Analysis of spatial autocorrelation in higher-priced mortgages: Evidence from Philadelphia and Chicago

Yonghua Zou *

School of Public Administration, Nanjing University of Finance and Economics, 3 Wenyuan Rd., Qixia, Nanjing, Jiangsu 210046, China
Department of Geography and Urban Studies, Temple University, 329 Gladfelter Hall, Philadelphia 19122, PA, USA

ARTICLE INFO

ABSTRACT

An accurate and reliable model is critical for analyzing racial/ethnic and socioeconomic inequality in the spatial distribution of higher-priced/subprime mortgages. Employing a spatial error model, this research analyzes spatial autocorrelation in higher-priced mortgages in the Philadelphia and Chicago MSAs. The empirical results show that higher-priced mortgages occur disproportionately on tracts with a higher proportion of African–American and Hispanic residents, lower income, and higher investment risks, as well as tracts in fringe suburbs. The results imply that the government needs to enforce fair lending policies to alleviate social inequality arising from subprime lending. The paper also demonstrates the difference of subprime mortgage market dynamics between two MSAs, suggesting that local governments need to consider local demographic and socioeconomic characteristics when they design housing policy interventions. Furthermore, the paper compares the results of the OLS model and the spatial error model, highlighting that the spatial error model can yield better model fitness and more accurate estimate coefficients. Analyzing spatial autocorrelation is a methodological innovation in mortgage studies, which can advance our understanding of the spatial distribution of higher-priced mortgages across neighborhoods within a MSA.

Introduction

The subprime/higher-priced mortgage is a result of America's financial market innovations, such as automated underwriting, risk-based pricing, and mortgage securitization (Chomsisengphet & Pennington-cross, 2006; Mayer & Pence, 2008; Pennington-Cross & Nichols, 2000). Compared to conventional mortgages, subprime mortgages offer lower underwriting standards to allow some low-income or less creditworthy borrowers to access mortgage credit (Coleman, LaCour-Little, & Vandell, 2008). For both lenders and borrowers, subprime mortgages imply high risks; while subprime mortgage lenders bear higher credit risks and collateral risks, borrowers have to pay higher interest rates and fees. The subprime mortgage is considered a key triggering factor of the meltdown of the housing credit market, as well as the severe global financial crisis and economic downturn after 2008.

Examining the spatial distribution of subprime mortgages is critical to advance our understanding of the equality of housing finance accessibilities for different neighborhoods within a city or a metropolitan area. A handful of existing literature has studied the spatial distribution of subprime/higher-priced mortgages (Bradbury, Case, & Dunham, 1989; Newman & Wyly, 2004; Calem, Gillen, & Wachter, 2004; Calem, Hershaff, & Wachter, 2004; Ding, Ratcliffe, Stegman, & Quercia, 2008; Mayer & Pence, 2008; Pennington-Cross, 2002). Using conventional OLS methods, the existing literature drew a consistent conclusion that low-income and minority neighborhoods obtained disproportionate numbers of subprime mortgages. The existing literature, however, has a common limitation – researchers have not taken into account spatial autocorrelation in their analyses. Spatial autocorrelation refers to the phenomena of a variable value in a location is influenced by the values of its neighbors, and therefore violating the independence assumption and potentially causing estimate bias in a conventional regression model (Anselin & Bera, 1998; Chakraborty, 2009; Krause & Bitter, 2012). The conventional OLS model assumes that observations are randomly distributed and residuals are uncorrelated. However, a value in a location may be similar to, or different from, the values at nearby locations (Anselin & Bera, 1998; Landry & Chakraborty, 2009). Under the circumstances, the residuals produced by the conventional OLS model may be spatially correlated. If the residuals are spatially

* Address: School of Public Administration, 3 Wenyuan Rd., Qixia, Nanjing, Jiangsu 210046, China. Tel.: +86 159 6138 1832.
   E-mail address: yonghuazou@gmail.com

correlated, the OLS model will result in bias of the estimated parameters and may generate inaccurate conclusions (Basu & Thibodeau, 1998).

Researchers have examined spatial autocorrelation in a wide range of topics, including air quality (Kim, Phipps, & Anselin, 2003), environmental justice (Chakraborty, 2009; Grineski & Collins, 2010; Landry & Chakraborty, 2009; Raddatz & Mennis, 2013), urban deprivation (Longley & Tobón, 2004), crime studies (Ceccato & Oberwittler, 2008), housing prices (Basu & Thibodeau, 1998; Bourassa, Cantoni, & Hoesli, 2007, 2010; Can & Megbolugbe, 1997; Cohen & Coughlin, 2008; Yu, Wei, & Wu, 2007), and neighborhood quality (Dubin, 1992). However, very little literature as of yet has examined the spatial autocorrelation in subprime/higher-priced mortgage studies.

Subprime/higher-priced mortgages are inclined to be spatially autocorrelated for the following reasons: (1) people with similar racial/ethnic backgrounds, income levels, education levels, and cultural background are more likely to live within close proximity to one another; (2) housing in the same neighborhood or nearby neighborhoods usually have similar housing quality and value; (3) people living in the same neighborhood or nearby neighborhoods share similar location-based amenities, such as transportation, shopping, recreation, and school access; and (4) people living in the same neighborhood or nearby neighborhoods share similar housing financial services provided by local institutions, including subprime/higher-priced mortgage lenders (Basu & Thibodeau, 1998). The characteristics of geographic clustering of subprime/higher-priced mortgages require researchers to account for potential spatial autocorrelation, or spatial dependence, in mortgage market studies.

Geographical clusters of subprime/higher-priced mortgages have resulted in serious foreclosure and nearby property depreciation, which not only hurt the tax base of a number of municipalities, but also exacerbated social inequality between subprime neighborhoods and non-subprime neighborhoods (Immergluck & Smith, 2005, 2006; Pennington-cross, 2006). As a result, analyzing the accurate spatial distribution of subprime/higher-priced mortgages is critical for making place-based foreclosure-prevention and other housing policies. This paper aims to address the limitations of prior literature by solving the spatial autocorrelation in subprime/higher-priced mortgage distribution across neighborhoods within the Philadelphia MSA and the Chicago MSA, respectively. The paper employs a conventional OLS method and a spatial regression (or simultaneous autoregressive regression, SAR) method, as well as compares their results to highlight the advantages of the spatial regression method (Anselin & Bera, 1998; Landry & Chakraborty, 2009).

The contribution of this paper is twofold. The first contribution lies in its methodological innovation. After taking autocorrelation account in the multivariate statistical analysis, the paper provides more reliable and accurate results. Integrating GIS technique, the paper also finds some new dynamics of subprime mortgage spatial distribution, such as distances to CBD, which were not examined by previous literature using conventional analysis tools. Second, based on empirical results, the paper provides some policy implications to rethink subprime mortgage policies in the US, such as how to alleviate social inequality arising from subprime mortgages, and design policy interventions considering the dynamics of subprime mortgage distribution in different MSAs.

The remainder of this paper is organized as follows. The next section introduces the study areas, data sources, and variables. The third section introduces the research methods. The fourth section reports and compares the empirical results of the OLS model and the spatial error model. The fifth section provides policy implications. The final section contains a discussion and conclusion.

Study areas, data sources and variables

Study areas

This paper conducts the analysis at the individual metropolitan level, employing the Philadelphia MSA and the Chicago MSA as two study cases. The individual metropolitan level study allows researchers to focus on the intra-MSA mortgage-lending pattern without a control for fixed effects across different MSAs (Calem, Gillen, et al., 2004; Ding et al., 2008). This paper selects two cases to investigate whether or not a similar higher-priced mortgage pattern exists in different MSAs. The Philadelphia and Chicago MSAs are comparable in terms of size; the Philadelphia MSA is the fifth largest with a population of approximately six million people, while the Chicago MSA is the third largest with around nine million people. In addition, both regions have diverse racial and ethnic populations with heterogeneous neighborhoods, including those within the central city and those of surrounding suburbs. Both areas also face the challenge of residential segregation. Furthermore, both regions had an active, but controlled, subprime/higher-priced mortgage market prior to the Great Recession. Both Philadelphia and Chicago have been studied, or compared, widely in the previous literature on mortgage studies (Calem, Gillen, et al., 2004; Calem, Hershaff, et al., 2004; Crossney, 2010; Immergluck & Smith, 2005, 2006).

In the case of Philadelphia, this paper studies nine counties, including five (Bucks, Chester, Delaware, Montgomery, and Philadelphia) in Pennsylvania and four (Burlington, Camden, Gloucester, and Salem) in New Jersey. In the case of Chicago, the area studied includes eight counties (Cook, DuPage, Grundy, Kane, Kendall, Lake, McHenry, and Will) in Illinoi. Fig. 1 demonstrates the jurisdiction boundary (counties) of the studied areas.

Data sources and variables

HMDA data

Home Mortgage Disclosure Act (HMDA)[1] data is considered the most comprehensive mortgage dataset in America's metropolitan areas and has been widely used in the previous literature on mortgage studies. HMDA provides information of loan type, purpose, amount, fees, lenders, approval/rejections, and property locations. Also included is the applicants' demographic information, including their race/ethnicity, gender, and income (Avery, Brevoort, & Canner, 2007). Most previous research employs the Department of Housing and Urban Development's (HUD) annual list of originating lenders specialize in subprime lending to identify subprime loans (Calem, Gillen, et al., 2004; Immergluck & Smith, 2005). However, this method may result in estimate bias. For instance, subprime loans originated by "none listed subprime lenders" were excluded, while non-subprime loans originated by listed lenders were included. Since 2004, HMDA also identified mortgages based on their annual percentage rates (APRs); first-lien mortgages with an APR 3% higher than the designated threshold, and junior lien mortgages with an APR 5% higher than the designated threshold are classified as "higher-priced" mortgages (Avery et al., 2007; Mayer & Pence, 2008). To decrease estimate bias in the analysis, this paper employs "higher-priced mortgages" to represent subprime mortgages.

---

[1] HMDA was created by Congress in 1975, for the purposes of improving mortgage serve efficiency, attracting private investment, and decreasing lending discrimination (FFIEC, 2012). Under HMDA, mortgage lenders with more than 30 million assets and with branches within a metropolitan area are required to report each mortgage applications to the Federal Financial Institution Examination Council (FFIEC) (Calem, Gillen, et al., 2004; Calem, Hershaff, et al., 2004).