Community Impacts of Decision Modeling for Foreclosed Redevelopment

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COMMUNITY IMPACTS OF DECISION MODELING FOR FORECLOSED REDEVELOPMENT

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Introduction

- Research goal: Apply decision modeling to assist community-based organizations engaged in foreclosure response
- Purpose of talk: Generate range of alternative residential property acquisition strategies based on policy impact metrics and demonstrate social benefits of decision-assisted foreclosure response as compared to current practice
- Current project:
  - *Decision Science for Housing and Community Development: Local Evidence-Based Responses to Foreclosures* (with Jeffrey Keisler, Senay Solak, David Turcotte, Armagan Bayram and Rachel Drew)
POLICY, PLANNING AND ANALYTICS PRELIMINARIES
The foreclosed housing crisis is a primary cause of community distress

Aggregate effects:
- Over 4 million homes lost to foreclosure
- 30% decline in house prices
- $7 trillion in home equity lost

Socio-geographic concentrations:
- High-priced areas that overbuilt
- Economically struggling cities with high rates of subprime lending
- Lower-income and minority households

Social and economic consequences of foreclosures:
- Residential stability
- Personal well-being
- Spill-over effects

(Sources: Joint Center for Housing Studies 2013; Immergluck 2010; McKernan et al. 2014)
Many regions also face long-term social and economic decline

• Symptoms:
  - 30 cities with 500,000 or more residents have lost 8.61% of their populations on average
  - Number of vacant housing units has increased by 44%
  - Eight cities facing population declines have incurred $23 billion in debt before declaring bankruptcy

• Causes:
  - Urban deindustrialization
  - Federal policy supporting out-migration to suburbs
  - Foreclosed housing crisis and the Great Recession

• Traditional remedies:
  - Investments in housing, employment and physical infrastructure

(Sources: Popper and Popper 2002, Hollander et al. 2009)
In working housing markets, consider a range of conventional responses

Which responses may be most appropriate for which neighborhoods at which times?

What is an optimal strategy associated with a particular response?

Source: foreclosure-response.org (2013a)
If markets are weak, consider alternative land uses

Which options are most appropriate for which parcels at what time? How to balance multiple objectives?

Source: Baltimore City Department of Planning (2012)
‘Data analytics’ can help design innovative responses

• Purpose of analytics is to derive knowledge and actionable insights from data

• Analytic tools are applied to datasets to determine
  • What has happened (descriptive analytics)
  • What is likely to happen (predictive analytics)
  • What course of action to follow (prescriptive analytics)

• Community-focused data analytics is different from applications to large and/or for-profit organizations
  • Values-driven
  • Collaborative
  • Inductive
  • Multi- and mixed-methods
  • Appropriate use of resources and capacity

(Source: Johnson 2014)
Multiple types of data and technologies can meet community organization needs

- Visualization-based technologies
- Database-driven technologies
- Model-driven technologies

Source: Johnson (2012)

Source: http://www.policymap.com/
DATA ANALYTICS FOR FORECLOSURE RESPONSE
Example: Foreclosure responses depend on the level of foreclosure risk and housing market strength

<table>
<thead>
<tr>
<th>MARKET STRENGTH</th>
<th>FORECLOSURE IMPACT RISK</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C. Actual high foreclosure density</td>
</tr>
<tr>
<td>1. Strong</td>
<td>Facilitate rapid sales to sustainable owners, low/no subsidy</td>
</tr>
<tr>
<td>2. Intermediate</td>
<td>High payoff/priority, rehab and rapid sale to sustainable owners, target subsidies, neighborhood maintenance</td>
</tr>
<tr>
<td>3. Weak</td>
<td>More emphasis on securing/demolishing, land banking to hold until market rebound</td>
</tr>
</tbody>
</table>

Which neighborhoods should receive what kinds of services?

Source: foreclosure-response.org (2013b)
Census tracts can be classified according to foreclosure risk and housing market strength

<table>
<thead>
<tr>
<th>Market Strength</th>
<th>Foreclosure Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
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<tr>
<td>9</td>
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<td>8</td>
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<td>7</td>
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<td>5</td>
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<td>15</td>
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<td>2</td>
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</tr>
<tr>
<td>1</td>
<td>41</td>
</tr>
</tbody>
</table>

How can we analyze data for specific cities or neighborhoods?

Source: foreclosure-response.org (2014c)
We can scan on-line maps to view neighborhoods one variable at a time…

Source: http://www.foreclosure-response.org/maps_and_data/lisc_maps.html
Or we can develop city-level tabulations to identify concentrations of risk

<table>
<thead>
<tr>
<th>Boston, MA</th>
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<th>0</th>
<th>1</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>1</th>
<th>4</th>
<th>2</th>
<th>22</th>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>3</td>
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<td>12</td>
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<tr>
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<td>10</td>
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<table>
<thead>
<tr>
<th></th>
<th>Highest</th>
<th>Lowest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreclosure Risk</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Source: Data from foreclosure-response.org (2014c); authors’ calculations |

But where are these tracts actually located?
Foreclosure risk and housing market strength are clearly concentrated in specific portions of Boston…

Source: Data from foreclosure-response.org (2014c); created using ArcGIS 10 (ESRI, Inc. 2011)
Now we can decide what kinds of responses may be best-suited for specific geographies, and justify our decisions with data.

Source: Data from foreclosure-response.org (2014c); created using ArcGIS 10 (ESRI, Inc. 2011)
We have used data analytics to identify specific interventions at a local level.

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Challenge now is to translate qualitative descriptions into specific prescriptions.
Foreclosure response decision model optimizes two social objectives

**Index:**

\[ i = 1, \ldots, N: \text{index of candidate properties for acquisition} \]

**Decision variables:**

\[ x_i = \begin{cases} 1, & \text{if foreclosed property } i \text{ is acquired for redevelopment} \\ 0, & \text{otherwise} \end{cases} \]

**Parameters:**

- \( S_i \): Estimated strategic value associated with acquisition candidate \( i \)
- \( P_i \): Estimated social value associated with acquisition candidate \( i \)
- \( C_i \): Estimated acquisition cost of acquisition candidate \( i \)
- \( B \): total funds available for purchase of acquisition candidates
- \( N \): total number of units to be acquired
We solve two model variants corresponding to CDC practice

\[ \text{Optimize } \{ S(x) = \sum_{i=1}^{n} S_i \cdot x_i; P(x) = \sum_{i=1}^{n} P_i \cdot x_i \} \]

s.t.

\[ \sum_{i=1}^{n} C_i \cdot x_i \leq B \]

\[ \sum_{i=1}^{n} x_i = N \]

\[ x_i \in \{0, 1\}, i = 1, \ldots, n \]

Jointly optimize social objectives

Limit expenditures to budget available

- or -

Acquire only a given number of properties
Model results can be viewed in ‘objective space’ as well as ‘decision space’

Source: Johnson et al. (2014)
DATA ANALYTICS FOR MUNICIPAL SHRINKAGE
Example: Select parcels in declining neighborhoods for re-purposing

<table>
<thead>
<tr>
<th>Land Use or Planning Classification</th>
<th>Metrics</th>
</tr>
</thead>
</table>
| Urban Agriculture                   | • 0.5 acre or greater  
  • Slope < 5%  
  • Tree cover cannot exceed 30% of cluster area |
| Stormwater Drainage                | • 1/8 acre or greater  
  • Slope < 5%  
  • Within 20’ of a stormdrain |
| Potential development opportunity  | • Housing Market Typology (1/4 mile from ‘Regional Choice’ or ‘Middle Market Choice’)  
  • (¼ mile from anchor institutions  
  OR  
  • ¼ mile from minimum of 2 building permits plan) |
| Blight Elimination                 | • >50 % vacant  
  • Distressed HMT  
  • Public Safety ‘hot spots’  
  • High visibility blighted areas:  
    1. Primary street  
    2. Adjacent to public destination |

Source: Johnson and Hollander (2013)
Clusters qualify for a variety of uses

<table>
<thead>
<tr>
<th>Cluster Code</th>
<th>Location</th>
<th>Use/Classification</th>
<th>Number of Clusters that Qualify</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2_1</td>
<td>City Hall</td>
<td>Urban Agriculture</td>
<td>10</td>
</tr>
<tr>
<td>4.3_1</td>
<td>Polk St</td>
<td>Stormwater Drainage</td>
<td>38</td>
</tr>
<tr>
<td>9.1_1</td>
<td>Washington Blvd</td>
<td>Potential Development</td>
<td>23</td>
</tr>
<tr>
<td>2.3_1</td>
<td>Blight</td>
<td>Blight Elimination</td>
<td>7</td>
</tr>
</tbody>
</table>

Total clusters (combined): 118

Source: Johnson and Hollander (2013)
Eligibility sets vary over space

Source: Johnson and Hollander (2013)
Clusters vary widely by size and cost

Source: Johnson and Hollander (2013)
Baltimore Planning decision model is a stylized attempt to generate strategy alternatives

Index and set:
\[ i = 1, \ldots, N: \text{index of clusters} \]
\[ j \in \{U, S, D, B\}: \text{set of land uses & classification} \]

Decision variables:
\[ x_{ij} = \begin{cases} 1, & \text{if cluster } i \text{ is acquired for land use or classification } j \\ 0, & \text{otherwise} \end{cases} \]

Parameters:
\[ a_i = \text{size of cluster } i, \text{ in acres} \]
\[ c_i = \text{acquisition and demolition cost for cluster } i \]
\[ B = \text{acquisition and demolition budget} \]
The model assigns land uses to clusters to optimize multiple planning objectives

\[
\text{Maximize } \{U(x) = \sum_{i=1}^{N} a_i \cdot x_{iU}, S(x) = \sum_{i=1}^{N} a_i \cdot x_{iS}, \\
D(x) = \sum_{i=1}^{N} a_i \cdot x_{iD}, B(x) = \sum_{i=1}^{N} a_i \cdot x_{iB}\}
\]

s.t.

\[
\sum_{i=1}^{N} \sum_{j \in J} c_{ij} \cdot x_{ij} \leq B
\]

\[
\sum_{j \in \{US,D\}} x_{ij} \leq 1, \ i = 1, \ldots, N
\]

\[
x_{iB} \leq \sum_{j \in \{US,D\}} x_{ij}, \ i = 1, \ldots, N
\]

\[
x_{ij} \in \{0, 1\} \forall i, j
\]

- Jointly maximize land area devoted to specific uses
- Budget
- Single land use
- Cannot assign to classification category unless selected for land use
Objective-space results demonstrate wide variance in objective values across problem instances

Source: Johnson and Hollander (2013)
Decision-space results show variation in acquisition and re-purposing decisions
Conclusion

Creative data analytics involves multiple methods and technologies

• Geographic information systems
• Database analysis
• Decision science

…and multiple data types

• Qualitative data, from stakeholder engagement
• Quantitative data, from administrative datasets

...to generate a range of policy alternatives that consider

• Multiple competing objectives and resource constraints
• Practitioner expertise

Best use of these methods may fulfill the promise of community development that is “integrated, broadly collaborative, data-driven, and focused on what works, and entrepreneurial” (Seidman 2012)
Thanks!

Foreclosed housing project book (under development):
http://works.bepress.com/michael_johnson/58

Foreclosed housing project description:
http://umb.libguides.com/foreclosed_housing
Resources


