SPATIAL ANALYSIS OF THE IMPACT OF VACANT, ABANDONED AND FORECLOSED PROPERTIES

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Summary

The terms *vacant*, *abandoned*, and *foreclosed* are, unfortunately, becoming increasingly familiar, not only to those involved in the study of housing, but to anyone who reads the newspaper or watches the news. They are often discussed together, even though the two processes—vacancy/abandonment on one hand and foreclosure on the other—do not entirely overlap. Certainly, while the two may share space as part of a larger picture of a housing market in crisis, not all foreclosed properties become vacant and abandoned, and not all vacant and abandoned properties are the direct result of a foreclosure.

Complications arise when one tries to estimate the impact of one of these processes in the absence of information on the other. Unfortunately, this has been commonplace, as accurate data on vacant/abandoned properties have been much more difficult to obtain than data relating to foreclosures. Since this is not the case for Columbus, Ohio, both processes are studied simultaneously to estimate the impact of each while holding constant the impact of the other. This is the first analysis to do so.

A sequence of three models is estimated, revealing that examination of foreclosure in isolation overstates its impact on surrounding house prices. Estimating the impact of vacant/abandoned properties in isolation leads to a misunderstanding not only of the magnitude of the impact, but also of the impact's spatial footprint. This combination leads to an overestimation (by more than double) of the impact of vacant/abandoned properties on surrounding house prices.

Modeled together, the impact of a vacant property on a nearby house sale is more severe, but has a smaller "spillover" effect—out to 500 feet. The effect of foreclosures, by contrast, is more moderate, but has a significant impact out to 1,000 feet. Additionally, since the distribution of foreclosures is more widespread throughout the study area, their estimated aggregate impact (for 2006) of more than $97.5 million far outpaces the $16.9 million impact of vacant/abandoned properties, which are more clustered in the core of the city.

While the specific regression coefficients estimated for Columbus will pertain to that market only, the relevance of the demonstrated modeling approach applies universally. The relationship between the geographies of the two issues and the links between them in the substantive process of housing decline make the approach demonstrated here critical if the role of either vacant/abandoned properties or foreclosure is to be accurately understood in any local housing market.

1. Introduction

Healthy housing markets lay the foundation for community vitality. A strong local housing market is evidence that households are invested in their neighborhoods, both financially and figuratively. A city of strong neighborhoods breeds a confidence among households, businesses, developers, and community leaders that spills over into the city's economy in general.

A housing market in crisis, on the other hand, could be foretelling of a city in despair. Can the tax base be maintained? What about the current level of city services? If a city is forced to alter the tax/service balance, will additional residents consider "voting with their feet" by moving to another city? This negative energy also spills over into other areas of the economy. When human and economic resources start to flow from a city, that drain feeds upon itself, as remaining resources and population become increasingly isolated, with fewer and fewer reasons to stay.

With this link between a community's housing and its broader economic health in mind, it is important to understand the forces that could potentially weaken the housing market. For years now, the predominant force of interest to cities has been "sprawl," and while the causes and implications of sprawl continue to be addressed, two new challenges are competing for top billing in terms of their debilitating effects on urban, and increasingly suburban, communities. These are (1) vacant and abandoned[1] (V&A) properties, and (2) residential foreclosure.

The research detailed here thus considers the impacts of both of these challenges in the context of the single-family housing market of Columbus, Ohio. This research pushes the current discussion forward on these topics in two ways. First, these impacts are considered jointly, while previous research has considered separately the impacts of foreclosures *or* of vacant/abandoned properties. Second, they are analyzed in a spatial econometric model—the local spatial effects have not been modeled in

[1] This research deals only with the combination of vacant and abandoned together. Housing may be temporarily vacant as part of the normal turnover of the housing market – while a landlord seeks a tenant, or while a house sits for sale after its former occupants have moved to a new dwelling. This research focuses only on dwellings that are vacant and abandoned, where there is no apparent effort being made to bring the dwelling back into productive use.

previous research. The current approach, therefore, will not only estimate the related effects on house price of both foreclosure and vacant/abandoned properties, but it will also distinguish between each of those effects and any spatial influence/misspecification, which, left unaddressed, could compromise efforts to accurately understand the underlying impacts.

2. Background

Policy interest and research focusing on vacant and abandoned properties and foreclosure has certainly gained momentum in the recent past, both nationally and here in Ohio. For example, the National Vacant Properties Campaign[2] and Rebuild Ohio[3] are currently involved in national and state level research, respectively, documenting the depth and breadth of the vacant and abandoned property problem. Similarly, Policy Matters Ohio[4] has produced a series of reports detailing the continuing severity of the foreclosure problem in Ohio.

Despite the increased media coverage as of late, however, these topics are not new to the urban scene. For example, Accordino and Johnson (2000) used mailed questionnaires and telephone interviews to investigate the degree to which abandoned property was perceived as a significant problem across U.S. cities. Their findings suggested that not only was it a problem in general, but that it was especially pronounced in cities that were only moderately growing or even in decline. It is notable that the survey took place well in advance of any mention of a subprime lending crisis, a foreclosure crisis, or a housing market slowdown. The issue of vacant and abandoned properties was already a prominent urban challenge *before* any of the more recent complications were introduced to the market.

Cohen (2001) provides an overview of the problem at the national level, and then focuses on three neighborhoods in Baltimore, Maryland, to illustrate the challenges vacant and abandoned properties posed there. Even at the time of Cohen's study, however, the problem of vacant and abandoned properties was predominantly an older

[2] http://www.vacantproperties.org
[3] www.vacantproperties.org/rebuildohio.html
[4] www.policymattersohio.org

industrial city type of problem, linked to population loss and out-migration. In other words, it was an issue of regional population dynamics that manifested itself in the housing market, rather than an issue specifically emanating from the housing market itself.

Bier and Post (2003) reinforce this message. They focus on a region's balance of new households and new housing units. They call attention to the unavoidable result when the latter outpaces the former: the market creates a surplus of housing units. When this occurs, those units at the bottom of the market, typically in the region's central city, fall out of the market—they become vacant.

Apgar and Duda (2005) estimated the direct costs borne by a city due to vacant properties as a summation of the various municipal costs that are associated with the services provided by various agencies. The total cost to a city can be as low as $27 but can run as high as $34,199. Rebuild Ohio (2008) undertook a similar approach, and across eight Ohio cities documented more than 15,000 vacant and abandoned properties and over $60 million dollars in costs associated with them.

Beyond measuring these direct costs, research has begun to address the impact of foreclosure and abandonment on local housing markets. This is typically accomplished via hedonic modeling (Rosen, 1974). In a hedonic model, the characteristics of a house are used as independent variables in a regression model in an effort to explain or predict the sales price of that house. Hedonic modeling is widely used to measure housing market impacts and externalities, and has recently been applied independently to both vacant and abandoned properties and foreclosures.

For example, the report Blight Free Philadelphia (2001) details a hedonic model used to estimate the house-price impact of vacant and abandoned properties on sales prices of nearby houses in Philadelphia. They found that proximity to a vacant and abandoned house can lower the sales price of a nearby house by more than $7,000. Similarly, Immergluck and Smith (2005) studied the Chicago housing market and found that foreclosures citywide have decreased surrounding property values from roughly $600 million to $1.39 billion.

Lin et al. (2007) find that neighboring property values can decline by as much as 8.7 percent when a foreclosure is located within a distance of 0.9 kilometers of the sold house. They also find that the spillover effects diminish with both increased time and distance from the foreclosure.

Each of these papers detailing the investigation of foreclosures and vacant and abandoned properties has pushed the research field forward in our understanding of these negative housing market impacts. However, if we are to believe each of analyses independently, then we also have to believe that each model contains some level of misspecification, since each is missing a critical variable: the V&A property models do not account for the impact of foreclosure, and the foreclosure models do not account for the impact of V&A properties. Modeling efforts are further complicated by the overlapping nature of the processes, the geographies of their impact and the possibility that vacancy/abandonment and foreclosure are hitting specific neighborhoods with greater frequency and density than others. It is likely that current models are actually reporting an unknown combination of the impact of *both* factors, potentially mixed in with a neighborhood effect, if in fact these housing externalities are correlated with other neighborhood characteristics. The substantive contribution of the current research, then, is to simultaneously estimate the house-price impact of both V&A properties and foreclosures in a single model. This is the only way to distinguish between the unique housing market impacts of each.

Methodologically, these impacts are estimated in a spatial econometric context. The advantage of this approach is that the local (spatial) unexplained variation in housing price is extracted from the error term, where it creates problems with the underlying assumptions of the classical linear model. It is possible, for example, that this previously unmodeled spatial variation could create bias in the other regression coefficients, including those on the distribution of vacant/abandoned and foreclosed properties. It brings that variation into the deterministic portion of the model where it is estimated as an additional predictor/explanatory factor of house price variation. In the problem domain of housing prices, this has an entirely plausible empirical explanation—either that the price of neighboring houses influences the price of your house, or that there is a "neighborhood effect" that similarly impacts nearby houses. When the variables of particular interest to a hedonic model are also local/spatial in nature, as is the case here, separating out these local influences becomes even more important. What if, for example, the local effect attributed to a vacancy or foreclosure variable was actually due to a general negative neighborhood effect?

3. Study Area & Data

Based on the data experience detailed by Rebuild Ohio (2008), Columbus, Ohio was selected as the study area for this research.[5] The necessary sales, parcel, and structural information all originated from county auditor records. The Franklin County auditor distributes regularly updated digital records containing such information. In addition, the City of Columbus maintains and updates annually an electronic database detailing their stock of vacant and abandoned properties. Community Research Partners receives both of those data sets, and made them available for this research. Additionally, Community Research Partners, located in Columbus, has been spatially and temporally tracking foreclosures in the city using court records available via the Internet, and they shared those records as well. This research would not have been possible without their cooperation. It is relatively rare to find a city with quality information across its sales, vacancies, and foreclosures. This is likely the reason that these three topics have yet to be studied together at the parcel level.

Variables relating directly to the sold house that are used in the final model include the age of the house and the number of bedrooms, bathrooms, half-bathrooms, and other rooms. The presence of central air and at least one fireplace are included as indicator variables. Also included is the size of the lot (entered in natural logarithmic form). Franklin County tracks two measures that are useful in understanding the quality of a house: current condition, measured as poor, fair, average (the left-out, or

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[5] The study area includes the portion of Columbus that is located within Franklin County. Columbus also extends into both Delaware and Fairfield counties.

reference, category[6]), good, and very good, and construction quality, measured on a common grading system of A (best), B, C (the left-out category), D, and F.

In addition to the data directly relating to housing, a fully specified hedonic price model also requires data about the neighborhood. These data capture the impact of "location" on the selling price of the house. Schools are often a top priority for buyers, but since this study is contained to one city, one might think schools are not a variable of interest. For Columbus, however, this is not the case. The City of Columbus has within it the Columbus School District, along with several districts that would otherwise be considered "suburban." In fact, through various formulations of the models detailed in the following section, the distinction between specific districts generally was not a significant explanatory variable. What *was* significant was a single indicator variable noting whether or not the property was located within the Columbus School District.

Two additional variables included in the models were measured over the 1990 to 2000 time period. The first is the raw percent growth in renter-occupied housing. This was consistently more meaningful than whether the neighborhood was predominantly renter- or owner-occupied. The second was a growth ratio, used to measure changes in local housing demand. It is defined as the change in housing units over the decade divided by the change in households over the decade. Higher ratios would be associated with an oversupply of housing, and thus lower anticipated prices. Neighborhood stability is measured as the proportion of the population over five years of age that lived in the same house five years ago. Finally, we measured the distance (and its square) over the road network from each house to downtown Columbus as a measure of accessibility. Seasonal variations in price are captured through quarterly indicator variables, with the third quarter acting as the left-out category.

The final models contain information on 9,046 single-family-house transactions, as well as the location of 6,083 foreclosure filings[7] and 4,152 properties identified by the city as vacant and abandoned.

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[6] The regression coefficients on these indicator variables ("very good condition," for example) are interpreted as a price premium (or penalty) relative to an otherwise identical house that instead is characterized by the left-out category ("average condition," for example).

The first research task was to spatially integrate all of the data from the various sources into one geographic database. In some cases, this involved geocoding, or electronically matching data records to their location on a map (sales, foreclosures, vacant and abandoned properties), and in other cases it involved assigning these data to their relevant parcel, census block group, or school district.

While the data were aligned spatially, it is important to note the shortcomings in the data relating to their temporal detail. The vacancy and abandonment, foreclosure, and sales data are all for calendar year 2006. While the specific date for the foreclosure filing and the sale are known, there is no way to know the specific date a residence actually became vacant and/or abandoned. A vacant and abandoned property generally comes to the city's attention through their active inventorying process. Knowing the date at which the city became aware of the property still wouldn't pinpoint the date at which the property changed from a productive use to a potentially negative neighborhood externality; it merely reflects the nature of the city's scheduling for surveying specific neighborhoods. Thus, it turns out that the date associated with vacancy and abandonment that we have available is not relevant to the process under study here.

In addition, it is possible that properties appear on none, one, or both lists of vacant/abandoned properties and foreclosed properties. For one, our primary argument motivating this analysis is that the processes of vacancy and abandonment and foreclosure are distinct and should be estimated separately. For example, it is common that a property will go through much of the foreclosure process while still occupied. Additionally, in strong housing markets, a foreclosed property might be vacant for only a short time while it transitions to its new owner, but never abandoned. If in fact foreclosure does cause, or even result from, vacancy and abandonment, then the property appears on both lists, and nearby properties would be subject to the impact of both externalities. The consequence of keeping the lists distinct simply means that the effect investigated here is additive.

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[7] Foreclosure *filings* are studied here as a proxy for actual foreclosures. A filing may or may not result in an actual foreclosure—the owner may become up-to-date on the amount owed, sell the property, or reach some other agreement with the lender.

Although the creation of three mutually exclusive categories of impact (vacant and abandoned; foreclosed; vacant, abandoned, and foreclosed) would allow for an interaction effect, we lacked both the temporal detail in the data to know if the two events occurred together, and the justification to expect an impact different from the ones revealed individually. Thus, rather than build additional variables, we chose to model the separate effects within a single calendar year.

4. Method

A critical step in estimating any impact on a neighborhood housing market is deciding what the specific impact area might be. An exploratory spatial data analysis approach is taken here, where a base model is specified and then a set of variables, covering small increments of a larger potential impact area, are added to the model. In this fashion, the impact can be estimated over different spatial scales, whereby the effect can vary with distance, and in a (piecewise) non-linear fashion. For example, this approach would allow a distance-decay to the impact, where the effect of the externality decreases as distance from it increases. This approach avoids having to choose an arbitrary distance within which the externality (foreclosure or vacancy) is hypothesized to have an impact, and beyond which there is no impact expected. However, one isn't absolved entirely from the arbitrary decisionmaking process—the size of the increment still must be chosen, and 250 feet is used here. Thus, the impact of a sale being "near" a foreclosed or abandoned property is investigated in "rings" of 250 feet. In the presentation of the models, these are referred to as Ring 1 (0 to 250 ft), Ring 2 (250 to 500ft.), etc. Four rings were significant for vacant/abandoned and foreclosed properties in the base model, and were thus retained for subsequent models.

The modeling process undertaken is broken down into three stages. Underlying each model stage is the base hedonic model specification, classically explaining the variation in sale price as a function both of measures of the structural characteristics of the house and of characteristics of the house's neighborhood and location. This is Model 1. Model 1(f) and Model 1(v) use ordinary least squares (OLS) methodology to estimate *separately* the impacts that (f)oreclosures and (v)acant properties have on house price. These models are used to represent estimates of what we might understand the separate impacts to be if we had data on *only* the distribution of foreclosures *or* vacant/abandoned properties, but not both.

Model 2 estimates the impact of both externalities in the same OLS model, and thus for the first time identifies the impact of one, while holding the influence of the other constant. Even modeled jointly, however, it is possible that these effects are being clouded by unexplained local spatial variation in the model. Model 3, then, estimates the impacts jointly in a spatial econometric framework.

The process for estimation of the final spatial model is as follows: The regression residuals from Model 2 are investigated for spatial randomness, and the null hypothesis of "no spatial relationships" is rejected. This means that the residuals that are close to each other in location (in this case, within 500 feet) are close to each other in value. In other words, the residuals are not independently distributed.

The next challenge is to characterize the spatial pattern in the residuals and incorporate that characterization into the regression model itself. Two alternatives are explored. If the spatial variation in the residuals is better explained by the average housing prices surrounding each house, then a spatial lag model would be appropriate. A spatial lag model includes as a predictor variable in the model the average sale price of surrounding models in explaining the price of the subject house. Since the asking and sale price of a house is often influenced by the sales prices of nearby houses, this would be a reasonable housing market explanation. In this case, however, the spatial structure of the residuals was better explained by the average residual surrounding each house. This calls for a spatial error model, which includes as a predictor the average error term of houses within a 500-foot buffer of the sold house. The choice between models is accomplished via the values of the traditional and robust Lagrange–Multiplier tests.

The need for a spatial error specification is often attributed to unmeasured neighborhood influences that are common to proximate houses, but not captured in the model. It is also possible that the influences are measured, but imperfectly, for example, by using census data that produces sharp boundaries to socioeconomic data that more likely follow a more gradual gradient in reality. This produces measurement error that again would be similar for proximate properties.[8]

5. Results

The first point of interest lies in the disparate spatial distributions of foreclosed properties compared to vacant and abandoned properties. Figure 1 shows the distribution of foreclosures to be much more widespread than that of vacant and abandoned properties. Thus, although foreclosure and vacancy and abandonment are often discussed as being part of the same overall process, it is not the case that each component has the same spatial footprint. Thus, regardless of the findings of the regression coefficients of the regression models, at the core of any subsequent findings is the fact that **the effects of vacancy and abandonment are far more concentrated in the central city. Foreclosures, on the other hand, have spread through the city, and their impact is felt nearly universally throughout each of the city's neighborhoods.**

The results for Models 1, 1f, and 1v are presented in Table 1. The dependent variable is the natural logarithm of house price, and the data cover calendar year 2006. Since Model 1 serves as the base for all models, some time will be spent in its description before moving on to the specific variables of interest (foreclosures and vacant and abandoned property impacts).

The structural characteristics of the house contribute to sale price in predictable ways. For example, of the size characteristics (bedrooms, bathrooms, half baths, other rooms, lot size), are all positive and all are significant. A 10-percent price premium is associated with the presence of a fireplace. A few of the model variables are likely too large, but are possibly picking up an additional unmeasured quality theme. For example, the coefficients associated with the presence of central air (a 26% price premium) and additional half baths (an 11% price premium for each) are likely higher

[8] Spatial specifications were carried out in the GeoDa software.

than we would otherwise anticipate. This view is bolstered by the fact that in more complete specifications, the value of some of these coefficients decreases substantially.

The quality variables line up in rank order, with price penalties for condition and quality being below average, and premiums associated with those that are above average. The extreme values of these price penalties and premiums are not unexpected, as the city of Columbus has a wide range of single-family housing opportunities, from aging inner-city houses to newer suburban-like development. The impact of being located within the Columbus School District is not significant in Model 1, but given the spatial distribution of the quality variables, it is likely that the influence of being located in the Columbus School District is being captured in the quality variables. The impact does become significant and negative in subsequent specifications.

Growth ratio, rental transition, and neighborhood stability are all consistently negative and significant, the last of these unexpectedly so. It is possible that residential turnover might be lower in the older parts of the city that have been built out for decades, without any recent new construction. These neighborhoods, which have on average older housing stock, could be associated with lower overall price levels.

Distance to downtown Columbus (and its square) is significant in all but the base model, and is consistent with a price gradient that declines as one moves away from the central city, but at a decreasing rate. The turning point in each model is reached before 10 miles, such that prices increase with distance after that point.

Table 2 shows the results of Models 2 and 3. Model 2 contains all of the variables of the base model, plus both the foreclosure and vacant/abandoned variables. Model 3 is the spatial-error specification, which includes the spatial lambda coefficient, which is an indicator of the importance of space in the regression model. The adjusted R-squared is presented for all models, but is not directly comparable between the OLS and the spatial models. The likelihood function, the Akaike Information Criterion and the Schwarz Criterion are comparable across models, and each shows improvement between Model 2 (OLS approach) and Model 3 (spatial approach).

The specific focus of this research is in the performance of the foreclosure and vacant/abandoned variables across all of these models. Coefficients are extracted from the respective tables and presented graphically in Figures 2 and 3. Figure 2 focuses on the regression coefficients of the foreclosure variables, and the trend of the coefficients across all models is logical—foreclosures closer to the sold house have a larger negative impact than foreclosures farther away. The blue line shows the coefficients from Model 1f, which would represent our best estimate of the impact of foreclosures if we had no information on the distribution of vacant/abandoned properties.

Across all buffer sizes, the estimated impact of foreclosures is less severe when vacant/abandoned properties are included in the model, as shown in Model 2, the full OLS model, which is depicted in red. When foreclosures alone are included in the model, some of the unmeasured negative impact of vacant/abandoned properties is being incorrectly attributed to the influence of nearby foreclosures. Thus, in models where the impact of foreclosures is modeled, and the distribution of vacant/abandoned properties is not included, the impact of foreclosures is being overestimated. That is clearly the case here, and it is potentially the case in other similarly specified models.

Model 3, shown in yellow in Figure 2, further refines the estimate, and not in a uniform manner. Herein lies the difficulty in not capturing spatial effects when they are present—the impacts on the regression coefficients are not uniform. In this case, the impacts in the nearest and farthest rings are less severe, while the impacts in the intermediate rings are more severe.

A similar scenario plays out in Figure 3, which focuses on the regression coefficients of proximate vacant/abandoned properties. The blue line represents the coefficients in Model 1v, where the influence of foreclosures in not measured. The vacant/abandoned coefficients of Model 2 are shown in red. The impact of vacant/abandoned properties becomes more severe in the closest ring, but less severe in the remaining rings when foreclosures are included in the model. In the 250-foot ring, when the impact of vacant/abandoned properties is measured alone, its estimated coefficient is biased toward zero, because the coefficient is actually picking up some of the (less severe) influence of foreclosures. When foreclosures are added to the spatial model (Model 3, shown in yellow), the impact of vacant/abandoned properties is more severe in the closest ring, less severe in the second ring, and *not* significant in the third and fourth rings. Thus, **when foreclosures and vacant/abandoned properties are investigated together in a spatial model, the impact of the latter is more severe very close to the sold property, but has a smaller impact on/in the neighborhood.** The harsher impact is consistent with the visual blight that often accompanies a vacant and abandoned house. However, contrary to the results when modeled alone (Model 1v), the impact is not significant beyond 500 feet.

Figure 4 presents the coefficients from the final model (Model 3), comparing the magnitude and significance of the impacts of foreclosures and vacant/abandoned properties. Just as was shown by their raw spatial distribution in Figure 1, **Figure 4 shows two distinct impacts**, despite the fact that these phenomena are often discussed as being so closely related. The per-foreclosure impact on a sold house is less severe in close proximity, but its impact is more spatially robust—it is significant out to 1,000 feet, and decreases only to slightly higher than 1 percent. The per-vacant/abandoned property impact is more severe within the first 250-foot ring, at about 3.5 percent, but is less than 1 percent in the subsequent ring and is insignificant beyond the second ring.

From a city's perspective, this particular finding highlights the importance of returning housing to a productive use as quickly as possible. In cases where foreclosure precedes vacancy and abandonment, the potential for avoiding the more severe "vacancy/abandonment" impact should serve as an additional municipal incentive to keep the occupants in that house. Targeted foreclosure prevention and resolution outreach services could be helpful in this regard. Where vacancy cannot be avoided, the finding highlights the importance of maintaining a property throughout the foreclosure process, so that although foreclosed and vacant, a property retains its value so that abandonment is unlikely to occur. A city's housing/code enforcement department could play a strong role here, taking a proactive approach in identifying and targeting recently foreclosed properties.

When vacancy and abandonment does occur, these results show that the city could curb value loss by demolishing or rehabilitating abandoned properties as quickly as possible. Since the estimated impacts revealed here are realized only when nearby houses sell, a short-lived instance of neighborhood blight is preferable to a lingering one. An abandoned house that is allowed to remain so for two or three years would negatively impact every sale in its vicinity over that time period. Swift action to remove the blight would limit the negative impact, and potentially even turn its impact to a neighborhood gain through increased green space, reinvestment, or both.

What is clear from this group of models is that even though foreclosure and vacant/abandoned properties are part of the same housing crisis that is plaguing many urban areas, their spatial distribution and their spatial impacts are distinct.

The aggregate implications of refining these estimates are dramatic. Figure 5 shows the results when the impacts are summed across all sold houses. When each impact was modeled separately, the total impact of foreclosures (from Model 1f) was more than $126 million, and the total impact from vacant/abandoned properties (from Model 1v) was nearly $42 million. The biggest improvement in our understanding of how these processes operate together came from modeling them in the same OLS regression model (Model 2). The total estimated impact of foreclosures was reduced to approximately $98 million, and the total impact of vacant/abandoned properties was reduced by more than half, to just over $18 million.

The reduction in foreclosure impact is due exclusively to the coefficients being refined by the presence of vacant/abandoned properties in the model. The reduction in vacant/abandoned impact occurs primarily because the geography of the impact was refined. In Model 1v, the impact was significant out to 1000 feet. In Model 2, the impact was only significant out to 500 feet. In the spatial model, where a neighborhood effect is explicitly measured, each aggregate impact is further refined, but only modestly so. Modeled separately, we would have thought the aggregate impact of these market externalities to be nearly $168 million. **However, modeling these impacts jointly and in a spatial framework has revealed that aggregate number to be an overestimate, and a substantial one—nearly $57 million higher. The total 2006 housing market impact estimated here is slightly more than $114 million.**

The final balance between the impact of foreclosure and the impact of vacant/abandoned properties shown in Figure 5 may seem at odds with Figure 4, which shows the more severe local impact of vacant/abandoned properties. Remember, though, that the overall distribution of vacant/abandoned properties is relatively concentrated when compared to that of foreclosure, as shown in Figure 1. Thus, the citywide spillover effect of foreclosures winds up being much greater, since foreclosures are more widely spread throughout the city. For example, while 1,670 sales had at least one vacant/abandoned property within 250 feet, more than twice as many properties (3,788) were within 250 feet of a foreclosure. **More properties in the City of Columbus suffered the neighborhood effect of foreclosure, leading to the larger aggregate impact.**

The picture is much more balanced when the impacts are investigated on a per-property basis, as shown in Figure 6. It is important to note that these are the per-property impacts *for properties that were proximate to a foreclosure or vacant/abandoned property*. This is not the average impact for all properties. Since some properties are not impacted by either distribution, it did not make sense to divide the aggregate impact among all properties. Here again, the differences in the underlying distribution of the two housing market ills becomes apparent. The larger aggregate impact of foreclosures is spread among a larger number of impacted properties, whereas the smaller aggregate impact of vacant/abandoned properties is shared among relatively fewer properties. For properties impacted by both, the price penalty for their location near foreclosed and vacant/abandoned properties was more than $8,600.

	Model 1: Base				Model 1f: Foreclosures Only				Model 1v: Vacant and Abandoned Only			
	B	Std. Error	t	Sig.	B	Std. Error	t	Sig.	B	Std. Error	t	Sig.
(Constant)	10.889	0.042	260.556	0.000	11.189	0.041	273.013	0.000	11.185	0.041	269.701	0.000
Sale: Quarter 1	-0.035	0.011	-3.197	0.001	-0.035	0.010	-3.334	0.001	-0.028	0.010	-2.706	0.007
Sale: Quarter 2	-0.013	0.010	-1.241	0.214	-0.010	0.010	-1.040	0.298	-0.013	0.010	-1.338	0.181
Sale: Quarter 4	-0.045	0.011	-4.194	0.000	-0.035	0.010	-3.442	0.001	-0.045	0.010	-4.315	0.000
Lot size*	0.118	0.011	10.864	0.000	0.069	0.010	6.615	0.000	0.072	0.011	6.819	0.000
Age of House	-0.001	0.000	-5.601	0.000	-0.001	0.000	-5.025	0.000	0.000	0.000	0.040	0.968
Other Rooms	0.065	0.006	11.440	0.000	0.073	0.005	13.524	0.000	0.077	0.005	14.114	0.000
Bedrooms	0.059	0.007	8.654	0.000	0.068	0.006	10.495	0.000	0.065	0.007	10.005	0.000
Baths	0.073	0.006	12.765	0.000	0.069	0.005	12.591	0.000	0.078	0.006	14.103	0.000
Half baths	0.113	0.009	12.258	0.000	0.102	0.009	11.644	0.000	0.105	0.009	11.899	0.000
Central Air	0.256	0.012	22.245	0.000	0.191	0.011	17.056	0.000	0.185	0.011	16.249	0.000
Fireplace	0.100	0.009	11.348	0.000	0.068	0.008	8.013	0.000	0.082	0.009	9.664	0.000
Quality: F	-0.440	0.128	-3.427	0.001	-0.394	0.122	-3.220	0.001	-0.476	0.123	-3.872	0.000
Quality: D	-0.276	0.011	-25.000	0.000	-0.252	0.011	-23.905	0.000	-0.264	0.011	-24.918	0.000
Quality: B	0.461	0.018	26.207	0.000	0.397	0.017	23.573	0.000	0.448	0.017	26.610	0.000
Quality: A	0.782	0.037	21.282	0.000	0.716	0.035	20.432	0.000	0.790	0.035	22.456	0.000
Condition: Poor	-0.290	0.047	-6.181	0.000	-0.310	0.045	-6.940	0.000	-0.204	0.045	-4.526	0.000
Condition: Fair	-0.133	0.019	-6.906	0.000	-0.120	0.018	-6.545	0.000	-0.108	0.018	-5.849	0.000
Condition: Good	0.137	0.012	11.821	0.000	0.114	0.011	10.304	0.000	0.120	0.011	10.798	0.000
Condition: Very Good	0.500	0.023	21.699	0.000	0.414	0.022	18.682	0.000	0.413	0.022	18.497	0.000
Columbus Schools	-0.002	0.011	-0.142	0.887	-0.016	0.011	-1.495	0.135	-0.028	0.011	-2.545	0.011
Growth ratio	-0.004	0.001	-5.728	0.000	-0.003	0.001	-4.137	0.000	-0.002	0.001	-3.453	0.001
Rental transition	-0.003	0.000	-5.774	0.000	-0.002	0.000	-3.520	0.000	-0.002	0.000	-4.323	0.000
Neihborhood stability	-0.004	0.000	-10.102	0.000	-0.002	0.000	-6.787	0.000	-0.004	0.000	-10.980	0.000
Distance to CBD	-0.010	0.008	-1.331	0.183	-0.036	0.007	-4.943	0.000	-0.061	0.007	-8.141	0.000
Distance (squared)	0.002	0.000	4.657	0.000	0.003	0.000	7.394	0.000	0.005	0.000	10.972	0.000
# of FF: Ring 1	*(The base model does not include the impact of foreclosed or V/A properties.)*				-0.031	0.004	-8.220	0.000	*(Model 1v includes only the impact of vacant properties, not foreclosures.)*			
# of FF: Ring 2					-0.018	0.002	-7.876	0.000				
# of FF: Ring 3					-0.015	0.002	-8.182	0.000				
# of FF: Ring 4					-0.016	0.001	-11.124	0.000				
# of V/A: Ring 1					*(Model 1f includes only the impact of foreclosures, not V/A properties.)*				-0.035	0.004	-8.887	0.000
# of V/A: Ring 2									-0.009	0.002	-3.759	0.000
# of V/A: Ring 3									-0.005	0.002	-2.815	0.005
# of V/A: Ring 4									-0.009	0.001	-6.454	0.000
Adjusted R-squared	0.62				0.65				0.65			
F (sig)	584(0.000)				588(0.00)				576 (0.00)			

Table 1. Comparison of Model 1 (the base model), Model 1f that includes only foreclosed properties, and Model 1v that includes only vacant/abandoned properties.

	Model 2: Full OLS				Model 3: Spatial Error Specification			
	B	Std. Error	t	Sig.	Coefficient	Std.Error	t	Sig.
(Constant)	11.279	0.041	275.816	0.000	11.359	0.046	245.228	0.000
Sale: Quarter 1	-0.031	0.010	-3.087	0.002	-0.033	0.009	-3.512	0.000
Sale: Quarter 2	-0.011	0.009	-1.167	0.243	-0.017	0.009	-1.915	0.055
Sale: Quarter 4	-0.038	0.010	-3.710	0.000	-0.034	0.009	-3.657	0.000
Lot size*	0.053	0.010	5.082	0.000	0.071	0.011	6.786	0.000
Age of House	0.000	0.000	-1.724	0.085	-0.001	0.000	-2.758	0.006
Other Rooms	0.078	0.005	14.556	0.000	0.069	0.005	13.400	0.000
Bedrooms	0.070	0.006	10.969	0.000	0.074	0.006	12.023	0.000
Baths	0.073	0.005	13.532	0.000	0.054	0.005	10.837	0.000
Half baths	0.100	0.009	11.631	0.000	0.082	0.008	10.058	0.000
Central Air	0.167	0.011	14.954	0.000	0.130	0.011	12.386	0.000
Fireplace	0.065	0.008	7.729	0.000	0.058	0.008	7.176	0.000
Quality: F	-0.444	0.120	-3.684	0.000	-0.448	0.112	-4.016	0.000
Quality: D	-0.249	0.010	-23.974	0.000	-0.239	0.012	-20.681	0.000
Quality: B	0.405	0.017	24.373	0.000	0.403	0.018	22.244	0.000
Quality: A	0.736	0.035	21.300	0.000	0.757	0.038	19.762	0.000
Condition: Poor	-0.243	0.044	-5.503	0.000	-0.277	0.041	-6.699	0.000
Condition: Fair	-0.103	0.018	-5.711	0.000	-0.089	0.017	-5.304	0.000
Condition: Good	0.111	0.011	10.190	0.000	0.100	0.010	9.704	0.000
Condition: Very Good	0.384	0.022	17.531	0.000	0.277	0.021	13.259	0.000
Columbus Schools	-0.028	0.011	-2.634	0.008	-0.025	0.013	-1.904	0.057
Growth ratio	-0.002	0.001	-3.337	0.001	-0.002	0.001	-2.846	0.004
Rental transition	-0.001	0.000	-3.297	0.001	-0.002	0.001	-3.052	0.002
Neihborhood stability	-0.003	0.000	-8.130	0.000	-0.003	0.000	-7.628	0.000
Distance to CBD	-0.056	0.007	-7.692	0.000	-0.059	0.009	-6.672	0.000
Distance (squared)	0.005	0.000	10.085	0.000	0.005	0.001	8.813	0.000
# of FF: Ring 1	-0.024	0.004	-6.474	0.000	-0.021	0.004	-5.599	0.000
# of FF: Ring 2	-0.013	0.002	-5.960	0.000	-0.016	0.002	-6.929	0.000
# of FF: Ring 3	-0.012	0.002	-6.548	0.000	-0.013	0.002	-7.280	0.000
# of FF: Ring 4	-0.012	0.001	-8.150	0.000	-0.011	0.001	-7.095	0.000
# of V/A: Ring 1	-0.040	0.004	-10.440	0.000	-0.036	0.004	-9.335	0.000
# of V/A: Ring 2	-0.005	0.002	-2.310	0.021	-0.006	0.002	-2.556	0.011
# of V/A: Ring 3	0.000	0.002	-0.164	0.870	-0.003	0.002	-1.527	0.127
# of V/A: Ring 4	-0.002	0.001	-1.624	0.105	-0.002	0.001	-1.466	0.143
LAMBDA	(No spatial coefficient in the OLS model.)				0.284	0.011	25.219	0.000

	Model 2	Model 3
Adjusted R-squared	0.66	0.71 (pseudo-R-squared)
F (sig)	541(0.000)	-
Log likelihood	-2988.7	-2415.0
Akaike info criterion	6045.3	4898.1
Schwarz criterion	6287.0	5139.8

Table 2. Comparison of the final two models. Both models include foreclosures and vacant/abandoned properties. Model 2 is specified via OLS, while Model 3 is a spatial specification, estimated via maximum likelihood.

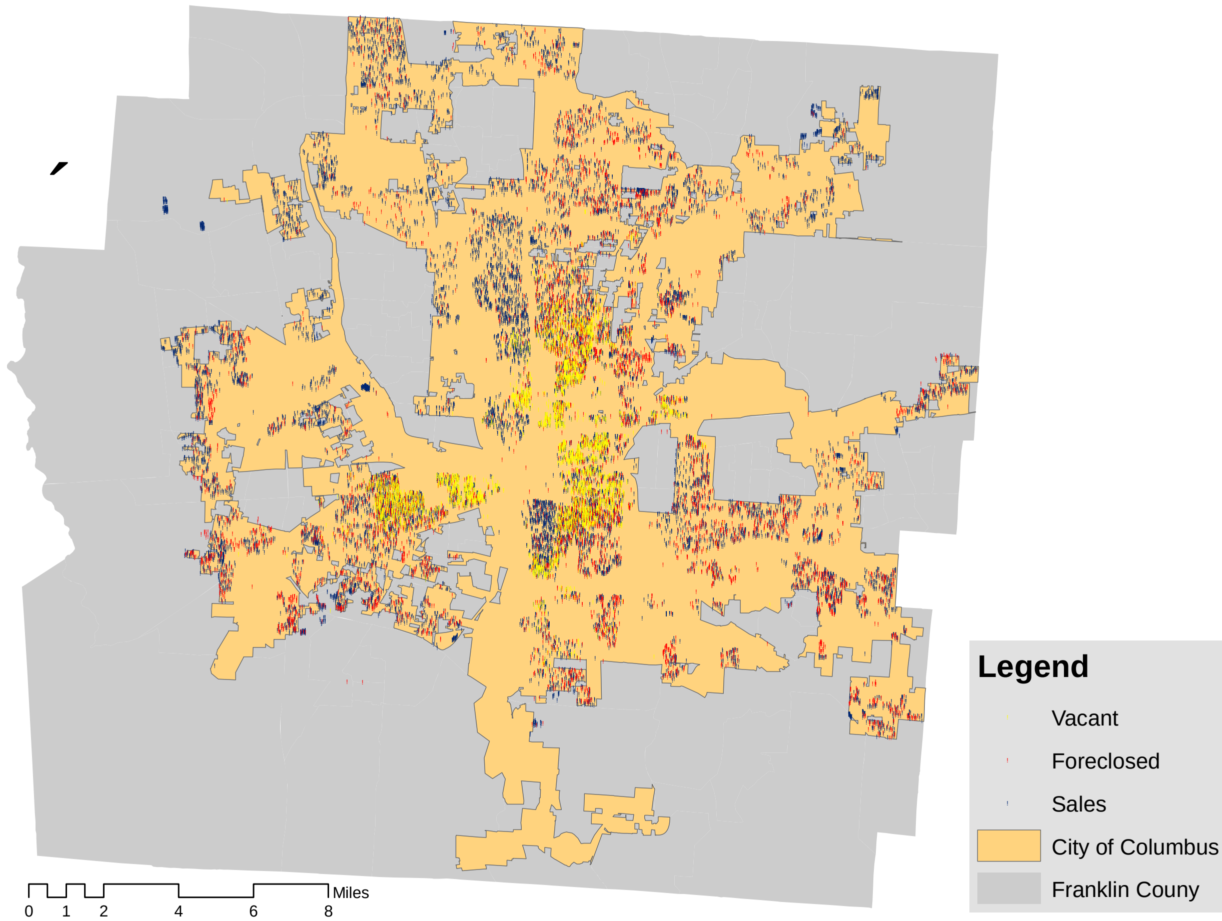

Figure 1. Map of Columbus OH, showing the distribution of 2006 single family sales, foreclosures, and vacant/abandoned properties. Figure 2. Regression coefficient values for the foreclosure variables across three models.

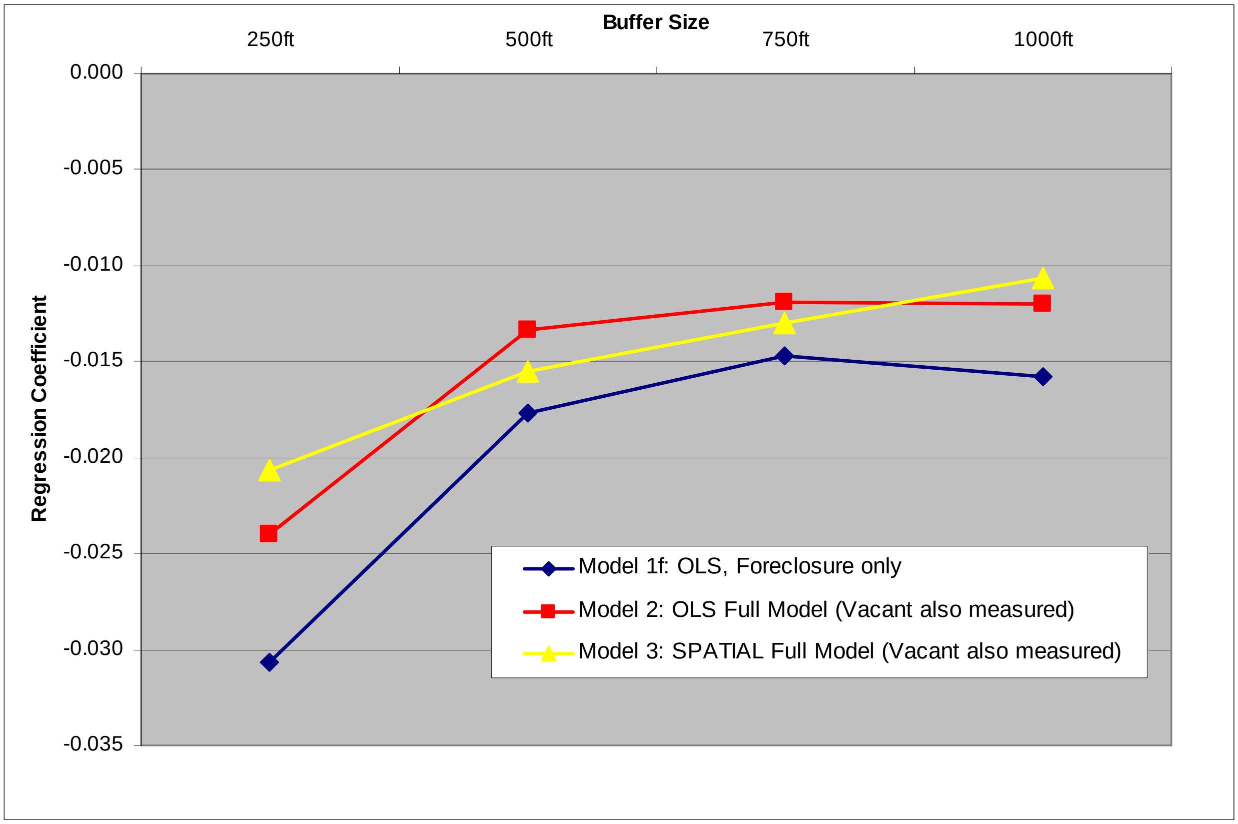

Figure 2. Regression coefficient values for the foreclosure variables across three models.

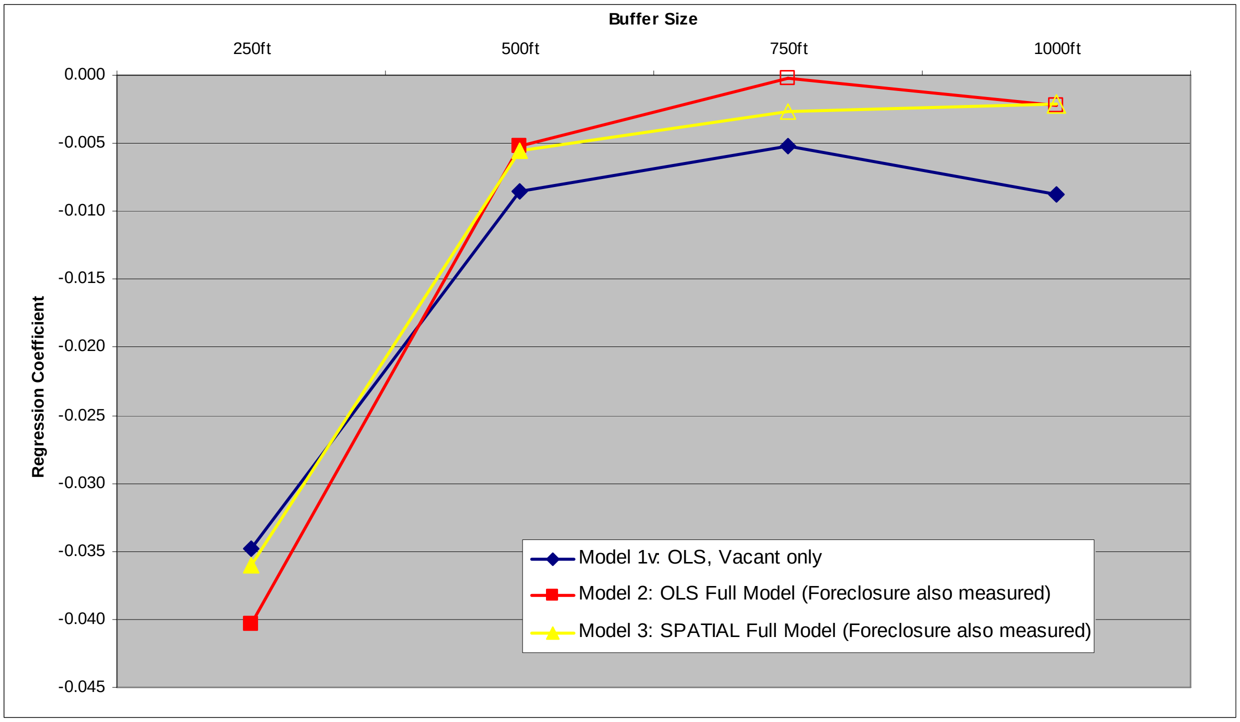

Figure 3. Regression coefficient values for the vacant/abandoned variables across three models. Hollow symbols indicate that coefficient values are insignificant for that buffer.

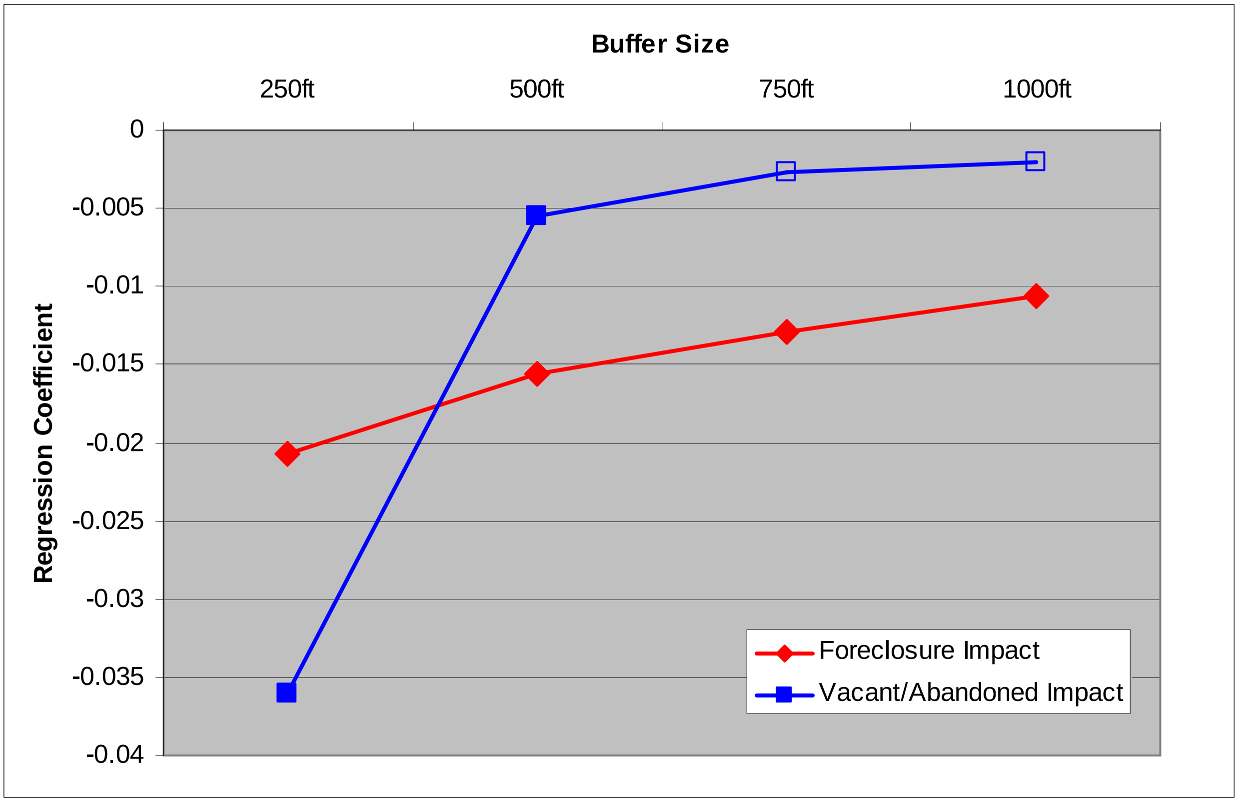

Figure 4. Comparison of the foreclosed and vacant/abandoned regression coefficients from the spatial model (Model 3). Hollow symbols indicate that coefficient values are insignificant for that buffer.

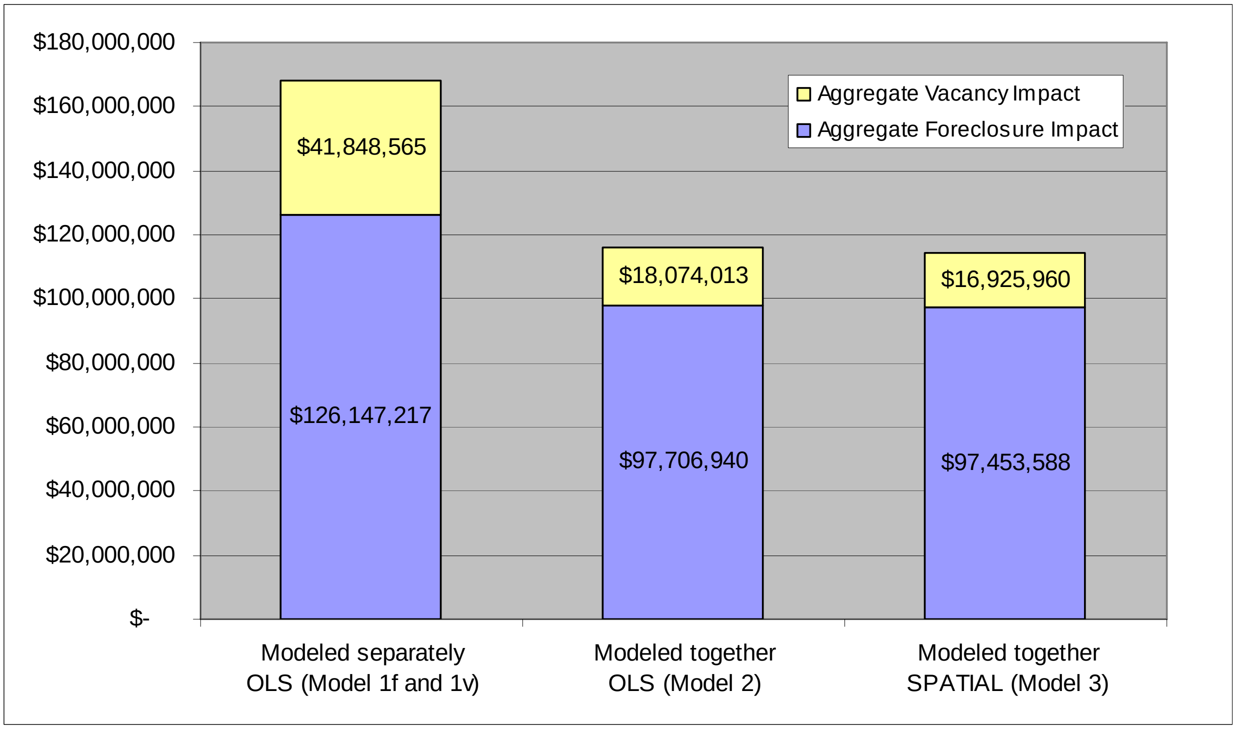

Figure 5. Aggregate impacts calculated from the regression coefficients of each model.

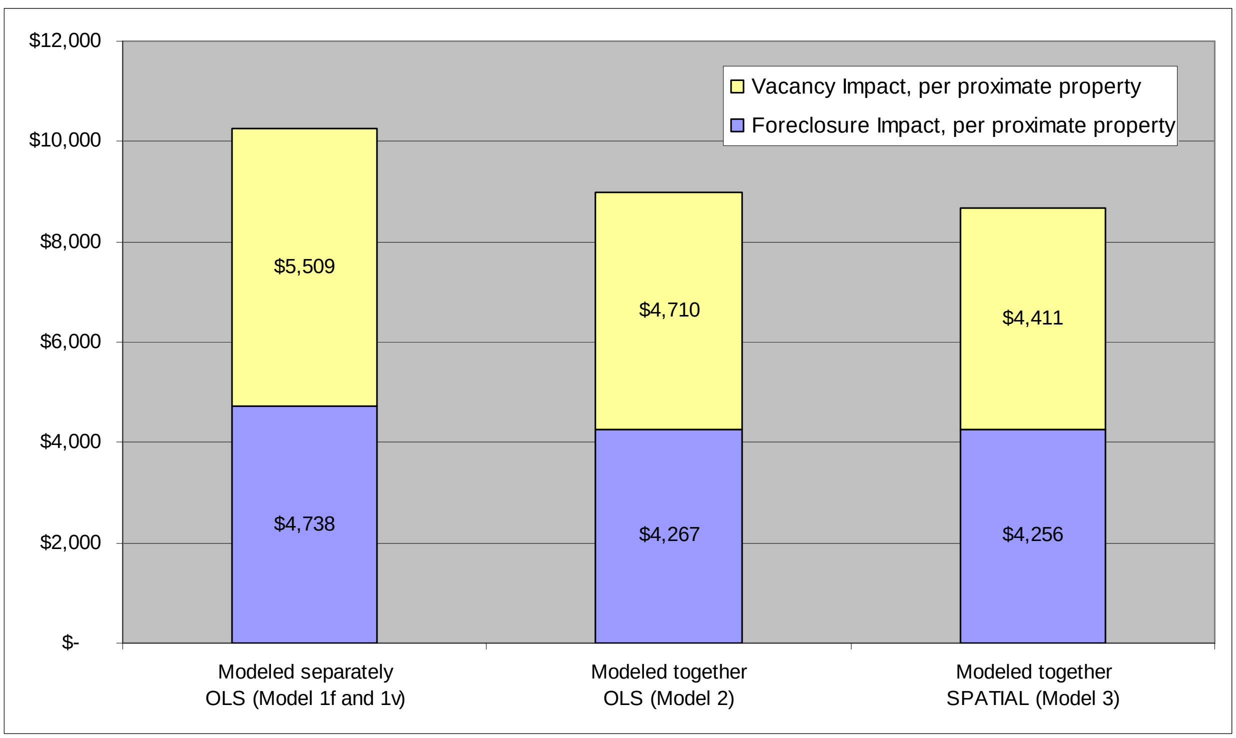

Figure 6. Per-impacted-property implications of proximate foreclosures and vacant/abandoned properties.

6. Discussion

On its face, the results here seem to be only a clear case of a missing variables issue. Both Models 1f and 1v are missing a key, relevant component that influences both the magnitude and significance of other key variables in the model. But there is a substantial policy impaction here that shouldn't be overlooked.

As jurisdictions search for responsible parties to the foreclosure crisis, the question that might follow is "Responsible for *what*?" Cities that see climbing municipal costs, falling tax collections, and homeowners who fear eroding equity might instead ask, "Responsible for *what amount of money?,"* and this research gets directly to that question. It demonstrates that modeling foreclosures alone overstates their financial impact on surrounding properties. Modeling vacant/abandoned properties alone understates the impact in very close proximity, but in aggregate also overstates the total damage done to the housing market. Just as important, refining the model changes the geography of the vacant/abandoned impact, which has been revealed to expire after 500 feet in the Columbus market. This has the effect of further reducing the overall impact to the housing market of these two ills.

In addition, it is important to remember in the case of vacant/abandoned properties, that cites have faced this issue long before there was a foreclosure crisis. Vacancy and abandonment appear in core cities when the housing filtering process isn't augmented by a healthy demand for central city housing. As higher-income households move from the city to the suburbs, and subsequently from the suburbs to the exurbs, they leave behind houses that are typically filled by lower-income households who are similarly moving up from their previous housing situation. Higher-quality housing has thus "filtered down" to a lower-income household. As this filtering process works its way down the housing chain to the bottom of the housing stock, and typically inward towards the core of the city, vacancy results unless there is some combination of redevelopment pressure, a strong first-time-buyer market, strong regional population growth, etc. There has to be some generator of city housing demand to keep this often worst-in-region housing viable, and when there isn't, widespread vacancy grips the city. This only encourages further out-migration.

Surely, some of the vacancies included in this research were a result of these regional population dynamics and not exclusively of the more recent housing forces.

Thus, while vacancy and abandonment are certainly linked/related to the foreclosure process, the sum of the vacant and abandoned property problem is likely an intertwined combination of the more recent foreclosure crisis and the regional population and housing dynamics (filtering) that long preceded it. The foreclosure crisis seemed to hit hardest and earliest in weak market cities that didn't have the robust housing market to pull homeowners out of unfavorable housing situations. Thus, while separating the impact of foreclosure from the impact of vacant/abandoned properties was possible, further refining the vacant/abandoned impact between foreclosure and filtering remains a substantial research challenge. As a result, cities seeking damages from those involved in the foreclosure crisis should be careful to provide supporting evidence that can be tied explicitly to the impacts of foreclosure, and separated from the broader impacts of vacant/abandoned properties.

Finally, it is important to note the process by which the individual regression coefficients shown in Figure 4 translate into the aggregate and per-property impacts shown in Figures 5 and 6. While the regression coefficients reflect the process, the aggregate and per-property impacts are a reflection of both the process and the spatial distribution of the phenomena under study. That is, the aggregate impact shown here is explicitly dependent on the geography of vacant, abandoned, and foreclosed properties.

Where does this leave cities besides Columbus, Ohio? One should never simply pick up regression coefficients from one location and assume they apply to another. But it is unavoidable that cities will look to this and similar research to try to better understand the impacts of the housing crisis in their own cities, and in that vein, it is encouraging that the results reported here are consistent with those that have come before. The regression coefficients reported here describe the result of a housing market process, and certainly a body of evidence is growing as to the nature and magnitude of that process.

The aggregate impact, however, represents how that process has acted upon Columbus's specific housing geography. Its distribution of sales, foreclosures, and abandonment are all in play in determining the aggregate impacts, and these would not necessarily apply to other cities that have their own unique housing context.

7. Conclusion

The research presented here contributes to the developing research literature surrounding foreclosed, vacant, and abandoned properties, in the context of the City of Columbus, Ohio. First, the spatial distribution of each of these housing market challenges is distinct. Foreclosures are more widely distributed throughout the city, while vacant/abandoned properties are more highly concentrated closer to Columbus's downtown. Second, there are serious consequences to modeling each separately. The geography of the issue, the absolute impacts, and impacts relative to one another all change when both influences are modeled together.

This highlights the importance of being explicit in discussions of foreclosures, vacant/abandoned properties, and their impacts. Not all foreclosure filings become vacant/abandoned properties, and not all vacant/abandoned properties are the direct result of a foreclosure. This further complicates an already tricky issue—measurement of the aggregate impact of the current housing crisis. While methodological advances allow us to better understand the house-price impact of these influences simultaneously and in a spatial context, a critical gap remains in assessing what caused the foreclosure or triggered the property into vacancy/abandonment in the first place.

These issues leave fruitful paths for further research, and two are highlighted here. Further refinement of the data might make possible property level sequencing of foreclosure filings and subsequent findings of vacancy and abandonment (or vice-versa). The success of such an effort would be highly dependent on the quality of the local data, and would possibly introduce further timing issues. Given the appropriate data, though, it could provide interesting insights into the typical sequencing of these related problems. Second, the common approach of concentric impact rings was employed in this research, but further exploration into alternate impact neighborhoods might also be of interest. For example, impacts might extend farther *along* city streets than they do *across* them.

Although measuring local housing market impacts in general is not new, the same can not be said for modeling the related spatial processes at the core of the current housing crisis. While subsequent enhancements will undoubtedly move this body of research beyond what is presented here, it is clear that incorporating the impacts of both foreclosures and vacancy/abandonment in future research is critical. The effects of one can not be fully understood in the absence of the other.

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