Challenges in Using PUMS to Generate Small Area Demographic Multipliers

Sidney Wong, Ph.D., Gabrielle Connor, Brooke Queenan & Alison Shott, Ph.D.

Community Data Analytics

ACS Data Users Conference
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Alexandria, VA
Introduction

• Demographic Multipliers
• Local Variations
• New Generation of Multipliers
• Sample Size Issues
• Challenges Ahead
• Q & A and Discussions
Demographic Multipliers

Definition, Examples, Housing and Household Specificity, and Estimation Steps
What is a Demographic Multiplier?

- An average ratio of various populations or demographic measures per household
- Cohort – age or grade groups
- Further differentiation – rent or value
- Common Examples:
  - Number of school-age children per household (SAC)
  - Average household size (AVHH)
Traditional Demographic Multipliers

Before 2006

• 1978 The Fiscal Impact Handbook
• 1985 The New Practitioner’s Guide to Fiscal Impact Analysis
• 1994 Development Impact: Assessment Handbook

2006

Both use 2000 Census-PUMS records

• Fannie Mae Series
  – 50 States & DC
  – AVHH, SAC, Public School-Age Children

• Who Lives in NJ Housing?
  – 3 sub-state regions & NJ
  – AVHH, SAC, Public School Children
  – More elaborate
Household Attributes & Housing Configurations

**Household Attributes:** Multipliers are specific to the sample drawn from PUMS:
- Households in recently built housing units
- Households living in specialized housing

**Housing Configurations** from Fannie Mae Series, derived from 2000 PUMS

<table>
<thead>
<tr>
<th>Bedroom</th>
<th>Single-Family Detached</th>
<th>Single-Family Attached</th>
<th>5+ Units Own</th>
<th>5+ Units Rent</th>
<th>2-4 Unit</th>
<th>Mobile</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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</tbody>
</table>

Each is subdivided into four housing value groups.

76 configurations, only large states have full coverage.
Multipliers and Impact Studies

• Critical to forecast added populations and school enrollment.
• Public finance: assess impact fees and costs to support public services and staffing.
• Proposed development projects, comprehensive planning, rezoning, annexation, etc. required impact studies.
• Various types of impact studies:
  – School
  – Fiscal
  – Economic
  – Traffic
  – Environmental
  – Political
  – Social
  – Cumulative
Steps to Generate Multipliers

1. Specifying Geography by PUMA
2. Merging PUMS Person and Housing Record
3. Selecting Relevant Variables
4. Eliminating non-Household Records
5. Selecting Records by Sample Characteristics
6. Creating Housing Configurations
Steps to Generate Multipliers

7. Applying Various Weights
8. Grouping Variables by Age or Grade Cohorts
9. Calculating Weighted Number of Households by Housing Configuration
10. Calculating the Weighted Sums of Each Variable
11. Computing per Household Figures
12. Listing Results by Housing Configurations
Variations across Geographies

Compare PUMA and State-level Multipliers
SAC Variations in Ohio PUMAs

3-Bedroom Single-Family Units, Owned and Rented Distribution of 93 PUMAs by SAC Value Groups

Source: Community Data Analytics, 2017

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Large Variations in Ohio SAC
2-Bedroom Multifamily Units, Owned and Rented

- 93 PUMAs in OH
- OH SAC: 0.276
- Highest SAC: 0.556
- Lowest SAC: 0.056
- Wide range of variations
- Variance ranges from -80% to 102%
- Median Variance: -6%

2015 Newly Moved-In Household Sample
Source: Community Data Analytics, 2017
SAC Variations in Other States

2-Bedroom Multifamily Units, Owned and Rented

District of Columbia and Maryland, 2014

New Jersey, 2015

Map for PUMAs available during Q & A.

Source: Community Data Analytics, 2016 & 2017

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# New Generation Demographic Multipliers

## Improvements and Specialized Samples

<table>
<thead>
<tr>
<th>TENURE</th>
<th>ALL OCCUPIED UNITS</th>
<th>ALL SINGLE-FAMILY</th>
<th>SINGLE-FAMILY DETACHED</th>
<th>ATTACHED</th>
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<tbody>
<tr>
<td>RENTER-OCUPIED</td>
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<thead>
<tr>
<th>STRUCTURE TYPE</th>
<th>ALL MULTI-FAMILY</th>
<th>OWNER AND RENTER OCCUPIED</th>
<th>OWNER-OCUPIED</th>
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New Generation of CDA Multipliers

- Using current 5 percent 5-year PUMS
- Local multipliers to minimize state average effects
- Alternative sample to ensure sample size
- Appropriate housing configurations
- Proxy sample for specialized housing or households
Specialized Samples

- Households living in condominiums
- Households who have retirees and no teenagers
- Low and moderate income households
- Households with transit commuters
- Double income without kid households
- Millennial households
- Other custom households or development types
Other Differentiations

• SAC is usually divided into age cohorts or proxy grade groups
• Public School Attendees by grade groups
• Multipliers can be specific to housing value or rent groups
• Significant sample size problem
• Unreliable confidence interval
Sample Size Issues

### Supplementary Sample

<table>
<thead>
<tr>
<th>TENURE</th>
<th>ALL OCCUPIED UNITS</th>
<th>OWNER-OCUPIED</th>
<th>RENTER-OCUPIED</th>
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<tbody>
<tr>
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<td>All</td>
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<td>1 bedroom or Studio</td>
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<table>
<thead>
<tr>
<th>SINGLE-FAMILY</th>
<th>ALL SINGLE-FAMILY DETACHED &amp; ATTACHED</th>
<th>DETACHED</th>
<th>ATTACHED</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>1 bedroom or Studio</td>
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Sample Size Issues

- The sample size of the traditional recently built unit sample is a function of recent housing construction.
- Highly differentiated housing configurations lacks sufficient sample size even at the state level.
- Same problem for specialized samples.
Newly Moved-in Households

- Households recently moved in a unit, regardless of whether it is recently built.
- Likely occupants of the development – potential movers.
- Sample size 3 to 7 times larger than the traditional recently built unit sample.
- Sample size less affected by housing activities.
- It provides reliable multipliers for most common housing configurations at the aggregate PUMA level.
- It reflects long term effects.
Comparing 2 Samples

AVHH Scatterplot, 0 to 4 Bedroom Units

New Jersey

Pearson R = 0.988
N = 72

Pennsylvania

Pearson R = 0.973
N = 72

Source: Community Data Analytics, 2017 based on 2010-2014 5-Year ACS-PUMS
Not 100 Percent Match

- High degree of correlation at the state level, but ....
- T-test results comparing AVHH and SAC vary.
- Is the Newly Moved-In Household sample a reasonable alternative or just a complement?
## Weighted and Unweighted Observations

Should 600 weighted households be the cut-off?

<table>
<thead>
<tr>
<th>Selected Samples</th>
<th>Unweighted Households</th>
<th>Weighted / Unweighted Ratio Minimum</th>
<th>Weighted / Unweighted Ratio Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recently Built Unit Sample</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Maryland, 4-B or less</td>
<td>2000</td>
<td>4 up</td>
<td>17.6</td>
</tr>
<tr>
<td>Configurations</td>
<td>2014</td>
<td>6 up</td>
<td>14.9</td>
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<tr>
<td><strong>Newly Moved-In Household Sample</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Maryland, 4-B or less</td>
<td>2000</td>
<td>36 up</td>
<td>17.8</td>
</tr>
<tr>
<td>Configurations</td>
<td>2014</td>
<td>44 up</td>
<td>15.7</td>
</tr>
<tr>
<td>Ohio, 4-B or less</td>
<td>2015</td>
<td>120 up</td>
<td>16.0</td>
</tr>
<tr>
<td><strong>2015 Ohio 93 PUMAs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-B Single Family</td>
<td></td>
<td>88 to 359</td>
<td>13.6</td>
</tr>
<tr>
<td>2-B all Multifamily</td>
<td></td>
<td>37 to 313</td>
<td>16.7</td>
</tr>
<tr>
<td>2-B Townhome</td>
<td></td>
<td>4 to 78</td>
<td>8.2</td>
</tr>
<tr>
<td>2-B MF 5+ unit, rented</td>
<td></td>
<td>11 to 168</td>
<td>18.4</td>
</tr>
</tbody>
</table>
Housing Configurations

- Should 30 or 50 unweighted observation as a cut off?
- Insufficient sample size for highly differentiated configuration cannot be resolved?
- The affinity principle
  - Same configuration but from respective region
  - Same geography but broader or blended configuration
Challenges Ahead

Approximation of Missing Data, Statistical Constructs

<table>
<thead>
<tr>
<th>TENURE</th>
<th>ALL OCCUPIED</th>
<th>RENTER-OWNED</th>
<th>RENTER-RENTED</th>
</tr>
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<tbody>
<tr>
<td>ALL OCCUPIED</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>RENTER-OWNED</td>
<td></td>
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<tr>
<td>OWNER-OWNED</td>
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</tbody>
</table>

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Information from the Region for Approximation?

Applying a ratio from the reference region.

### School-Age Children

<table>
<thead>
<tr>
<th>Region Description</th>
<th>Region Ratio</th>
<th>Region Ratio %</th>
<th>PUMA Original</th>
<th>PUMA Adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-Bedroom Multifamily</td>
<td>0.98</td>
<td>100.00%</td>
<td>0.87</td>
<td>0.87</td>
</tr>
<tr>
<td>3-B Multifamily 2-4 Unit</td>
<td>1.02</td>
<td>104.08%</td>
<td>-</td>
<td>0.906</td>
</tr>
<tr>
<td>3-B Multifamily 2-4 Unit Rented</td>
<td>1.16</td>
<td>118.36%</td>
<td>-</td>
<td>1.030</td>
</tr>
</tbody>
</table>
Statistical Construct for Municipality

- Municipal boundaries vs PUMA geography
- Can we pull PUMS records to create a statistical construct that carries selected attributes of a target municipality?
- Feasibility of developing a multivariate model with a series of dummies?
### Previous Work

#### What is a Demographic Multiplier and Why Does it Matter?

**Sidney Wong, Ph.D.**  
Senior Advisor, Econsult Solutions Inc.  
Updated March 2017, original in November 2016

Recently, the CDA team got the opportunity to present at two American Planning Association (APA) Chapter conferences on fiscal impact analysis and data needs in forecasting development impacts. During and after our sessions we received a lot of questions focused on the technical nature regarding demographic multipliers, data sources, applications, and statistical issues. While I have touched on this subject in a previous post and in a recent APA article, I am happy to further expand on CDA’s research in demographic multipliers and efforts in updating and expanding the old series based on the 2000 Census records.

#### American Community Survey (ACS)

An ongoing survey taken each year by the Census Bureau. It provides 1-year, 3-year, and 5-year estimates of demographic, housing, social, and economic information.

- **Bedroom:** The room in a housing unit designed to be used as a bedroom; a one-room unit such as studio, efficiency, or in-law apartment is considered as having no bedroom.
- **Condominium Sample:** A sample

#### CDA Glossary

- **2-4 Unit:** A housing unit in a structure containing 2, 3, or 4 units.
- **5+ Units:** A housing unit in a structure containing 5 or more units.
- **55+ Household Sample:** Part of the Newly Moved in Household Sample limited to households with at least one member aged 55 and over and the absence of persons below 19 and K to 12th grade students.
- **Condominium Sample:** A sample

---

**Challenges in Using PUMS to Generate Small Area Demographic Multipliers**

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Research of Community Data Analytics Team


If you are interested, please leave your contact information.
Questions
Advice Sought

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