Property Tax Delinquency and its Spillover Effects on Nearby Properties

Abstract – This paper investigates the impact of property tax delinquency on the sales price of nearby residential properties, an effect that we call the "delinquency discount". Using a unique data set from Chicago, we control for the duration of delinquency as well as the potential simultaneous relationship between property tax delinquency and home prices. We find the delinquency discount of one additional recently delinquent property within 660 feet is 3.4 percent on nearby housing prices. We also find that the effect of the delinquency discount increases with the duration of delinquency and decreases with distance from the sale. The results provide local governments with a more complete estimate of the cost of property tax delinquency. This is important as lawmakers weigh the benefits and costs of alternative policies.

Key Words: State and Local Taxation, Housing Supply and Markets, Property Tax Delinquency

JEL Classifications: H71, R31

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Acknowledgements
The authors thank the Lincoln Institute of Land Policy for help with the foreclosure data in this paper.

1. Introduction

As shown in the most recent housing market collapse, homeowners experience phases of financial distress. Due to the spatial nature of the housing market, the effects of one homeowner's financial distress are also likely to be borne by nearby homeowners. For example, some work has attempted to measure the spillover effect of one homeowner's mortgage foreclosure on nearby properties, and a review of the literature (Lee, 2008) concludes that this foreclosure effect ranges between a 0.9 percent to 8.7 percent reduction in the sales price of nearby properties. [1] However, the spillover effects from other types of homeowner financial distress are a not as well understood.

An especially important type of distress in recent years is property tax delinquency. The untimely payment of property tax bills is another form of financial distress, and delinquent property taxes are likely to cause negative spillovers on nearby properties that are similar to foreclosures. Property tax delinquency may occur when the homeowner no longer has a mortgage payment or when the financial distress is less severe than with mortgage foreclosure.[2] According to the 2012 American Community Survey (ACS), over 25 million housing units, representing 34.3 percent of all owner-occupied housing units, did not have a mortgage. This paper investigates the impact of property tax delinquency on the sales price of nearby residential properties, an effect that we call the "delinquency discount". To do this, we expand the contagion effect analysis by examining property owners in financial distress as revealed by property tax delinquency.

[1] Among a large literature, examples include Harding et al. (2009), Immergluck and Smith (2006), and Schuetz et al. (2008).

[2] A mortgage payment is typically due once a month with relatively quick repercussions from non-payment; whereas, property tax payments are usually once or twice a year with longer grace periods to pay the bill (and fees).

We use a sample of approximately 34,500 home sales and the population of tax delinquent properties from 2010 to 2013 in Chicago, Illinois. Each sales transaction acts as an origin creating a 'neighborhood' in which surrounding neighbors' property tax payment status may affect the transaction price. Like many other spatial spillovers, we expect the effect to dissipate with distance, so we vary the size of the neighborhood. Like the foreclosure literature, we use visual distress or blight, social disconnection, increased housing supply, and decreased valuation from sales of distressed homes as potential channels through which neighboring sales prices are lowered. Further, we also consider the duration of delinquency as it signals the magnitude of financial distress of the homeowner. We include a duration measure ranging from one to over three years in delinquency. Lastly, as foreclosure is likely positively correlated with property tax delinquency, we measure the delinquency discount net of the foreclosure rate by controlling for the area's foreclosure rate using a measure derived from the public use microdata area's foreclosure rate. These spillover effects from property tax delinquency contribute to a more complete picture of financial distress in the housing market than has previously been examined.

We estimate the magnitude of the delinquency discount with three methods: traditional hedonic, repeat sales transactions, and (our preferred method) a matching estimation technique. The duration of the delinquency also observably varies with each delinquent property within the neighborhood allowing us to determine the effect of each stage of delinquency on sales price.

We find that the delinquency discount from one additional tax delinquent property ranges from 0 to -16.9 percent depending on the modeling technique, duration of

delinquency, and distance from sale. Under the preferred specification, we find that the delinquency discount of one additional recently delinquent property within 660 feet of a property is 3.4 percent on nearby house prices, which corresponds to a delinquency discount in sales price of approximately $8,309 at the average sales price. We also find that this delinquency discount increases with the duration of delinquency and decreases with distance from the sale.

The remainder of the article is organized as follows. We first provide more background on the delinquency process coupled with a literature review. The discussion of the methodology is in the third section. The fourth section describes the data, and the results are presented in the fifth section. The final section concludes the article.

2. Understanding Property Tax Delinquency

Property tax delinquency affects local governments' ability to provide goods and services to its residents. Further, collection of unpaid property tax bills is costly both administratively and financially. Excessive delinquent property tax balances during economic downturns exacerbate these costs. For example, in 2013 Detroit experienced a property tax delinquency rate of 48 percent (Alm et al., 2014) making budgeting for local public services difficult, while Philadelphia in 2011 experienced a property tax delinquency rate of 19 percent with an uncollected balance of $472 million (Kekstra, 2011). Localities apply penalties when taxpayers pay property taxes late, and in persistent cases of delinquency governments may force the transfer of ownership to recoup some costs of delinquency. Regardless, local governments must often cut services or raise taxes to cover the revenue shortfall from unexpectedly high rates of property tax delinquency (Miller, 2013).

As our data are from Chicago, Illinois, we focus on how the county collects and penalizes property tax delinquency. Note that each municipality with a property tax may handle delinquent properties differently.

a. Types of delinquent properties

We define four types of delinquent properties corresponding with the duration of delinquency. The duration of delinquency is an important consideration as length of time signals the strength of financial distress of the homeowner.

Property taxes are due twice a year in Chicago. The first installment is due every year on the first business day of March. The second installment due date varies each year, but is typically 6 to 9 months after the first installment. The county publishes information on properties with an unpaid balance after the second installment in the local newspaper. We define this set of estates as "published" delinquent properties. An owner of a published delinquent property pays their balance due prior to the following tax lien sale.

The county holds a tax lien sale annually, and the sale typically occurs 7 to 9 months after the second installment due date. A tax lien sale is the sale of delinquent property taxes by a local government to private investors. When a taxpayer becomes delinquent, the local government places a lien against the property. This lien represents a collateralized receivable but not direct ownership of the property. We define properties that are delinquent at the time of the tax lien sale as "sold" and "unsold" delinquent properties. A sold property is one where the lien is sold to an investor; whereas, an unsold property is unsuccessful at the tax lien sale.

The unsold properties that continue to be delinquent are offered at the bi-annual scavenger sale. We label this type of delinquent property as "tax foreclosure". The total

duration of delinquency at this point is three years or longer. These properties are by statute eligible for tax foreclosure. Figure 1 provides a visual representation of the four types of delinquency examined; published, sold, unsold, and tax foreclosure.

b. *Previous literature*

Numerous studies have examined the spillover effect of foreclosed properties on nearby properties (Lee, 2008). The studies are informative, but even so they largely ignore homeowners in financial distress who are without a mortgage or homeowners in financial distress who are not delinquent on their mortgage payment. The active foreclosure discount literature does, however, provide innovations to empirical methodology. For example, Harding et al. (2009) measure the impact of foreclosure on proximate properties while disentangling the simultaneity issue. The causality direction is confounded by the fact that additional foreclosures nearby tend to lower prices, but lower prices may cause additional foreclosures. Harding et al. (2009) address this endogeneity by simultaneously estimating a local price trend and the foreclosure discount. We employ this strategy.

To our knowledge, there are only three studies that directly estimate the delinquency discount. These studies find a significant negative relationship between the concentration of property tax delinquent properties and the sales price of nearby properties. Using property tax delinquency data from Cleveland for the years 1992 through 1994, Simons et al. (1998) find that a one percentage point increase in property tax delinquent properties decreases residential sales prices in the “nearby area” by 2.245 percent. This study suffers from spatial consistency as the “nearby area” is defined as property on the same page as the auditor’s map book (Lee, 2008). Additionally, the study

does not control for the potential endogeneity between property tax delinquency and home prices, so that the results are likely biased.

A more recent study (Whitaker and Fitzpatrick, 2012) of Cleveland home sales between April 1, 2010 and June 20, 2011 finds that tax-delinquent recent foreclosures reduce the sales price of nearby homes by as much as 7.6 percent. The study finds evidence that the effect of nearby foreclosures is overestimated when nearby tax delinquent and vacant properties are not considered. The study, however, does not control for the potential endogeneity between property tax delinquency and home prices.

The most recent study (Gillen, 2013) was conducted in Philadelphia. The study finds that each additional delinquent property within 500 feet of the sale (under five delinquent properties in total) is associated with a 0.218 percent reduction in the sales price. Gillen (2013) controls for endogeneity between property tax delinquency and home prices by implementing an event study strategy that disentangles changes in the local price trend and changes in the number of nearby delinquent properties. He also estimates a nonlinear relationship between home prices and nearby delinquent properties. The study finds that beyond the first five delinquencies each additional delinquency is associated with a 1.089 percent decline in the sales price; after 15 delinquencies, each additional delinquency is associated with a 0.451 percent decline in the sales price.

We improve upon the previous literature in three important ways. First, we empirically estimate the effect of nearby delinquent properties on sales price while controlling for the duration of delinquency. Second, we control for endogeneity between property tax delinquency and home prices by using a matched sales technique that improves the precision of the estimate. Third, we estimate the delinquency discount while

controlling for local incidences of foreclosure. These three improvements tighten the estimate of the delinquency discount.

c. *Mechanisms*

Some mechanisms through which delinquency and the duration of delinquency may affect nearby house values include lack of maintenance, loss of social connectivity, or home abandonment. While we do not differentiate the importance of each mechanism in our estimates, the magnitude of the delinquency discount for different types of delinquent properties indicate that one mechanism is more likely (or more influential) than the others.

As delinquent property taxpayers have limited financial resources, their ability to maintain their property is reduced significantly. If this effect is compounded by additional nearby homeowners suffering financial distress, neighborhood blight is likely to cause a delinquency discount. Alternatively, the decision to become delinquent may be a signal of property abandonment. Homeowners vacating properties induce a largest strain on the social atmosphere of the neighborhood. As the social connectivity of the residents falls the delinquency discount increases. Additionally, vacant properties attract crime (Spelman, 1993), and rising crime rates may depress the value and reduce the attractiveness of a nearby property.

Further, when blighted and/or vacant properties are put up for sale or auction, this increases the supply of available houses. The increased supply leads to lower prices, and, when these properties are sold, the sales price puts further downward pressure on the valuation of nearby properties. These are some of the same causal pathways through which foreclosure negatively impacts nearby housing values (Lee, 2008).

These causal pathways may be a function of the duration of delinquency. Harding et al. (2009) find that the longer a homeowner is delinquent on mortgage payments the larger the foreclosure discount on nearby properties. We argue that the estimated delinquency discount should also increase with the duration of delinquency. If property neglect or neighborhood blight increases with the duration of delinquency, we expect the delinquency discount from tax foreclosure eligible properties to be the largest followed by sold, unsold, and published properties.

The relationship between sold and unsold properties does not depend on the duration of delinquency but rather the condition of delinquent properties. Prior research (Miller and Nikaj, 2013; Miller, 2014) finds that the probability of a tax lien selling at auction depends on the investors estimate of the property's market value. Investors are unwilling to purchase liens against properties that are seriously neglected. These properties require significant repairs in order to resell or rent. Since an unsold property may require a larger investment than a sold property, we expect the delinquency discount from nearby unsold properties to be larger.

3. Methodology

We use three methods to determine the size of the delinquency discount: standard hedonic, repeat sales, and matching. The models provide estimates of the implicit or shadow prices for each characteristic of the property and location. We are particularly interested in the delinquency discount, or the implicit price for the count of nearby delinquent properties. We calculate counts of delinquent properties within 660 feet and between 661 and 1,320 feet as we expect the discount to diminish with distance from the

property.[3] Likewise, the delinquency discount should vary with the duration of delinquency, so we measure each type of delinquency within both rings.

The standard log-linear hedonic model controls for a set of observed characteristics at the property and/or neighborhood level. Following Rosen (1974), we estimate an expanded version of the standard log-linear hedonic specification;[4]

$$\ln(P_{ij}^{t}) = \alpha + \sum_{d=1}^{2}\sum_{l=1}^{4}\beta_{ld}N_{ild} + \Omega' Z_i + \lambda F_j^t + \gamma^t + \theta_j + \varepsilon_i \qquad (1)$$

In equation (1), the dependent variable, P_{ij}^{t}, is the natural log of sales price of property i in neighborhood (measured by census tract) j at time t. The responding variable, N_{ild}, is number of nearby (distance d) delinquent properties for property i with duration of delinquency l. The delinquency discount by duration and distance is quantified by the estimates of β_{ld}. Each property is also described by a vector of observable time invariant characteristics[5], Z_i, and the public use microdata area foreclosure rate at time t, F_{jt}. The set of implicit prices for the observable characteristics is given by the vector $\mathbf{\Omega}$ while a version of the foreclosure discount is given by λ. We include census tract fixed effects, θ_j, to capture unobserved characteristics constant over time. We also include fixed effects for quarter of sale to control for unobservable changes in the housing market over time. The random error term is denoted ε_{it}.

The hedonic specification has two main advantages. The first is estimating multiple implicit prices for the observable characteristics of the property and location.

[3] The assignment of nearby properties using concentric rings is consistent with the literature. Immergluck and Smith (2006) use the same size rings to estimate the Chicago foreclosure discount. Harding et al. (2008) use 4 rings: up to 300 feet, 301-500 feet, 501-1,000 feet, and 1,000-2,000 feet. Their results suggest that by the fourth ring the impact goes to zero. In addition, 660 feet by 660 feet is a good approximation of a city block in Chicago (Ahlfeldt and McMillen, 2014).

[4] This technique is similar to Simons et al. (1998).

[5] We include a standard set of controls including number of bedrooms, number of bathrooms, presence of a fireplace, garage size, age of home, distance from the central business district (measured as straight line distance to the intersection of State and Madison), and indicators of being close to transit, Lake Michigan, and rail lines.

The second is that this technique retains a large sample size (when compared to a repeat sales model, as discussed below). The specification does have several weaknesses. The model requires specifying a functional form that may not be the appropriate form, it may suffer from unobservable characteristics or omitted variable bias that fixed effects may not fully capture, and it does not directly address the simultaneity concerns between property tax delinquency and home prices. Even so, the hedonic specification provides a useful benchmark for comparison with the other models.

We use a repeat sales analysis as a second method to determine the delinquency discount. The repeat sales strategy examines only those homes that have sold more than once. This method can be derived from a similar estimating equation as the hedonic specification with one fundamental change, differences:

$$\ln(P_{ij}^{\tau} / P_{ij}^{t}) = \sum_{j=1}^{19} \mu_j D_{i,j} + \sum_{d=1}^{2} \sum_{l=1}^{4} \beta_{ld} (N_{ild}^{\tau} - N_{ild}^{t}) + \lambda (F_j^{\tau} - F_j^{t}) + \varepsilon_i^{t,\tau} \qquad (2)$$

The dependent variable in equation (2) is the natural log of the ratio of transaction price at time τ to sales price at time t where τ>t. D is the standard indicator matrix that identifies transaction date. As before, the coefficients of interest are β_{ld}, which describe the delinquency discount by duration of delinquency and distance to the property. As the foreclosure rate varies over time, we include the difference.

This estimating equation is similar to the specification that Harding et al. (2009) use to identify the causal impact of additional foreclosures on sales price. They point out that by simultaneously estimating a local price trend, μ, and the impact of nearby foreclosed properties, the bias is removed from the estimates of the foreclosure discount.[6] We employ the identical strategy, but we use it to measure the delinquency discount. This

[6] Assuming the difference in number of foreclosed (or delinquent) properties is not correlated with the error term.

strategy assumes that the size of the discount is constant over time and that the effect is linear in additional delinquent properties.[7]

By differencing, the repeat sales method removes all time invariant characteristics (both observable and unobservable) of the property and location.[8] This is one of the main advantages of this strategy, but it comes at a significant cost. The number of homes sold more than once over a relatively short time period may be few and those that do sell more than once may be different than those that sell only once. This sample selection issue may produce bias in the estimated discount.

Our third method uses a matching technique to determine the discount to sales price associated with nearby property tax delinquency. To estimate the unbiased value of the delinquency discount, we must simultaneously estimate the local price indices. However, the small sample size (due to the short time period) and selection issues create concern about the repeat sales analysis. The matching estimation process is a hybrid of the hedonic and repeat sales models that keeps advantages of both. Matching provides a much larger sample size than the repeat sales method.[9] Further, by matching on observable and location characteristics of each property, this technique uses pairs of sales from different dates to estimate the discount just as the repeat sales analysis.[10]

To construct the matched sample, we pair each transaction in the first period to a similar transaction in each of the subsequent periods, thereby creating a smaller sample than the full sample but also a more consistent sample (conditional on observable

[7] The linear assumption is tested below with a quadratic specification as a robustness check.
[8] The technique also assumes the implicit prices of those attributes are constant over time. If either of these two assumptions does not hold then the repeat sales estimation suffers from omitted variable bias, similar to the hedonic approach.
[9] We include 24,342 additional transactions when compared to the repeat sales approach. This allows us to provide a more robust estimate of the delinquency discount especially in neighborhoods with few transactions.
[10] In fact the repeat sales model is a specific form of the matching technique where each property is matched to itself in later periods.

characteristics) over time.[11] We use propensity score matching to select the pair of each transaction, basing the match on all of the property and location characteristics found in the hedonic method. McMillen (2012) pioneered this approach to better estimate local price indices, and he provides a detailed description of implementing the technique.[12] The estimating equation for the matched sample is identical to equation (2). We use the matched pairs instead of identical properties sold at two time periods to calculate the differences.

4. Data

The transaction data in Chicago has been compiled from multiple sources by the Institute for Housing Studies (IHS) located in the Real Estate Center at DePaul University. We use the residential transaction data for Chicago from 2010 to 2013. IHS manages an extensive collection of housing data from Cook County, Illinois including transaction level property sales. The data include transaction price and date as well as the following housing characteristics: number of bedrooms, number of bathrooms, a fireplace indicator, number of garage spaces (up to two spaces), and year of construction. Also, the data include for each property sold the property identification number (PIN). We use the PIN to determine the physical location of each property and use ArcGIS to geo-coded all transactions.

[11] There were 2,046 transactions in the first quarter of 2010. We pair each of those transactions without replacement to the transactions in the subsequent 15 quarters. We end with 30,104 observations due to some imperfect matches and quarters with lower than 2,046 transactions. This corresponds to 28,058 pairs or repeat sales, as the first quarter transactions are not paired to themselves.

[12] The matching technique is also more flexible than either the hedonic or repeat sales specifications in that the later focus on changes over time in mean prices whereas the matching technique can characterize changes in price levels throughout the full distribution. Deng et al. (2012) use this flexibility to calculate price indices across the full distribution of prices for Singapore from 1995-2010.

IHS cleaned the data of outliers that do not appear to be arm's length transactions by matching the multiple listing service (MLS) provide by MRED and the recorder of deeds via Property Insight Inc. Using the matching process, potential data entry errors, unpredicted depreciation, total renovation, or fraud which may bias the estimate of the delinquency discount are mitigated.

We use the foreclosure data compiled by IHS court data provided by the Property Insight and the Record Information Service (RIS).[13] We calculate the annual single family foreclosure rates by public use microdata area (PUMA) in City of Chicago. The universe count of the total number of properties in each area is based on the Cook assessors' office data.

The Cook County Treasurer's Office supplied property tax delinquency data from 2010 to 2013. The Treasurer's Office list includes every delinquent property in the city of Chicago and the duration of delinquency by tax year. Additionally, the delinquency data include PINs which we use, similar to the transaction data, to determine the physical location of the property.

The data include 34,644 transactions. In Table 1, we present summary statistics for the full sample, the repeat sales sample, and the matched sample. Housing characteristics for all three samples are similar in mean and standard deviation. The average home sold over the sample period had about three bedrooms and two bathrooms, 86 percent of transactions included at least a one car garage. The homes, on average, are located about 8.75 miles from the central business district (the intersection of State and

[13] As a robustness check, we also use proprietary foreclosure data from RealtyTrac. RealtyTrac reports foreclosure "activity" in terms of foreclosure legal filings and notices on a zip code basis. We measure foreclosure activity using RealtyTrac's "notice of trustee sale" counts. These data are only for 2010-2011 which reduces the samples size; however, the results are unaffected by the source of the foreclosure data.

Madison streets), and are a little over 63 years old. The average home sold had over two published delinquent properties and almost two sold delinquent properties within 660 feet. The average number of unsold and tax foreclosure delinquent properties per transaction is about 0.75 and 0.25, respectively.[14] All of the delinquency measures increase in the second ring (between 660 and 1,320 feet) as more area is included (three times the area of the first ring). Noticeably, the repeat sales sample includes 3,716 transactions or 1,858 properties with two transactions during the period of observation.[15] The matched sample includes 28,058 transactions. This is one benefit of using the matched sample; it preserves a larger sample than the repeat sales.

5. Results

a. Log-Linear hedonic estimates

We estimate equation (1) with two different specifications. In the first specification, we include only the property tax delinquency effects for the first ring, within 660 feet.[16] In the second specification, we incorporate the delinquency effects of both rings, up to 1,320 feet from the property. In both specifications, the estimating equation contains the observable property and location characteristics. The specifications also control for the foreclosure rate at the public use microdata area. Lastly, in an attempt to control for the unobservable characteristics, we use census tract and quarter of sale fixed effects.

[14] The total amount of taxes owed by these delinquent properties within 660 feet of the average transaction is approximately $14,500.
[15] We exclude properties with three or more transactions.
[16] We count the number of each type of delinquent property and estimate the effects of each type separately, naming them collectively the property tax "delinquency discount" effects.

Table 2 presents the estimation of the log-linear hedonic specification. The results of specification (1) imply that one additional published property within 660 feet leads to a statistically significant delinquency discount of 0.4 percent or $977 of the average sale price. The discount is statistically significant, and grows to 1.9 percent ($4,641) and 1.5 percent ($3,664) for the sold and unsold properties, respectively. Specification (2) controls for counts of delinquent properties in both rings, and the results imply roughly the same impacts for additional delinquent properties within 660 feet as specification (1) with the exception of the statistical significance of the effect from additional published delinquent properties. The estimated discount of an additional published delinquent property between 660 and 1,320 feet is 0.3 percent or $733. Additional sold and unsold delinquent properties are associated with discounts of 0.8 and 0.2 percent ($1,954 and $488), respectively; however, the unsold delinquent properties effect is not statistically significant. Interestingly, we find evidence that additional tax foreclosure properties within the second ring increase sales prices by 0.4 percent but not statistically significantly.

The results from the log-linear hedonic specification are consistent with the prior literature and provide a benchmark for comparison with the other models. The hedonic specification does not directly address the simultaneity issue.

b. Repeat sales estimates

Table 3 reports the repeat sales estimation of the discount following equation (2). The repeat sales approach directly addresses the simultaneity issue, and presents unbiased estimates of the discount. These advantages come at some cost. The model only includes 1,858 properties, and the precision of the estimates falls dramatically.

We use the same two specifications as with the log-linear hedonic estimates. The first suggests that tax foreclosure properties have a statistically significant discount on sales price of 6 percent. The second finds statistically significant discounts for additional unsold properties within 660 feet (5.5 percent) and additional tax foreclosure properties between 660 and 1,320 feet (4.5 percent), and statistically significant premiums for additional published properties between 660 and 1,320 feet (1.7 percent). Noticeably, both specifications yield negative impacts of higher foreclosure rates on sales price.[17] While these results are in line with our priors and the previous literature, we are concerned with the small number of observations. Thus, we rely on the matching technique to improve the precision of the estimated discounts.

c. Matching estimates

We use the matching technique to combat the issues with the repeat sales approach. Table 4 provides the matched-sample repeat sales estimates of the discount for both specifications. The results show all types of delinquency generate statistically significant discounts. In the preferred specification, the discounts range in magnitude from 1.7 to 11.5 percent (or $4,041 to $27,334). The results are larger in magnitude but in line with expectations, and they are much more precisely measured as compared to the repeat sales approach.

As expected, the estimated discount decreases with distance. This result may indicate the importance of visibility, and it is also consistent with prior observation in both the foreclosure and property tax delinquency literature (Gillen, 2012; Harding et. al, 2009). In addition, the findings suggest that increases in the duration of delinquency

[17] A one unit change in foreclosure rate over this short time span is a tremendous increase, particularly since the foreclosure rate was generally falling during this time period.

increase the discount. The discount structure is suggestive that blight is a significant mechanism driving the discount.[18]

The results are also consistent with the mechanism of additional housing supply and reduced valuation. Homeowners under financial distress for longer periods may be forced into selling their homes. This increases the local housing supply available to buyers pushing down the price. These properties are also maintenance deprived which when sold reflects on nearby homes through comparable sales. One plausible explanation for the discount difference between the sold (4.9 percent) and unsold (1.9 percent) properties in the second ring is that these properties are less visible than properties in the first concentric ring. Therefore, it is possible that the second ring mechanism is dominated by valuation and supply rather than blight. It is easy to imagine that sold properties may be more likely to sell than unsold and tax foreclosure properties.

d. Quadratic Specification

As a robustness check, we estimate a second order polynomial form of equation (2).

$$\ln(P_{ij}^{\tau} / P_{ij}^{t}) = \sum_{j=1}^{19} \mu_j D_{i,j} + \sum_{d=1}^{2}\sum_{l=1}^{4} \beta_{ld}(N_{ild}^{\tau} - N_{ild}^{t}) + \sum_{d=1}^{2}\sum_{l=1}^{4} \beta_{ld}((N_{ild}^{\tau})^2 - (N_{ild}^{t})^2) + \lambda(F_j^{\tau} - F_j^{t}) + \varepsilon_i^{t,\tau} \quad (3)$$

We use the matched sample to estimate the discounts for each type of delinquency. Table 5 shows for the first ring the second order terms are important. For sold and unsold types of delinquent properties the discount is decreasing with additional delinquent properties. The quadratic effect of tax foreclosure properties in the first ring shows increasing discount. In combination, these effects are intuitive as additional

[18] This assumes that blight increases with duration of delinquency. It may be that the property is improved by the city once foreclosure is assessed. Maintenance (such as yard work) or demolition may occur quickly at this stage.

delinquent properties (sold and unsold) may not have the same effect as the first few delinquent properties; yet, if severely neglected (tax foreclosure) these properties may reduce sales prices by even more than a single property that is poorly maintained. The second ring results do not support second order terms except for the tax foreclosure properties. The discount is decreasing in additional tax foreclosed properties.

6. Conclusion

In this analysis, we improve upon the previous literature in three important ways. First, we empirically estimate the delinquency discount while controlling for the duration of delinquency. Second, we use the matched sales technique to control for endogeneity between property tax delinquency and home prices. Third, we estimate the delinquency discount while controlling for foreclosure rates.

Our estimation results from three different approaches clearly indicate a significant "delinquency discount" on nearby home prices. In our preferred specification, we find the discount of one additional nearby recently delinquent property within 660 feet is 3.4 percent, an impact of $8,309 at the average sales price. We also find that this impact increases with the duration of delinquency and decreases with distance from the sale.

Our results highlight the importance of extending the discussion of financial distress among homeowners beyond foreclosure. The literature examining the deleterious effect of foreclosure is extensive, examining such factors as childhood outcomes (Been et al., 2011), health outcomes of homeowners (Pollack and Lynch, 2009), and the foreclosure discount (Immergluck and Smith, 2006). The deleterious effects of property

tax delinquency and tax foreclosure are likely to be highly correlated with (mortgage) foreclosure.

By focusing on the foreclosure crisis, policymakers have neglected homeowners without a mortgage. Over 25 million housing units or 34.3 percent of owner-occupied housing units did not have a mortgage in 2012. Homeowners without mortgages were not immune to economic downturns. Therefore, examining the social cost of property tax delinquency provides a more complete picture of the housing market collapse. This study helps in that pursuit by confirming the existence of a delinquency discount in Chicago. The results can be used to design policies that mitigate the social cost of property tax delinquency as well as to spur additional research on social cost of property tax delinquency.

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Table 1. Descriptive statistics.

	Full Sample		Repeat Sales		Matched Sample	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Sales price	$244,239	$ 370,297	$ 192,345	$ 253,482	$ 237,691	$ 362,892
Log of sales price	11.758	1.185	11.702	0.966	11.774	1.114
Number of published delinquent properties within 660 feet	2.662	2.503	2.915	2.582	2.629	2.405
Number of sold delinquent properties within 660 feet	1.969	2.351	2.178	2.336	1.968	2.305
Number of unsold delinquent properties within 660 feet	0.772	3.056	0.484	2.125	0.295	1.121
Number of tax foreclosure delinquent properties within 660 feet	0.257	1.196	0.175	0.866	0.096	0.337
Number of published delinquent properties between 660 and 1320 feet	6.954	5.590	7.611	5.623	6.892	5.269
Number of sold delinquent properties between 660 and 1320 feet	5.115	5.288	5.520	5.075	5.075	5.116
Number of unsold delinquent properties between 660 and 1320 feet	2.073	7.799	1.423	5.714	0.807	2.654
Number of tax foreclosure delinquent properties between 660 and 1320 feet	0.686	2.937	0.505	2.139	0.252	0.602
Number of bedrooms	3.377	0.938	3.325	0.747	3.389	0.939
Number of bathrooms	2.063	0.895	2.082	0.812	2.071	0.897
Fireplace	0.907	0.291	0.901	0.299	0.904	0.295
Garage, 1 car	0.116	0.321	0.115	0.319	0.120	0.325
Garage, 2 car	0.753	0.431	0.762	0.426	0.759	0.427
Distance from city center (in miles)	8.742	2.856	9.140	2.511	8.721	2.801
Within 1/4 mile of EL stop	0.053	0.225	0.036	0.185	0.054	0.226
Within 1/2 mile of Lake Michigan	0.016	0.126	0.011	0.106	0.017	0.131
Within 1/4 mile of rail line	0.105	0.307	0.075	0.263	0.106	0.308
Age of house at time of sale	63.671	38.317	59.600	35.686	62.669	37.989
Foreclosure Rate	2.798	1.174	2.984	1.108	2.924	1.118
Number of observations	34,644		3,716		30,104	

Notes: Residential (up to 6 units) sales transaction data for Chicago area between January 1st 2010 and December 31st 2013. Repeat sales transactions only include those homes that sold twice during the time span. Matched sample applies McMillen's (2012) matching technique to produce a pseudo repeat sales data set. Foreclosure rate corresponds to the yearly ratio of foreclosed properties to households at the PUMA5-level. Amounts of taxes owed are in $1000s.

Table 2. Log-linear hedonic regressions.

Specification:	(1)		(2)	
	Coeff.	Std. Err.	Coeff.	Std. Err.
Property Tax Delinquency Effects				
Ring 1 - Within 660 feet				
Published delinquent properties	-0.004*	0.002	-0.003	0.002
Sold delinquent properties	-0.019***	0.005	-0.016***	0.004
Unsold delinquent properties	-0.015**	0.007	-0.013**	0.005
Tax foreclosure properties	-0.003	0.005	-0.005	0.003
Ring 2 - Between 660 and 1320 feet				
Published delinquent properties	.	.	-0.003**	0.001
Sold delinquent properties	.	.	-0.008***	0.002
Unsold delinquent properties	.	.	-0.002	0.002
Tax foreclosure properties	.	.	0.004	0.003
Property Characteristic, Location, and Foreclosure Effects				
Number of bedrooms	0.048***	0.010	0.048***	0.010
Number of bathrooms	0.299***	0.035	0.299***	0.035
Fireplace	0.013	0.014	0.013	0.014
Garage, 1 car	0.245***	0.017	0.244***	0.017
Garage, 2 car	0.326***	0.021	0.325***	0.020
Age of house at time of sale	0.004***	0.001	0.004***	0.001
Age squared	-0.000***	0.000	-0.000***	0.000
Distance from city center	0.034	0.038	0.022	0.036
Within 1/4 mile of EL stop	-0.031	0.021	-0.032	0.021
Within 1/2 mile of Lake Michigan	-0.071	0.103	-0.075	0.105
Within 1/4 mile of rail line	0.010	0.022	0.002	0.021
Foreclosure rate	-0.037*	0.018	-0.033***	0.017
Constant	10.667***	0.374	10.826***	0.349
Tract fixed effects	Yes		Yes	
Quarter fixed effects	Yes		Yes	
N	34644		34644	
R^2	0.848		0.849	
F-statistic	.		.	

Notes: The dependent variable is the natural log of the sales price. The property tax delinquency effects are measured in number of delinquent properties within a given distance from residential sales transactions in Chicago, Illinois. Published tax delinquent properties are those listed by the municipality to have not paid at least one installment of the property tax owed. Unsold delinquent properties are those listed in themunicipality's tax lien sale for missing two or more property tax payments and the tax lien was not sold at the sale. Sold delinquent properties are those listed in the municipality's tax lien sale for missing two or more property tax payments and the tax lien was sold at the sale. Tax foreclosure properties are those for which the property tax has not been paid for two years or longer and the municipality is foreclosing the property.

Table 3. Repeat sales regressions.

Specification:	(1)		(2)	
	Coeff.	Std. Err.	Coeff.	Std. Err.
Property Tax Delinquency Effects				
Ring 1 - Within 660 feet				
Published delinquent properties	-0.011	0.011	-0.012	0.011
Sold delinquent properties	-0.005	0.011	-0.002	0.012
Unsold delinquent properties	-0.035	0.022	-0.055***	0.017
Tax foreclosure properties	-0.060***	0.014	0.012	0.024
Ring 2 - Between 660 and 1320 feet				
Published delinquent properties	.	.	0.017***	0.005
Sold delinquent properties	.	.	-0.008	0.011
Unsold delinquent properties	.	.	0.011	0.011
Tax foreclosure properties	.	.	-0.045***	0.015
Foreclosure Effect				
Foreclosure rate	-0.846***	0.203	-0.851***	0.189
N	1858		1858	
R^2	0.536		0.348	
F-statistic	.		.	

Notes: The dependent variable is the natural log of the ratio of sales price, recent to prior. The property tax delinquency effects are measured as the difference (second sale minus first sale) in the number of delinquent properties within a given distance from residential sales transactions in Chicago, Illinois. Published tax delinquent properties are those listed by the municipality to have not paid at least one installment of the property tax owed. Unsold delinquent properties are those listed in themunicipality's tax lien sale for missing two or more property tax payments and the tax lien was not sold at the sale. Sold delinquent properties are those listed in the municipality's tax lien sale for missing two or more property tax payments and the tax lien was sold at the sale. Tax foreclosure properties are those for which the property tax has not been paid for two years or longer and the municipality is foreclosing the property.

Table 4. Matched-sample repeat sales regressions.

Specification:	(1)		(2)	
	Coeff.	Std. Err.	Coeff.	Std. Err.
Property Tax Delinquency Effects				
Ring 1 - Within 660 feet				
Published delinquent properties	-0.073***	0.005	-0.034***	0.003
Sold delinquent properties	-0.133***	0.006	-0.073***	0.004
Unsold delinquent properties	-0.142***	0.012	-0.085***	0.011
Tax foreclosure properties	-0.169***	0.031	-0.115***	0.025
Ring 2 - Between 660 and 1320 feet				
Published delinquent properties	.	.	-0.024***	0.003
Sold delinquent properties	.	.	-0.049***	0.002
Unsold delinquent properties	.	.	-0.019***	0.004
Tax foreclosure properties	.	.	-0.017	0.016
Foreclosure Effect				
Foreclosure rate	-0.378***	0.044	-0.353***	0.041
N	28058		28058	
R^2	0.536		0.577	
F-statistic	110.42		128.91	

Notes: The dependent variable is the natural log of the ratio of sales price, recent to prior. The property tax delinquency effects are measured as the difference (matched sale minus 2010Q1 sale) in the number of delinquent properties within a given distance from residential sales transactions in Chicago, Illinois. Published tax delinquent properties are those listed by the municipality to have not paid at least one installment of the property tax owed. Unsold delinquent properties are those listed in themunicipality's tax lien sale for missing two or more property tax payments and the tax lien was not sold at the sale. Sold delinquent properties are those listed in the municipality's tax lien sale for missing two or more property tax payments and the tax lien was sold at the sale. Tax foreclosure properties are those for which the property tax has not been paid for two years or longer and the municipality is foreclosing the property.

Table 5. Matched-sample repeat sales regressions -Quadratic specifications.

Specification:	(1)		(2)	
	Coeff.	Std. Err.	Coeff.	Std. Err.
Property Tax Delinquency Effects				
Ring 1 - Within 660 feet				
Published delinquent properties	-0.085***	0.010	-0.017**	0.006
Quadratic term	0.001	0.001	0.001	0.001
Sold delinquent properties	-0.140***	0.011	-0.038***	0.007
Quadratic term	0.001	0.001	0.002**	0.001
Unsold delinquent properties	-0.202***	0.015	-0.101***	0.150
Quadratic term	0.008***	0.001	0.004***	0.001
Tax foreclosure properties	-0.164***	0.040	-0.007	0.031
Quadratic term	0.004	0.019	-0.055**	0.019
Ring 2 - Between 660 and 1320 feet				
Published delinquent properties	.	.	-0.025***	0.007
Quadratic term	.	.	0.000	0.000
Sold delinquent properties	.	.	-0.051***	0.003
Quadratic term	.	.	0.000	0.000
Unsold delinquent properties	.	.	-0.020**	0.008
Quadratic term	.	.	0.000	0.000
Tax foreclosure properties	.	.	-0.115***	0.021
Quadratic term	.	.	0.036***	0.005
N	28058		28058	
R^2	0.526		0.579	
F-statistic	104.94		126.42	

Notes: All regressions include a control for the puma5-level foreclosure rate. Published tax delinquent properties are those listed by the municipality to have not paid at least one installment of the property tax owed. Unsold delinquent properties are those listed in themunicipality's tax lien sale for missing two or more property tax payments and the tax lien was not sold at the sale. Sold delinquent properties are those listed in the municipality's tax lien sale for missing two or more property tax payments and the tax lien was sold at the sale. Tax foreclosure properties are those for which the property tax has not been paid for two years or longer and the municipality is foreclosing the property.

Figure 1

Phases of Delinquency