Estimating Strategic Impacts Of Foreclosed Housing Redevelopment Using Spatial Analysis

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Estimating Strategic Impacts of Foreclosed Housing Redevelopment

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Motivation

Foreclosed housing crisis in U.S. and Great Recession has had severe impacts on individuals and housing markets:

- 2.0 million homeowners are severely delinquent on mortgage payments and 2.2 million are in the foreclosure process
- 11.1 million homeowners have negative equity; real equity is $6.3 trillion, down from $14.9 trillion in 2006 and less than $10.1 trillion in mortgage debt
- Case-Schiller index of home prices in 18 of 20 large metropolitan areas have decreased over 2010; prices overall are at 2003 levels
- 19.4 million households pay more than half of their income for housing
  (Joint Center for Housing Research 2011)

Federal government has spent over $11 billion in foreclosure-related programs:

- Neighborhood Stabilization Program
- American Recovery and Reinvestment Act
- Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010

But progress, measured by number of homeowners with permanently-modified loans, or number of foreclosed properties acquired and redeveloped, has fallen short of expectations
Role of community-based organizations

CBOs lead local responses to foreclosure crisis and are essential to neighborhood stabilization and revitalization:

- Homebuyer education
- Foreclosure counseling
- Renter advocacy
- Family support
- Housing and economic development
- Community planning

Mission-driven CBOs have significant experience and expertise, but often lack commensurate technical resources to generate maximum impact.
Decision modeling opportunities

Researchers have focused on foreclosed housing and acquisition by community-based organizations

- Values elicitation to identify goals, objectives, attributes and decision opportunities
- Short-term bidding policy design for foreclosed housing acquisition opportunities
- Long-term investment strategies across neighborhoods, housing types and time periods
Research questions

- What characteristics of foreclosed housing are salient to the problem of community-based foreclosed housing acquisition and redevelopment?
- How can such characteristics be quantified?
- How can they be used in decision models?
Social impacts of housing foreclosures

- **Families:**
  - Financial insecurity and economic hardship
  - Personal and family stress, disruption and ill health

- **Communities:**
  - Property values, vacancies, prices and rents
  - Disorder, crime and violence
  - Public sector costs and fiscal health

- **Data to estimate many of these impacts are limited**
  (Kingsley, Smith and Price 2009)
Aspects of foreclosed housing relevant to CBOs

- **Social value**
  - Impacts upon community distress measures associated with foreclosed housing
    - Criminal offending
    - Blight
    - Property values

- **Strategic value**
  - Ability of redevelopment projects to further CBO goals
    - Proximity to neighborhood amenities and disamenities
    - Support for economic redevelopment

- **Development value**
  - Ability of project success
    - Acquisition and redevelopment costs
    - Likelihood of successful acquisition
Foreclosed housing attributes for decision modeling

We identify and measure attributes known to be important to CBOs:

- **Property values**
  - What is the expected foregone loss in property values associated with successful acquisition and redevelopment of certain foreclosed housing units?

- **Strategic values**
  - What location-based measures of foreclosed properties embody a CBO’s strategic goals and resident preferences?

If these measures vary across candidate properties and are not highly correlated, then they are candidates for inclusion in multi-criteria decision models.
Research results for foreclosed housing attributes

- **Property values:**

- **Strategic values:**

- **Entire project:**

**Focus for this presentation is strategic values**
Strategic value analysis

How can we represent the value of a foreclosed acquisition opportunity with respect to a CDC’s mission?

- Unit characteristics
- Proximity to local amenities and disamenities

Antecedents:

- Implicit markets for housing attributes (Rosen 1974)
- Hedonic price functions (Bartik and Smith 1987)
- Household utility maximization as a function of housing attributes (Sheppard 1999)
- ‘Push’ and ‘pull’ factors in hedonic models (Li and Brown 1980)

Limited research on housing and neighborhood amenities influence housing acquisition and redevelopment decisions of CDCs
What are amenities and disamenities?

- **Amenities:**
  - Schools, parks, cultural venues, full-service grocery stores, other CDC-developed housing, transit stops, ‘strategic corridors’

- **Disamenities:**
  - Crime ‘hot spots’, vacant lots, distressed housing, excessively busy intersections

Notions of amenities and disamenities that are believed to influence strategic value of properties may vary widely
A theory of strategic value for foreclosed housing acquisition

Assumptions:

- Proximity to amenities and disamenities within a given neighborhood are the only relevant considerations
- Amenities and disamenities can be grouped into discrete categories (e.g. ‘schools’, ‘crime locations’)
- Decisionmaker has defined preferences for categories of amenities and disamenities
- Decisionmaker has defined preferences for amenities (overall) as compared to disamenities

Strategic value of a given property is a function of:

- Aggregate value of property with respect to all local amenities
- Aggregate value of property with respect to all local disamenities
Strategic value functions

Definitions and Sets

- **Amenities**
  
  $j = \text{index of amenities}; \ j = 1, 2, \ldots, J$
  
  $l = \text{index of class of amenities}; \ l = 1, 2, \ldots, L$
  
  $w_l = \text{weight or priority assigned to amenity class } l$
  
  $d_{ij}^l = \text{distance between property } i \text{ and amenity } j \text{ in class } l$

- **Disamenities**
  
  $k = \text{index of disamenities}; \ k = 1, 2, \ldots, K$
  
  $p = \text{index of class of disamenities}; \ p = 1, 2, \ldots, P$
  
  $w_p = \text{weight or priority assigned to disamenity class } p$
  
  $d_{ik}^p = \text{distance between property } i \text{ and disamenity } k \text{ in class } p$. 
Strategic value functions

\[ A_i^l = \text{aggregate value of property } i \text{ with respect to all local amenities in class } l \]
\[ \equiv g(\{w_i\}, \{d_{ij}^l\}) \]

\[ D_{p_i} = \text{aggregate value of property } i \text{ with respect to all local disamenities in class } p \]
\[ \equiv h(\{w_p\}, \{d_{ik}^p\}) \]

\[ S_i = \text{strategic value associated with candidate property } i, \text{ accounting for all local amenities and disamenities} \]
\[ = f(\{A_i^l\}, \{D_{p_i}\}) \]
Strategic value functions

Suppose that there are two competing ‘frames’ through which amenities and disamenities may be viewed:

- *Individual residents*, who may care only about the closest amenity, or disamenity
- *CBOs*, which may care most about cumulative impact of amenities and disamenities on neighborhood revitalization efforts
Alternative functional forms

- Individual resident frame:
  \[ A^l_i = \text{value to property } i \text{ of all nearby amenities } j \text{ in class } l \]
  \[ = \frac{1}{\min \{ d^l_{ij} \}} \]
  \[ D^p_i = \text{value to property } i \text{ of all nearby disamenities } k \text{ in class } p \]
  \[ = \min \{ d^p_{ik} \} \]

- CBO frame:
  \[ A^l_i = \text{value to property } i \text{ of all nearby amenities } j \text{ in class } l \]
  \[ = \frac{1}{\sum_{j=1}^{l} \frac{1}{(d^l_{ij})^2}} \]
  \[ D^p_i = \text{value to property } i \text{ of all nearby disamenities } k \text{ in class } p \]
  \[ = \frac{1}{\sum_{j=1}^{l} \frac{1}{(d^p_{ik})^2}} \]
Aggregating class-level measures

- We use linear additive measures to aggregate class-level measures for the individual and CBO frames:

\[ A_i = \sum_{l=1}^{L} w_l \cdot A_i^l \]

\[ D_i = \sum_{p=1}^{P} w_p \cdot D_i^p \]

\[ S_i = w_a \cdot A_i + w_d \cdot D_i \]
Case Study: Chelsea, MA

- Between 2009 – 2010, we collaborated with a local CDC to understand foreclosed housing development processes, gather data and refine our decision models.
- We apply the SVI model to 35 foreclosed residential properties as of October 2009.
Amenities and disamenities are distributed widely
Researchers’ and CBO’s views of amenities and disamenities differ

Table 3
Description of features (amenities and disamenities) identified.

<table>
<thead>
<tr>
<th>Feature type</th>
<th>Number of proximate locations</th>
<th>Source of data</th>
<th>Relevant to CDC?</th>
<th>Criteria for inclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amenities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schools</td>
<td>5</td>
<td>Mass GIS</td>
<td>No</td>
<td>Any school in or within 500 m of the CDC service area</td>
</tr>
<tr>
<td>Bus stops</td>
<td>27</td>
<td>Mass GIS</td>
<td>No</td>
<td>Any bus stop in or within 500 m of the CDC service area</td>
</tr>
<tr>
<td>Parks &amp; open space</td>
<td>3</td>
<td>Mass GIS</td>
<td>No</td>
<td>Any recreational space in or within 500 m of the CDC service area</td>
</tr>
<tr>
<td>CDC-owned properties</td>
<td>28</td>
<td>CDC</td>
<td>Yes</td>
<td>All properties owned by CDC as of 2011 EXCEPT foreclosure acquisitions after October 2009</td>
</tr>
<tr>
<td>Police stations</td>
<td>1</td>
<td>Mass GIS</td>
<td>No</td>
<td>Police stations in or within 500 m of the CDC service area</td>
</tr>
<tr>
<td>City hall</td>
<td>1</td>
<td>Mass GIS</td>
<td>No</td>
<td>City hall</td>
</tr>
<tr>
<td>CDC-identified strategic corridors</td>
<td>4</td>
<td>CDC</td>
<td>Yes</td>
<td>Identified by the CDC in 2009</td>
</tr>
<tr>
<td>Libraries</td>
<td>1</td>
<td>Mass GIS</td>
<td>No</td>
<td>Public library branches in or within 500 m of the CDC service area</td>
</tr>
<tr>
<td>Disamenities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other foreclosed properties</td>
<td>33</td>
<td>CDC</td>
<td>Yes</td>
<td>Properties in the CDC service in foreclosure as of October 2009</td>
</tr>
<tr>
<td>Crime locations</td>
<td>7</td>
<td>CDC</td>
<td>Yes</td>
<td>Identified by CDC in May 2010</td>
</tr>
</tbody>
</table>

Table 4
Amenity and disamenity weight specifications.

<table>
<thead>
<tr>
<th>Feature set</th>
<th>All features</th>
<th>CDC-identified features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base case weights</td>
<td>• $w_A = 0.6; w_D = 0.4$</td>
<td>• $w_A = 1; w_D = 0$</td>
</tr>
<tr>
<td></td>
<td>• $w_I = 0.208$ (schools, bus stops, parks, CDC-owned properties)</td>
<td>• $w_I = 0.278$ (CDC-owned properties, other foreclosed properties, strategic corridors)</td>
</tr>
<tr>
<td></td>
<td>• $w_L = 0.042$ (police department, city hall, library, strategic corridors)</td>
<td>• $w_L = 0.167$ (crime locations)</td>
</tr>
<tr>
<td></td>
<td>• $w_k = 0.5$ (other foreclosed properties, crime locations)</td>
<td>• $w_k = 1; w_D = 0$</td>
</tr>
<tr>
<td>Alternative weights</td>
<td>• $w_A = 0.2; w_D = 0.8$</td>
<td>• $w_A = 1; w_D = 0$</td>
</tr>
<tr>
<td></td>
<td>• $w_I = 0.05$ (schools, bus stops, police department, city hall, library, parks, strategic corridors)</td>
<td>• $w_I = 0.7$ (CDC-owned properties)</td>
</tr>
<tr>
<td></td>
<td>• $w_L = 0.65$ (CDC-owned properties)</td>
<td>• $w_L = 0.1$ (other foreclosed properties, strategic corridors, crime locations)</td>
</tr>
<tr>
<td></td>
<td>• $w_k = 0.5$ (other foreclosed properties, crime locations)</td>
<td></td>
</tr>
</tbody>
</table>
SVI measures vary by frame, amenity definition, weighting scheme

<table>
<thead>
<tr>
<th></th>
<th>Average [std. deviation]</th>
<th>Weights</th>
<th>Resident frame</th>
<th>CDC frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full set of amenities/disamenities</td>
<td>Base</td>
<td>0.254 [0.086]</td>
<td>0.163 [0.080]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alternative</td>
<td>0.286 [0.168]</td>
<td>0.171 [0.148]</td>
<td></td>
</tr>
<tr>
<td>CDC-specified features only</td>
<td>Base</td>
<td>0.249 [0.139]</td>
<td>0.185 [0.133]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alternative</td>
<td>0.252 [0.163]</td>
<td>0.208 [0.170]</td>
<td></td>
</tr>
</tbody>
</table>

CBO frame, CBO-specified amenities and disamenities, base weights

Individual resident frame, all amenities and disamenities, alternative weights
Implications of strategic value impacts analysis

<table>
<thead>
<tr>
<th>Weights</th>
<th>Features</th>
<th>Frame</th>
<th>Average of purchased properties</th>
<th>Average of top three properties</th>
<th>% Lost strategic value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base case</td>
<td>All</td>
<td>Resident</td>
<td>0.251</td>
<td>0.414</td>
<td>39.4%</td>
</tr>
<tr>
<td></td>
<td>CDC</td>
<td>CDC</td>
<td>0.186</td>
<td>0.335</td>
<td>44.4%</td>
</tr>
<tr>
<td></td>
<td>CDC</td>
<td>Resident</td>
<td>0.374</td>
<td>0.520</td>
<td>28.0%</td>
</tr>
<tr>
<td></td>
<td>CDC</td>
<td>CDC</td>
<td>0.315</td>
<td>0.471</td>
<td>33.2%</td>
</tr>
<tr>
<td>Alternative</td>
<td>All</td>
<td>Resident</td>
<td>0.230</td>
<td>0.619</td>
<td>62.8%</td>
</tr>
<tr>
<td></td>
<td>CDC</td>
<td>CDC</td>
<td>0.156</td>
<td>0.511</td>
<td>69.4%</td>
</tr>
<tr>
<td></td>
<td>CDC</td>
<td>Resident</td>
<td>0.425</td>
<td>0.633</td>
<td>32.8%</td>
</tr>
<tr>
<td></td>
<td>CDC</td>
<td>CDC</td>
<td>0.251</td>
<td>0.414</td>
<td>39.4%</td>
</tr>
</tbody>
</table>

Significant losses, as measured by percent of normalized estimated strategic value associated with actual CBO purchases compared to top three properties within each analysis category

November 13, 2016
What is the relationship between different strategic value measures?

Table 6
Correlations of strategic value outputs.

<table>
<thead>
<tr>
<th>Weights</th>
<th>Features</th>
<th>Frame</th>
<th>Base weights</th>
<th>Alternative weights</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>All</td>
<td>CDC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resident</td>
<td>CDC</td>
<td>Resident CDC</td>
</tr>
<tr>
<td>Base</td>
<td>All</td>
<td>Resident</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>CDC</td>
<td>Resident</td>
<td>0.90</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>CDC</td>
<td>CDC</td>
<td>-0.63</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alt</td>
<td>All</td>
<td>Resident</td>
<td>0.87</td>
<td>0.74</td>
</tr>
<tr>
<td></td>
<td>CDC</td>
<td>Resident</td>
<td>0.80</td>
<td>0.74</td>
</tr>
<tr>
<td></td>
<td>CDC</td>
<td>CDC</td>
<td>-0.40</td>
<td>0.73</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
- Correlations between alternative SVI measures are:
  - Strong and positive (bold) for same sets of features across two weighting schemes
  - Strong and negative (italics) for resident frames with all features, and for CDC-defined features, either frame, for both weighting schemes
  - Moderate and negative for CDC frame, all features vs. CDC-defined features, either frame, both weighting schemes
- Functional form of the strategic value equations is less important than the choice of features to include and weights to apply
What is the relationship between different foreclosed property attributes?

Correlations between SVI measures and PVI are moderate to low

- Correlations between SVI measures and assessed value are very low
- Correlation between PVI and assessed value has been shown to be low

No correlations between impact measures are strong and positive, supporting a multi-objective optimization approach to property selection

Table 8
Correlations of strategic value with other property considerations.

<table>
<thead>
<tr>
<th>Weights</th>
<th>Features</th>
<th>Frame</th>
<th>PVI values</th>
<th>Assessed property value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base case</td>
<td>All</td>
<td>Resident</td>
<td>-0.07</td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>CDC</td>
<td>-0.04</td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>CDC</td>
<td>Resident</td>
<td>0.32</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>CDC</td>
<td>CDC</td>
<td>0.35</td>
<td>0.00</td>
</tr>
<tr>
<td>Alternative</td>
<td>All</td>
<td>Resident</td>
<td>-0.36</td>
<td>-0.06</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>CDC</td>
<td>-0.34</td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>CDC</td>
<td>Resident</td>
<td>0.08</td>
<td>-0.08</td>
</tr>
<tr>
<td></td>
<td>CDC</td>
<td>CDC</td>
<td>0.14</td>
<td>-0.15</td>
</tr>
</tbody>
</table>
Discussion

- First known instance of quantifying ‘strategic value’ of candidate foreclosed housing acquisitions
- Field research with community partners is essential to identifying salient amenities and disamenities
- ‘Frames’ and alternative amenities sets provide rich source of variation in SVI reflecting specific problem contexts and stakeholder perspectives
- PVI, SVI and assessed value (proxy to market value) may serve as inputs to biobjective knapsack problem for foreclosed housing property selection
Questions?