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Neighborhood decline and mixed land uses: mitigating housing abandonment in shrinking cities

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Abstract

Neighborhood decline is a critical issue in shrinking cities. Components of sustainable urbanism such as mixed land uses have risen as possible urban planning-based approaches to help mitigate urban and neighborhood decline. This research identifies examines if mixed land uses can help mitigate urban decline by using the tax delinquent status of single family houses as a proxy for decline in Dayton, Ohio, USA. Logistic regression models are utilized to estimate the probability of tax delinquency. The results suggest that the proximity to mixed land uses is associated with increasing or decreasing the probability of tax delinquent for single family lots. The number of commercial and industrial lots in a neighborhood also has effects on the probability of a lot becoming tax delinquent, but the specific types of commercial and industrial lots dictate the direction of effects. The existence of commercial apartment lots, retail lots, and industrial food and drink plant lots were shown to help decrease the probability of tax delinquent lots. Also, decreasing the amount of property tax applied to parcels can help to limit distress in neighborhoods. This research contributes to the ongoing efforts to stymie the amount of residential abandonment in depopulating and declining cities.

Keywords

Urban decline; shrinking cities; tax delinquency; sustainable urbanism; mixed-use development

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1. Introduction

The 2008 collapse of the American housing market resulted in massive foreclosures and widespread housing abandonment throughout a large amount of U.S. cities (Crump et al., 2008; Immergluck, 2008). Many cities in the U.S. Rust Belt (a postindustrial region in the upper Northeastern and Midwestern states) such as Illinois, Indiana, Michigan, New Jersey, New York, Ohio, Pennsylvania, and West Virginia (Kahn, 1999), were hit particularly hard by this collapse. As a result, many of these cities are characterized by visible symptoms of urban decline (Crump et al., 2008). Prior to the sub-prime mortgage crisis, however, many cities in the Rust Belt were already experiencing significant losses in population, due primarily to deindustrialization (Hollander et al., 2009). Consequentially, many depopulating industrial cities are characterized by high unemployment, poverty, and crime rates as well as increased vacancy and abandonment (Wiechmann and Pallagst, 2012). Revitalizing distressed urban areas is vital to assure sustainable long-term urban development in terms of stabilizing tax bases, maintenance costs, and the vibrancy of neighborhoods (Newman et al., 2016b). Depopulated cities are already supplied with the fundamental facilities and infrastructure to serve future projected U.S. urban population growth (e.g. water supply, sewers, etc...), making them prime candidates for absorbing the new development required for forecasted population increases (Mallach, 2012).

The concept of sustainable urbanism was initially based on ecological principles in an effort to minimize the environmental impacts of urban development. However, this concept has rapidly broadened and now incorporates most aspects of the built environment including transportation, land-use, and environmental and resource management components. The broadening of the conceptual definition of sustainability led to new design approaches such as New urbanism, Smart Growth, and Transportation Oriented Development (Jabareen, 2006; Park et al., 2016). Simultaneously, proponents of sustainable urban development developed new theories based on research framed around these approaches, claiming that mixed land-uses can help counteract the effects of urban decline for distressed, neglected, vacant, or abandoned residential properties (Bramley and Power, 2009; Haas, 2012; Williams, 2005). These theories have not been substantially evaluated, however. While depopulation has widely been discussed as a primary contributor to urban decline (Hollander et al., 2009), the specific aspects of sustainable urban land-uses which can potentially aid in counteracting the effects of urban depopulation have not been thoroughly evaluated. This study attempts to fill this gap by examining if mixed land-uses can help deter urban residential decline in depopulating cities.

Using the depopulating city of Dayton, Ohio (located in the Rust Belt), we examine components of mixed land-use factors at both the neighborhood and parcel levels using built environment characteristics to determine which factors contribute to mediating or stimulating residential urban decline. Residential property tax delinquent status is used as a measure for urban decline. The assumption is that if aspects of mixed use development enhance benefits to housing owners, then its increased application could help cities prevent the spreading of distressed or neglected residential areas. Data on tax delinquent and tax current lots in the city were assessed using logistic regression models to determine whether

the components of mixed use development are a significant factor in decreasing residential tax delinquent lots.

2. Literature review

2.1 Urban decline and housing abandonment

Severely depopulating cities have recently been referred to as ‘shrinking cities (Newman et al., 2016a).’ Several journal articles published between 2002 and 2014 revealed that 73 U.S. cities were identified as shrinking (Ganning and Tighe, 2015). While cities such as Cleveland and Detroit sometimes serve as the posterchildren of shrinkage, as of 2007, 370 cities throughout the world with populations over 100,000 shrunk by at least 10% over the last 50 years (Oswalt and Rieniets, 2007). One in six large cities worldwide were also substantially shrinking (Pallagst, 2012). As a result, many of shrinking cities have high rates of distressed or neglected residential neighborhoods characterized by excessive amounts of vacant or abandoned housing units (Martinez- Fernandez et al., 2012). A multitude of elements have been shown to be related to housing abandonment, but it primarily occurs based on three conditions; 1) an owner has stopped maintenance of the property due to monetary conditions, 2) an owner refuses to meet the financial responsibilities of the property such as paying property taxes or mortgage payments, and 3) the property remains unused for an extended period of time (Hillier et al., 2003; Keenan et al., 1999; Newman et al., 2016a).

In an empirical analysis estimating the decreased value of adjacent residential properties, Whitaker and Fitzpatrick IV (2013) compared several urban decline measurements such as property tax delinquency, vacancy, and foreclosures in Cuyahoga County, Ohio. Results showed that the tax delinquent lots which were foreclosed on were primarily due to owners who could not maintain their properties due to financial distress. The tax delinquent lots meet criteria that Hillier et al. (2003) defined as a being an abandoned property: an owner stops maintenance of the property, and an owner refuses to meet the financial responsibilities of the property (such as paying property taxes). The location of tax delinquent lots provides the capability to identify distressed or neglected properties. In fact, tax delinquent properties outnumber vacant properties two or three times more in a majority of declining cities, making them a better proxy for measuring urban decline than vacant land (Whitaker and Fitzpatrick IV, 2013). Relatedly, when assessing high-poverty areas where low income households exceed 20%, tax delinquent properties can be a key factor leading to decreased property values (Whitaker and Fitzpatrick IV, 2013).

Tax delinquent properties are typically abandoned or unoccupied. Abandoned houses can have a negative spillover effect to tangent properties as they typically lower the value of adjacent lots (Newman and Saginor, 2014). In turn, city governments may begin to diminish urban infrastructure investments in these areas due to shortages in tax revenue. Therefore, a tax current residential lots’ proximity to a cluster of existing tax delinquent property and the overall number of distressed properties in a neighborhood have been reported as crucial factors for predicting the spread of residential decline (Dewar, 2006; Farris, 2001; Schilling and Logan, 2008; Whitaker and Fitzpatrick IV, 2013; Zhang, 2012). These terms are heavily dependent on property owners’ decisions. As such, the amenities provided from a given

house's surrounding neighborhood are also important factors for predicting future housing abandonment (Leavitt and Saegert, 1988). A number of previous studies suggest that tax delinquency, vacancy, or abandonment are heavily determined by the spatial and land-use characteristics of a property, but it is also partly the result of the diverse interactions among several influencing socio-economic factors (Newman, 2013). Neighborhood characteristics, such as areas with higher percentage of ownership (as opposed to rentable houses), higher median income, and higher percentage of non-minority residents are shown to have lower abandonment rates (Zhang, 2012). On the other hand, the age of a house has also been shown to have a positive influence on the probability of a residential lot becoming abandoned; the older the house the higher the chance of abandonment (Zhang, 2012).

2.2 Sustainable urbanism, mixed land-uses, and housing abandonment

The current discourse on using mixed land-use for sustainable urbanism purposes is quite mature, yet still unsolved (Williams, 2010). There are a variety of strategies, approaches, and/or visions for developing a sustainable urban environment, as every city has distinctively different natural and built environment conditions (Guy and Marvin, 1999). Efforts toward a sustainable urban development framework typically stem from two distinct directions: new development or retrofitted development (Burkholder, 2012). On one hand urban development can be newly constructed in a sustainable manner on a clean slate of land. On the other hand, development can be placed within existing urban areas in pockets or parcels characterized by vacancy or abandonment. The ladder approach allows for development to occur in areas already supported by the necessary infrastructure to cater to such development. Within both approaches, there are planning strategies that can create sustainable urban form such as adopting New Urbanist, Transit-Oriented Development, Smart Growth, or Complete Street principles (Jabareen, 2006). Current challenges, such as urban decline, require a deepening of specialized knowledge to determine the most appropriate steps for achieving sustainable urban growth (Williams, 2010).

Approaches to sustainable urbanism incorporate environmental concerns as well as economic, social, and built environment related dimensions. These dimensions typically include accessibility, walkability, social equity, mixed occupancy, and a diversity of housing typologies (Chiu, 2004; de Souza Briggs, 2004; Dempsey et al., 2011; Fainstein, 2005; Vojnovic and Darden, 2013). Sustainable approaches to urban development are important for neighborhoods in decline because they incorporate many facets that seek to assuage the condition. For example, mixed land-uses and a mixture of housing typologies have long since been listed as components contributing to sustainable urbanism (Ford, 1999; Soni and Soni, 2016; Williams et al., 2000). These elements are said to primarily determine the basic lay-out of neighborhoods and the flow of activities of residents within them (Lynch and Rodwin, 1958; Spangenberg and Lorek, 2002; Halme et al., 2004; Park, 2017). It has also been shown that mixed land-uses also help increase social activity while allowing people increased access to places for shopping, eating, and playing, thus increasing interaction capabilities (Lee and Moudon, 2008). This increased interaction assists in mediating social isolation that occurs more often in neighborhoods with higher quantities of abandoned structures (Rogers and Park, 2018) and underinvested communities (Dewar, 2006; Schilling and Logan, 2008). Ideally, increased social interactions bond and bridge social capital,

resulting in increased neighborhood safety, community support, and eventual neighborhood revitalization (Saegert et al., 2002).

Mixed land-uses, however, have been shown to have varying effects on housing prices, which have been used in the literature to reflect neighborhood satisfaction (Yang, 2008). Shultz and King (2001) suggested that increased commercial land-uses have positive influences on housing values, while industrial land-uses can present negative associations, when examining the phenomena at U.S. Census Block level boundaries (Shultz and King, 2001). In addition, Yoon (2018) showed that the development of neighborhood scaled commercial land-use clusters can stimulate residential development. While a greater mix of land use can increase housing prices (Geoghegan et al., 1997), people are sometimes less willing to pay premiums for houses where various kinds of land-uses are located (Sohn et al., 2012; Song and Knaap, 2003). The level of mixed land uses can ultimately result in differing effects: 1) being closer to a commercial area is likely to increase housing prices, while being farther away from multi-family housing, institutional areas, and industrial land-uses can raise housing prices and 2) having a large proportion of commercial and multi-family housing tends to increase property values, but larger ratios of industrial and institutional land-uses in neighborhoods tends to decrease them (Song and Knaap, 2004). In addition, the location of vacant land uses in commercial and residential zones has been shown to positively affect the chance of land use conversion to community open spaces (Park and Ciorici, 2013).

It has been shown that abandoned houses can have a negative spillover effect onto adjacent properties; they typically lower the value of tangent lots (Newman and Saginor, 2014). In general, the spillover effect from distressed properties can negatively impact surrounding properties (Skogan, 1990). For example, Shlay and Whitman (2006) examined the impact of abandoned lots on neighboring property values in Philadelphia, Pennsylvania, USA finding that residential properties closer to abandoned lots had lower property values than those of properties located farther away from abandoned spaces (Shlay and Whitman, 2006). Mikelbank (2008) examined the impact of vacant and abandoned lots in Columbus, Ohio, USA, finding that the spillover effect was highly concentrated around abandoned lots (up to 500 feet beside a vacant property and up to 1,000 feet near an abandoned property). Relatedly, Griswold and Norris (2007) assessed land-use status in Flint, Michigan, USA, reporting that an abandoned structure within a 500 feet distance of a lot could reduce property values by 2.27%. Relatedly, Han (2014, 2017a, 2017b) illustrated that the amount, distance from, and duration of an abandoned property degrades nearby property values, using Baltimore, Maryland, USA as a study site.

4. Research Objectives

While the effects of the spillover effect of distressed properties have been thoroughly researched, what remains unclear is whether or not the use of mixed land use, as a means of promoting sustainable urbanism, can help counteract issues associated with urban decline. Two research questions are posed to properly assess the possible relationships of between mixed land-uses and urban decline, using tax delinquent housing as a proxy:

Q1) How does the intensity of neighboring tax delinquent lots affect the probability of residential tax delinquency?

Q2) How do mixed land-uses affect the probability of residential tax delinquency?

4. Methodology

4.1 Research target: measurement of distressed properties in Dayton, Ohio

As noted, U.S. Rustbelt cities are highly characterized by population loss and distressed properties (Hollander et al., 2009). For example, manufacturing jobs in the Dayton, Ohio metropolitan area have drastically decreased since the 1960s (NPA Data Services, 1995). By the early 1990s, the service and retail trade sectors of the Dayton metropolitan area economy began to employ more people than did manufacturing (Howe et al., 1998). However, new service jobs tended to locate in suburban areas outside of Dayton's urban boundary, contributing to central city decline (Howe et al., 1998). The population of Dayton city rapidly decreased by 46%, from 262,332 to 141,759, between 1960 and 2010 (United States Census Bureau, 2010). Eventually, the ability to manage population loss became a serious concern, since the city was originally built to support a larger population.

Continual population loss in Dayton left traces of distressed and neglected residential properties. Table 1 illustrates the number of lots within the city boundary by land use type based on the County GIS data in 2014 (Montgomery County, 2014a). The city contains 71,652 lots including residential, commercial, industrial, and other land use types. In addition to these data, the Real Estate Tax Information System in Montgomery County, Ohio (Montgomery County, 2014b) offers annual property tax and tax delinquent data for each lot in the county. After joining the property tax and tax delinquent data with the GIS parcel data, the spatial distribution of the tax delinquent lots was identified and joined with detailed lot level characteristics (e.g. land and building sizes, appraised values, property tax values, length of tax delinquent years, and net tax delinquent values). The location of tax delinquent lots enables the ability to identify distressed or neglected properties; the owners of tax delinquent lots would not or could not maintain their properties due to financial distress or strategic default cases (Whitaker and Fitzpatrick IV, 2013). If an owner were unwilling or unable to pay their property tax, this approach allowed us to track both when an owner falls behind in tax payments as well as the total amount of unpaid payments.

Table 1 shows the tax delinquency status by land use in 2014. On average, about one-third of Dayton's residential lots were tax delinquent. Among the 57,927 residential lots, 45,007 lots were identified as single family. By definition, single family lots have one single family housing unit within one parcel. Accordingly, this analysis covers both single family lots and single family housing units. Owners and investors (rather than developers) manage single family housing units, therefore single family housing units can represent the housing market of individual owners better than multi-family housing units (Kolbe, 2007). In Dayton, single family lots were composed of 25.65% tax delinquent lots. Among the 45,007 single family lots, we dropped outliers based on building floor area, building value, and building age. Single family lots without having building floor area information or building value information, or having too small (smaller than 632 square feet and \$3,190 – bottom 1%

among the single family lots) or too large (larger than 3,190 square feet and \$156,340 – top 1% among the single family lots) building floor areas and building values were excluded from our analysis. Also, single family lots with buildings built before 1880 (bottom 1% among the single family lots) were excluded. In summary, we excluded 1,970 single family lots and used 43,037 single family lots for the final analysis.

4.2 Modeling the probability of tax delinquent

Tax delinquent lots were used as the dependent variable. This was determined by whether a lot was tax delinquent or tax current in 2014 (0 is tax current, and 1 is tax delinquent). In Table 2, the summary statistics of the dependent variable indicate that the distribution of tax delinquent status did not change much after dropping the 1,970 outliers. The mean value of the dependent variable, 0.26, does not considerably change from the percentage of tax delinquent single family lots before excluding the outliers in Table 1 (25.65%).

Two constructs of the independent variables were operationalized with the parcel and neighborhood level characteristics as moderator variables: 1) neighborhood level tax delinquent status, and 2) neighborhood level mixed land use status. The 2010 U.S. Census Block Group boundary was utilized as the unit of neighborhoods to measure the neighborhood level variables. The 2010 U.S. Census Block Group boundary offers rich socio-economic census data, and its relatively small spatial scale enables us to capture homogeneous neighborhood level tax delinquent and land-use characteristics (Van Zandt et al., 2012). There were 175 Block Groups within the city boundary; 165 of them contain at least one single family lot used in the analysis. Each of the 165 Block Groups includes around 261 single family lots, on average. The number of neighborhood tax delinquent lots and mean years of tax delinquency were measured by the Block Group boundary. Table 2 shows the number of tax delinquent lots by land-use types and mean tax delinquent years. On average, a single family lot had 146 tax delinquent lots within its Block Group boundary, and 128 of them were residential tax delinquent lots. The mean years elapsed after tax delinquency was 3.84 years. The neighborhood level mixed land-use status was also identified by the Block Group boundary. The number of non-vacant nor tax delinquent commercial/industrial lots, were measured as the active lots. In addition, the subcategories of the commercial and industrial land-use types enable us to distinguish their effects by commercial apartment lots, retail lots, restaurant lots, office lots, parking lots, heavy and light manufacturing lots, small industrial lots, and food and drink industrial lots. On average, a single family lot had 20.95 commercial lots and 4.16 industrial lots within its Block Group boundary.

The moderator variables were designed to control for the lot and neighborhood level characteristics. Appraised property value, imposed annual property tax, age and floor area of the building, and whether a property is a rental property or not were selected as the lot level moderator variables. The assessed property value (in U.S. Dollars, USD) and floor area (square feet) were divided by 1,000 to make their coefficients more readable. The appraised property value variable was not necessarily proportional to the imposed annual property tax variable due to the property tax reduction and exemption factors. The statewide rental property registration program was used to identify single family rental properties. Based on

the registration program, 13% of single family lots were identified as rental properties. The U.S. Census 2013 American Community Survey (ACS) 5-year estimates were used to indicate the Block Group level neighborhood socioeconomic characteristics. These characteristics include percentage of minority population (Hispanic or Latino, African Americans, Asian Americans, American Indian, and Native Hawaiians), percent of vacant housing units, percent of housing ownership, and percent unemployment. Table 2 lists a summary of lot and neighborhood level statistics. On average, for a single family lot in the city, the lot value was \$57,090, the county charged \$800 for property tax, and the building floor area was 1,290 square feet for structures originally built 76.95 years ago. In neighborhoods, the percent of minority population was 52.98%, 20.99% of housing units were vacant, 55.12% of housing units were owner-occupied housing units, and 19.99% of the population was unemployed, on average.

Since the dependent variable was assessed as binary data, the probability of being a tax delinquent lot was estimated through logistic regression models. Accordingly, the positive or negative coefficients of each independent variable show the chance of being tax delinquent lots (positive coefficients) or being tax current lots (negative coefficients). The modeling process follows two steps. Model 1 was designed to show the general effects of the delinquent lots, commercial lots, and industrial lots without considering their subcategories. For Model 2, the land-use types of tax delinquent lots and subcategories of commercial and industrial lots were utilized.

5. Results

Table 3 shows the coefficients, odds ratios, and z-values from the Model 1 and Model 2 logistic regression analyses. With 43,537 observations, the pseudo R-squared (McFadden's Adjusted) values are 0.387 and 0.388 for both models. The property tax variable, indicating the value of imposed property tax in 2014, was square root transformed for the fitting of the logistic regression models. In the same vein, the squared floor area variable was added with the original floor area variable. These two variables illustrate their non-linear relationship with the probability of being tax delinquent lots.

In Model 1, the number of tax delinquent lots at the neighborhood level has a significant and positive sign, indicating that the probability of tax delinquent will likely to be increased in single family lots that are located with other tax delinquent lots. Model 2 shows that the number of tax delinquent residential lots was the only significant variable. Other land use types of tax delinquent lots do not affect the probability of tax delinquency on single family housing lots. For every additional residential tax delinquent property at the neighborhood level, the odds of a tax delinquent lot occurring increase by 0.11%. The Block Group level mean delinquent tax year also has a significant and positive sign, indicating that the odds of tax delinquent increase by 9.81% (Model 1) or 8.67% (Model 2) for every one year increase. These results imply there is an existing spillover effect of neighboring tax delinquent lots.

Model 1 indicates that the effects of active commercial and industrial lots have opposing relationships. In general, active commercial lots at the neighborhood scale tend to decrease the probability of tax delinquent single family lots, while those of the active industrial lots

tend to increase the probability. Based on Model 2, a single family lot with a higher number of apartment and retail lots will have a lower chance of becoming tax delinquent. For every one additional neighborhood apartment and retail lot, the odds of a tax delinquent lot decrease by 1.16% and 0.8%, respectively. On the other hand, every one additional small industrial lot will increase the odds of a tax delinquent lot by 3.11%. However, not all industrial lots tend to increase the chance of tax delinquency. For each additional industrial food and drink plant lot, the odds of tax delinquency decrease by 4.98%.

All lot characteristic variables are statistically significant in Models 1 and 2. The property value variable has a negative relationship with tax delinquency, indicating that houses with higher property value will have less chance of becoming tax delinquent. For every additional \$1,000 increase in property value, the odds of tax delinquent decrease by 5.83% (Model 1) and 5.76% (Model 2). The rental property dummy variable and the building age variable are also statistically significant. For a single family lot with a rental housing unit, the odds of becoming tax delinquent decreases by 47.48%. For every additional one year in a building's age, the odds increase by 1%. The predicted probabilities of tax delinquent lots by the amount of property tax and the floor area are illustrated in Figure 1. The probability of tax delinquency is 33% when the property tax value is \$800.48. If the property tax is increased to \$1,000, \$1,200, or \$1,400, the probability increases to 43%, 51%, and 59%, respectively. On the other hand, decreasing the property tax can also decrease the probability. If the property tax is decreased to \$600, \$400, or \$200, the probability is decreased to 23%, 14%, and 6%, respectively. The predicted probabilities of tax delinquency by the floor area decreases from 27% to 25% when the floor area increases from 600 square feet to 1,800 square feet. Since there were not enough number of single family lots with larger than 1,800 square feet floor area, we are unable to distinguish the effect of floor size for these lots with large size floor areas. Among the neighborhood characteristics variables, the percent of the minority population is the only significant variable. For an additional one percentage point increase of minority residents in the neighborhood area, the odds of property abandonment increase by 0.99%.

6. Conclusions and Discussion

This research determined which aspects of sustainable urbanism help mitigate distressed and neglected single family lots in Dayton, Ohio using two neighborhood level aspects: 1) tax delinquent status and 2) mixed land-uses. The findings suggest that the level of neighborhood tax delinquency and mixed land-uses are associated with increasing or decreasing the chance of tax delinquency for single family lots in distressed areas. The number of residential tax delinquent lots and the mean length of tax delinquent years in a neighborhood were shown to decrease the probability of single family housing tax delinquency. The adverse effects from the neighboring residential tax delinquent lots reaffirmed the findings from previous literature: there is a continued spillover effect from existing distressed lots. In addition, results also imply that the length of tax delinquency (the lots that had been in tax delinquent status for an extended period of time) is critical factor to mitigate distressed neighborhoods. The amount of commercial and industrial lots also have effects on the probability of being a tax delinquent lot, in general, but the specific types of commercial and industrial lots dictate the direction of effects. For example, the existence of

commercial apartment lots, retail lots, and industrial food and drink plant lots were shown to help decrease the probability of tax delinquent lots. When including moderator variables, results illustrate a downward spiral of distressed single family lots. A low priced single family lot with an aged and small sized housing unit under 1,800 square feet in floor area in a minority neighborhood tends to experience tax delinquency more than other single family lots. Inversely, decreasing the annual property tax from \$800 to \$600 is shown to decrease the probability of becoming tax delinquent by 10 percent, from 33% to 23%. Single family lots whose owners rent the property tend to decrease the odds by 47.48%. These results set up a trajectory for both stymieing the process of housing tax delinquency and future regeneration of distressed sites. In both cases, the emphasis should be on creating strategies to either prevent or disallow future tax delinquent lots.

These findings suggests that the inclusion of mixed land-uses can assist in both weathering the battle against urban decline over time as well as lessening the proportion of tax delinquency at the neighborhood scale. As shown, areas with commercial, apartment, retail, and industrial lots within residential pockets tended to show a smaller probability of tax delinquency. Planning for increased mixed use environment in strategic locations within a city can, according to this research, help to increase investment in properties, promote higher property values, and discourage abandonment. The ability to break up vast swaths of residential land-uses may also, help limit the spillover effect onto normally adjacent residential properties.

When interpreting these results, two limitations of this study should be regarded. First, the logistic regression model is one of many analytical approaches to diagnose possible relationships, and it does not indicate causation. Also, as the pseudo R-square values for the two models were relatively low, so interpretation of the results should be carried out carefully. A longitudinal analysis could be a solution to more thoroughly examine causal relationships. Second, the definitions of distressed or neglected residential units and its measurements can vary across cities. Future studies using other cities for comparison are recommended. Our final model assumes that the tax delinquent single family lots were distressed or neglected lots so their owners could not maintain their properties. However, not all tax delinquent lots are necessarily unused and heavily damaged due to deferred maintenance, and accordingly, some tax delinquent lots may not have notable differences from tax current lots (Whitaker and Fitzpatrick IV, 2013).

Despite those limitations, this research contributes to the ongoing efforts to understand the distressed residential properties in the cities suffering urban depopulation. The results show that some elements of sustainable urban environment can help mitigate neglected residential lots. Consistent monitorization of inventories of tax delinquent and tax current lots can be used to target risk areas. Areas with concentrated and prolonged tax delinquent lots should be considered at high-risk for future tax delinquency. Decreasing the amount of property tax and increasing commercial opportunities in neighborhoods could help to revitalize these high risk areas.

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Figure 1.
Predicted Probability of Tax Delinquent with 95% Confidence Intervals

Table 1

Tax delinquent status by land-use categories

Land-use	Number of lots	Number of tax delinquent lots	Percent of tax delinquent lots
Total	71,652	20,078	28.02%
Residential	57,927	17,257	29.79%
Single family	45,007	11,544	25.65%
Multi-family	3,836	1,480	38.58%
Condominium	528	46	8.71%
Other residential	394	134	34.01%
Vacant land	8,162	4,053	49.66%
Commercial	7,273	2,024	27.83%
Industrial	1,595	254	15.92%
Others	4,857	543	11.18%

Table 2

Summary of Statistics

Variable	Measurement	Level*	Mean	S. D.	Min.	Max.
<u>Single family tax delinquent dummy variable</u>	The dependent variable shows whether a single family lot was delinquent (1) or not (0).	Lot	0.26	0.44	0	1
<u># of delinquent lots</u>	These variables identify the number of property tax delinquent lots by each Census Block Group.	BG	146.33	123.69	0	652
Commercial lots		BG	12.69	17.30	0	90
Industrial lots		BG	1.73	4.69	0	27
Residential lots		BG	128.46	104.79	0	506
<u>Mean delinquent year</u>	This variable shows the mean years elapsed after delinquent by each Census Block Group.	BG	3.84	1.72	0	13
<u># of active commercial lots</u>	These variables identify the number of commercial lots that were neither delinquent nor vacant by each Census Block Group.	BG	20.95	26.67	0	293
Apartment lots		BG	6.15	6.13	0	35
Retail lots		BG	4.56	6.32	0	39
Restaurant lots		BG	1.53	3.20	0	34
Office lots		BG	1.45	4.79	0	103
Parking lots		BG	0.93	3.10	0	66
<u># of active industrial lots</u>	These variables identify the number of industrial lots that were neither delinquent nor vacant by each Census Block Group.	BG	4.16	14.09	0	144
Heavy manufacturing lots		BG	0.25	0.99	0	8
Light manufacturing lots		BG	0.80	2.99	0	32
Small industrial lots		BG	1.55	5.88	0	65
Food and drink ind. lots		BG	0.16	1.65	0	22
<u>Lot characteristics</u>	The lot characteristics were identified for each single family residential lots.					
Value (USD/1000)		Lot	57.09	30.50	6	230.84
Property tax (USD)		Lot	800.45	627.18	0	43,437
Rental property		Lot	0.13	0.33	0	1
Building age (year)		Lot	76.95	24.97	1	134
Floor area (sqft/1000)		Lot	1.29	0.42	1	3.11
<u>Neighborhood characteristics</u>	The neighborhood level characteristics were captured by each Census Block Group based on 2013 American Community Survey (ACS) 5- year estimates.					
% minority		BG	52.08	37.81	0	100.00
% vacant housing units		BG	20.99	13.36	0	70.57
% housing unit ownership		BG	55.12	19.42	0	97.44
% unemployment		BG	19.99	12.47	0	63.90

Note: S.D. standard deviation; Min. minimum value; Max. maximum value; ind. industrial; sqft Square Feet

* Level: the spatial scale level of data (BG: Block Group level data based on the 2010 Census, Lot: lot level data based on the county GIS data)

Table 3

Logistic Regression Models for Delinquent Single Family Housing Lots in Dayton, Ohio

Variable	Model 1			Model 2		
	Coefficient	Odds R.	z	Coefficient	Odds R.	z
<u># of delinquent lots</u>	0.0008	1.0008 ***	4.26			
Commercial lots				−3e−5	1.0000	−0.02
Industrial lots				−0.0077	0.9923	−1.22
Residential lots				0.0011	1.0011 ***	4.03
<u>Mean delinquent year</u>	0.0935	1.0981 ***	6.48	0.0831	1.0867 ***	5.36
<u># of active commercial lots</u>	−0.0022	0.9978 *	−2.45			
Apartment lots				−0.0116	0.9884 ***	−3.84
Retail lots				−0.0080	0.9920 +	−1.85
Restaurant lots				0.0023	1.0023	0.30
Office lots				0.0022	1.0022	0.35
Parking lots				0.0081	1.0081	0.80
<u># of active industrial lots</u>	0.0090	1.0091 ***	6.55			
Heavy manufacturing lots				−0.0159	0.9842	−0.71
Light manufacturing lots				0.0143	1.0144	0.81
Small industrial lots				0.0306	1.0311 ***	4.21
Food and drink ind. lots				−0.0511	0.9502 *	−2.07
<u>Lot characteristics</u>						
Value	−0.0601	0.9417 ***	−48.31	−0.0593	0.9424 ***	−46.24
(Property tax) ^{0.5}	0.1854	1.2036 ***	81.39	0.1855	1.2038 ***	81.36
Rental property	−0.6475	0.5234 ***	−15.31	−0.6498	0.5222 ***	−15.35
Building age	0.0098	1.0099 ***	11.81	0.0100	1.0100 ***	11.77
Floor area	−0.5413	0.5820 **	−2.92	−0.4985	0.6074 **	−2.68
(Floor area) ²	0.1578	1.1709 **	2.62	0.1417	1.1522 *	2.34
<u>Neighborhood characteristics</u>						
% minority	0.0099	1.0099 ***	16.44	0.0098	1.0099 ***	15.60
% vacant housing units	0.0008	1.0008	0.56	0.0017	1.0017	1.14
% housing unit ownership	0.0016	1.0016	1.53	0.0005	1.0005	0.41
% unemployment	−0.0006	0.9994	−0.50	−0.0003	0.9997	−0.23
<u>Constant</u>	−4.5175		−23.79	−4.4885		−22.66
N		43,037			43,037	
Log Likelihood		−15,037			−15,020	
Pseudo R-squared (McFadden's Adjusted)		0.387			0.388	

+Note: p < .10;

*p < .05;

**
p < .01;

p < .001;

Odds R. Odds Ratio; ind. industrial

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