Uncovering the Determinants of Shippers' Willingness to Shift from Road to Rail Freight Transport

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Outline

- ❑ Introduction
- ❑ Modal Shift
- ❑ Binary Choice Model
- ❑ Results & Discussion

Introduction

Freight transport plays a significant role in Australia’s economy.

Total Freight

Total Freight to grow 26% by 2050

Road Freight

Road Freight to increase 77% by 2050

Rail Freight

Rail Freight projected to grow 6% by 2050

Modal Shift

Road is predominantly the mode of choice for urban, inter-urban and regional freight and most import supply chains.

- ❑ Heavy vehicle tax reforms
- ❑ Carbon emission tax

The need to encourage a Modal shift of freight from road to rail

A change in the design of freight transport-related policies towards modal shift

Data:

Revealed Preference (RP) data collected in 2017

Import and export container movements

Covers 43,560 individual freight movements

Data includes:

- Commodity type
- Commodity Weight
- Origin and Destination
- Transport mode choice
- Shipment Value (AUD)
- O-D Postcode & Timestamp

Choice Modeling:

When, Why and How Should Freight be Moved?

Optimization models such as linear programming

Choice models, such as binary choice models

Binary Choice Model

$$P_n(i) = \frac{\exp(V_{in})}{\sum_{j=1}^{k} \exp(V_{jn})}$$

Where:
$P_n(i)$ = probability of shipper n choosing mode I,
V_{jn} = utility derived by individual n from mode j,
K = number of available modes of transportation

Hence, the utility by a shipper n from mode j, V_{jn}, is derived as a linear function of the explanatory variables as follows:

$$V_{jn} = \beta_{0j} + \beta_{1j}X_{1n} + \beta_{2j}X_{2n} + \cdots + \beta_{nj}X_{qn}$$

Where:
β_{0j} = Alternative Specific constant for mode j,
β_{1j} , β_{2j}, ….., β_{nj} = Coefficients associated with explanatory variables
X_{1j} , X_{2j}, ….., X_{nj} = Explanatory variables for shipper n
Q = number of explanatory variables included in the model

Choice Modeling:

For our model, the utility by a shipper n from mode j, V_{jn}, is derived as a linear function of the explanatory variables as follows:

$$P_n(i) = \frac{\exp(V_{in})}{\sum_{j=1}^{k} \exp(V_{jn})}$$

$$V_{rail} = Constant_{Rail} + \beta_0 + Availability_{Rail} + \beta_{Dist} * Dist_{sc} + \beta_1 * Weight_{agriculture} + \beta_2 * Weight_{mining} + \beta_3 * Weight_{agriculture} + \beta_4 * Weight_{chemical} + \beta_5 * Weight_{textile} + \beta_6 * Weight_{wood} + \beta_7 * Weight_{food} + \beta_8 * Weight_{household} + \beta_9 * Weight_{coal} + \beta_{10} * Value_{agriculture} + \beta_{11} * Value_{mining} + \beta_{12} * Value_{chemical} + \beta_{13} * Value_{textile} + \beta_{14} * Value_{wood} + \beta_{15} * Value_{household} + \beta_{16} * Value_{coal}$$

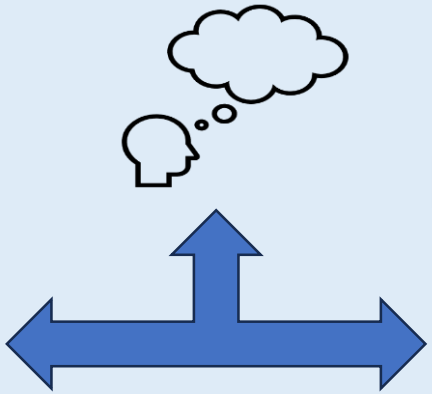
Results

Variable	Value	Rob. Std. err	Rob p-value	Value	Rob. Std. err	Rob p-value
Commodity type		**Shipment Value**			**Shipment Weight**	
Agricultural products	10.30	1.05	0.00	0.02	0.01	0.00
chemical products	-2.89	0.71	0.00	0.07	0.07	0.01
textiles	0.00	0.00	0.00	0.04	0.01	0.00
craft products	-15.6	4.40	0.00	0.05	0.01	0.00
Household materials	0.95	0.18	0.00	0.00	0.00	0.00
construction materials	-3.94	0.91	0.00	0.07	0.01	0.00

Variable	Value	Rob. Std. err	Rob p-value
Alternative Specific Constant of Rail	-13.70	1.57	0.00
Distance	0.36	0.04	0.00
Rail mode accessibility	9.45	1.56	0.00

Statistics	Value
No of parameters:	14
Final log likelihood	-2680.88
Akaike Information Criterion	5389.77
Bayesian Information Criterion	5508.19

Discussion



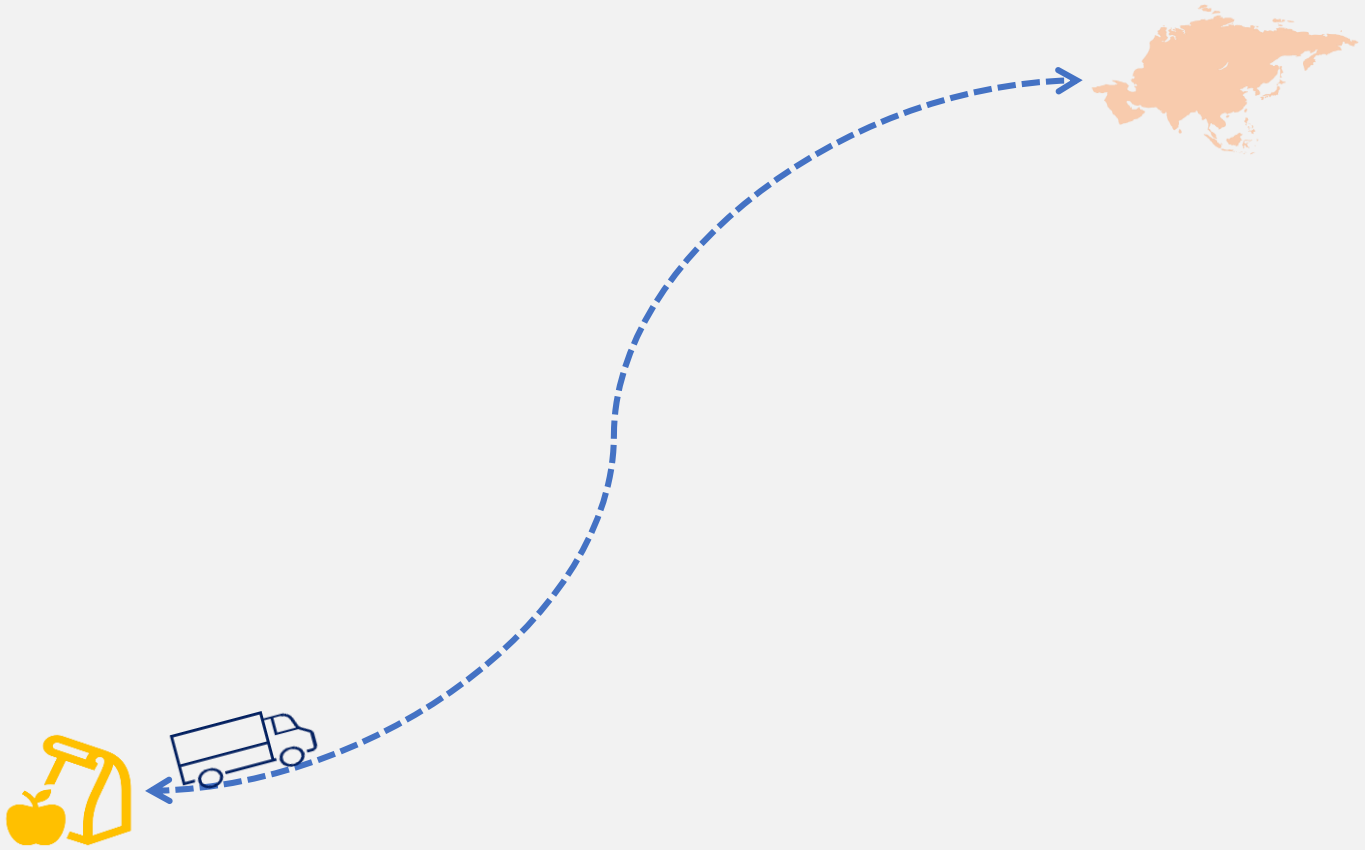
Rail is the least preferred mode (ASC = -13.7)

Discussion

- Weight and shipment size influences mode choice significantly

For commodities such as food, dairy, fruit, and beverages, increasing the shipment size increases the likelihood of using rail (co-efficient = 0.0538)

Discussion



Longer distance increases the probability of choosing rail

Discussion

- AUD Value of the commodity plays a significant role (high-value commodities shippers choose road)

For agricultural, forestry and livestock products with a low shipment value (ship = rail)

For commodities with high shipment value, such as household items(ship = road)

Discussion

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Rail Availability

Mode accessibility & availability significantly influences choice (co-efficient = 9.45)

Recommendations for Policymakers

- Encouraging modal shift isn’t just about building infrastructure but creating connected modal networks
- Emphasis on improving the speed and reliability of rail transport e.g., speed freight trains
- Enabling freight bundling options by encouraging partnerships between shippers

THANK YOU

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Excluded Variables

The model some variables and estimates due to insignificant results:

- Empty container (Com 10)
- Freight values for:
  - Mining, coal, limestone, metallic ores, nonmetallic minerals (Com2)
  - Metallic and machinery products, primary and fabricated metal products, electronics, electrical machinery, transport equipment (Com3)
  - Light industrial products, textiles, leather (Com5)
  - Food, dairy, fruit, beverages, tobacco, seafood (Com7)

Excluded Variables

The model some variables and estimates due to insignificant results:

- Freight weight for:
  - Agricultural, forestry, fishery and livestock products (Com1)
  - Metallic and machinery products, primary and fabricated metal products, electronics, electrical machinery, transport equipment (Com3)
  - Wood and paper products, lumber or wood products, pulp, paper or allied products, printed matter (Com6)
  - Coal products, rubber or plastic products, clay, concrete, glass, and stone products