



Innovative Applications of O.R.

Stochastic models for strategic resource allocation in nonprofit foreclosed housing acquisitions

Armagan Bayram^a, Senay Solak^{a,*}, Michael Johnson^b^a Department of Operations and Information Management, Isenberg School of Management, University of Massachusetts, Amherst, MA, United States^b Department of Public Policy and Public Affairs, McCormack Graduate School of Policy and Global Studies, University of Massachusetts, Boston, MA, United States

ARTICLE INFO

Article history:

Received 23 April 2012

Accepted 27 August 2013

Available online 5 September 2013

Keywords:

OR in societal problem analysis

OR in strategic planning

Foreclosures

Stochastic programming

Resource allocation

ABSTRACT

Increased rates of mortgage foreclosures in the U.S. have had devastating social and economic impacts during and after the 2008 financial crisis. As part of the response to this problem, nonprofit organizations such as community development corporations (CDCs) have been trying to mitigate the negative impacts of mortgage foreclosures by acquiring and redeveloping foreclosed properties. We consider the strategic resource allocation decisions for these organizations which involve budget allocations to different neighborhoods under cost and return uncertainty. Based on interactions with a CDC, we develop stochastic integer programming based frameworks for this decision problem, and assess the practical value of the models by using real-world data. Both policy-related and computational analyses are performed, and several insights such as the trade-offs between different objectives, and the efficiency of different solution approaches are presented.

© 2013 Elsevier B.V. All rights reserved.

1. Introduction

A dramatic increase in mortgage foreclosures has had adverse effects in all sectors of the economy but especially in the housing sector in the United States. Home foreclosures have resulted in massive losses of consumer wealth. U.S. households lost around \$1.1 trillion per year on average in home value between 2007 and 2011 (Daily Finance, 2011; Zillow, 2010), and the fraction of mortgages that are more than 90 days delinquent has been over 8% (Norman, 2010). The foreclosure crisis in Europe has not had as severe of an impact, but the European mortgage market also saw a 1.2% decline in 2008 due to the same economic crisis (European Mortgage Federation, 2010), while rates of severe mortgage delinquency are generally about a third of U.S. rates (European Commission, 2011).

Several efforts by governments, companies and social organizations have been in place to reduce the losses realized due to the foreclosure problem. In the United States, such social organizations involve non-governmental/nonprofit entities referred to as community development corporations (CDCs). Among other community development projects, these organizations try to mitigate the socio-economic impacts of foreclosures by purchasing, redeveloping and selling foreclosed properties. While CDCs are more common in the United States than elsewhere in the developed world

(Anheier, 2005), our research is applicable to non-US government actors at the local and regional levels as well.

While actions of CDCs help maintain social and economic stability in neighborhoods, the resources typically available to these entities are limited, and thus efficient resource allocation strategies are needed to maximize the effectiveness of their investments. Considering these resource limitations and the uncertain nature of the social returns to be realized from property acquisitions, CDCs face several complex decision problems, which can be categorized as being strategic or tactical.

The strategic decision problems for CDCs involve setting priorities for residential real estate investments and developing specific resource allocation plans for different geographical regions that comprise a given service area. These decisions typically consider a timeline of 1–3 years into the future. The tactical decision problems, on the other hand, are short-term and are primarily related to the selection of particular foreclosed units for acquisition and redevelopment.

In this paper, we focus on the strategic resource allocation problem faced by CDCs, which, however, cannot be addressed independently from tactical decision problems. Strategic resource allocations need to consider potential availability and acquisitions of individual foreclosed units in the future, as well as the social impacts associated with these acquisitions which are all redeveloped and placed on market for sale. Given that all acquired properties are redeveloped, by acquisition we imply both the acquisition and redevelopment activities on a property unless noted otherwise in the paper. Another key issue is that all these decisions are made

* Corresponding author. Tel.: +1 4135455681.

E-mail addresses: abayram@som.umass.edu (A. Bayram), solak@isenberg.umass.edu (S. Solak), michael.johnson@umb.edu (M. Johnson).

under uncertainty, as several relevant inputs for the decision making process are determined by the state of the local and national economy, which is inherently uncertain. For example, the number of foreclosures to occur in a given region over the planning horizon, the purchase price of a foreclosed property, as well as the value generated by an acquired property are directly related to the economic conditions, and thus are not known in advance. Our decision framework is intended to capture these complexities in determining optimal resource allocations to different geographical regions by considering the specific acquisition decisions to be made in response to different realizations of future uncertainty. To address these issues, we develop strategic resource allocation models under uncertainty, apply these multi-period stochastic models to a case study of a community-based organization, and discuss the solutions with respect to their policy implications and effectiveness.

Contributions of this research involve multiple dimensions. First, we note that we address an important decision problem that directly deals with effective management of public resources to improve social welfare, a central concern of public-sector operations research (Gass, 1994). Moreover, this policy-relevant application of decision modeling contributes to the scholarly body of work in community-focused operations research for housing and community development (Johnson, 2011). Second, the stochastic foreclosed housing acquisition models we develop are novel variants of stochastic resource allocation problems. These stochastic decision models are, to the best of our knowledge, the first in the area of private- or public-sector housing investment, for which we demonstrate that certain rule-based heuristics can perform quite well. As a third dimension, we note that we use data derived from CDC practice to rigorously apply and assess realistic problem instances. We demonstrate that our models, and the results derived from them, are generalizable to similar investment or resource allocation problems where the objectives may involve only financial returns.

2. Literature review

In this section, we discuss the relevant literature separately for the methodological and practical components of our analysis.

2.1. Literature review on strategic stochastic resource allocation

The problem we study falls into the general category of strategic stochastic resource allocation problems. The literature on this broad theme is substantial with several applications and problem types. We summarize some relevant stochastic and dynamic models for resource allocation, and discuss their applicability to the problem we study. Mild (2004) provides a review on strategic resource allocation models specifically with a multicriteria structure, but no stochastic optimization model is presented. Some relevant stochastic models to our research include Loch and Kavadias (2002), where the authors develop a dynamic model for allocating resources to different new product development projects and identify analytical solutions by considering different types of return functions. Solak, Clarke, Johnson, and Barnes (2010) describe a stochastic programming approach to project portfolio management in the presence of endogenous uncertainty, which considers a single objective consisting of maximization of expected returns. In addition to these studies, Chalabi, Epsten, McKenna, and Claxton (2008) propose a two-stage stochastic mathematical programming formulation to optimally allocate resources within and between healthcare programs when there is an exogenous budget and the parameters of the healthcare models are uncertain. The analysis of Loch and Kavadias (2002) assumes theoretical distributions

and is not applicable to our problem due to the existence of complex relationships modeling multiple objectives in our framework. Chalabi et al. (2008) limit their analysis to a small-scale two stage formulation without any algorithmic discussion or numerical analysis. In contrast to Solak et al. (2010), our study addresses multiple objectives, including a measure of social utility, and uses novel return functions.

As a stochastic resource allocation model with a multi-objective structure, Medaglia, Graves, and Ringuest (2007) describe allocating limited resources to R&D projects by considering multi-criteria under uncertainty. Cheng, Subrahmanian, and Westerberg (2003) propose an investment strategy model for firms based on two-stage multi-objective optimization framework. The problem formulation leads to a multi-objective Markov decision problem representation, which is used to define Pareto optimal design strategies. Our work extends the relatively limited scope of Medaglia et al. (2007), which is static and simulation based, and extends that of Cheng et al. (2003) through the use of multi-stage stochastic programming. While many other studies on stochastic resource allocation with different applications and modeling structures exist in the literature, complementary to these existing models, we develop a multi-stage stochastic programming approach to a strategic resource allocation problem involving multiple social objectives.

2.2. Literature review on foreclosure related housing policy

While foreclosures have many negative impacts on neighborhoods (Kingsley, Smith, & Price, 2009), data limitations generally result in analyses of property value impacts of foreclosures. Campbell, Giglio, and Pathak (2009) use regression analyses of house prices and extend their analysis to estimate the total lost value from properties proximate to a foreclosed unit. Harding, Rosenblatt, and Yao (2009) estimate different effects on sales of non-distressed properties also by using regression analysis and present findings related to specific features of neighborhoods, foreclosed units, or the surrounding market conditions. Harding et al. (2009), along with Schuetz, Been, and Ellen (2008), also assess the impact of multiple foreclosures in an area, where the authors conclude that the number of proximate foreclosures generally multiplies the effects on neighboring house prices. In contrast to these descriptive and exploratory studies, our prescriptive decision models are intended to mitigate these negative impacts.

There also exist some related works on CDCs and their involvement in housing markets through property acquisitions. Swannstrom, Chapple, and Immergluck (2009) describe acquisition strategies that CDCs employ to acquire and redevelop foreclosed housing, and NeighborWorks (2009) describes the difference of these strategies from those used for traditional community development. Key challenges encountered by CDCs during implementation of foreclosure acquisition and redevelopment strategies are investigated by Bratt (2009). Based on the observations from those studies, Simon (2009) describes some suggestions for CDCs and policy makers to implement. We add to this qualitative literature through a quantitative rigorous approach aimed to help CDCs in their long term strategic decision processes.

A relevant stream of research for the traditional housing market that focuses on purchasing strategies also exists. Such an analysis is performed by Drew, Skitmore, and Lo (2001), where the authors use regression analysis to measure competitiveness and offer a purchasing strategy model in selecting which properties to bid for. In another related paper, Yao and Zhang (2005) develop optimal dynamic portfolio decisions on housing investments for individual investors over a lifetime. Unlike these papers, we explicitly consider stochasticity in a portfolio model involving both near and long term decisions, as well as multiple objectives.

Download English Version:

<https://daneshyari.com/en/article/479855>

Download Persian Version:

<https://daneshyari.com/article/479855>

[Daneshyari.com](https://daneshyari.com)