Spatial and Temporal Dimensions of Foreclosure Diffusion during the Great Recession

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Despite extensive interest in the impacts of the Great Recession and housing crisis, we know relatively little about the distribution of foreclosures and housing distress across American neighborhoods. To date, studies of the patterns and effects of foreclosure have relied on data from limited geographic areas – often a single metropolitan area or selected counties within a metro area – and over short periods of time (e.g., Daneshvary and Clauretie 2011; Gangel et al. 2011; Immergluck and Smith 2006; Lin et al. 2009; Pfeiffer and Molina 2013; Rogers 2010; Wassmer 2011). No research to date has systematically evaluated the neighborhood dynamics of foreclosure for a large set of areas at multiple geographic scales (e.g., within states, metros, cities, and suburbs), assessed how the concentration of foreclosures changed over time and spread throughout the U.S., or investigated how foreclosure concentrations relate to neighborhood sociodemographic conditions.

In this paper we make use of unique new data on virtually all foreclosure events occurring between 2005 and 2013 to provide a first national-level assessment of the spatial and temporal dynamics of the housing crisis as it unfolded – from the lead-up to the Great Recession and into the current recovery. Moving beyond extant strategies that rely on the estimation of spatial variation in the prevalence of foreclosures, we utilize geo-referenced data on nearly 20 million foreclosed housing units as compiled by RealtyTrac to produce direct measures of housing foreclosure concentrations within census block-groups across the U.S. We combine these data with information on the composition of neighborhoods (block-groups) from the decennial censuses and the American Community Survey (ACS), providing comprehensive data for the examination of the spatiotemporal patterns of foreclosure concentration and their correlates. The paper is focused on three main goals: First, we describe the spatial distribution of neighborhood foreclosure. We utilize exploratory spatial data analysis to detail the geographic distribution of housing foreclosures in America's neighborhoods and to assess changes in this spatial distribution as the Great Recession unfolded. Particular focus is directed on understanding unevenness in the patterns of, and trends in, neighborhood foreclosure concentrations across regions, states, metropolitan and micropolitan areas, and locations within metropolitan areas (central cities, inner-, middle-, and, outer-ring suburbs). Second, we provide a formal analysis of the spatiotemporal diffusion of foreclosures using emerging spatial econometric models. Specifically, we apply dynamic spatial panel regression strategies to model the foreclosure concentrations within block-groups over time (months between 2005 and 2013) and the diffusion of foreclosures between adjacent block-groups. This approach will provide insights into the extent to which housing-related financial distress accumulates in specific areas and spreads in a manner consistent with contagion arguments, thereby providing potentially valuable information for policies aimed at arresting this distress. Third, we assess the extent to which the sociodemographic conditions in the neighborhood affect spatiotemporal patterns of foreclosure concentration. Drawing on observations and theoretical arguments related to the uneven impacts of the Great Recession, we incorporate measures of block-group racial, ethnic, and socioeconomic composition into our spatial panel models to assess the extent to which the concentration of non-white minority groups and low-income populations affect temporal increases in foreclosure and/or exacerbate the risk of foreclosure diffusion from nearby areas.

Background: The shortage of evidence on the temporal and spatial patterns of foreclosure is problematic given the far-reaching repercussions of housing foreclosures and the important role such research play in shaping public policy. Each foreclosed housing unit can cost a city tens of thousands of dollars in lost revenue and processing fees (Carr 2007; Moreno 1995) and there is strong evidence that foreclosures diminish the value of surrounding properties (Daneshvary and Clauretie 2011; Immergluck and Smith 2005; Lin et al. 2009; Wassmer 2011). Foreclosures are also likely to have profound impacts on neighborhood distress and instability, leading to a density of vacant, neglected, and abandoned properties, heightening the appearance of neighborhood deterioration, driving up crime, and increasing the likelihood of racial transition (Baxter and Lauria 2000; Ellen et al. 2013; Immergluck and Smith 2006; Wallace et al. 2012). These repercussions are particularly important in light of research linking foreclosures, neighborhood composition, and stability to public health (e.g., Bjornstron 2011; Browning et al 2011; Cozier et al 2007; Saegert et al 2011).

Given these impacts, municipalities and community organizations have developed strategies to prevent foreclosures (Quercia et al. 2008) while federal programs, such as the Neighborhood Stabilization Program, target relief efforts to areas with the highest risk of foreclosure (Pinedo and Baumgardner 2009). Yet these efforts are based on extremely sketchy information about the spatial and temporal dimensions of foreclosure dynamics. While a matter of public record, information on housing foreclosures is severely limited, as no federal agency or public organization compile foreclosure listings in a common database. Consequently, our current understanding of temporal and spatial variation in foreclosures, particularly at the neighborhood level, is limited largely to a small group of states and counties offering relatively open access to foreclosure proceedings (Coulton et al. 2009; Li 2011; Lin et al. 2009; Mikelbank 2008; Wardrip and Pelletaier 2008). The only national-level data with information on neighborhood housing distress was created by the Department of Housing and Urban Development for use in its Neighborhood Stabilization Program which offers federal aid to locales suffering from housing blight, abandonment, and other neighborhood disorders associated with high concentrations of foreclosure. HUD's data, however, are limited in a number of important ways. First, their limited temporal precision and coverage – with estimates of foreclosure levels during two broad periods between 2007 and 2010 – precludes a thorough investigation of the growth in foreclosures in the period preceding the housing crisis and into the current recovery. Second, the HUD figures represent a blunt *approximation* of the *predicted* risk of foreclosure in each census tract based on metro-wide changes in housing values, county- and place-level unemployment rates, and tract-level information on the number of high-cost loans (see US HUD 2010). Though not based on actual foreclosures, these crude estimates have not only provided the basis for the allocation of over $7 billion in federal spending but have been utilized in academic research on the consequences of the housing crisis (Kim et al. forthcoming; Schootman et al. 2012). We overcome these issues by using temporally-precise data on the number of actual foreclosures in specific areas over a nine-year period that spans the time before, during, and after the housing crisis (2005-2013). The data we use cover nearly every metropolitan and micropolitan county in the U.S.

Our analyses are informed by key arguments related to the "contagion" of foreclosure (Daneshvary and Clauretie 2011; Harding et al. 2009; Immergluck and Smith 2006; Lin et al 2009). Three aspects of these arguments are of particular interest in the analysis. First, contagion models suggest that foreclosures tend to accumulate disproportionately within some neighborhoods over time. Foreclosures appear to have negative spillover effects on the value of nearby properties (Harding et al. 2009; Lin et al 2009) as foreclosed units increase local supplies of available housing, may be sold at a discount, or may sit vacant and neglected, becoming visible signs of deterioration and reducing demand for area housing. All of these mechanisms may increase the risk of additional foreclosures in the area as housing values drop below the loan balances for nearby properties, reducing opportunities to refinance or sell in the face of financial hardship. Thus, this contagion argument suggests that a single foreclosure incident may trigger further foreclosures in a neighborhood. Second, these arguments suggest that foreclosures in one neighborhood may affect foreclosure concentrations in nearby areas as the devaluation of property extends across somewhat-arbitrary census boundaries. Third, smaller-scale studies of specific metropolitan areas show that neighborhood foreclosure rates are associated with neighborhood sociodemographic conditions, suggesting that the risk of both temporal and spatial diffusion of foreclosure from surrounding neighborhoods may be highest in lower-income areas and those with relatively large minority populations (c.f., Baxter and Lauria 2000; Kaplan and Sommers 2009; Lee et al. 2010; Li and Morrow-Jones 2010). Thus, we take advantage of the substantial spatial and temporal detail in our data to test related hypotheses using emerging methods of spatial panel regression. As described below, these models allow us to examine the spatial concentration of foreclosures as a dynamic process, simultaneously considering the evolution of foreclosures within neighborhoods, the effects of local sociodemographic composition, and the impacts of foreclosure concentrations in surrounding neighborhoods.

Data and Methods: Data for this project come from a variety of sources on housing foreclosure and racial and SES composition of neighborhoods, surrounding neighborhoods, and broader areas. Foreclosure data come from RealtyTrac, which assembles local foreclosure listings and documents from counties across the U.S. Through an agreement with RealtyTrac, we have acquired the entire database of foreclosure events (including pre-foreclosure filings, public auction notices, and bank repossessions) for the 2005 to 2013 period, which provide the universe of foreclosure filings for 2,860 of 3,141 counties. These counties contained 96% of all real estate transactions in the US during the time period. Most important for our purposes, these data include the physical addresses of all properties in the foreclosure process and the timing of the filings. Data on neighborhood sociodemographic conditions come from Summary Files 1 and 3 of the 2000 decennial census and the 2010 decennial census, as well as from the 2005-09 and 2008-12 American Community Surveys. The number of housing units within geographic units – which form the denominator in measures of foreclosure rates – is based on annual tax parcel data for residential units and available through a contract with Lender Processing Services.

The focus of our analysis is on residential neighborhoods, defined here as census block groups. We also describe the spatial distribution of neighborhood foreclosure at several macro geographies, including the four census regions, nine divisions, 50 U.S. states, and metropolitan and micropolitan areas. To insure valid longitudinal comparisons, we impose the current OMB metropolitan and micropolitan definitions on all time points. We further differentiate between central cities (as defined in Frey 2012) and suburbs. Among suburbs, we use GIS tools to draw concentric 'rings' based on the contiguity of county subdivisions (which cover land area not contained by census places) to the central city: 1st-order rings are those spatially contiguous to a central city, 2nd-order rings are those contiguous to the 1st ring, and so on (Timberlake et al. 2012). These rings are grouped into *inner-suburbs*, *middle-suburbs*, *and outer-suburbs* based on their distance from the central city.

Utilizing the RealtyTrac data, we compile a complete listing of foreclosures between 2005 and 2013. Given our interest in housing dynamics, we restrict our analysis to residential properties (based on standardized land use codes). With these data, we create a panel file of unique foreclosure events that tracks individual properties through the foreclosure process. To do so, we use a rule-based matching algorithm (Elmagarmid et al 2007) based on multiple fields – including address, tax parcel number, transaction and judicial case IDs– that identify unique properties, remove potential sources of redundancy, and to impute any incomplete information (e.g., property type recorded on the *lis pendens* but not on the Notice of Trustee Sale). Although our panel file include all events in the foreclosure process, we restrict our analyses to cases representing the first visible sign of housing distress – a listing for public auction (i.e., Notice of Trustee Sale, Notice of Foreclosure Sale) or repossession by a bank (Real Estate Owned). Doing so serves multiple purposes: 1) it prevents counting the same property multiple times in calculating foreclosure rates; 2) it normalizes the foreclosure process across states since all states require public filings for such events; and 3) it follows from our theoretical interest in the broader neighborhood responses to foreclosures. Using the geographic information provided by RealtyTrac, we then create block-group foreclosure counts for each month, quarter, and year between 2005 and 2013. In addition, we calculate annual foreclosure concentrations for each neighborhood by dividing the total number of foreclosed properties over the 12 calendar months by the total number of units represented in residential tax-parcel data for the area and year. Utilizing these data and GIS tools we also produce measures of foreclosure levels in surrounding block-groups. These spatially-lagged measures of foreclosure represent the weighted average foreclosure level in areas surrounding each neighborhood. We define 'neighbors' based on a distance-decay model which treats nearby neighborhoods as having more influence than further-away ones by assigning weights to each neighborhood based on the inverse of the distance between centroids (Crowder and South 2008; Fotheringham et al. 2002).

We use these data to describe the spatial distribution of levels of, and changes in, neighborhood foreclosure concentrations. As an initial step we use percentage distributions and visual displays to plot these patterns over time and across space, doing so separately for each macro unit (regions, divisions, and states) and community area (metropolitan and micropolitan areas) and, for metropolises, central-city and suburban locations within those areas. We use a range of exploratory spatial data analysis (ESDA) tools – including global and local indicators of spatial autocorrelation that compare foreclosure levels in each block-group to levels in spatially-adjacent areas, LISA maps, and heat-surface maps – to describe and visualize foreclosure distributions across space, and to identify basic spatial patterns (Anselin 1995; 1996; 2005). Of particular interest here will be the emergence of new foreclosure hotspots, changes in the intensity of hotspots, and possible hotspot diffusion as the housing market faltered and the recession deepened. While the geographic scope of the data is vast, it is useful to examine spatial dynamics in ESDA within specified geographic areas, which facilitates the discovery of spatial process unique to particular areas (or types of areas). Thus, we plan to apply ESDA tools to assess the spatial dynamics within a purposive sample of metropolitan areas that vary in terms of the overall level of foreclosure, population size and change, and region.

We also employ emerging spatial econometric models to formally investigate spatiotemporal foreclosure processes, examining the diffusion of foreclosures across neighborhoods and across time, and assessing the association between the dynamic distributions of foreclosure and the racial and socioeconomic composition of the neighborhood. Specifically, we employ a spatial panel regression (SPR) approach (Elhorst, 2003, 2009) that moves beyond typical applications of spatial analysis by allowing us to simultaneously examine both the spatial *and* temporal patterns of foreclosure. To make use of the temporal precision in the foreclosure data within the SPR framework, we structure the analysis files into block-group-month format with each observation providing information on the cumulative foreclosure count and sociodemographic characteristics of the block-group in each month between 2005 and 2013.

In order to take full advantage of the richness of the data, we utilize a form of SPR that Anselin (2001) refers to as "time-space dynamic," allowing us to assess the extent to which foreclosures in any block-group accumulate over time (in linear or nonlinear fashion) and are shaped by foreclosures in surrounding neighborhoods. These models allow for tests of the effects of local racial and sociodemographic conditions and are suitably flexible to allow for consideration of both spatial error autocorrelation and spatial lags (Elhorst, 2003, 2009). The inclusion of state and state-by-month fixed effects allows us to account for unobserved variation in state practices for processing and recording foreclosure events. The basic model can be written as:

$$F_{ist} = \lambda_0 W_i F_{ist} + \gamma_0 F_{is,t-1} + \rho_0 W_i F_{is,t-1} + X_{ist}\beta_0 + c_i + \phi_s + \delta_{st} + V_{ist}$$

where $F_{it} = (f_{1t}, f_{2t}, \ldots f_{Nt})'$ is a *n x 1* column vector of foreclosure counts for each block-group (*i*) in each month (*t*); W_i is an *n x n* spatial weights matrix describing the spatial arrangement of all blocks (f_{it}) in the system; X_{it} is an *n x* k_x matrix of observed characteristics (e.g., racial composition, median income levels) of block *i* at time *t*; β_0 is a matching matrix of fixed but unknown regression parameters; c_{i0} is a *n x 1* vector of fixed effects that account for time-invariant block-specific confounders; ϕ_s is a set of state fixed effects; δ_{st} are state-by-month fixed effects; and V_{it} is a *n x 1* vector of independently and identically distributed error terms, representing unobserved factors for block *i* at time *t*, with a zero mean and variance σ_0^2. The SPR analysis provides the first geographically-comprehensive and temporally-sensitive examination of the spatial and chronological progression of housing foreclosures from the pre-crisis period through the current recovery.

Ongoing Research

To date, we have completed assembly of the RealtyTrac foreclosure data – including the allocation of units into residential and non-residential domains, the matching of foreclosure events to unique borrowers, and the georeferencing of nearly 20 million housing events – and linked the foreclosure data to census-based geographic entities (blocks, block groups, tracts, counties, etc.). We use our final longitudinal file consisting of 9.3 million foreclosures to calculate block-group foreclosure rates for nearly every census block group in the US over the 2005 to 2012 period. As expected, these data reveal a strong temporal ordering to the concentration of foreclosures in American neighborhoods with the foreclosure rate of the typical block group exploding from a base of 0.26 (foreclosures per 100 housing units) in 2005 to a peak of 1.53 in 2010 and down to 1.07 in 2012. As state- and local-level analyses have previously identified, preliminary analysis of our national foreclosure database reveal substantial spatial variation in foreclosures, with the highest foreclosure rates being observed in the Mountain and Pacific divisions and lowest levels in the Great Plains and New England. More specific to our research goals, initial spatial analysis reveal not just a tendency for neighborhoods with heightened foreclosure levels to be spatially-connected, but a relationship that appeared to strengthen as the housing crisis emerged. Specifically, in 2005 Global Moran's *I* was 0.03, but increased to 0.21 to 2010. In the months ahead we will implement more-advanced spatial tools – namely spatial panel regression models – to explicitly evaluate these spatial dynamics and to test theoretically-guided arguments implied by diffusion/contagion processes, and assess the roles of underlying racial and socioeconomic structure in shaping foreclosure concentrations.

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