Warehousing Land Use and Transportation Interactions
A case study of Toronto, Ontario

Kevin Gingerich, Hanna Maoh, William Anderson
Introduction

Wegener (1995)
This presentation examines the transport - land use relationship from both directions.

Part 1
Location choice model of warehousing

How does transportation affect land use?

Part 2
Impact of a major airport on warehousing freight trips

How does land use affect transportation?
Location choice model of warehousing

How does transportation affect land use?

http://www.clipartlogo.com/image/edificio_312787.html
Warehousing Data

• Warehouse data was obtained from InfoCanada
  – Firm set comprising of Industry (SIC), location, and approximate employment

• **489 warehouses** in the Toronto CMA
  – 41 comprised of food/cold storage (SIC 4221 and SIC 4222)
  – 448 comprised of other storage (SIC 4225 and SIC 4226)

• By proportion, the 489 warehouses represent:
  – 0.2% of all firms in the Toronto CMA (489 / 218,496)
  – 10.7% of all warehousing firms in Canada (489 / 4,550)
Location Choice Methods of Analysis

- Model type: multinomial / mixed logit
- Decision maker: individual warehouses \( w \)
- Alternatives: census tracts \( t \)
- Choice set constrained to 5 alternatives
  - 1 residing tract + 4 randomly selected tracts
- Model estimated using \textit{NLOGIT} software
Model Assumptions

• Common MNL assumptions
  – Independence of irrelevant alternatives
  – Errors are independent and identically distributed

• Warehouses (or their owners) have full information and land availability to maximize their utility

• The explanatory variables have not changed over time
  – Current model based on 2015 data
  – Actual location decisions were made in the past
Explanatory Variables

• Proximity to Highways
  – Expectation: Positive
Explanatory Variables

- Proximity to intermodal rail yards
  - Expectation: Positive
Explanatory Variables

- Proximity to Pearson Airport
  - Expectation: Positive
Explanatory Variables

- Rural Census Tract
  - Expectation: Positive
Explanatory Variables

• Proportion of industrial land use
  – Expectation: Positive
Explanatory Variables

- Real estate prices not included

- Residential income per zone originally included as a proxy
  - Dropped from final model due to high negative correlation with proportion of industrial land

- Difficult to capture real estate prices when the warehouse was actually established
### Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>MNL</th>
<th>MXL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>T-statistic</td>
</tr>
<tr>
<td>AIRPORT&lt;sub&gt;7km&lt;/sub&gt;</td>
<td>1.21</td>
<td>5.90</td>
</tr>
<tr>
<td>CN_YARDS</td>
<td>1.08</td>
<td>1.91</td>
</tr>
<tr>
<td>HIGHWAY&lt;sub&gt;200m&lt;/sub&gt;</td>
<td>0.85</td>
<td>5.90</td>
</tr>
<tr>
<td>RURAL</td>
<td>2.00</td>
<td>10.86</td>
</tr>
<tr>
<td>LAND_USE&lt;sub&gt;ind&lt;/sub&gt;</td>
<td>5.08</td>
<td>15.29</td>
</tr>
<tr>
<td>σ - LAND_USE&lt;sub&gt;ind&lt;/sub&gt;</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Log-Likelihood (0)</td>
<td>-787.02</td>
<td></td>
</tr>
<tr>
<td>Log-Likelihood (β)</td>
<td>-459.47</td>
<td></td>
</tr>
<tr>
<td>ρ^2</td>
<td>0.416</td>
<td></td>
</tr>
</tbody>
</table>
Impact of a major airport on warehousing freight trips

How does land use affect transportation?

http://www.torontopearson.com/b2b.aspx#
Comparison analysis of:
- Trips related to warehouses near Pearson Int’l Airport
- Trips related to warehouses in other areas of the Toronto CMA

Do freight trips occurring at warehouses near the airport differ from other warehouses?
- By location
- By industry
- By supply chain process (i.e. intermodal or final destination)
Proximity to Airport
Data

• Warehouses from location study

• GPS data from March, 2013 utilized to derive trips

• End points for trips identified from primary stops
  – A stop occurs when a truck dwells for 15 minutes or longer
  – 931,000 primary stops identified in this dataset

• Each trip must:
  – start or end within 250 meters of a warehouse identified in Toronto
  – Have no other firm closer to the corresponding start/end
  – Be completed within a reasonable time window
Final Trips

• Total trips starting/ending within 250 meters of a Toronto warehouse with no other closer firms include:
  – 1,940 trips from the warehouse to destination
  – 1,075 trips from origin to warehouse

• Trips pertaining to warehouses within 7 km of Pearson airport include:
  – 1,248 airport related trips from warehouse to destination
  – 595 airport related trips from origin to warehouse
Total Trips – Warehouse to Destination
Total Trips – Origin to Warehouse
### Trip Distances (km)

<table>
<thead>
<tr>
<th>Direction</th>
<th>Trip Type</th>
<th>Average</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warehouse to Destination</td>
<td>All</td>
<td>1,016</td>
<td>3,558</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Airport</td>
<td>1,202</td>
<td>3,425</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>681</td>
<td>3,558</td>
<td>10</td>
</tr>
<tr>
<td>Origin to Warehouse</td>
<td>All</td>
<td>844</td>
<td>3,544</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Airport</td>
<td>1,070</td>
<td>3,544</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>564</td>
<td>3,427</td>
<td>12</td>
</tr>
</tbody>
</table>

- Warehousing trips pertaining to the airport travel larger distances overall
  - Average of 1.8 x larger compared to other warehousing trips
Key Findings

Part 1 • Proximity to transportation has a major role in the location choice of warehouses along with the proportion of land used for industrial land

Part 2 • Trips pertaining to warehouses near the airport travel almost twice as far on average compared to other warehousing trips
Thank you for listening!

Feel free to ask any questions

Contact Information

• Kevin Gingerich
• E-mail: gingerik@uwindsor.ca