IF YOU BUILD IT, THEY WILL COME? A DYNAMIC ANALYSIS OF THE FACTORS AFFECTING THE TRANSIT RIDERSHIP IN THE NEW YORK CITY REGION

City College of the City University of New York
January 2010

Donald M. Varley – don_varley@urscorp.com
Presentation Outline

- Introduction
- Factors Affecting Transit Ridership
- Variables and Data Description
- Modeling Methodology
- Model Results
- Conclusions
- Questions
Introduction – Recent Trends

[Graph showing trends in transit ridership and real gasoline price from 1996 to 2009. The graph includes two lines: one for transit ridership (in thousands) and the other for real gas price (in cents per gallon).]
Questions This Study Will Answer:

- What are the underlying causes of transit ridership, particularly what is the causal relationship between transit supply and transit demand?

- What are the short and long term effects of gasoline price on transit ridership?
Internal Factors Affecting Transit Ridership

- Transit Service Supplied
- Transit Fare
External Factors Affecting Transit Ridership

- Population and Employment
- Gasoline Price
Population and Employment
Real Transit Fare

Real Transit Fare Unites

Jan-96 to Jan-09

Real Fare (Oct. 08 $)
Real Gas Prices
Rail Service (Transit Supply)

[Graph showing the trend of transit service supplied for Rail Service (10,000s VRM) from Jan-96 to Jan-03 with data points indicating a steady increase over the years.]
Transit Ridership (Transit Demand)
Introduction - Type of Analysis

- Cross Sectional Analysis
- Time Series Analysis
Modeling Methodology

Preliminary Steps
1. Random Walk Test
2. Unit Root Test
3. Cointegration

Model Development
- Identification
- Estimation
- Diagnostic Checking

ARFIMA Model Results
- Tests of Significance
- Lead / Lag Analysis
- Elasticity Calculation

Questions:
1. Is transit ridership a random walk?
2. Is transit ridership stationary?
3. What is the underlying data generating process?

- What is the correct ARFIMA model for the factors of transit ridership?

- What is the causal relationship between transit service and ridership?
- What are the short-term and long-term impacts of gasoline on transit ridership?
Preliminary Steps

- Test for Random Walk
- Ordinary Least Square (OLS) Model
  - Transit Ridership = Previous Month + Constant
- Fails Test – Transit Ridership is not a Random Walk
Preliminary Steps

- Unit Root Test
  - Test for Stationarity

- No Unit Root Found, Implies Non-Stationary
Preliminary Steps

- Co-integration Test
  - Understand Underlying Data Generating Process

- Transit Service and Labor Force are Co-Integrated

- Transit Fare and Gasoline Prices are not Co-Integrated
Model Development – ARFIMA Models

- Auto-Regressive Fractionally Integrated Moving Average Model
  - AR(p) – Auto-Regressive
  - d – Fractional Integration Parameter
  - MA(q) – Moving Averages
Model Development

- Box and Jenkins Method
  - Identification (AR(p) and MA(q))
    - Visual Inspection
  - Estimation (d and variable coefficients)
  - Diagnostic Checking (residuals)
## Model Results - Seasonality

<table>
<thead>
<tr>
<th>Constant and Fractional integration Parameter</th>
<th>Coefficient</th>
<th>Std.Error</th>
<th>t-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>196.61</td>
<td>99.38</td>
<td>1.9</td>
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<td>d parameter</td>
<td>0.48</td>
<td>0.03</td>
<td>14.7</td>
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</table>

<table>
<thead>
<tr>
<th>Ridership at t-1</th>
<th>Coefficient</th>
<th>Std.Error</th>
<th>t-value</th>
<th>Probability</th>
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<tbody>
<tr>
<td>AR-1</td>
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<td>0.13</td>
<td>4.1</td>
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</table>

*Log-likelihood: -664.2*

<table>
<thead>
<tr>
<th>Seasonality</th>
<th>Coefficient</th>
<th>Std.Error</th>
<th>t-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seasonal (Jan.)</td>
<td>-30.52</td>
<td>2.38</td>
<td>-12.8</td>
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<td>Seasonal (Feb.)</td>
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<td>4.16</td>
<td>-3.79</td>
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<td>-23.93</td>
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<td>-5.32</td>
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<td>Seasonal (May)</td>
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<td>-2.58</td>
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<td>Seasonal (July)</td>
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<td>Seasonal (Aug.)</td>
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<td>Seasonal (Sept.)</td>
<td>-22.41</td>
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<td>Seasonal (Oct.)</td>
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<td>4.23</td>
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<tr>
<td>Seasonal (Nov.)</td>
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*Log-likelihood: -539.9*
## Model Results – Independent Factors

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<th>Independent Factors</th>
<th>Coefficient</th>
<th>Std.Error</th>
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<tbody>
<tr>
<td>Real Gas Price (cents/gal.)</td>
<td>0.14</td>
<td>0.05</td>
<td>3.02</td>
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<td>Real Gas Price (t-13)</td>
<td>0.13</td>
<td>0.06</td>
<td>2.24</td>
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<td>Transit Fare (Oct 08 dollars)</td>
<td>-8.55</td>
<td>3.47</td>
<td>-2.46</td>
<td>0.02</td>
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<tr>
<td>Labor Force (t-5) (100,000s of Employed people in workforce)</td>
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<td>0.01</td>
<td>2.97</td>
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<tr>
<td>Service Level (10,000s of VRM)</td>
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<td>0.03</td>
<td>2.19</td>
<td>0.03</td>
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<td>Service Level (t-4)</td>
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<td>0.04</td>
<td>2.53</td>
<td>0.01</td>
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</table>

Log-likelihood: -528.3
Model Results - Seasonality

Seasonal Transit Ridership

- Average from Data
- Model Coefficient
Model Results

- Residual Analysis
- Portmanteau Statistic = 21.0 (Significant at 95%)
## Model Results – Time-Series Attribute

- **Lead / Lag Relationships**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Immediate Impact</th>
<th>Lag Impacts (months)</th>
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</thead>
<tbody>
<tr>
<td>Gas Prices</td>
<td>Yes</td>
<td>13</td>
</tr>
<tr>
<td>Service Level</td>
<td>Yes</td>
<td>4</td>
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<tr>
<td>Fare</td>
<td>Yes</td>
<td>10</td>
</tr>
<tr>
<td>Labor Force</td>
<td>No</td>
<td>5</td>
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</tbody>
</table>
## Model Results – Time-Series Attributes

- **Short-Term and Long-Term Elasticities**

<table>
<thead>
<tr>
<th></th>
<th>Short-Term</th>
<th>Long-Term</th>
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</thead>
<tbody>
<tr>
<td>Gas Prices</td>
<td>0.11</td>
<td>0.19</td>
</tr>
<tr>
<td>Service Level</td>
<td>0.13</td>
<td>0.27</td>
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<tr>
<td>Fare</td>
<td>-0.40</td>
<td>-0.80</td>
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<tr>
<td>Labor Force</td>
<td>0.00</td>
<td>0.59</td>
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</table>
Model Results – Gas Price Elasticity

Gas Price Elasticity

![Graph showing gas price elasticity against real gasoline price. The graph uses different markers for short-term and long-term elasticity, with points scattered across the chart to represent various observations.]
Conclusions

- Transit Demand Follows Transit Supply
- Gasoline Prices Influences Transit Ridership
- Short-Term and Long-Term Elasticities
- Transferable Methodology
- Future Research
Questions
Acknowledgements

- Prof. Chen, Thesis Advisor
- Prof. McKnight and Prof. Paaswell, Review Committee
- Mr. Tillotson, Mr. Marchwinski, NJ Transit
- Mr. Lutin, Newark College of Engineering
- Mr. Mosseri, Mr. Gazillo, URS Corporation
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