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Choosing the Right Model: Effects of Economic Model Selection Truck-Freight Network Investment Prioritization

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A Framework for Determining Highway Truck-Freight Benefits and Economic Impacts

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The Washington State Freight Mobility Plan

Goal:

Develop and **prioritize** freight transportation system improvement strategies that support and enhance trade and sustainable economic growth, safety, the environment, and goods delivery needs in the state.

Make a strong case for funding Washington state's freight priority projects in the reauthorization of the federal transportation bill and freight programs, and future state transportation packages.

Guide capital and operating investments in the state's freight systems.

Background

- To prioritize, it must be recognized.

- Fully evaluate the truck-freight benefits.
  - Direct benefits
  - Indirect benefits

Research Objectives

- Propose a transparent methodology for calculating both the direct freight benefits and the larger economic impacts of freight projects.
- Apply the methodology for projects assessment.

Methodology

- Identify Benefits
  - Literature review
  - WSDOT current project prioritization process
  - Three technical groups (urban goods movement, global gateway, and rural economies)

Identifying the Beneficiaries of Network Improvement

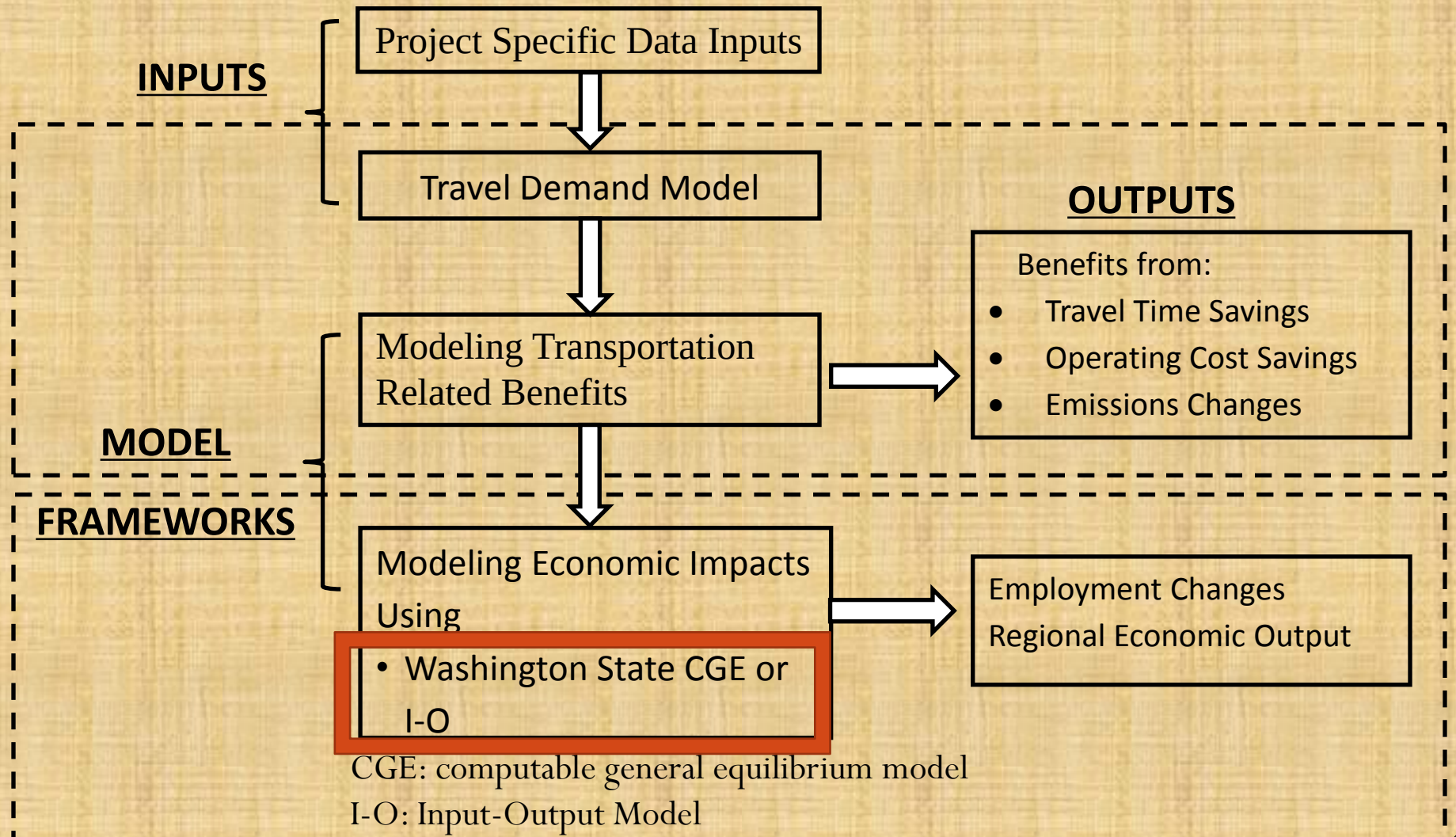
- **Carriers:** Travel Time; Reliability; Accessibility; Safety
- **Shippers:** Where carriers experience efficiency gains, shippers may configure long run changes to their scale, scheduling and overall logistics.
- **Industries and Markets:** The freight recipients may be able to adjust market production patterns as well as distribution and supply regions.
- **Non-Freight Impacts: Economic Development**: As business productivity (shipper, carrier, and recipient) is enabled, changes to activity patterns impacting job creation are enhanced.
  - Necessitates the implementation of Economic Impact Models.

Methodology

- **Direct Freight Benefits:**
  - Truck travel time savings
  - Truck operating cost savings
  - Truck emission changes

- **Economic Impacts:**
  - Employment changes
  - Regional economic output changes

Methodology



CGE: computable general equilibrium model

I-O: Input-Output Model

Methodology--Economic Impacts Analysis (EIA) – Model

Objective: Develop statistical models to represent the flow of dollars between industries has been used to relate transportation investments to productivity and employment.

- **Input-Output (I-O) Models**
  - Fixed Priced Model – Partial Equilibrium
  - Frequently (and easily?) used by policy analysts
  - Is a fixed price assumption reasonable for this type of shock?
    - Production Technology Improvement
  - Backwards Linkages
    - Where to apply the shock?

Methodology--Economic Impacts Analysis (EIA) -- Data

- Utilizes Social Accounting Matrices (SAM) from the 2010 IMPLAN data.
- Aggregate into 20 industrial Sectors:

Aggregation Code	Freight Dependent Industries	Aggregation Code	Other Industries
AGFOR	Agriculture and Forestry	INFO	Information Services
MIN	Mining	FININS	Financial and Insurance
UTIL	Utilities	REAL	Real Estate
CONST	Construction	PROTEC	Professional and Technical
MANUF	Manufacturing	MANAG	Management
WTRAD	Wholesale Trade	ADMIN	Administration
RTRAD	Retail Trade	SOCSER	Social Services
TRAWAR	Transportation and Warehousing	ARTS	Arts and Entertainment
TRUCK	Transport by Truck	FOOD	Food Services
WMAN	Waste Management	OTHR	Other (Including Government)

Methodology--Economic Impacts Analysis (EIA) – Model

Objective: Develop statistical models to represent the flow of dollars between industries has been used to relate transportation investments to productivity and employment.

- **Computable General Equilibrium (CGE) Models**
  - Market Clearing Prices and Quantities.
  - Allows flexibility in price
  - Firm Production: Household Inputs: Intermediate or Final Consumption
  - However, significantly more difficult to operate…correctly.
  - Initiating the shock

Methodology--Economic Impacts Analysis (EIA) – I-O Model

- Carrier benefits=>increased productivity=> reduced costs to freight dependent businesses=> output increase.

$$D_{1i} = D_{0i}(X_{1i}/X_{0i})^{e} ,$$

D_{0i} = Output before Infrastructure Investment for Industrial Sector i (IMPLAN generated)

D_{1i} = Output after Infrastructure Investment for Industrial Sector i

X_{0i} = Cost of Production attributable to trucking before Infrastructure Investment for Industrial Sector i

X_{1i} = Cost of Production attributable to trucking after Infrastructure Investment for Industrial Sector i

e = Elasticity of output with respect to production cost

Methodology--Economic Impacts Analysis (EIA) – CGE Model

- Create four regional CGE models.
  - 2 Geographic scales
  - Long-Run (LR) and Short-Run (SR) scenarios
- Model the infrastructure investment as an improvement in technology.
  - Improves the productivity of the transportation system
  - Initiate the CGE through a counterfactual that shifts the industry supply curve: (Cobb-Douglas shown for simplicity)

$$Q=S(K^{\alpha}L^{1-\alpha})$$

    - Value of the shift is dependent upon the percent change in operating costs to the trucking industry

Case Study

- Interstate-highway widening project
  - 10 mile, 2 lanes each direction.
  - A critical connector for the region and serves approximately 9,000 trucks daily.
  - Freight demand is projected to increase by 30% over the next 10 years.
  - Adding one lane each direction.

Case Study -- Economic Impacts

Travel Demand Model Benefit Output	$	4,533,563
Spokane County Intermediate Expenditures (TRUCK)	$	139,875,763
Statewide Intermediate Expenditures (TRUCK)	$	1,760,368,000
Change in Truck Transport Productivity -Spokane County		3.24%
Change in Truck Transport Productivity -State		0.26%

Case Study -- Economic Impacts

	Employment	Output
Statewide Model		
LR-CGE	47.3	$22,241,506
I-O	81.5	$13,272,773
Spokane County Model		
LR-CGE	78.0	$28,675,616
I-O	65.5	$8,071,935

- CGE Output > I-O Output
- Employment?

Case Study -- Economic Impacts

County

	Employment Change		Output Change	
Sector	**LR-CGE**	**I-O**	**LR-CGE**	**I-O**
MANUF	45.8	5.6	$13,676,449	$1,732,818
TRAWAR	-2.6	1.2	$ 125,054	$ 148,070
TRUCK	-38.0	4.1	$ (179,227)	$ 463,447
Total	**78.0**	**65.5**	**$28,675,616**	**$8,071,935**

Statewide

	Employment Change		Output Change	
Sector	**LR-CGE**	**I-O**	**LR-CGE**	**I-O**
MANUF	27.0	9.9	$11,510,000	$4,668,419
TRAWAR	-3.2	1.7	$ 166,450	$264,503
TRUCK	-32.8	4	$ 80,113	$479,240
Total	**47.3**	**81.5**	**$22,241,506**	**$13,272,773**

Case Study -- Economic Impacts - CGE

Region	Initial Employment Level	Change in Employment		Change in Activity Quantity (%)	
		SR	LR	SR	LR
County	264,128	25.5	77.9	2.31	3.06
State	5,647,012	22.4	47.2	0.20	0.21

- **Price for truck services and regional output sales change:**
  - County
    - SR: 1.94% decrease in price and $9.8 million increase in sales
    - LR: 1.67% decrease in price and $28.7 million increase in sales
  - State
    - SR: 0.18% decrease in price and $10.5 million increase in sales
    - LR: 0.14% decrease in price and $22.2 million increase in sales

Discussion

- The I-O model results will never produce a negative number when modeling an increase in output by a sector.
- The I-O model does not account for the trucking industry becoming more efficient and able to do more with fewer trucks.
  - Over estimates employment change.
- Output CGE>Output I-O
  - Productivity and flexibility
- Geography Matters
  - Expected region of impact

Limitations and Future Work

- Limitations of using TDMs
- Limited feedback loops between TDM and Impact Models
- Future work
  - Freight performance data
  - Enhancing dynamic nature of models

Conclusion

- A quantitative and transparent methodology capturing freight benefits can be used for freight project impacts assessment and project prioritization.
- Industrial base of a geographical region significantly impacts model outputs.