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Pricing Freight Transport to Account for External Costs

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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.

What This Project Addresses

- External costs of freight transport include the effects of accidents, damage to roads, air pollution, traffic congestion, and emissions of carbon dioxide.
- If such external costs were taxed, how would the choice of mode of transportation—truck vs. rail—be affected?
- To what extent are resources (including infrastructure) misallocated because prices do not reflect all costs?

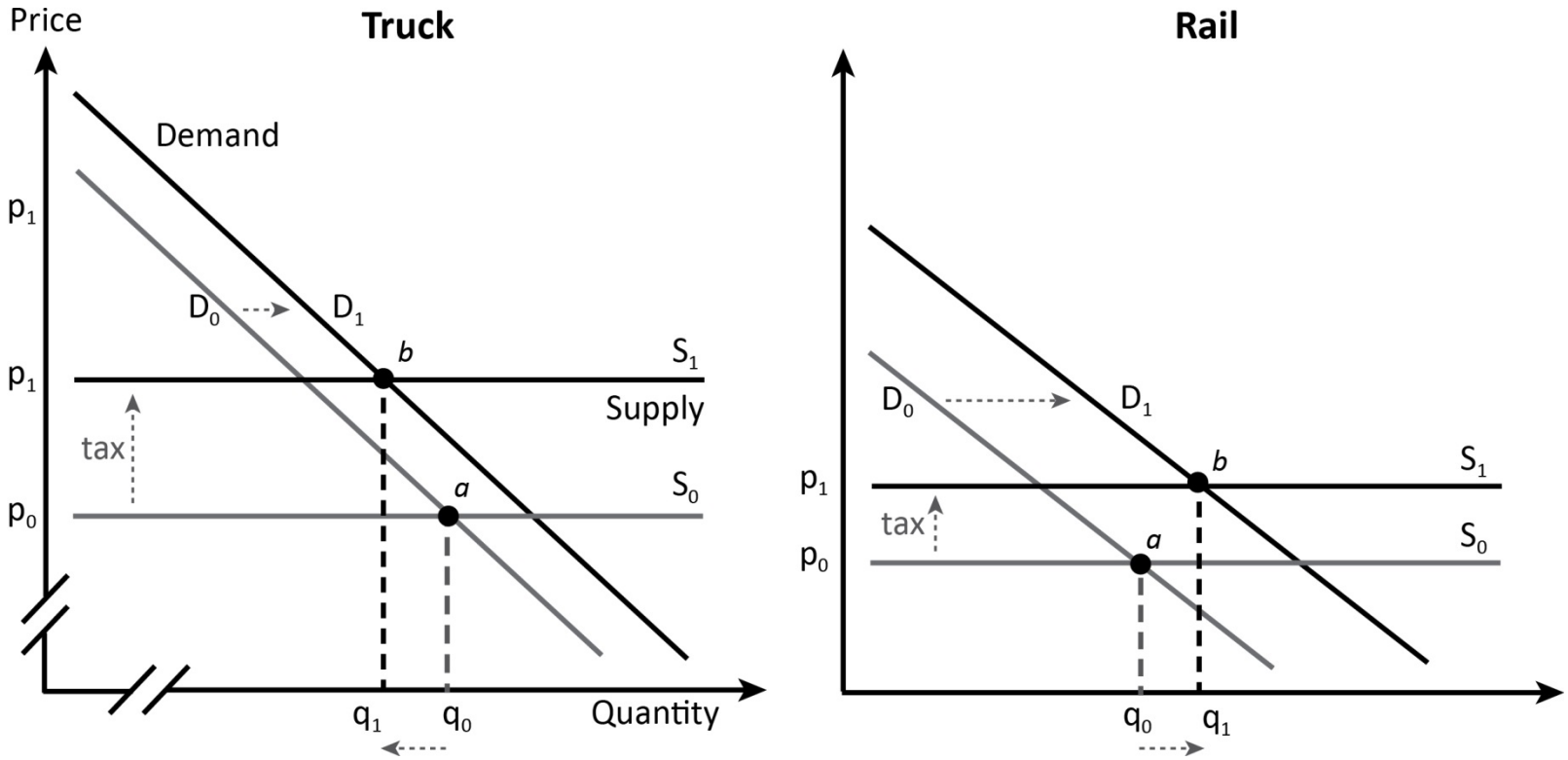
Typical External Costs May Be Eight Times Higher for Transport by Truck Than by Rail

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_2	0.02 to 0.22 to 0.9	0.01 to 0.05 to 0.2
Total of Median Costs	**4.0**	**0.5**

Note: For damages from CO_2, three numbers are shown to describe the distribution of estimates of external costs; values toward the middle of the range are much more likely to be selected. For other sources of external costs, two numbers are shown; all of the values in the range are equally likely to be selected.

Policies to Reflect External Costs in Transport Prices Would Shift Some Shipping From Truck to Rail



Adding external costs to shipping rates would increase shipping costs for both modes. External costs for trucks are greater.

Outline of the Approach

- Construct economic model of mode-choice response to changes in shipping costs
  - Model is based on observed price elasticities by mode and commodity
- Initial conditions: Truck, rail market shares (ton-miles) from 2007 Freight Analysis Framework (FAF) data
- Experiment: Change transport prices by adding external costs (as taxes) to rates charged by truck and rail carriers
- Outcomes predicted by repeated simulation of the model:
  - Changes in ton-miles for each mode
  - Reductions in external costs
  - Tax revenue generated by each policy

Four Policy Options

- Average-external-cost (AEC) tax
  - A weight-distance tax on average costs per ton-mile, from accidents, pavement damage, traffic congestion plus a fuel tax on NOx, PM, CO_2 emissions
  - Trucking tax rates: 2.3¢ per ton-mile, $1.50 per gallon
  - Rail tax rates: 0.3¢ per ton-mile, $1.50 per gallon
- A distance tax (vehicle miles traveled, or VMT, tax) plus a fuel tax
  - Trucking tax rates: 30¢ per mile, $1.50 per gallon
  - Rail tax rates: 12¢ per mile, $1.50 per gallon
- VMT tax only
- Fuel tax only

Who Will or Will Not Switch Modes?

- Shippers who only weakly prefer trucking to rail will switch when relative prices change.
- Many shippers will not switch even if prices change substantially.
  - Shippers for whom only one mode is available
  - Shippers for whom one mode is ideally suited (truck shippers in markets where rail service is slow or sporadic and bulk-commodity shippers)
- On the margin, a shipper will switch depending on how much the tax affects trucking prices, on a percentage basis, relative to rail prices.

Average Shipping Rates, 2007

Estimated Average Cents per Ton-mile Measured in Constant 2014 Dollars

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: AEC Tax

- The ratio of truck to rail external costs is 8:1.
- The AEC tax has a much smaller effect on relative prices.
  - Shippers willing to pay more for truck transport than for rail
  - New tax is in addition to existing taxes on diesel fuel
- There is an average predicted increase in shipping costs from the AEC tax.
  - Trucks: 19%
  - Rail: 12%

Overview of Findings: AEC Tax (Continued)

- Predicted effects vary by commodity and route.
  - Little effect for short-haul (mostly truck) and bulk transport (mostly rail)
- There is a 3.6% overall predicted shift in ton-miles from truck to rail, 0.8% decline in total tons shipped.
- There are 3 million fewer truck trips and 0.8 million more railcar trips in 2007 under the simulated policy than under existing policy.
  - Diesel fuel savings of almost 700 million gallons
  - Roughly $2 billion reduction in external costs

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

	AEC Tax	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

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

Likely Range of Outcomes and Sensitivity Analysis

			Sensitivity Analysis Based on Alternative Model Parameters				
Policy Effect	**AEC 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	0.8 to 0.8	0.5	1.1	0.5	0.9	0.7

Likely Range of Outcomes and Sensitivity Analysis (Continued)

- 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.

Data and Parameters

- The unit of observation for freight shipping is total ton-miles and tons shipped in 2007.
  - By state pair, each of 39 commodities, and two transport modes
  - Almost 76,000 observations
  - 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 circuity, 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
Bulk Commodities/Raw Materials	
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
Finished Goods	
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 the AEC Tax

- Among the policy options analyzed, the AEC tax most accurately reflects external costs, but it would be the most costly to administer.
  - The government must know the weight and distance of every shipment.
- The VMT tax requires distance only, 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 reflect external costs less accurately or less comprehensively.
  - The policy simulations examine the importance of that trade-off.

Sources for Numeric Values

- External costs
  - Particulates/NOx: Matthews et al., J. Infrastructure Systems (2001)
  - CO_2: 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