The effects of impact fees on urban form and congestion in Florida

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Urban and Regional Planning
1. Background
2. Hypothesis
3. Operationalization
4. Results & Findings
5. Implications and Suggestions
Background
Impact fee

- “Partial payment to local governments for the cost of additional facilities necessary as a result of new development”
- As of 2006, 41 Counties, 184 municipalities reported impact fee revenue in FL
Impact fee

- Transportation IF: $85 million in 1993 and $558 million in 2006 in FL
- As of 2006, 33 Counties, 71 municipalities reported impact fee revenue
Impact fee → Urban Form

- Impact Fee → Compactness of urban form
  - disincentivizing sprawl by increasing the development cost on urban fringe

A Graphical Depiction of Sprawl

Development Fees and Single Family Home Construction

Bluffstone et al. (2008) p.435,443
The relationship between urban form and congestion is different based on travel behavior.

**Compactness of Urban Form → Increase in congestion**
- High density & land use mix → trip frequency → increase in congestion

**Compactness of Urban Form → Decline in congestion**
- High density & land use mix → less VMT + less travel time

Hypothesis
Hypothesis

- Conceptualization
  - Growth Management effect

- Revenue effect

Diagram:
- Total Impact Fee $\rightarrow$ Urban Form (compactness) $\rightarrow$ Congestion (rci, tti, delay, cost)
- Transportation Impact Fee $\rightarrow$ Increase of investment on transportation infrastructure $\rightarrow$ Congestion (rci, tti, delay, cost)
Operationalization
Data

- Observation: County in MSA 2006
- Time: 2000, 2006
- Data
  - Impact Fee: Office of Economic & Demographic Research
  - Residential Urban Form: Property tax roll in FL in 2000 and 2006
  - Employment Urban Form: Census Transportation Planning Products (CTPP) in 2000, & Longitudinal Employer-Household Dynamics (LEHD) in 2006
  - Congestion: the project “The Economic Cost of Traffic Congestion in Florida” funded by FDOT.

Galster et al. (2001), Theobald (2001), Custinger et al. (2005), Sarzynski et al. (2006)
Operationalization: IIF

- Intensity of Impact Fees (IIF): Quantity of total impact fee

\[ IIF = \frac{\sum_{i=1}^{m} \sum_{t=1}^{n} impact\_fee_{i,t}}{total\_newly\_built\_floor\_area/1000} \]

(i = municipalities including unincorporated area, t = analysis time period)
Operationalization: DIF

- Difference of impact fees across county (DIF)

\[ DIF = IIF_{\text{outside\_of\_central\_city}} - IIF_{\text{central\_city}} \]

- Rationale of development movement by imposing IF

Legend:
- **DIF**
  - -3480 - -2000
  - -2000 - -500
  - -500 - -300
  - -300 - 0
  - 0
  - 0-400
  - 400-800
  - 800-1100
  - 1100-1400
  - 1400-2800
  - 2800-4100

Cases:
- Case 1: Same IF
- Case 2: No IF
- Case 3: Low to high
- Case 4: High to low
Operationalization: TIFC

- Transportation impact fee per capita (TIFC)

\[ TIFC = \frac{\sum_{i=1}^{m} \sum_{t=1}^{n} transportation\_impact\_fee_{i,t}}{\text{population\_2000}} \]

(i = municipalities including unincorporated area, t = analysis time period)

Legend

ITIF

- 0
- 0 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 300
- 300 - 500
- 500 - 700
- 700 - 1000
- 1000 - 1300
- 1300 - 2100

Broward county (2006)
Operationalization: Urban form

- Extended Urbanized Area (EUA)
  - "the Census Bureau-defined urbanized area, as well as each additional outlying square-mile cells that have 60 or more dwelling units within county”
  - EUA is based on the threshold between suburban and exurban density: 1 unit per 10~11 acres (60 DW / mi²) by Theobald (2001).

Galster et al. (2001), Theobald (2001), Custinger et al. (2005), Sarzynski et al. (2006)
Operationalization: Urban form

- **Density**
  - "The average number of housing units (jobs) per square miles of developable land in the EUA."

Visual Representation of Density

Sarzynski et al. (2006)
Operationalization: Urban form

- Concentration

  “The percentage of housing units (jobs) that would need to move in order to produce an even distribution of housing units (jobs) within square-mile cells across the EUA.”

Visual Representation of Concentration

Sarzynski et al. (2006)
Operationalization: Urban form

- Centrality

  “the ratio of the average distance to the centroid of the urban core cell from the centroids of the grids comprising the EUA to the average distance to centroid of urban core cell of a housing unit (job) within the EUA.”

Visual Representation of Centrality

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Sarzynski et al. (2006)
Operationalization : Urban form

Proximity

“the ratio of the average distance among centroids of square-mile cells in the EUA to the weighted average distance among housing units (jobs) in the EUA”.

Visual Representation of Proximity
Maps: Residential Density

Legend

**hden00**
- 0
- 0 - 200
- 200 - 500
- 500 - 700
- 700 - 1000
- 1000 - 1510

Legend

**hden06**
- 0.00000
- 0.000001 - 200.00000
- 200.000001 - 500.000000
- 500.000001 - 700.000000
- 700.000001 - 1000.000000
- 1000.000001 - 1640.000000
Operationalization: Congestion

- Congestion of urban areas within County
  - **RCI**: Annual Roadway Congestion Index.
  - **TTI**: Ratio of travel time in the peak period to travel time at free-flow conditions.
  - **Total Delay per capita**: Sum of the difference between average traveling times and traveling Times at Free Flow Speeds divided by the population
  - **Total congestion cost per capita**: Sum of Annual Passenger Delay Cost, Annual Passenger Fuel Cost, and Annual Commercial Vehicle Cost divided by the population
Results & Findings
## Descriptive statistics

### Residential Urban form model

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>IIF</td>
<td>41</td>
<td>1380.05</td>
<td>1113.41</td>
<td>0.89</td>
<td>4537.77</td>
</tr>
<tr>
<td>DIF</td>
<td>41</td>
<td>642.22</td>
<td>1549.58</td>
<td>-3479.62</td>
<td>4014.80</td>
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<tr>
<td>TIF per capita 00</td>
<td>41</td>
<td>171.52</td>
<td>193.51</td>
<td>0.00</td>
<td>776.65</td>
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<tr>
<td>Change of housing density</td>
<td>41</td>
<td>1.12</td>
<td>0.10</td>
<td>0.97</td>
<td>1.54</td>
</tr>
<tr>
<td>Change of housing centrality</td>
<td>41</td>
<td>1.00</td>
<td>0.05</td>
<td>0.84</td>
<td>1.08</td>
</tr>
<tr>
<td>Change of housing proximity</td>
<td>41</td>
<td>1.00</td>
<td>0.02</td>
<td>0.92</td>
<td>1.04</td>
</tr>
<tr>
<td>Change of housing concentration</td>
<td>41</td>
<td>0.95</td>
<td>0.08</td>
<td>0.76</td>
<td>1.11</td>
</tr>
<tr>
<td>RCI00</td>
<td>41</td>
<td>1.36</td>
<td>0.27</td>
<td>0.84</td>
<td>2.07</td>
</tr>
<tr>
<td>RCI06</td>
<td>41</td>
<td>1.37</td>
<td>0.28</td>
<td>0.63</td>
<td>1.96</td>
</tr>
<tr>
<td>TTI00</td>
<td>41</td>
<td>1.35</td>
<td>0.17</td>
<td>1.00</td>
<td>1.69</td>
</tr>
<tr>
<td>TTI06</td>
<td>41</td>
<td>1.35</td>
<td>0.16</td>
<td>1.00</td>
<td>1.68</td>
</tr>
<tr>
<td>Delay per capita 00</td>
<td>41</td>
<td>10.49</td>
<td>7.10</td>
<td>0.00</td>
<td>25.09</td>
</tr>
<tr>
<td>Delay per capita 06</td>
<td>41</td>
<td>10.73</td>
<td>8.02</td>
<td>0.00</td>
<td>45.10</td>
</tr>
<tr>
<td>Cost per capita 00</td>
<td>41</td>
<td>199.32</td>
<td>132.29</td>
<td>0.00</td>
<td>457.04</td>
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<td>Cost per capita 06</td>
<td>41</td>
<td>264.26</td>
<td>208.53</td>
<td>0.00</td>
<td>1224.82</td>
</tr>
<tr>
<td>Difference of population growth</td>
<td>41</td>
<td>0.03</td>
<td>0.25</td>
<td>-1.22</td>
<td>0.37</td>
</tr>
<tr>
<td>Change of population</td>
<td>41</td>
<td>0.16</td>
<td>0.13</td>
<td>-0.07</td>
<td>0.63</td>
</tr>
<tr>
<td>Change of AMI</td>
<td>41</td>
<td>0.17</td>
<td>0.05</td>
<td>0.07</td>
<td>0.26</td>
</tr>
<tr>
<td>Road expenditure</td>
<td>41</td>
<td>1354.70</td>
<td>569.22</td>
<td>639.11</td>
<td>3421.01</td>
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<td>Transit expenditure</td>
<td>41</td>
<td>141.70</td>
<td>260.91</td>
<td>0.00</td>
<td>1369.89</td>
</tr>
<tr>
<td>Change of # of vehicles</td>
<td>41</td>
<td>0.24</td>
<td>0.18</td>
<td>-0.42</td>
<td>0.83</td>
</tr>
</tbody>
</table>

Note. Number of samples in employment urban form model are 34 due to unidentified jobs in CTPP
Regression (residence)

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Change of density</th>
<th>Change of Centrality</th>
<th>Change of proximity</th>
<th>Change of concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.94838</td>
<td>1.00701</td>
<td>1.00347**</td>
<td>0.99612**</td>
</tr>
<tr>
<td>IIF</td>
<td>0.0000018</td>
<td>0.0000010</td>
<td>-0.0000004</td>
<td>-0.0000250*</td>
</tr>
<tr>
<td>DIF</td>
<td>0.0000031</td>
<td>-0.0000023</td>
<td>-0.0000034</td>
<td>0.0000013</td>
</tr>
<tr>
<td>Change of population</td>
<td>0.38605***</td>
<td>0.01422</td>
<td>0.02658</td>
<td>-0.13415</td>
</tr>
<tr>
<td>Difference of population growth</td>
<td>-0.12704**</td>
<td>0.02064</td>
<td>0.01545</td>
<td>-0.07696</td>
</tr>
<tr>
<td>Change of AMI</td>
<td>0.46842**</td>
<td>-0.14987</td>
<td>-0.09384*</td>
<td>0.20897</td>
</tr>
<tr>
<td>Road expenditure</td>
<td>0.0000245</td>
<td>0.0000139</td>
<td>0.0000093*</td>
<td>-0.0000166</td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>0.56</td>
<td>-0.11</td>
<td>0.16</td>
<td>0.13</td>
</tr>
<tr>
<td>$F$ (p-value)</td>
<td>9.42(0.00)</td>
<td>0.32(0.92)</td>
<td>2.27(0.06)</td>
<td>1.95(0.1)</td>
</tr>
</tbody>
</table>

Note: significance level : * 10%, ** 5%, *** 1%
Result 1: impact fee ➔ urban form

Regression (employment)

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Change of density</th>
<th>Change of Centrality</th>
<th>Change of proximity</th>
<th>Change of concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.95553***</td>
<td>1.08369</td>
<td>0.99448</td>
<td>1.03952</td>
</tr>
<tr>
<td>IIF</td>
<td>-0.0000408***</td>
<td>-0.0000003</td>
<td>-0.0000013</td>
<td>-0.0000526***</td>
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<tr>
<td>DIF</td>
<td>0.0000124</td>
<td>0.0000114</td>
<td>0.0000004</td>
<td>0.0000048</td>
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<tr>
<td>Change of population</td>
<td>-0.16913</td>
<td>0.02217</td>
<td>-0.00398</td>
<td>-0.01966</td>
</tr>
<tr>
<td>Change of employment</td>
<td>0.66679***</td>
<td>-0.27398***</td>
<td>-0.05668**</td>
<td>0.2853*</td>
</tr>
<tr>
<td>Change of AMI</td>
<td>0.58646**</td>
<td>-0.43026</td>
<td>0.0178</td>
<td>0.12795</td>
</tr>
<tr>
<td>Road expenditure</td>
<td>-0.0000204</td>
<td>-0.0000031</td>
<td>0.0000075</td>
<td>0.0000115</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.6972</td>
<td>0.2844</td>
<td>0.0946</td>
<td>0.107</td>
</tr>
<tr>
<td>F (p-value)</td>
<td>13.67(0.00)</td>
<td>3.19(0.02)</td>
<td>1.57(0.2)</td>
<td>1.66(0.17)</td>
</tr>
</tbody>
</table>

Note: significance level : * 10%, ** 5%, *** 1%
Result 2: impact fee → congestion (residence)

Seemingly unrelated regression (SUR)

<table>
<thead>
<tr>
<th>Dependent</th>
<th>RCI06</th>
<th>TTI06</th>
<th>delaypc06</th>
<th>costpc06</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.10703</td>
<td>0.228311</td>
<td>-27.6564</td>
<td>-733.685</td>
</tr>
<tr>
<td>Congestion 00 (RCI,TTI,Delay,Cost)</td>
<td>0.680813***</td>
<td>0.597746***</td>
<td>0.586816***</td>
<td>0.742314***</td>
</tr>
<tr>
<td>TIFC</td>
<td>0.000104</td>
<td>0.000132</td>
<td>0.006707</td>
<td>0.165436</td>
</tr>
<tr>
<td>IIF</td>
<td>-0.00006*</td>
<td>-0.00002</td>
<td>-0.00239**</td>
<td>-0.05937*</td>
</tr>
<tr>
<td>DIF</td>
<td>2.205E-06</td>
<td>-0.00002</td>
<td>0.000776</td>
<td>0.019267</td>
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<tr>
<td>Change of housing density</td>
<td>0.44731</td>
<td>0.240275</td>
<td>33.90135***</td>
<td>904.34***</td>
</tr>
<tr>
<td>Transit expenditure</td>
<td>0.00028**</td>
<td>0.000212***</td>
<td>0.004861</td>
<td>0.119396</td>
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<tr>
<td>Change of vehicle</td>
<td>0.309043*</td>
<td>0.168152*</td>
<td>-7.63325</td>
<td>-228.11</td>
</tr>
<tr>
<td>Change of population</td>
<td>-0.02732</td>
<td>-0.12269</td>
<td>-19.5028</td>
<td>-552.392**</td>
</tr>
<tr>
<td>Weighted r-square</td>
<td>0.65</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: significance level: * 10%, ** 5%, *** 1%
## Summary of Results (SUR)

<table>
<thead>
<tr>
<th></th>
<th>RCI</th>
<th>TTI</th>
<th>Delay</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IIF</strong></td>
<td>-*</td>
<td>-</td>
<td>-*</td>
<td>-*</td>
</tr>
<tr>
<td><strong>DIF</strong></td>
<td>+</td>
<td>+</td>
<td>+*</td>
<td>+*</td>
</tr>
<tr>
<td><strong>TIFC</strong></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Change of density (res)</td>
<td>+</td>
<td>+</td>
<td>+*</td>
<td>+*</td>
</tr>
<tr>
<td>Change of centrality (res)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Change of proximity (res)</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Change of concentration (res)</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Change of density (emp)</td>
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<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td>Change of centrality (emp)</td>
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<tr>
<td>Change of proximity (emp)</td>
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<tr>
<td>Change of concentration (emp)</td>
<td>-*</td>
<td>-*</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Findings

- Impact fees decrease housing concentration, job density and concentration
  - “Buying out” of level of service (Downs, 2003)
- No “Growth Management” Effect through urban form
- Compact urban form (residential density) may increase congestion
  - Increase in demand for road on condition of fixed supply
- IIF decreases congestion, but DIF increases congestion
  - high total impact fee may disincentivize new development
    - less new development ➔ decrease of congestion
- No impacts of TCIF: no “Revenue Effect”.
  - TIFC increases congestion, but not significant
  - Expenditure of road impact fee: local road
  - Insufficient amount of transportation impact fee compared to actual road infrastructure cost.
Implications & Suggestions
Implications and Suggestions

- To mitigate congestion, it is necessary to define the amount of impact fee based on the actual infrastructure cost.
- To improve effectiveness of impact fee, inter-governmental coordination and collaboration might be important.

Future Study

- Observation: county → MSA
- Longitudinal or panel analysis
- Development location and type
- Congestion: highway, arterials + local
Thank you.
Questions?