working paper

11 19

Inter-Regional Home Price Dynamics through the Foreclosure Crisis

Francisca G.-C. Richter and Youngme Seo

FEDERAL RESERVE BANK OF CLEVELAND

Working Paper 11-19 September 2011

Inter-Regional Home Price Dynamics through the Foreclosure Crisis

Francisca G.-C. Richter and Youngme Seo

Overall regional conditions such as employment, geography, and amenities, favor the co-movement of housing prices in central cities and their suburbs. Simultaneously, over half a century of sprawl may induce a negative relation between suburban and central city home prices, with central city values falling relative to suburban home values. What happens to the relationship between subhousing markets when cities are shocked by the foreclosure crisis? This paper builds repeat-sales indices to explore home price dynamics before and after the foreclosure crisis in the Cleveland area, a market that in the aggregate had little home price appreciation prior to the crisis, but significant follow-up depreciation. The analysis finds evidence that connectedness, expressed as the relative importance of neighboring housing market conditions in explaining city home prices, increases among submarkets even as they experience varying levels of foreclosure rates, and that foreclosure effects give little sign of receding in the near future. The analysis is relevant to the discussion of economic recovery among city and suburban communities as the nation faces high inventories of soon-to-be foreclosed properties.

Keywords: Intra-regional housing markets, repeat-sales home price indices, spatial panel, foreclosure effects

JEL codes: R10, R30.

Francisca G-C Richter is at the Federal Reserve Bank of Cleveland and can be reached at francisca.g.richter@clev.frb.org. Youngme Seo is a former visiting scholar at the Bank.

1 Introduction

Two distinct forces influence the relationship of sub or intra-urban housing markets within a metropolitan area. On the one hand, over half a century of sprawl can induce a negative relation between suburban and central city home prices, with central city values falling relative to suburban home values [3]. On the other hand, regional conditions such as employment, population trends, geography, as well as central city institutions and amenities would seem to favor the co-movement of housing prices in cities within an MSA. In a paper titled 'The Shared Fortunes of Cities and Suburbs' Rappaport [18] argues that cities and suburbs depend on each other for economic growth. His analysis finds that over the course of three decades (1970-2000) populations of central cities and their suburbs in the U.S. have more often grown or declined together, rather than at each other's expense. Haughwout and Inman [12] show that weak central city finances have a significant effect on the suburban economy, slowing the growth of suburban incomes and population, and depressing suburban home values.

For old industrial cities like Cleveland, Detroit, and Pittsburgh, that never fully recovered from the loss of manufacturing jobs in the seventies and have seen little to no population growth in the past decade, both effects -sprawl and deteriorating regional conditions- may have contributed to weaken their housing markets. But what happens to this sub-market connectivity when it is shocked by the foreclosure crisis? And more specifically, how is this interrelationship affected by the crisis in a market that did not experience a boom or bubble, but was nevertheless shocked by a sharp decline in home prices?[1] Foreclosures have the potential of influencing home prices in at least two different ways: At large enough rates, foreclosures can affect the value of surrounding homes by making them less attractive assets. Even in areas with lower rates of foreclosures, lower prices of foreclosed and surrounding homes may shift demand away from comparable homes in other neighborhoods, driving their home prices down. Both effects would seem to contribute to an increased positive relationship (connectivity) of home prices at the intra-regional level. At the same time, the fact that foreclosure rates vary considerably throughout sub-markets or cities within an MSA would seem to favor a disassociation of housing markets at the city level.

[1]According to Abel and Deitz [1], a small cluster of Midwestern cities, including the Cleveland and Detroit MSAs fall into the 'Bust, No Boom' category, while others like Phoenix and Los Angeles experienced both a boom and a bust.

The extent by which homes nearby vacant or foreclosed properties depreciate in value has been documented and estimated in recent work for several housing markets. In the Columbus, OH market, Mikelbank finds that each vacant or abandoned property within a quarter mile of a house for sale lowers its value by 3.6 percent and each foreclosure does so by 2.1 percent[17]. Immergluck [13] obtains equivalent estimates for Chicago in 1999. He finds that property values within an eighth mile of a foreclosure are 1.1 percent lower than comparable properties out of a foreclosure ring. Both papers use hedonic models. Harding, Rosenblatt, and Yao [10] derive repeat sale home price indices that incorporate the effects of nearby distressed properties for seven MSAs. They find evidence of a diffusion or contagion effect of foreclosed properties to nearby homes, with discounts of up to about 1 percent per nearby foreclosed property. Hartley [11] separates the effects of foreclosures on the value of surrounding homes into what he calls disamenity and supply effects and finds evidence for both. The disamenity effect refers to homes becoming less attractive assets due to the presence of a nearby foreclosed home; this is the effect that Harding, Rosenblatt and Yao attempt to measure. On the other hand the supply effect lowers home prices of comparable assets due to the increased supply of housing contributed by the foreclosed home. But while the disamenity effect decreases as distance from the foreclosed home increases, the supply effect is not limited to nearby homes. Demand for comparable homes in neighborhood B may also be affected by the increased supply and lower prices of homes in nearby neighborhood A as a consequence of foreclosures in A. Both effects have the potential to increase the co-movement or connectedness of home prices in cities near each other.

The aforementioned body of work is valuable in that it provides a quantifiable estimate, at a certain point in time, of losses due to foreclosure externalities. The present analysis adds to the understanding of foreclosure effects by providing a qualitative assessment of possible changes taking place in the relationship of sub market home prices through time. Both types of analysis are relevant to the discussion of economic recovery among city and suburban communities. For exploratory purposes, we compare home price changes in zip codes most and least affected by foreclosures within an MSA. We then construct repeat sale price indices for 15 cities in the Cleveland

MSA, during the 1990-2009 period, for which sales data are available[2]. We test for stationarity of the city-to-MSA index ratio before the crisis and for the whole period as a measure of sub-market connectedness. We proceed to estimate a model for home prices over moving time periods to assess home price index responses to shocks from own and neighboring market distress. The measure of distress used is the percent of all sales that are sheriff sales, likely to be positively correlated to rates of foreclosure and recent vacancies. We find that, as of the fourth quarter of 2009, home price connectedness increases among sub-markets even as they face varying levels of foreclosure rates. While home prices are highly persistent from one period to the next, the relative importance of local and neighboring housing market conditions to city home prices seems to have increased in recent times. Furthermore, the influence of foreclosure effects on housing prices gives little sign of receding in the near future. The remaining of the paper is structured as follows. Section 2 presents the zip code level analysis of home prices and foreclosure rates; section 3 computes and describes the home price index estimates; section 4 analyzes sub-market connectedness through stationarity testing; section 5 develops the model and presents results, and section 6 concludes.

2 Home Price Changes in Areas More and Less Impacted by Foreclosures

To obtain a general idea of how home prices within an MSA have responded to the foreclosure crisis, we compare home price changes in zip codes, most and least affected by foreclosures within an MSA, for various MSAs in Ohio for which data are available[3]. We use quarterly data from 2006 to 2009 from the following sources: foreclosure rates from Lender Processing Services Inc.

[2]Recall that CoreLogic provides repeat sales home prices at the zip code level for some zip codes in the County but there is not a clear zip to city correspondence.

[3]It is important to clarify that the comparison may exclude the most distressed areas in an MSA. In Cleveland, for instance, areas with the highest foreclosure rates in the available sample data (percent of foreclosures out of all active loans) coincide mainly with areas that in 2007 fell in the fourth *and* third quartile of actual foreclosure filing rates, as a percent of all estimated mortgaged units in the County (using data from the Cuyahoga County Common Pleas Court and Census 2000).

(LPS)[4], repeat sales CoreLogic home price indices (CHPI)[5], and home value indices from Zillow (ZHVI) [14][6]. The analysis is limited to MSAs with (1) at least 25 active loans per zip code in the LPS data set and with (2) at least 10 zip codes for which home price index data is available. The analysis using CHPI, while possibly more reliable than with ZHVI, is constrained to fewer MSAs. As it turns out, patterns are consistent irregardless of the home price -or value- data used, so we present only graphs derived with the CHPI data. Within each MSA, zip codes are ranked by their median foreclosure rates during the 2006Q1-2009Q4 period. Zip codes in the lowest quartile are classified as less impacted relative to the MSA, while those in the top quartile fall into the more impacted category within the MSA. The second and third quartiles are dropped from the analysis. Median foreclosure rates are averaged over all zip codes within each of these two categories for each MSA, and plotted in figure 1. Foreclosure rates in the hardest hit quartile are about twice or more those in the least hit quartile. Figure 2 shows the average compound annual CHPI growth rate for the top and bottom foreclosure quartiles[7]. The fact that most values scatter around the red, 45^o angle line suggests that home price changes in the top and bottom foreclosure rate quartiles are not too different from each other. Overall, during the 2006-2009 period, zip codes in the data, most and least affected by foreclosures within their MSA have experienced relatively similar growth rates in home prices. Differences in CHPI growth rates would seem to be driven more by inter- as opposed to intra-sub-market differences in foreclosure rates.

[4]LPS claims to cover roughly about 60% of the mortgage market, but with a higher proportion of prime loans as compared to the market.

[5]These are calculated using a weighted repeat sales methodology, for single family housing including distressed sales.

[6]According to Hagerty [9], Zillow Inc. reports that its so called Zestimates come from a proprietary computer program that takes into account sale prices for nearby, comparable homes Comparison is based on size and other physical attributes of the home, its past sales history and tax-assessment data. Zillow Inc. reports a 7.2% median margin of error on its estimate. The index for a certain geographic area is the median of all ZHVI's computed for the area, and it excludes foreclosed and REO properties [14]. A Wall Street Journal analysis of 1,000 recent home sales found that the median difference between the Zillow estimate and the actual price was 7.8% [9].

[7]For each zip code, the compound growth rate is $100\left[\left(\frac{CHPI_{2009Q2}}{CHPI_{2006Q1}}\right)^{\frac{4}{13}}-1\right]$.

3 Data and Repeat Sale Index Estimation

Most static analysis of spillover effects in U.S. housing markets uses hedonic pricing models. Hedonic models allow researchers to estimate price indices for a standard home while controlling for variation in housing attributes. According to Case and Shiller [6] the hedonic approach requires large quantities of individual sales data and the accuracy of the indices depends on how well the model is able to estimate and control for the implicit value of each considered attribute. Repeat sales indices, on the other hand, more directly control for different attributes because same property, paired sales data are used to estimate the returns on housing. Still a property may have changed characteristics from one sale to the next, so paired sales data for which sale price differences are extreme, are usually excluded from the sample. Wang and Zorn [19] provide a clear and detailed presentation of the repeat sales methodology, first introduced by Bailey et al. in 1963 [2]. Returns on the value of homes are assumed to follow a particular growth path through time. Observed sales of homes in a market (cities, in our case) at any point in time can be seen as draws from a probability distribution of returns for that particular time period. Likewise, cumulative growth rates -with respect to a base year- for home values within the city may also be modeled as random variables at any fixed point in time. Viewed in this way, a population home price index at time t can be defined as a central tendency statistic of this distribution. But while the idealized population consists of returns for each home at each time period, in reality, one only observes returns when sales of previously sold homes occur. Therefore, sample index values for each city in each of T periods are obtained as parameter estimates of the following regression of log price relatives on an indicator vector for sale periods:

$$
\begin{aligned}
\frac{p_{i,j}}{p_{i,k}} &= \frac{I_j}{I_k} u_{i,j,k} \text{ or} \\
\ln(\frac{p_{i,j}}{p_{i,k}}) &= \ln(I_j) - \ln(I_k) + \ln(u_{i,j,k}) \\
&= D_i' L + \ln(u_{i,j,k}) \qquad (1)
\end{aligned}
$$

where $p_{i,j}$ is the sale price for home i at period j, I_j is the city home price index for period j, $L = [\ln(I_1), ..., \ln(I_T)]'$, and $u_{i,j,k}$ is an error term. $D_i = [d_{i,1}, ..., d_{i,T}]'$, where $d_{i,j} = -1$, $d_{i,k} = 1$, and $d_{i,t} = 0$ for all other t in $[1, ..., T]$.

Sample indices are the parameter estimates for I_t's computed to account for variance heterogeneity due to differences in length of time between sales. We follow the three stage process detailed by Case and Shiller in [6], and the resulting estimates are smoothed via a 4-period moving average to lessen seasonality effects. Using this methodology, we estimate quarterly repeat-sales indices for Cleveland and 14 neighboring cities, from 1976 to the fourth quarter of 2009 and use indices in the period of interest (1990Q1 to 2009Q4)[8]. The residential sales data includes arms-length transactions not only for single, but for two-family homes as well, excluding sheriff sales and quit claim deeds among other non-warranty sales.

The estimated home price indices are displayed in the top panel of figure 3, along with the reported Case-Shiller index for the Cleveland MSA. The Cleveland MSA encompasses five counties, Cuyahoga, Geauga, Lake, Lorain, and Medina. Cuyahoga is home to the central city and suburbs considered in this study was the county hardest hit by foreclosures and has even been called the epicenter of the crisis (see Coulton et al.[7] for a detailed account of the evolution of and local response to the crisis). Indices tend to peak between 2005 and 2006, with the outer ring suburbs, in the bottom row, taking a little longer to start their decline[9]. For most cities, our repeat sale indices tend to drop considerably more than the Case-Shiller MSA index in recent times, but this drop is consistent with trends in the (un-indexed) average sales prices per period (bottom panel of figure 3) and the fact that we are focusing on the worst off cities within the MSA. As an indicator of market trends, Case-Shiller assigns smaller weights to sale pairs with larger price change deviations from the average price change for the entire market. This index is also smoothed via a three period moving average. Unlike Case-Shiller's, our index does not use any weighting scheme. We exclude sales lower than \$20000 or greater than \$750000. If the per-quarter price change of a sales pair is greater than 20% or lower than -8% the pair is excluded. Even with these screening conditions, our index estimates seem to include more low value transactions that Case-Shiller's.

As a measure of city level housing market distress, we use sheriff sales as a percentage of all sales. Sheriff sales are obtained from the Cuyahoga County

[8]We are interested in home prices since 1990, but using repeat sales from 1990 on, would limit the sales pairs in earlier years to homes bought and sold in very short periods of time. Expanding the time period to include the 1976-1989 period should reduce any possible bias due to small holding periods.

[9]These cities are Westlake, North Olmsted, Strongsville, and North Royalton.

Auditor and Recorder through Cleveland State University. Figure 4 displays 4 period moving averages of the percent of sales that are Sheriff sales for all cities and reflects a high variation in the foreclosure shock among cities. Hoping to capture suburbanization effects through changes in the population, we use city level data on the civil labor force from the Bureau if Labor Statistics (BLS). Unemployment trends at the regional level are from the BLS as well and mortgage interest rates are from Freddie Mac.

4 Sub-Housing Market Connectedness

Much of the work on the interconnectedness of housing markets has been applied to regions in the UK. Inter-regional diffusion or ripple effects (due to house price shocks) are hypothesized to spread throughout the country from one region to the next, but the evidence to support this hypothesis is mixed. Meen [16] argues that the stationarity of the ratio of regional to national home prices is suggestive of this interconnectedness as it reflects short-run deviations of sub-markets from the national market, but long-run co-movement of trends. In the U.S., Gupta and Miller [8] find support for ripple effects across metro areas in Southern California. Canarella, Miller and Pollard [5] study time series properties of several U.S. regional housing markets. Following Meen, they perform unit root tests (allowing for up to two structural breaks that capture recession periods in the early 1990's and 2000's) on the ratio of regional to national home price indices. They find some support for a weak segmentation of the U.S. housing market, where only East Coast metro areas exhibit ripple effects. Our interest, however, lies in exploring connectedness at the intra- as opposed to inter- regional level. Along those lines, Jones and Leishman [15] find that intra-regional migration contributes to the connectedness of sub markets in a sub region of Scotland. In the Cleveland MSA, intra-regional migration (manifested in part as sprawl) and decreased net immigration into the region have likely influenced city home price trends relative to the MSA.

Figure 5 shows that in all cities excepting the outer ring suburbs, the last 4 years exhibit a significant drop, clearly deviating from their long run trends. Up until the end of 2004, trends are much more supportive of a co-movement of indices for the inner ring suburbs as compared to the extended period. Applying Meen's method, we perform Dickey-Fuller unit root tests for each of

the log city-to-MSA home price index ratios for the pre-crisis period, through 2004, as well as for the whole 1990Q3-2009Q4 period. We find that, regardless of the time period, the unit root null hypotheses cannot be rejected in favor of stationarity of the log ratio of indices (see table 1). It is important to note, however, that Meen performs this test on simple price averages. Our smoothing of the price indices reduces noise in the data so that the test is able to capture relatively small price dispersions that would go unnoticed otherwise. In fact, performing the test on the non smoothed index leads to a rejection of the unit root null hypothesis for all cities in the first period. For the full time period, the stationarity hypothesis can no longer be supported for most inner ring suburbs.
It is likely that the abrupt change in the ratio starting in 2006 has to do in part with differences in screening the data used to calculate the Case-Shiller versus our repeat sale indices, but it is also due to our focusing on the county with the highest rates of non-prime lending, delinquencies, and foreclosure within the MSA. However, it is interesting to note that this discrepancy does not apply to outer-ring suburbs, that either continue with their long-run, slightly negative drift away from the MSA index, or marginally narrow this distance as the MSA index falls relative to the cities'.

5 A Spatial Dynamic Model of Intra-Regional Home Prices

Despite the lack of evidence for stationarity of the (log) city to MSA index ratios, for the most part, city indices do not deviate drastically from the MSA index until 2005, where a clear disruption takes place for central city and inner ring suburban home prices. We estimate a baseline spatial dynamic regression model of city home prices for the pre-crisis period that accounts for population changes, unemployment, the annual average interest rate for a 30 year fixed rate mortgage, and a measure of foreclosure-related distress. A similar model is presented by Brady [4], who analyzes diffusion patterns in monthly home prices for a dynamic panel of 31 California counties from 1995 through 2002. He estimates a county-fixed effects model of average single-family home sale prices. His right hand side variables besides the spatial and time lags of home prices include unemployment rate, population, and new construction that vary with time and county. Other explanatory variables are U.S. level real national mortgage rate and an industrial production index. Our analysis does not aim to capture diffusion effects from a one period shock to home prices, but rather to assess any qualitative changes in intra-regional home price dynamics that may have occurred due to high levels of foreclosures persisting over several periods of time.

The following dynamic panel model with a spatial endogenous variable is estimated:

$$Y_t = \rho W Y_t + \beta_1 Y_{t-1} + \beta_2 S_t + \beta_3 U_t + \beta_4 P_t + \beta_5 r30_t + \delta + e_t \qquad (2)$$

where Y_t is a 15×1 vector of estimated repeat sales home price indices for the t^{th} quarter, for the 15 cities used in the study, all within the Cleveland MSA. W is the 15×15 standardized spatial contiguity matrix among cities. The percent of sales that are sheriff sales is S_t. U_t is a vector of city unemployment rates, and P_t is adjusted civil labor force growth indexed to 1990[10] As with home price indices, a 4-period moving average is applied to sheriff sales percent, unemployment rates, and the adjusted civil labor force index. Finally, $r30_t$ is the annual average 30 year fixed rate and city fixed effects are represented by δ.

Clearly endogenous regressors are the time lag of hpi and its spatial lag. Unemployment and sheriff sales as a percent of all sales are possibly endogenous too. Changes in the percent of distressed sales are likely to affect the home prices of nearby houses, but it may also be the case that changes in home prices affect the percent of underwater borrowers, and thus, the percent of sheriff sales in the area. The model is estimated via two-stage least squares using as instruments the time lags of all endogenous regressors mentioned, as well as the spatial lags of sheriff sales, unemployment, and labor force, to instrument the spatial lag of home price index. This model is used to assess changes in the spatial and time persistence of foreclosure spillovers, via time varying parameters estimates. More explicitly, model 2 is estimated 40 times for the following sequence of time periods $[1990Q3 + t, 1999Q4 + t]_{t=0...40}$, where t refers to quarters, to see how and when changes in the model parameters take place.

---

[10]Civil labor force estimates from the BLS are updated with Census data, which can lead to significant discontinuities in Census years. To address this issue, we adjust data points between the years 1990 and 2000 (40 quarters) as follows: $\hat{clf}_t = (1 - t/40)clf_t + (t/40)clf_{2000Q1}$ so that new data points are a weighted average of the original data point and the 2000Q1 value. The weights are such that the contribution of the 2000Q1 data point increases as t moves away from 1990Q1 and closer to 2000Q1.

Table 2 reports the parameter estimates for both periods:1990$Q3-2004Q4$ and 1990$Q3-2009Q4$. Parameters of the rolling regression are presented in figure 6. The effect of distressed sales starts to change after 2005, and becomes clearly negative in late 2006, at the same time when spatial correlation among cities increases. For both periods, home price indices are highly persistent as can be seen through the size and significance of the time lag coefficient. Despite the fact that most of the variation in home prices is explained by the city's own time lag, it is interesting to note that the coefficient for the spatially lagged dependent variable in both periods is positive and significant while persistence through time is somewhat reduced. In other words, home prices in adjacent cities contribute to explain own city home prices and the size of this contribution seems to grow in recent times. So even as cities' have experienced foreclosure shocks of varying magnitudes, the connectivity between city home prices within the region has not weakened. Although one would expect loss of population as proxied by the adjusted change in civil labor force to relate to lower home prices, there is no significant contribution of this variable once the time and spatial lags are accounted. Similarly, unemployment and interest rate effects are estimated with very little precision. After 2005 the percent of home sales that are sheriff sales dramatically increases in all cities and its negative impact on city home prices becomes stronger.

6 Conclusions

Research supports the notion that central cities and their suburbs are tied together by their economic fate, growing or declining together, rather than at each other's expense. In particular, the weakening of central city institutions tends to have a negative effect on suburban home values. In this context, how does the foreclosure crisis affect the relationship between sub-housing markets around a central city strongly hit by such crisis? This paper explores home price dynamics before and after the foreclosure crisis for a group of cities in the Cleveland MSA, a market that in the aggregate experienced little home price appreciation prior to the crisis, but significant follow-up depreciation. The analysis includes inner and outer ring suburbs. Interregional connectedness, expressed as the relative importance of neighboring housing market conditions in explaining city home prices, has increased in the period following the crisis. This is the case even as home prices respond to different intensities of local distress as measured by the percent of home sales in the city that are sheriff sales. Possible factors that contribute to the increased connectedness of sub-housing markets besides overall regional conditions may be operating through the foreclosure disamenity and supply effects. While the disamenity effect is mainly localized around a relatively small distance from the foreclosed home, the supply effect has the potential to operate across neighborhoods, and thus, may add to the increased connectedness of home prices across cities. The analysis indicates that, as of the fourth quarter of 2009, inner ring suburbs have been the most hardly hit by the crisis and foreclosure effects on house price dynamics give little sign of receding in the near future.

References

[1] J.R. Abel and R. Deitz. Bypass the bust: The stability of Upstate New York's housing markets during the recession. *Current Issues in Economics and Finance*, 16(3), 2010.

[2] M.J. Baily, R.F. Muth, and H.O. Nourse. A regression method for real estate price index construction. *Journal of the American Statistical Association*, 58(304):933–942, 1963.

[3] T. Bier. Moving up, filtering down: Metropolitan housing dynamics and public policy. Discussion paper series, Brookings Institution, September 2001.

[4] R.R. Brady. Measuring the diffusion of housing prices across space and over time. *Journal of Applied Econometrics*, 26(2):213–231, March 2011.

[5] G. Canarella, S.M. Miller, and S.K. Pollard. Unit roots and structural change: An application to U.S. house-price indices. Working papers 2010-04, University of Connecticut, Department of Economics, February 2010.

[6] K. Case and J. Shiller. Prices of single-family homes since 1970: New

indexes for four cities. *New England Economic Review*, 79(1):45–56, 1987.

[7] C. Coulton, K. W. Hexter, A. Hirsh, A. O'Shaughnessy, F. G.-C. Richter, and M. Schramm. Facing the foreclosure crisis in Greater Cleveland: What happened and how communities are responding. Report, Federal Reserve Bank of Cleveland, June 2010.

[8] R. Gupta and S. Miller. The times series properties of house prices: A case study of the Southern California market. *Journal of Real Estate Finance and Economics*, 2009.

[9] J.R Hagerty. How good are Zillow's estimates? News article, The Wall Street Journal, February 2007.

[10] J. Harding, E. Rosenblatt, and V. Yao. The contagion effect of foreclosed properties. *Journal of Urban Economics*, 66:164–178, 2009.

[11] D. Hartley. The effect of foreclosures on nearby housing prices: Supply or disamenity? Working papers 2010-11, Federal Reserve Bank of Cleveland, September 2010.

[12] A. Haughwout and R. Inman. Should suburbs help their central city? *Brookings-Wharton Papers on Urban Affairs*, 2002.

[13] D. Immergluck and G. Smith. The external costs of foreclosure: The impact of single-family mortgage foreclosures on property values. *Housing Policy Debate*, 17(1), 2006.

[14] Zillow Inc. Real estate market report- FAQ. http://www.zillow.com/wikipages/Real-Estate-Market-Reports-FAQ/.

[15] C. Jones and C. Leisman. Spatial dynamics of the housing market: An interurban perspective. *Urban Studies*, 43:1041–1059, 2006.

[16] G. Meen. Regional house prices and the ripple effect. *Housing Studies*, 14:733–753, 1999.

[17] B.A. Mikelbank. Spatial analysis of the impact of vacant, abandoned and foreclosed properties. Working paper, Federal Reserve Bank of Cleveland, 2008.

[18] J. Rappaport. The shared fortunes of cities and suburbs. *Economic Review*, 90:33–60, 2005.

[19] F. T. Wang and P. M. Zorn. Estimating house price growth with repeat sales data: What's the aim of the game? *Journal of Housing Economics*, 6(2):93–118, 1997.

Table 1: Dickey-Fuller Unit Root Test Statistic for Log City-to-MSA Home Price Index Ratios

City		1990Q3-2004Q4	1990Q3-2009Q4
1	Cleveland	−1.443	0.096
2	Lakewood	−2.113	−0.516
3	Brook Park	−2.211	−0.692
4	Parma	−1.146	1.424
5	Garfield Heights	−3.565	3.958
6	Euclid	−1.846	3.040
7	East Cleveland	−1.839	0.144
8	Cleveland Heights	−1.115	0.386
9	South Euclid	−2.141	0.748
10	Shaker Heights	−1.846	0.798
11	Maple Heights	−1.912	0.227
12	Westlake	−1.239	−2.322
13	North Olmsted	−0.898	−0.765
14	Strongsville	−0.597	−1.446
15	North Royalton	−1.593	−2.181
	10% critical value	−2.596	−2.589
H1: ratio is AR(1) stationary in deviations from the mean.			

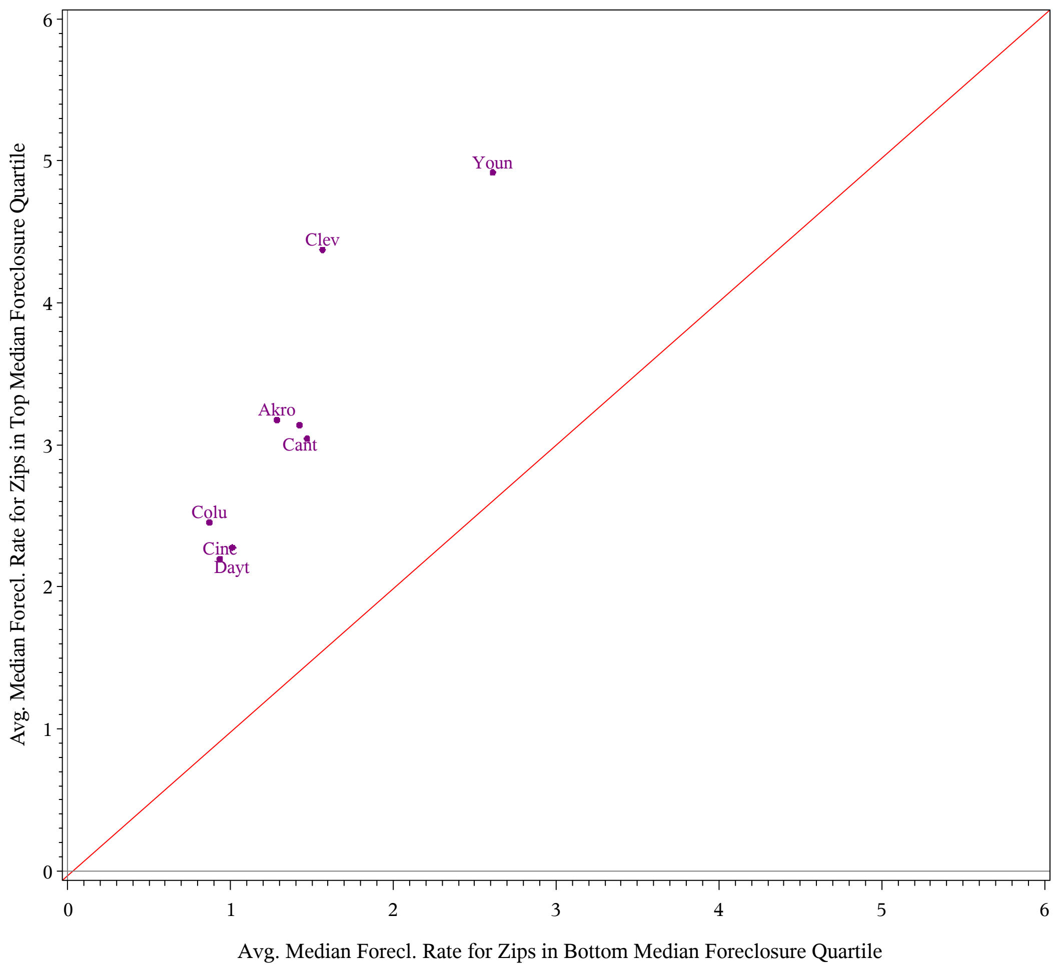

Figure 1: Average median foreclosure rates across zip codes in most and least distressed quartiles within MSAs. For each zip code, the median is taken over the period 2006Q1-2009Q4.

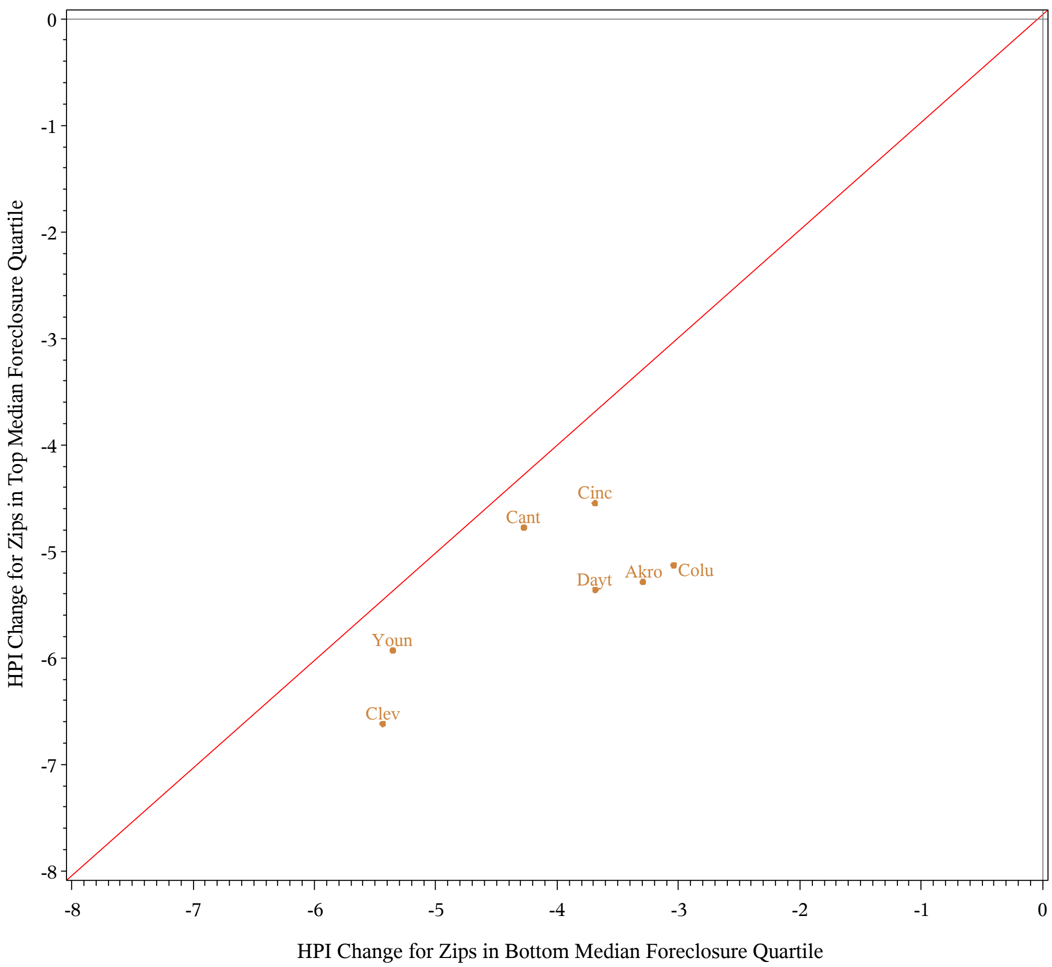

Figure 2: Average compound annual CoreLogic home price index growth rate in zip codes most and least hit by foreclosures within MSAs, over the period 2006Q1-2009Q2.

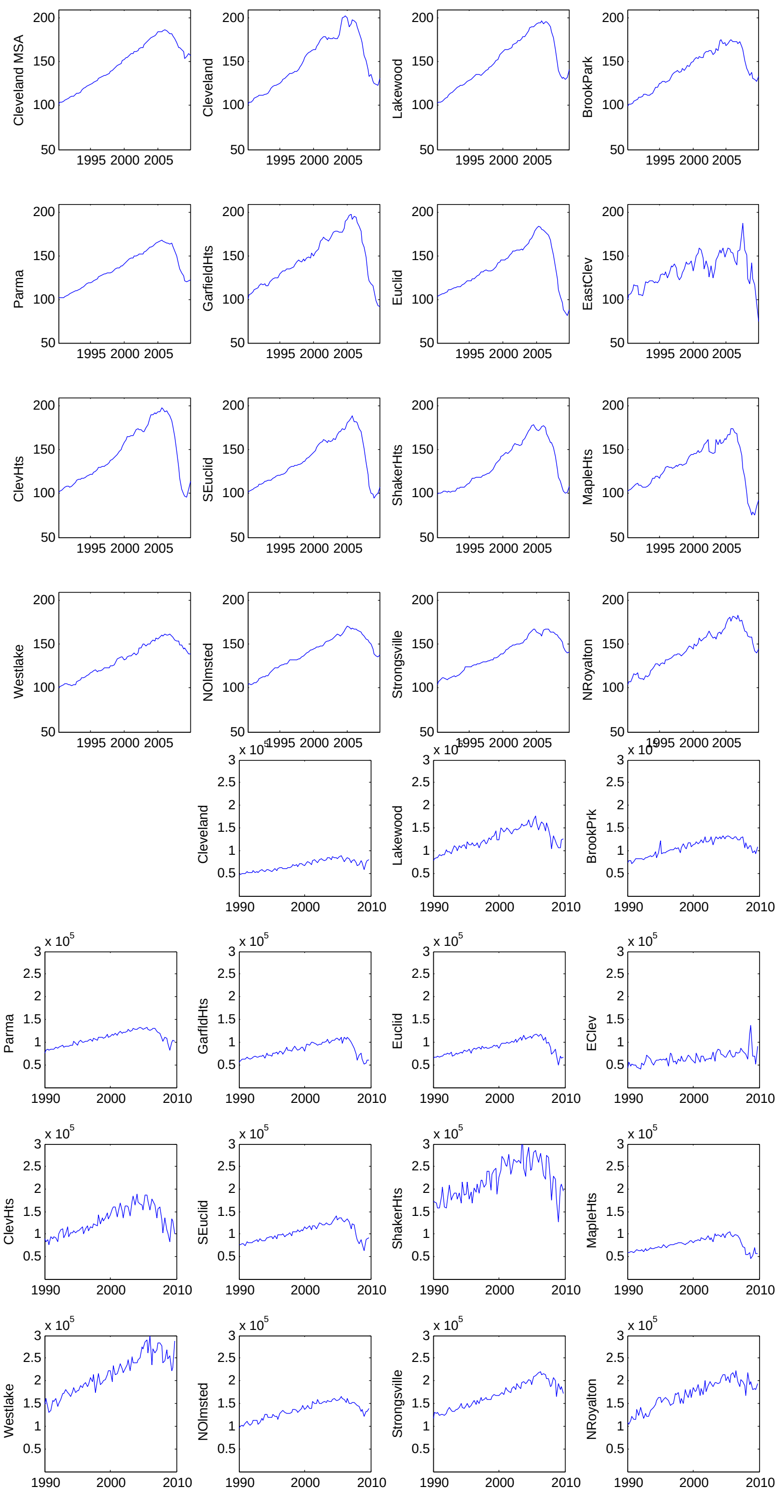

Figure 3: Estimated Repeat Sales HPIs (top) and Average Sales Price (bottom) for Screened Repeat Sales Pairs, 1990Q1-2009Q4

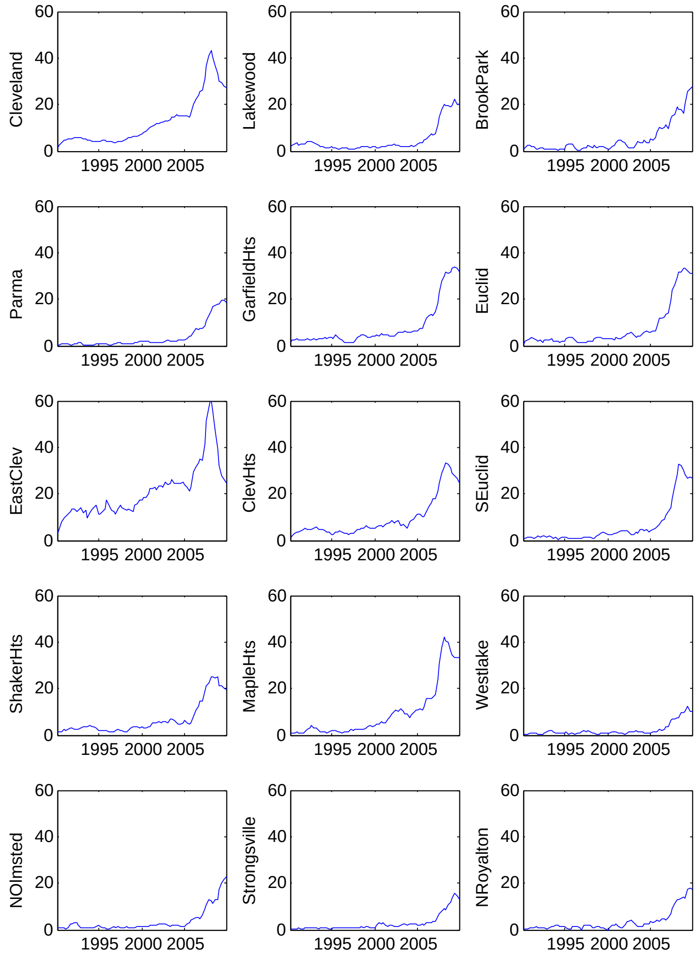

Figure 4: Four-Period Moving Average of the Percent of Home Sales that are Sheriff Sales, 1990Q1-2009Q4

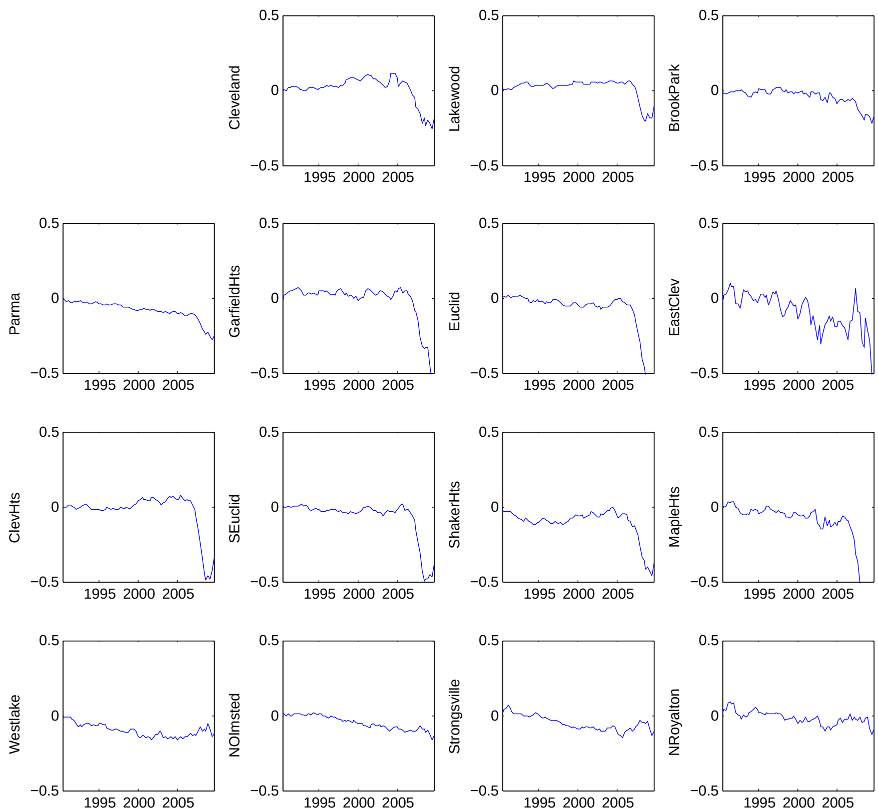

Figure 5: Estimated Log City-to-MSA Home Price Index Ratio for Period 1990Q1-2009Q4

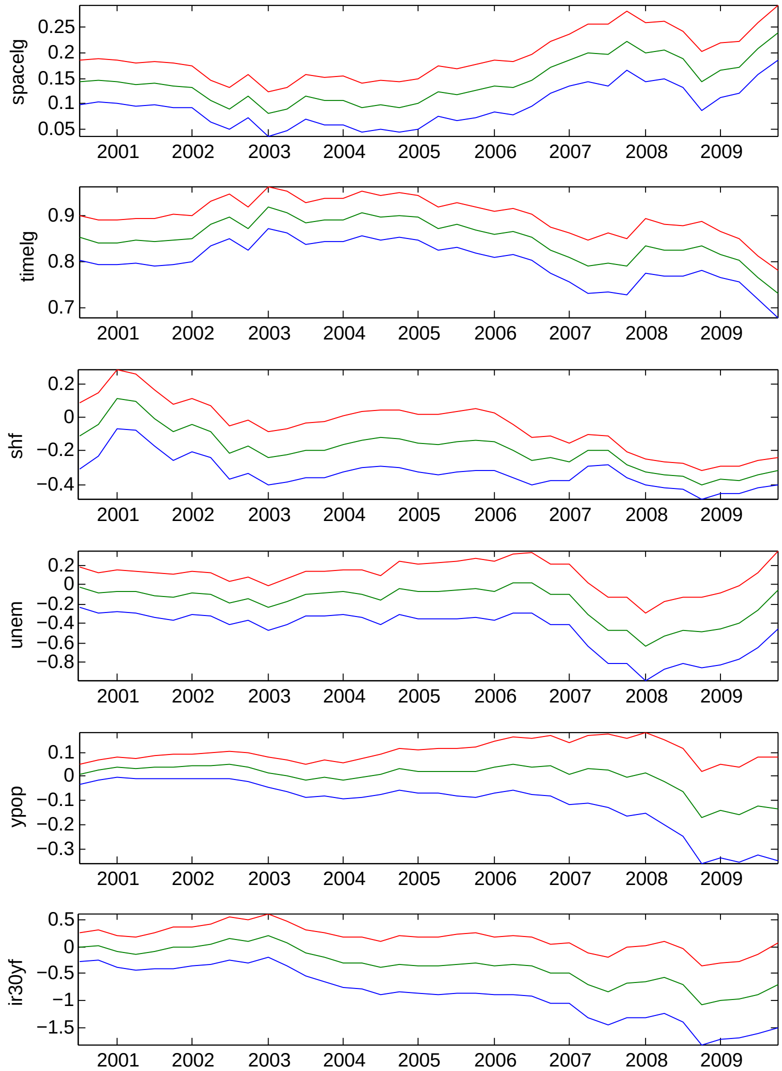

Figure 6: Time-varying Parameters for Model Sequentially Estimated Over the Period 1990Q3-2009Q4, with 40 Quarters each Time

Table 2: Spatial Dynamic Regression Model for 15 City Home Prices in the Cleveland MSA estimated via Two-Stage Least Squares

	1990Q3-2004Q4			1990Q3-2009Q4		
Variable	coeff.	t-val.	p-val.	coeff.	t-val.	p-val.
$w.y_{i,t}$: spatial lag of hpi	0.071	4.462	0.000	0.162	11.200	0.000
$y_{i,t-1}$: time lag of hpi	0.929	55.543	0.000	0.814	55.914	0.000
$shf_{i,t}$: % distressed sales	-0.122	-2.066	0.039	-0.280	-14.259	0.000
$unm_{i,t}$: % unemployment rate	-0.029	-0.391	0.696	-0.075	-0.985	0.325
$clf_{i,t}$: labor force change index	0.006	0.337	0.736	0.009	0.449	0.653
$r30_t$: annual avg. 30y fxd rate	-0.121	-0.790	0.430	-0.647	-4.129	0.000
City fixed effects	Yes			Yes		
Adj-R^2			0.988			0.981
σ^2			5.931			11.959
obs.			870			1170

Instruments: hpi_{t-2}, $unm_{i,t-1}$, $shf_{i,t-1}$, $w.y_{i,t-1}$, $w.shf_{i,t-1}$, $w.unm_{i,t}$, $w.clf_{i,t}$, where $w.$ stands for spatial lag.