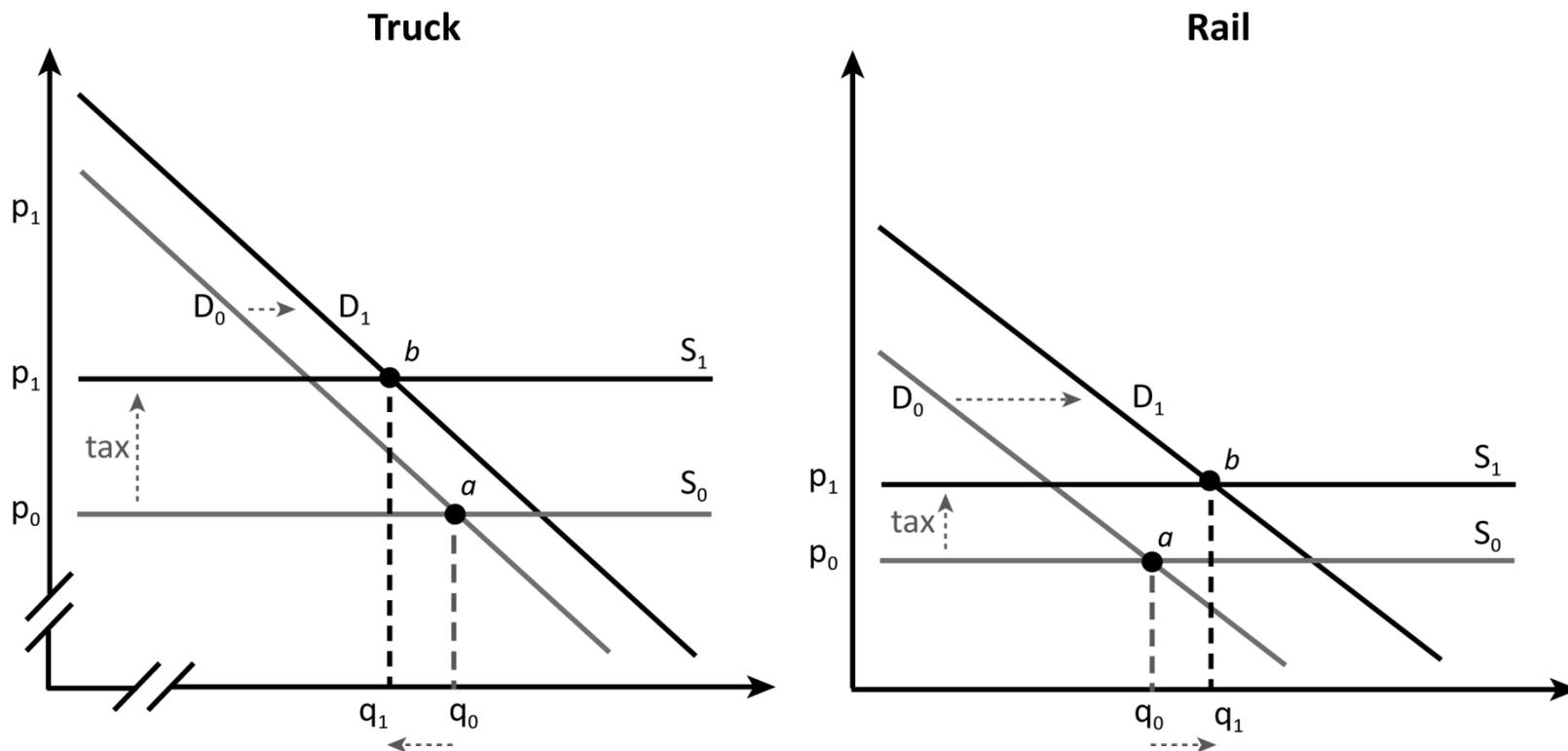
Type of Cost	Truck	Rail
Accident Risk	0.8 to 2.3	0.1 to 0.25
Pavement Damage	0.7 to 1.0	0.05 to 0.06
Particulates + NOx	0.6 to 0.8	0.1 to 0.2
Traffic Congestion	0.4 to 0.9	0 to 0.03
CO <sub>2</sub>	0.02 to 0.22 to 0.9	0.01 to 0.05 to 0.2
<b>Total of Median Costs</b>	<b>4.0</b>	<b>0.5</b>

# Outline of the Approach

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- Mode choice is modeled as responsive to changes in shipping costs by truck and rail
  - The model depends on mode- and commodity-specific price elasticities
- The initial conditions are market shares (of ton-miles) for truck and rail from the Freight Analysis Framework (FAF) data for 2007
- Prices are changed in the model by adding external costs to estimates of the rates charged by truck and rail carriers
- The final conditions predicted by the simulation model are observed:
  - Changes in ton-miles carried by each mode
  - Dollar value of reductions in external costs
  - Revenue from taxing external costs

# Policies to Include External Costs in Prices Would Cause Some Shipping to Switch From Truck to Rail



Adding external costs to shipping rates raises the cost to ship by both truck and rail. External costs for trucking are greater.

# Four Policy Options

- Average social-cost (ASC) pricing combines a weight-distance tax on surface costs plus a fuel tax on emissions
  - Surface costs: accident risk, pavement damage, traffic congestion
  - Emissions: particulates, NO<sub>x</sub>, CO<sub>2</sub>
  - Tax rates on truck shipping: 2.3¢ per ton-mile, \$1.62 per gallon
  - Tax rates on rail shipping: 0.3¢ per ton-mile, \$1.34 per gallon
- Vehicle miles traveled (VMT) tax (distance only, not weight) plus fuel tax
  - Truck tax rate: 30¢ per mile, \$1.62 per gallon
  - Rail tax rate: 12¢ per mile, \$1.34 per gallon
- VMT tax alone
  - Truck shipping taxed 30¢ per mile, rail shipping taxed 12¢ per mile
- Fuel tax alone
  - \$1.62 per gallon tax on truck fuel, \$1.34 per gallon tax on rail fuel

# Shippers Pay Higher Rates for Truck Transport

(Estimated average cents per ton-mile)

Type of Service	Truck	Rail
Carload/Truckload	14.6	4.7
Bulk	13.6	3.5
Intermodal	17.4	5.6
Auto Transport	13.8	9.6

# Overview of Findings

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- Because shippers pay more for truck transport than for rail, and because the simulated tax rates reflect external costs net of existing taxes on diesel fuel, the effect of the ASC tax on truck and rail rates would be far different from the 8:1 ratio of external costs of truck vs. rail
- Average predicted increase in shipping costs from ASC tax
  - Trucks: 19%
  - Rail: 12%

# Overview of Findings (Continued)

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- Predicted effects vary by commodity and route
  - Short-haul (mostly truck): little effect
  - Bulk transport (mostly rail): little effect
- 3.6% overall predicted shift (in ton-miles) from truck to rail, along with a decline of 0.8% in total tons shipped
- 3 million fewer truck trips over a year
  - Increase of 0.8 million railcar trips
- Almost 700 million gallons of diesel fuel would have been saved in 2007
- External costs would have been reduced by about \$2 billion in 2007

# Data and Parameters

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- The unit of observation for freight shipping is total ton-miles (and tons) shipped in 2007, separately for:
  - Every state pair, 39 commodities, and two modes
  - Almost 76,000 observations
  - These data come from the Freight Analysis Framework, based primarily on the 2007 Commodity Flow Survey
- The model's parameters are specified as ranges of possible values
  - Shipping rates, drayage costs, transport share of production and distribution costs, demand elasticities, rail route circuitry, empty returns, tax pass-through, and payload capacities
- In simulations, a specific value is drawn at random from each parameter's specified range

# Mode-Choice Elasticities

Commodity	Rail-Truck Elasticity
<b>Bulk Commodities/Raw Materials</b>	
Bulk Farm Products	0.02 to 0.03
Bulk Food Products	0.6 to 0.8
Lumber and Wood	0.6 to 0.7
Pulp and Paper	0.7 to 0.9
Bulk Chemicals	0.5 to 0.7
Primary Metals	1.2 to 1.5
Waste and Scrap	0.17 to 0.22
All Other Bulk	0.14 to 0.19
<b>Finished Goods</b>	
Finished Farm Products	3.5 to 3.7
Finished Food Products	2.0 to 2.2
Furniture	4.0 to 4.7
Finished Chemicals	3.2 to 3.5
Fabricated Metals	5.2 to 7.3
Machinery	3.7 to 4.8
Electrical Machinery	4.1 to 4.8
Motor Vehicles	0.2 to 0.3
Motor Vehicle Parts	1.1 to 1.4
All Other Finished	3.9 to 4.5

# Alternatives to ASC Tax

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- Among the policy options analyzed, the ASC tax (weight-distance tax plus fuel tax) most accurately reflects external costs, but it would also be the most costly to administer
  - The government must know the weight and distance of every shipment
- The VMT tax only requires distance, not weight
- The fuel tax is least costly to administer
  - A collection mechanism is already in place
- The VMT and fuel taxes have lower administrative costs but they reflect external costs less accurately or less comprehensively
  - The policy simulations examine the importance of that trade-off

# Results That Would Have Occurred in 2007 Under the Four Policy Options

	ASC Tax (Weight and distance plus fuel)	VMT Tax Plus Fuel Tax	VMT Tax	Fuel Tax
Average Cost Increase, Rail (Percent)	12.1	15.9	10.1	5.9
Average Cost Increase, Truck (Percent)	18.9	19.3	12.6	6.6
Shift in Ton-Miles From Truck to Rail (Percent)	3.6	3.9	3.8	0.8
Reduction in Total Tons Shipped (Percent)	-0.8	-0.7	-0.5	-0.3
Reduction in Number of Truck Trips (Millions)	-3.2	-3.3	-2.7	-0.9
Increase in the Number of Railcar Trips (Millions)	0.8	0.9	0.8	0.2
Gallons of Fuel Saved (Millions)	669	696	623	176
Reduction in External Costs (Billions of dollars)	2.3	2.4	2.1	0.6
Revenues From the Tax in 2007 (Billions of dollars)	68	70	43	26

# Discussion of Findings

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- The effects of the VMT tax plus the fuel tax are generally a little larger than those of the ASC tax
  - The ASC tax is a more accurate reflection of external costs
  - By ignoring weight, the VMT tax is higher on lighter shipments, and is lower on heavier shipments, compared to a tax on weight and distance
  - That drawback is a trade-off for lower administrative costs
- By itself, that VMT tax has effects nearly as large as the combination of VMT tax plus fuel tax, while raising \$27 billion less in revenues

# Likely Range of Outcomes and Sensitivity Analysis

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- Results are based on 1,000 iterations of the simulation model
- Variation in model predictions over those iterations is summarized as the “likely range” of values that the modeled outcomes might take
  - That range is defined as containing two-thirds of the model’s predictions, centered on the median prediction
- The influence of individual parameters on the model’s predictions is examined by varying the parameters’ values
  - Many of those sensitivity tests yield predictions that lie slightly outside of the likely range

# Likely Range and Sensitivity Analysis

Policy Effect	ASC Tax (Average result)	Likely Range	Double Rail Accident Risk	No Drayage or Lift Costs	Alternate Elasticities	Reduce Truck Rates by 5%	Raise Truck Rates by 5%
Change in External Costs (Percent)	-3.3	-3.0 to -3.5	-2.0	-3.7	-2.7	-3.6	-3.0
Fuel Savings (Percent)	2.9	2.6 to 3.2	2.0	3.3	2.5	3.2	2.6
Shift in Ton-Miles From Truck to Rail (Percent)	3.6	3.4 to 3.8	2.1	4.1	2.9	4.1	3.2
Reduction in Tons Shipped (Percent)	-0.8	-0.8 to -0.8	-0.8	-1.0	-0.8	-0.8	-0.7
Reduction in the Number of Truck Trips (Millions)	-3.2	-3.1 to -3.3	-2.5	-4.7	-3.0	-3.4	-3.0
Increase in the Number of Railcar Trips (Millions)	0.8	0.5 to 1.1	0.5	1.1	0.5	0.9	0.7

# Sources for Numeric Values

- External costs
  - Particulates/NOx: Matthews et al., J. Infrastructure Systems (2001)
  - CO<sub>2</sub>: Interagency Working Group on Social Cost of Carbon (2014)
  - All other external costs: Government Accountability Office (2011).
- Carrier rates (prices per ton-mile)
  - Department of Transportation, Surface Transportation Board, and Congressional Budget Office
- Mode-choice elasticities
  - Jones, Nix, and Schwier (1990), from “NCHRP Report 388: A Guidebook for Forecasting Freight Transportation Demand,” Transportation Research Board (1997).
- Ton-miles of freight shipped in 2007
  - Freight Analysis Framework, based on the Commodity Flow Survey