OVERVIEW

- Urban heat island and landscape
- Challenges of valuing environmental / ecosystem services
- Abbott and Klaiber (2011) solution: utilizing within and between-neighborhood/time information to its full extent
- Implications for water policy
Green landscaping associated with large water use in arid environments like Phoenix
- Provides numerous benefits: aesthetics, recreation, reductions in temperature

Transformation of natural landscape to concrete and heat absorbing materials increases heat retention
- For arid, warm climates these increase electric and water usage as well as reducing "comfort"

Policymakers concerned with long-run availability of cheap water need information on the valuations of these competing effects
- Nearly 75% of water use in Phoenix occurs outdoors!
GREEN LANDSCAPE

- Both parcel and neighborhood amenity flows are likely
- Correlated with spatial unobservables

- Obtained from remote sensing satellite imagery

URBAN HEAT ISLAND – PHOENIX TEMPERATURES

- Challenges:
  - Difficult to measure
  - Fluctuate annually
  - Correlated with density, development, landscape

- Measurement:
  - PRISM data to obtain block group temperature
  - Focus on July minimum

- Temperature ranges:
  - 73.068588 - 75.470001
  - 75.470002 - 76.859604
  - 76.859605 - 77.818100
  - 77.818101 - 79.004921
  - 79.004922 - 83.335999
HEDONIC PRICE REVIEW

- Homebuyers (or renters) view houses as “bundles” of desired characteristics and select a home to maximize their welfare given the constraints they face.
- If markets are reasonably competitive and in equilibrium then:
  - Willingness to pay of homeowners for a small change in an amenity can be recovered
- Environmental amenities can be viewed as capital assets yielding multiple flows of services
SPATIAL SCALE AND NON-MARKET SERVICES

- Services propagate over a range of spatial scales due to
  - Natural/physical conditions
  - Human perceptions
  - Institutional structure
- Some services are linked through physical processes, but vary over different spatial scales
  - E.g. Green landscaping and temperature
- **Big problem**: unobserved spatial variables are likely highly correlated with (dis)amenities of interest → Fixed Effects

SPATIAL FE APPROACHES

- **BUT**, FE estimation makes strong assumptions on the *scale(s) of amenity capitalization* relative to the *scale of variation*
  - If spatial effects are broader than the maximum extent of capitalization → traditional omitted variable bias.
  - If spatial effects are subsumed by maximum extent of capitalization → bias from recovery of partial effect or inability to detect an effect at all!
**THE HAUSMAN-TAYLOR ESTIMATOR (1981)**

- Define a “panel” as repeated transactions in a spatial (block group) and year combination (jt)
- Partition regressors:
  - Varying within panel (exogenous, endogenous) “fine” variables
  - Constant within panel (exogenous, endogenous) “coarse” variables
- Identify all “fine” variables using “within” variation.
- Identify *endogenous* coarse variables using exogenous “fine” variables as instruments
  - Exploit different scales of variation to use exogenous “fine” variables as essentially two different variables!

**DATA AND RESULTS**
Controlling for omitted variables and spatial scale
DATA

- 551,199 transactions between 1998 and 2004
  - Contain full suite of housing characteristics
  - Data on distances to CBD and highways, distances and proximity to parks, Census demographics
- 1,646 Census 2000 block groups
  - 10,021 panels with data
- Prices deflated by Case-Schiller and converted to annual rents

INSTRUMENTS

- Temperature is correlated with elevation and density – are these exogenous?
  - Form instruments using mean elevation, mean distance to subdivision open space, and mean subdivision open space adjacency

<table>
<thead>
<tr>
<th>Variable</th>
<th>Hausman Test for Exogeneity</th>
<th>Correlation w/ Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjacent subd. Open</td>
<td>0.3549</td>
<td>-0.1304</td>
</tr>
<tr>
<td>Subd open distance</td>
<td>0.145</td>
<td>0.266</td>
</tr>
<tr>
<td>Elevation</td>
<td>0.6295</td>
<td>-0.2789</td>
</tr>
<tr>
<td>Joint Test</td>
<td>0.326</td>
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</table>
HT RESULTS (SEMI-LOG)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>Std Err</th>
<th>z-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Within Panel Varying, Exogenous</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Adjacent subd. Open</td>
<td>0.0486</td>
<td>0.0035</td>
<td>13.9</td>
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<tr>
<td>Subd open distance</td>
<td>-0.0195</td>
<td>0.0083</td>
<td>-2.35</td>
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<tr>
<td>Elevation</td>
<td>0.1316</td>
<td>0.0212</td>
<td>6.2</td>
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<tr>
<td><strong>Within Panel Invariant, Endogenous</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature (block group)</td>
<td>-0.0360</td>
<td>0.0184</td>
<td>-1.96</td>
</tr>
<tr>
<td><strong>Within Panel varying, Endogenous</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Square footage</td>
<td>0.0505</td>
<td>0.0010</td>
<td>52.09</td>
</tr>
<tr>
<td>Lot acres</td>
<td>0.3453</td>
<td>0.0229</td>
<td>15.09</td>
</tr>
<tr>
<td># Rooms</td>
<td>-0.0156</td>
<td>0.0012</td>
<td>-13.58</td>
</tr>
<tr>
<td># stories</td>
<td>-0.0744</td>
<td>0.0034</td>
<td>-22.18</td>
</tr>
<tr>
<td># bathrooms</td>
<td>0.0465</td>
<td>0.0024</td>
<td>19.59</td>
</tr>
<tr>
<td>Age</td>
<td>-0.0093</td>
<td>0.0004</td>
<td>-25.62</td>
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<tr>
<td>Garage</td>
<td>0.0540</td>
<td>0.0030</td>
<td>18.04</td>
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<tr>
<td>Pool</td>
<td>0.0472</td>
<td>0.0011</td>
<td>41.47</td>
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<td>Green landscaping (parcel)</td>
<td>0.0123</td>
<td>0.0014</td>
<td>8.86</td>
</tr>
<tr>
<td>Green landscaping (subdivision)</td>
<td>0.0832</td>
<td>0.0077</td>
<td>10.76</td>
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</table>

*Robust standard errors calculated using 200 non-parametric clustered bootstraps

**DISCUSSION**

- Using the monthly mean rental price of $1398
  - MWTP for reduction of 1 degree is $50
  - MWTP for green parcel landscaping is $17
  - MWTP for green neighborhood is $116
- Important for policymakers to know household valuations for landscape and heat mitigation to design effective water policies
  - Substantial premium associated with these likely limits the effectiveness of simple rate changes
  - Suggests non-price changes are required to alter behavior
COMMENTS?

- E-mail: klaiber.16@osu.edu
A Model

\[ P_{ijt} = \alpha_0 + \alpha_1 x_{ijt}^1 + \alpha_2 x_{ijt}^2 + \alpha_3 z_{jt}^1 + \alpha_4 z_{jt}^2 + \eta_{jt} + \epsilon_{ijt} \]

- X contains within-panel varying characteristics such as sqft, acreage, green lawns, pools, ...
  - Contains subdivision wide measures of green landscape
  - Many of these are likely confounded by omitted variables
- Z contains characteristics that do not vary within panels such as census demographics, distances, etc.
  - Also contains block group temperature
- \( \eta_{jt} \) are unobserved panel random effects
MODEL (CONTINUED)

- Define
  \[ \delta_{jt} = \eta_{jt} + \alpha_2 Z_{jt}^1 + \alpha_4 Z_{jt}^2 \]
  \[ p_{ijt} = \alpha_0 + \alpha_1 x_{ijt}^1 + \alpha_2 x_{ijt}^2 + \delta_{jt} + \epsilon_{ijt} \]

- Fixed effects estimation cannot identify the marginal effects of \( Z^1 \)
  - Random effects can but cannot address omitted variable bias

- Need an approach that preserves identification of broad scale effects and accounts for potential omitted variables bias
  - Hausman-Taylor estimator

THE HAUSMAN-TAYLOR EST. – STEPS

1. Define panels based on \( t, i, j \) dimensions
   \[ p_{ijt} = \alpha_0 + \alpha_1 x_{ijt}^1 + \alpha_2 x_{ijt}^2 + \alpha_3 Z_{jt}^1 + \alpha_4 Z_{jt}^2 + \eta_{jt} + \epsilon_{ijt} \]

2. Use within (fixed effects) estimator to recover consistent estimates of \( \alpha_0, \alpha_1, \alpha_2 \) and get consistent estimates of
   \[ \delta_{jt} = \eta_{jt} + \alpha_3 Z_{jt}^1 + \alpha_4 Z_{jt}^2 \]

3. Get first-stage consistent estimates of \( \alpha_3 \) and \( \alpha_4 \) by regressing these "within" residuals on \( Z_{jt}^1 \) and \( Z_{jt}^2 \).

4. Utilize the information in hand to estimate the variances of the error components and perform a GLS transformation on the regression.
STEPS – CONTINUED

\[ P_{it} = \alpha_0 \bar{y}_{it} + \alpha_1 \bar{y}_{it} + \alpha_2 \bar{y}_{it} + \alpha_3 \bar{y}_{it} + \alpha_4 \bar{y}_{it} + \bar{e}_{it} \]

Omitted variables are still in the transformed error term, but transformed to be homoskedastic and free of serial correlation.

5. Conduct an instrumental variables regression using the following instruments

\[ \bar{X}_{it}, \bar{X}_{it}, \bar{X}_{it}, \bar{X}_{it}, \bar{X}_{it} \]

- Use fixed effects estimation for all “fine” variables
- Use variation in the panel mean of exogenous fine characteristics as instruments for endogenous “coarse” variables