Reassessed & Repossessed: Who Bears a Reassessment Shock?

Roxana Gonzalez-Cortes*

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Abstract

Most U.S. homes are assessed on mandated cycles of three years or longer. Appreciation goes untaxed between assessments and arrives as a discrete increase in the tax bill in the assessment year, which escrow passes through to the monthly mortgage payment. I study eight countywide assessments in the five largest North Carolina counties between 2011 and 2019, comparing each with counties that assess every year by synthetic difference in differences, and link each home's tax bill to its recorded deeds and foreclosure filings. An assessment raises a home's quarterly probability of a foreclosure filing by 31 percent, about 610 additional filings over two years in the median county. The additional filings decline steadily with home value, from 0.70 per 100 homes in the cheapest quartile to 0.37 in the most expensive. Where bills can be measured, a 10 percent larger bill increase roughly doubles the filing probability of the cheapest homes and leaves that of the most expensive unchanged. Long assessment cycles concentrate payment shocks, and the foreclosure filings that follow, on the owners least able to absorb them.

*Darla Moore School of Business, University of South Carolina, Roxana.Gonzalez@grad.moore.sc.edu.

1 Introduction

In U.S. counties that assess homes annually, property tax bills track market values, typically raising the owner's tax liability in small yearly increments. However, most homes in the United States are assessed on mandated cycles of three years or longer.[1] Between assessments the home's assessed value is fixed, so appreciation over the interval goes untaxed. Then, the accumulated appreciation enters the assessed value in a single year, delivering a discrete jump in the owner's bill. While assessment growth caps, homestead exemptions, and statuatory rate rollbacks mitigate the size of these shocks, reassessments can deliver the large jumps in property tax liabilities when these protections are weak or absent.

For mortgaged owners, an assessment jump reaches the household as a payment shock. Servicers pay property taxes from escrow and re-estimate the escrow account each year, so a higher tax bill raises the monthly mortgage payment and often adds a repayment of the escrow shortage. Over a full cycle, long-cycle owners pay less tax than they would under annual assessment, so a forward-looking owner who could save or borrow would absorb the jump without distress. Owners who cannot are exposed to a well-documented trigger of default, since larger required payments raise delinquency and foreclosure (Fuster and Willen, 2017; Ganong and Noel, 2020) and the timing of property tax payments alone moves default (Anderson and Dokko, 2016). Because many jurisdictions roll back rates after an assessment to hold revenue roughly constant, the jump falls on homes that appreciated faster than the jurisdiction average.

The owners least able to absorb a higher payment are concentrated in the cheapest homes. Low-income households hold less liquid savings and have less access to credit (Jappelli, 1990), so a payment increase they did not plan for is more likely to push them behind. They may also see it coming less clearly. Escrow already obscures the property tax (Cabral and Hoxby, 2012), a bill that stays flat for years gives owners little reason to expect a jump, and misperception of tax liabilities is greatest among low-income households (Gindelsky et al., 2023). If an assessment works through the payment, it should raise foreclosure filings and the foreclosures and distressed exits that follow, it should raise them most among the cheapest homes, and it should raise them more where the bill rises more. Section 3 develops these predictions.

I study the eight countywide assessments in the five largest North Carolina counties between 2011 and 2019. Each county assesses on a statutory cycle of four to eight years with no cap on assessment growth, so the date of each assessment is set by law and the accumulated appreciation enters the bill at once. I observe every recorded foreclosure filing, completed foreclosure and distressed exit of an owner-occupied home[2] and measure each as a quarterly rate per 100 homes. The comparison counties assess every year, so

[1] The share is computed from the Lincoln Institute's assessment-cycle and assessment-limit tables (2023) and housing stock estimates from the ACS (2024).

[2] A distressed exit is a completed foreclosure, a deed in lieu of foreclosure, a tax deed or a sale for less than the outstanding mortgage.

their bills never accumulate a correction. A plain difference in differences against the average such county would mislead, because filings in the treated counties were already rising relative to that average before the assessments (Figure 2). Synthetic difference in differences (Arkhangelsky et al., 2021) instead weights the comparison counties so that their filings move with each treated county's before its assessment, and weights the pre-period quarters that best predict the comparison counties' later path. Each assessment is estimated separately. This avoids the comparisons between early- and late-assessed counties that bias a pooled regression under staggered timing (Goodman-Bacon, 2021).

I first average the eight event estimates with equal weight, which gives the effect of an assessment on the average owner-occupied home. I then estimate each value quartile separately, with its own comparison counties and weights. Cheap and expensive homes trade in different submarkets, with different buyers and financing (Landvoigt et al., 2015), so each quartile needs a counterfactual of its own, one that a county-wide comparison cannot supply. Finally, in four of the events, Mecklenburg 2011 and 2019 and Guilford 2012 and 2017, county rolls record every parcel's bill. I estimate these events again against Florida counties, whose rolls also record bills, and divide each effect by the bill change it delivered, which gives the response to a 10 percent larger bill.

Findings. An assessment raises the probability that a home enters every stage of mortgage distress. In the two years after an assessment, a home's quarterly probability of receiving a foreclosure filing rises by 31 percent of its pre-period level. That accumulates to 0.52 additional filings per 100 owner-occupied homes over the eight quarters, about 610 filings in the median treated county of 118,000 homes. The probability of a completed foreclosure rises by 20 percent and that of a distressed exit by 18 percent, which accumulate to 0.16 and 0.24 homes per 100, about 190 foreclosures and 280 exits in the median county. These two estimates are positive in nearly every event, but on their own they are not distinguishable from zero against the comparison counties. The filing response is largest after the assessments of 2011 to 2013, which arrived as the foreclosure crisis wound down and many owners held little equity. Completed foreclosures rise by similar amounts in the early and late events alike.

Foreclosure filings steadily decline with home value quartile, from 0.088 points a quarter in the cheapest quartile to 0.075, 0.063 and 0.046 in the most expensive. The cheapest quartile accumulates 0.70 additional filings per 100 homes over two years, against 0.37 in the most expensive, about 210 and 110 filings in the median county. Completed foreclosures and distressed exits rise by similar amounts across quartiles, 0.16 and 0.23 homes per 100 over two years in the cheapest quartile against 0.15 and 0.22 in the most expensive, and peak in the third quartile. Larger filing effects among cheaper homes are consistent with more of their owners being close to default, with thinner equity and less liquid savings to absorb a higher payment.

Responses follow the size of the bill increase where the bill can be measured. In four events, Mecklenburg

2011 and 2019 and Guilford 2012 and 2017, county rolls record every parcel's bill, so I estimate them again against Florida counties, whose rolls record bills too, and scale each effect by the bill change it delivered. A 10 percent larger tax bill roughly doubles a bottom-quartile home's quarterly probability of receiving a foreclosure filing, while it leaves a top-quartile home's essentially unchanged, an 18 percent decline that is indistinguishable from zero. At the point estimate this amounts to about 2.6 additional filings per 100 homes at the bottom and none at the top over two years, and the response declines steadily across the quartiles in between. The decline in filings is consistent with owners of more expensive homes holding enough equity and savings to pay a higher bill, refinance or sell before falling behind. The same bill increase raises the probability of a completed foreclosure by 10 percent at the bottom and 31 percent at the top, and that of a distressed exit by 14 and 28 percent, about 0.15 to 0.29 homes per 100 over two years, though none of these estimates is distinguishable from zero. Owners of more expensive homes may also have the means to choose how they leave, through a sale below the mortgage balance or a deed in lieu of foreclosure before any filing, which might explain why their exits respond more relative to their lower pre-period rates.

Contribution. I contribute to research on how property tax assessment affects homeowners and on how required payments affect mortgage default, using a novel dataset. It links each owner-occupied home's annual property tax bill, drawn from county and state tax rolls in North Carolina and Florida, to its recorded deeds and foreclosure filings within each assessment window. Studies of assessment practice document how long intervals between assessments let assessed values drift from market values, and how that drift distributes the tax burden across homes of different value (Berry and Wang, 2024; Kim and Hou, 2025). Studies of mortgage default show that larger required payments raise delinquency and foreclosure, identifying payment effects from interest-rate resets, due-date calendars and program rules (Anderson and Dokko, 2016; Fuster and Willen, 2017; Ganong and Noel, 2020). This paper differs from both. It follows the correction that ends a long assessment interval to its consequences for mortgage distress, the outcome the assessment literature leaves unmeasured. It also uses a payment change whose date is fixed by statute and whose size varies across homes within the same county, which lets the payment response be compared across the value distribution.

Policy. A county that assesses once every eight years collects the same tax over the cycle as one that assesses every year, but it delivers the correction in a single bill. The estimates here put the cost of that timing at about 610 additional foreclosure filings over two years in a county of 118,000 owner-occupied homes, with the largest number falling on the cheapest homes. Shorter cycles would spread the same correction over smaller annual steps. Where annual assessment is too costly, phasing an assessment increase into the bill over several years, or spreading the resulting escrow shortage over a longer repayment period, would reduce the payment shock without changing what the owner eventually pays. These benefits must be weighed against the administrative cost of assessing more often, which the estimates here do not measure.

2 Institutional Background

2.1 How property tax bills are set

A home's property tax bill is the sum of the levies of every local government whose boundaries contain it, typically a county, a city or town, a school district and one or more special districts, each applying its own rate to the home's assessed value (Amornsiripanitch, 2024). The assessed value is the assessor's estimate of the home's market value multiplied by a statutory assessment ratio, which is 100 percent in some states and a fraction in others, and exemptions are subtracted from it before the rate applies (McMillen and Singh, 2020). In most states a county assessor estimates the market value of every parcel by mass appraisal from recent sales, while each governing body sets its own rate. A home's bill therefore changes when its assessed value changes or when the rates applied to it change, and the timing of the first depends on how often the assessor updates values.

States differ widely in how often assessors must update those values. Some require annual assessment, others set cycles of three to ten years, and a few, such as California, update a home's value only when it sells or is improved (Berry and Wang, 2024). Between assessments a home's assessed value is fixed, so it falls further behind the market each year that prices rise, and the gap closes in a single step at the next assessment (Fraenkel, 2024). Even an annual assessment lags the market, because the values set for a tax year are estimated from sales in earlier years (Berry and Wang, 2024). Long intervals also let assessed values drift unevenly across homes, which studies of assessment uniformity link to regressive tax burdens and which an assessment partly corrects (Berry, 2021; Kim and Hou, 2025).

Tax rates respond to assessed values. Many local governments set a target levy and divide it by the tax base, so a rise in assessed values is partly offset by a lower rate, and property tax revenue rises by about 0.4 percent for each 1 percent rise in house prices, with a lag of about three years (Lutz, 2008). Several states formalize the offset through truth-in-taxation rules, which require a jurisdiction to publish the rate that would raise its prior revenue on the new values and to justify any higher rate, and in Ohio the rates of voted levies fall automatically when values rise so that each levy raises a fixed dollar amount (Fraenkel, 2024). Where rates adjust this way, an assessment changes the total levy little and mainly reallocates it, raising bills for homes that appreciated faster than the jurisdiction as a whole and lowering them for homes that appreciated more slowly.

State law also limits how much of an assessment reaches the bill. Homestead exemptions remove a fixed amount or share of an owner-occupied home's value from the base, assessment growth caps limit the annual rise in a homestead's taxable value, and circuit breakers and deferrals relieve owners whose taxes are high

relative to their income.[3] Where these protections are strong, a large rise in market value reaches the bill gradually, and where they are weak or absent the full correction arrives in the assessment year.

2.2 How owners pay and fall behind

How the bill reaches the household depends on whether it holds a mortgage. Most mortgaged owners pay through an escrow account, into which the servicer collects a twelfth of the expected annual tax and insurance with each monthly payment and from which it pays the bill when due. Among homeowners in the American Community Survey linked to deed records, 60 percent pay through escrow, 20 percent hold a mortgage without escrow and 20 percent have no mortgage (Gindelsky et al., 2023). Federal rules require the servicer to analyze the account once a year and reset the monthly deposit to the projected bill, and a servicer that collects a shortage of a month's payment or more must spread it over at least twelve monthly installments.[4] A higher bill therefore raises the monthly mortgage payment within about a year of the assessment, by the increase in the tax plus the repayment of the shortfall the old deposit left. Owners who pay directly receive the bill from the tax collector and pay it in one or two installments. Escrow makes the tax less salient, and owners who pay through it misjudge their own taxes more than owners who pay directly (Cabral and Hoxby, 2012; Gindelsky et al., 2023).

An owner who cannot meet the higher bill falls behind on whichever obligation carries it. An escrowed owner who misses the higher monthly payment is delinquent on the mortgage, and continued delinquency leads to a foreclosure filing and, unless the owner cures the default, sells the home or deeds it to the lender, to a completed foreclosure. An owner who pays directly and misses the bill is delinquent to the county, which holds a lien on the home, adds interest and penalties, and can eventually sell the home through a tax foreclosure (Alfaro et al., 2021; Skidmore et al., 2025). A lender can also pay unpaid taxes on a loan without escrow and add the amount to the secured debt, which moves the delinquency back to the mortgage.[5] The outcomes in this paper follow both paths, through foreclosure filings and completed foreclosures, and through distressed exits that also count tax deeds, deeds in lieu and sales below the outstanding mortgage.

2.3 Assessment in North Carolina

North Carolina requires each county to assess all real property at its market value as of January 1 of the assessment year and to conduct a countywide assessment at least once every eight years, and a county's

[3] Florida caps the annual rise in a homestead's assessed value at 3 percent or the change in the consumer price index, whichever is lower (Fla. Const. art. VII, § 4(d)), and Michigan caps the rise in taxable value at 5 percent or inflation (Mich. Const. art. IX, § 3).

[4] 12 C.F.R. § 1024.17(c) and (f) (Regulation X).

[5] See, for example, the FHA model mortgage, HUD Handbook 4165.1 REV-2, Appendix II, paragraph 7.

commissioners may move an assessment earlier or adopt a shorter cycle by resolution.[6] Between assessments a home's assessed value changes only with new construction, demolition or a successful appeal. The state imposes no limit on how much an assessed value may rise and offers no general homestead exemption. Relief is confined to low-income owners who are elderly or disabled, who may exclude the greater of $25,000 or half of the home's value, and to disabled veterans.[7] Nearly all of an assessment therefore reaches the bill of the typical owner-occupied home in the year it takes effect.

The assessment year follows a fixed calendar. The county mails notices of the new values early in the year, and owners may appeal to the county's board of equalization and review and then to the state Property Tax Commission. Each county adopts its budget and tax rate by July 1, and in an assessment year it must first publish the revenue-neutral rate, the rate that would raise the prior year's revenue on the new values, adjusted for the average growth of the base through improvements, although it may adopt a different one.[8] Bills are mailed in the summer, fall due on September 1, and may be paid without interest through January 5. An owner therefore learns the new value months before the first higher bill, and an owner who pays through escrow sees the higher monthly payment once the servicer's next annual analysis follows that bill.

The five counties in this paper set different cycles. Mecklenburg assessed in 2003, 2011 and 2019 before moving to a four-year cycle, Durham and Wake in 2008 and 2016, Guilford in 2004, 2012 and 2017, and Forsyth every four years, so the eight assessments close cycles of eight, five and four years. Municipal and special-district rates sit on top of the county rate and can change every year, so revenue grows between assessments through the rate (Appendix Table A2). In 2013 Mecklenburg reviewed its 2011 roll and revised about 18 percent of values, with refunds and back-bills payable in 2015, inside the 2011 event's post-period, so the estimate for that event nets the original change against its partial reversal.

2.4 Assessment in the comparison counties

The comparison counties assess every year, so their assessed values follow the market in annual steps and their bills carry no deferred correction. Their bills are not unconstrained, since several of the states that supply most of the comparison weight cap the annual rise in a homestead's taxable value, Florida at 3 percent or the change in consumer prices, Michigan at 5 percent or inflation, and Arizona at 5 percent.[9] The counterfactual for a North Carolina assessment is therefore a schedule of small annual changes, held below the market in some comparison states, and the estimates measure the effect of receiving the correction in one year instead of in such steps.

[6] N.C. Gen. Stat. §§ 105-283, 105-285 and 105-286(a)(3).
[7] N.C. Gen. Stat. §§ 105-277.1, 105-277.1B and 105-277.1C.
[8] N.C. Gen. Stat. §§ 159-11(e) and 159-13.
[9] Ariz. Const. art. IX, § 18(3)(b). Florida and Michigan as in footnote 3.

3 Conceptual Framework

An owner with a mortgage pays the loan installment m and the property tax bill $\tau_t A_t$, where A_t is the assessed value and τ_t the combined rate, out of income y_t and liquid savings s_t. The owner falls behind when

$$m + \tau_t A_t > y_t + s_t, \tag{1}$$

and a missed payment ends in a foreclosure filing when the owner cannot close the gap by refinancing or selling, both of which require equity (Foote et al., 2008; Campbell and Cocco, 2015). Most owners pay the tax through escrow, so a higher bill reaches the monthly installment at the next escrow analysis, and payment increases set by rule are a documented trigger of default (Anderson and Dokko, 2016; Fuster and Willen, 2017).

The assessment cycle governs how the tax term in equation (1) moves over time. Under annual assessment A_t follows the market and the bill rises in small yearly steps. Under a long cycle A_t stays at its last assessed level, so appreciation goes untaxed until the county assesses again and the accumulated growth enters the bill in one year. How far a given home's bill moves at that point follows from an identity. Since the bill is the assessed value times the rate, the change in a home's log bill is

$$\Delta \ln B_i = \left(\Delta \ln A_i - \overline{\Delta \ln A}\right) + \left(\overline{\Delta \ln A} + \Delta \ln \tau\right), \tag{2}$$

where $\overline{\Delta \ln A}$ is the average change in homes' assessed values in the county. The first term differs across homes: it is positive for a home whose assessment grew faster than the county's and negative for one whose assessment grew more slowly. The second term is common to every home in the county. It is zero when the rate falls in proportion to the average growth in homes' assessed values and positive when the county keeps part of that growth as revenue. At the revenue-neutral rate, which holds the levy on all property fixed, it is zero only if homes grew as fast as the rest of the tax base.

Figure 1 illustrates the identity with two homes, each worth \$300,000 and taxed at 1 percent, in a county made up of the two. Over eight years one appreciates 5 percent a year, to \$443,000, and the other 2 percent a year, to \$351,000, so the county's assessed value grows by 32 percent. At the revenue-neutral rate total revenue stays at \$6,000, and the bills end at \$3,346 and \$2,654. Under annual assessment the bills reach those levels in yearly steps. Under an eight-year cycle both owners pay \$3,000 until the assessment, and then each bill moves by \$346 in one year. Over the cycle the faster-growing home pays less tax than it would under annual assessment and the slower-growing home pays more, by the shaded areas in the figure. An owner who expected the assessment could set the deferred tax aside and meet the increase without difficulty,

so the increase matters for owners who did not anticipate it or could not save. A given increase weighs most on owners with the least income and savings to absorb it, who in these counties own the cheapest homes (Jappelli, 1990).

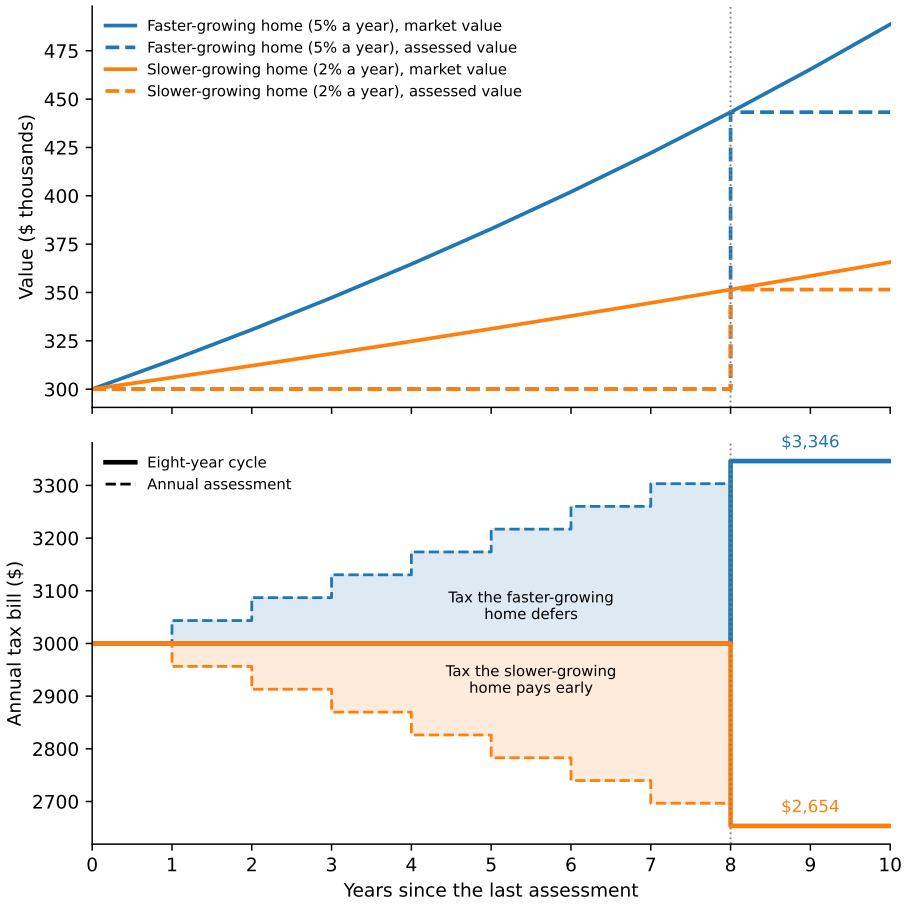


Figure 1: Two homes under annual assessment and under an eight-year cycle.
Notes. Illustration, not estimated. Both homes are worth $300,000 in year 0 and pay $3,000. The county consists of the two homes and sets its rate each year to raise $6,000. Top panel: market values and, under the eight-year cycle, assessed values. Bottom panel: annual bills. Shaded areas are the differences between the bills under the two schedules before the assessment.

Table 1 splits the change in owner-occupied homes' bills at the four assessments used in Section 6.3 by the identity in equation (2). The part common to every home ranges from −1.1 log points in Guilford in 2012 to +15.2 in Mecklenburg in 2019, where the county cut its rate by 24 log points while homes' assessed values rose by 39. The relative part separates the cheapest and most expensive quartiles by 6 to 19 log points within each event, and its sign changes across events: the cheapest quartile's assessments fell relative to the county's in the first three and rose in Mecklenburg in 2019. Comparisons across quartiles within a county difference out the common part, and with it the county's revenue decision.

Table 1: The bill change at four assessments, split into the part common to all homes and each quartile's relative assessment change.

	Common to all homes			Relative assessment change			
	Assessed value	Rate	Bill	Q1	Q2	Q3	Q4
Mecklenburg 2011	+5.3	−3.2	+2.2	−6.6	−7.7	+4.3	+9.8
Guilford 2012	−1.1	+0.1	−1.1	−5.4	−0.8	+2.2	+4.1
Guilford 2017	+3.5	−1.8	+1.8	−3.8	+0.8	+1.1	+2.0
Mecklenburg 2019	+39.2	−24.1	+15.2	+10.6	+2.1	−3.6	−8.9

Notes. Log points, from the tax year before the assessment to the assessment year, owner-occupied homes present in both years, excluding the top and bottom 1 percent of bill changes within each quartile. Common to all homes: the average change in assessed value, the average change in the combined county, municipal and district rate, and their sum, the average change in the bill. Relative assessment change: each quartile's average change in assessed value less the county's. A quartile's bill change is the common bill change plus its relative change, up to differences in municipal and district rates of less than one log point. Q1 is the cheapest quartile and Q4 the most expensive, on the block-group sort of Section 5.

If assessments raise foreclosure through the bill, an assessment should raise foreclosure filings and the completed foreclosures and distressed exits that follow. The rise should be largest among the cheapest homes, whose owners have the least income and savings to absorb a higher payment. And it should be larger where the bill rises more. Section 6.1 tests the first two predictions against annually assessing counties, averaging over the eight assessments and then estimating each value quartile separately. Section 6.3 tests the third by dividing each event's estimate by the bill change it produced.

4 Synthetic difference in differences

I estimate the effect of an assessment on foreclosures by comparing each of the eight North Carolina assessments with counties that assess every year. In those counties assessed values follow market values each year, so appreciation never accumulates untaxed and no discrete correction ever comes due. Their owners face the same regional housing and credit cycles as owners in the treated counties without the jump in bills. The unit of observation is a county-quarter, and each event is studied over the eight quarters before and after its assessment. The comparison counties stand in for how the treated county's outcomes would have moved had the assessment not occurred.

A pooled regression with county and quarter fixed effects, estimated by ordinary least squares across the eight events, would compare counties assessed at different dates, and the five treated counties are each assessed more than once. Under staggered timing such a regression uses counties already assessed as controls for counties assessed later, and its coefficient can mix effects of opposite sign (Goodman-Bacon, 2021). Estimating difference in differences one event at a time avoids that problem, but it weights every comparison county and every pre-period quarter equally and so requires the treated county's outcome to move parallel to

the average comparison county's. The treated counties are among the largest in the state, and before their assessments their foreclosure filings were rising relative to the average annually assessing county (Figure 2). Equal weights would attribute that difference in trends to the assessment.

Synthetic difference in differences (Arkhangelsky et al., 2021) keeps the fixed-effects structure of difference in differences and chooses the weights. Comparison-county weights make the weighted comparison path parallel to the treated county's before the assessment, so the counterfactual is built from counties whose filings were moving as the treated county's were. Time weights favor the pre-period quarters that best predict the comparison counties' post-period, so a quarter deep in the foreclosure crisis, which says little about where filings were heading, contributes little to the baseline. County fixed effects absorb any constant difference in levels, which matters because the treated counties are larger than most of their comparison counties. For event e, with outcome Y_{it} the quarterly rate per 100 owner-occupied homes in county i, the estimate solves

$$\left(\hat{\tau}_e, \hat{\mu}, \hat{\alpha}, \hat{\beta}\right) \;=\; \underset{\tau,\mu,\alpha,\beta}{\arg\min} \sum_i \sum_t \left(Y_{it} - \mu - \alpha_i - \beta_t - W_{it}\tau\right)^2 \hat{\omega}_i \, \hat{\lambda}_t, \tag{3}$$

where W_{it} equals one for the treated county after its assessment, α_i and β_t are county and quarter effects, and $\hat{\omega}_i$ and $\hat{\lambda}_t$ are the county and time weights, fitted separately for each event and outcome. The headline estimate averages the eight events with equal weight,

$$\bar{\tau} \;=\; \tfrac{1}{8} \textstyle\sum_{e=1}^{8} \hat{\tau}_e. \tag{4}$$

The county weights solve

$$\left(\hat{\omega}_0, \hat{\omega}\right) = \underset{\omega_0 \in \mathbb{R},\, \omega \in \Omega}{\arg\min} \sum_{t \in \mathcal{T}^-} \left(\omega_0 + \sum_j \omega_j Y_{jt} - Y_{0t}\right)^2 + \zeta^2 T_{\text{pre}} \|\omega\|_2^2, \tag{5}$$

where Ω is the set of nonnegative weights that sum to one, j indexes comparison counties and 0 the treated county. The intercept ω_0 lets the weighted comparison path sit at a different level from the treated county's, so the weights reproduce its movement and leave its level to the county effect. The penalty ζ, set as in Arkhangelsky et al. (2021) to $T_{\text{post}}^{1/4}$ times the standard deviation of the comparison counties' quarter-to-quarter changes, spreads weight across many counties and makes the solution unique. In the main estimates the largest weight in the median fit is 4 to 5 percent.

The time weights solve the same problem across counties,

$$\left(\hat{\lambda}_0, \hat{\lambda}\right) = \underset{\lambda_0 \in \mathbb{R},\, \lambda \in \Lambda}{\arg\min} \sum_j \Big(\lambda_0 + \sum_{t \in \mathcal{T}^-} \lambda_t Y_{jt} - \tfrac{1}{T_{\text{post}}} \textstyle\sum_{t \in \mathcal{T}^+} Y_{jt}\Big)^2, \tag{6}$$

choosing the pre-period quarters that best predict the comparison counties' post-period average. They are fitted on the comparison counties alone, so the assessment shock cannot influence which quarters enter the baseline, and are then applied to the treated county as well. In the main estimates they concentrate on the quarters just before each assessment, with 53 to 80 percent on the last one.

Arkhangelsky et al. (2021) derive the estimator's properties under a model in which each county's outcome responds to shocks common to all counties, such as movements in mortgage rates, regional house prices and unemployment, with a sensitivity specific to the county,

$$Y_{it} \;=\; \gamma_i' \upsilon_t \;+\; \tau W_{it} \;+\; \varepsilon_{it}, \tag{7}$$

where υ_t collects the common shocks in quarter t and γ_i the county's exposure to each. County and quarter fixed effects are the special case in which every county responds one for one to a single common shock and differs only by a constant level. Under this model the estimator is consistent and asymptotically normal when the errors are independent across counties, when their serial correlation within a county is limited, and when the weighted comparison counties can reproduce the treated county's exposure to the common shocks. The last condition has a testable implication, since a weighted comparison with the same exposure tracks the treated county closely before the assessment. The setting adds two requirements. The comparison counties must be untreated, which annual assessment guarantees. The treated county must not be assessed again inside its own window, which the choice of windows guarantees.

Inference rests on the comparison counties. For each event the estimator is rerun with each comparison county in turn treated as if assessed, which gives a distribution of effects where no assessment occurred. Drawing one placebo effect per event and averaging gives a placebo average (Cavallo et al., 2013). The standard error of $\bar{\tau}$ is the standard deviation of 200,000 such averages, the placebo variance of Arkhangelsky et al. (2021) carried to an average across events, and significance uses normal critical values. Arkhangelsky et al. (2021) recommend the placebo variance when treated units are few, and clustering here would rest on five counties or eight events. The placebo p is the share of the placebo averages at least as large in absolute value as $\bar{\tau}$. A second check moves the assessment to the midpoint of each pre-period, where none occurred, and estimates again.

The comparison counties are counties that meet the conditions of Section 5. A comparison county must be annually reassessed. The remaining screens require stable recording of sales and filings over the window, enough block groups to sort homes by value, and no quarter in which a value quartile is empty or thin. Each event draws on 89 to 109 counties that pass, and Table 3 charges every excluded county to the first condition it fails.

The eight events are the countywide assessments in the five largest North Carolina counties between 2011 and 2019. Mecklenburg assessed in 2011 and 2019, Guilford in 2012 and 2017, Forsyth in 2013 and 2017, and Durham and Wake in 2016. Five of them closed eight-year cycles, and Forsyth's two and Guilford's 2017 assessment closed cycles of four and five years. Each window runs eight quarters before and eight after the assessment and contains no other assessment of the same county.[10] Because cycle lengths differ across events, Section 6.2 also plots the eight event estimates against the length of the cycle each assessment closed.

The county estimates describe the average owner. The same estimator, run separately on each value quartile's series with its own weights, shows how effects vary across the home value distribution. Quartiles are cut within each county on the block-group median of past sale prices, so each quartile compares homes of similar value in the treated county with homes of similar value in the comparison counties. The quartiles warrant separate counterfactuals because cheap and expensive homes trade in different submarkets, with different buyers and financing (Landvoigt et al., 2015).

Each quartile's eight estimates are averaged with equal weight, with the same placebo standard errors and placebo test as the county estimates. To test whether the effect differs across quartiles, I take each event's gap between its cheapest-quartile and most-expensive-quartile estimates and average the eight gaps. Its placebo test draws, for each event, one comparison county that plays the treated county in both quartiles, so the placebo gaps keep the correlation between the two quartile estimates (Appendix Table A5). This applies the placebo variance of Arkhangelsky et al. (2021) to a difference between two estimates, and combines one placebo draw per event as Cavallo et al. (2013) do for synthetic-control estimates across events.

There are three outcomes. A foreclosure filing is the recorded start of a foreclosure proceeding against the home. A completed foreclosure is the transfer of title to the lender or a buyer at the foreclosure sale. A distressed exit is a completed foreclosure, a deed in lieu of foreclosure, a tax deed or a sale for less than the outstanding mortgage. Each is a quarterly rate per 100 owner-occupied homes, seasonally adjusted within county.

[10] Appendix A.4 reports estimates with post-periods of four and twelve quarters, holding the pre-period at eight. The twelve-quarter estimates exclude Mecklenburg's 2019 assessment, whose post-period would run into the 2020 foreclosure moratoria, and the longer post-period of Forsyth's 2013 assessment overlaps the pre-period of its 2017 assessment.

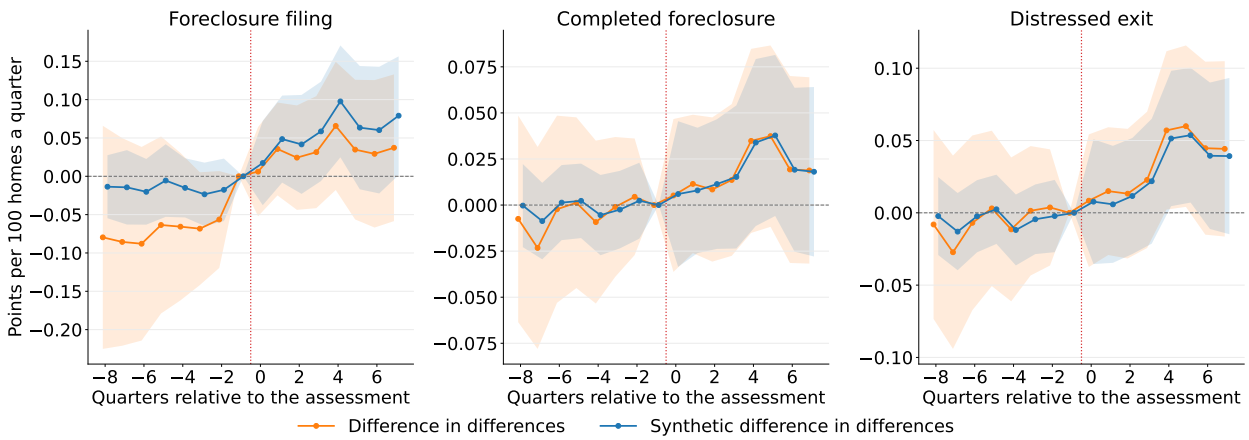


Figure 2: The effect of an assessment by quarter, difference in differences and synthetic difference in differences.

Notes. Each point is the gap between the treated county and its comparison in one quarter relative to the assessment, less the gap in the quarter before it, averaged over the eight events. Difference in differences compares each treated county with the equal-weighted mean of its comparison counties, and synthetic difference in differences with its weighted synthetic comparison. Outcomes are quarterly rates per 100 owner-occupied homes. Shaded bands are 95 percent intervals from placebo standard errors, the spread of averages in which one comparison county per event, treated as if assessed, takes the place of each treated county.

Figure 2 shows both estimators quarter by quarter. Under difference in differences, the filing gap between the treated counties and the average comparison county is 0.06 to 0.09 points a quarter lower in the two years before the assessment than in the quarter just before it, so treated filings were already rising relative to the average county, and the estimator counts that rise as part of the effect. Synthetic difference in differences keeps every pre-period filing gap within 0.025 points of the last pre-period quarter. Its post-period gap rises from 0.02 in the quarter of the assessment to between 0.06 and 0.10 from the third quarter on. Completed foreclosures and distressed exits show no pre-period trend under either estimator, and both rise from about the fourth quarter after the assessment, as filings reach completion.

5 Data

The deed and assessment records come from the Zillow Transaction and Assessment Database (ZTRAX, ICPSR Study 39652). Its transaction files record every deed, mortgage and foreclosure notice filed with the county recorder since about 1990, with the document type, recording date, sale price and loan amount. Its assessment files are a recent cross section of every parcel, with physical characteristics, location and the assessor's record of owner-occupancy. I link the two through the parcel identifier and express every dollar amount in 2025 dollars using the annual-average consumer price index for all urban consumers.[11]

The sample is owner-occupied homes, since rentals and second homes are not held by the households whose

[11] `https://fred.stlouisfed.org/series/CPIAUCSL`

mortgage payments an assessment changes. In most counties owner-occupancy comes from the assessor's occupancy field in ZTRAX. In Florida it comes from the state's statutory property rolls, which record the homestead exemption that only a resident owner can claim.[12] Counties with no source from which owner-occupants can be identified are left out of the comparison pool.

A foreclosure filing is a recorded notice that opens a foreclosure, a notice of default, notice of sale or lis pendens, identified by the same rule in every state. A completed foreclosure is a deed that transfers the home at a foreclosure sale, a foreclosure, trustee's or sheriff's deed or a certificate of sale, at any recorded price. A distressed exit is a completed foreclosure, a deed in lieu of foreclosure, a tax deed or a sale below the home's estimated payoff, the outstanding mortgage debt plus arrears and about 6 percent in selling costs. The debt amortizes each recorded loan over 30 years at 5 percent, which overstates it for owners who prepaid. Guilford's recorded filings are incomplete before 2012, at 4 and 28 percent of the state court count in 2010 and 2011, so in every county a completed foreclosure with no filing in the three years before it is assigned one at the county's median gap between filing and completion. Each outcome is the number of owner-occupied homes with the event in a quarter per 100 owner-occupied homes, seasonally adjusted within county.

A filing is the first recorded step of every mortgage foreclosure, and Figure A4 shows how filings end. It follows each filing on an owner-occupied home in the five North Carolina counties between 2011 and 2018 for eight quarters and records the first document that follows it. About 60 percent of filings reach a recorded outcome within two years. In the cheapest quartile, 38 percent end in a completed foreclosure, 10 percent in a sale with equity, 9 percent in a refinance, 3 percent in a sale below the remaining mortgage debt, and under 1 percent in a deed in lieu or a tax deed. The remaining 40 percent leave nothing on record, which covers cures, loan modifications and cases still pending. Completed foreclosures fall from 38 percent of filings in the cheapest quartile to 32 percent in the most expensive, and sales with equity rise from 10 to 17 percent, in line with more equity at the top. Owners without a mortgage can lose a home to a tax deed with no filing (Figure A3), and the distressed exit measure includes them.

To describe how effects vary across the home value distribution, I sort owner-occupied homes into value quartiles within each county. Each home that sold at arm's length between 1996 and the anchor year is valued at the median of its sale prices in 2025 dollars, and each census block group with at least 20 such homes is given the median of their values. Every owner-occupied home in the block group carries that value, sold or not, and quartiles are cut within county. The anchor year closes before each event's pre-period opens, so the sort uses no price from the window being studied. Sorting on the block group places homes that have not sold recently, which a sort on each home's own sale would leave out, and in Mecklenburg it places 94.5

[12] Michigan's ZTRAX occupancy field does not distinguish owners from absentee owners, so there a home is owner-occupied when the owner's mailing address in the county's parcel records matches the property address.

percent of owner-occupied homes in a quartile. It also averages away the transitory part of any single sale, which would otherwise revert toward the middle of the distribution and manufacture part of the gradient being measured. The quartiles therefore describe the cheapest quarter of neighborhoods within a county.

Tax bills come from county and state property rolls and are used only in the bill exercise of Section 6.3. Mecklenburg publishes a parcel-by-year record of assessed values covering 2001 and 2004 through 2023,[13][14] and Guilford publishes annual rolls from 2008 to 2025. A North Carolina bill is the parcel's assessed value times its combined county, municipal and district rate, with rates from the North Carolina Department of Revenue and county budget ordinances. For the comparison counties, Florida's Department of Revenue publishes statutory rolls of every parcel from 2002 to 2023. A Florida bill is the parcel's school taxable value times the county's total millage. I match these rolls to the ZTRAX parcels in 64 of Florida's 67 counties.

The eight assessments, their dates and the length of the cycle each closed come from the North Carolina Department of Revenue's record of county assessment years. Table 2 describes each event. The treated counties hold between 68,000 and 281,000 owner-occupied homes, 160,000 on average. Before the assessments, filings averaged 0.21 per 100 homes a quarter, completed foreclosures 0.11 and distressed exits 0.17, below the comparison pool's 0.27, 0.14 and 0.26. The county effects absorb that difference in level. Each event draws on 90 to 109 eligible comparison counties.

Table 2: The eight assessments.

				Treated county			Comparison counties			
County	Year	Cycle	Homes	Filing	Fore.	Exit	Filing	Fore.	Exit	Counties
Mecklenburg	2011	8	263,179	0.408	0.260	0.342	0.515	0.226	0.373	90
Guilford	2012	8	117,713	0.182	0.151	0.207	0.440	0.222	0.369	97
Forsyth	2013	4	86,211	0.388	0.113	0.174	0.434	0.188	0.344	97
Durham	2016	8	67,661	0.196	0.082	0.152	0.190	0.141	0.242	98
Wake	2016	8	280,848	0.117	0.046	0.103	0.190	0.141	0.242	98
Forsyth	2017	4	86,330	0.154	0.080	0.154	0.141	0.094	0.180	100
Guilford	2017	5	117,836	0.149	0.065	0.124	0.141	0.094	0.180	100
Mecklenburg	2019	8	264,074	0.106	0.041	0.091	0.097	0.043	0.113	109
Mean		6.6	160,482	0.213	0.105	0.168	0.269	0.144	0.255	99

Notes. Cycle is the years since the county's previous assessment. Homes are owner-occupied homes in the county. Rates are pre-period quarterly rates per 100 owner-occupied homes, eight quarters before the assessment. The comparison columns are equal-weighted means over the eligible comparison counties.

Selection into the comparison unit. Every county with identifiable owner-occupants and a usable record of sales enters the candidate set, and four conditions then decide, event by event, which can serve as a comparison. First, the county must assess annually, so it absorbs no discrete correction of its own inside the event's window. Second, its deed recordings must track its housing market over the window, so its

[13]The county archive holds no 2003 roll, and its 2002 file was written in April 2003 already carrying the 2003 reassessment, so neither year yields a bill.

[14]`https://mecksusftp001.blob.core.windows.net/gis/OpenMapping/index.html`

pre-period sales must reach at least 35 percent of its own best four-year stretch.[15] Third, the county must have at least 20 block groups with enough sales to receive a value, together holding at least 60 percent of its owner-occupied stock, so that its homes can be sorted by value. Fourth, every value quartile must record at least 10 sales in every quarter of the window, so that no quartile-quarter rate rests on a handful of sales.

Nine states assess annually, containing 745 counties, and I extract all of them. Forty-two have no usable record of sales, leaving 703. A further 296 have no source from which owner-occupants can be identified, leaving 407. Seventy-two cannot be sorted into value quartiles, most because too few of their homes sold in the anchor window, leaving 335. The conditions that depend on the assessment are then applied event by event to every county with an outcome series, a median of 367 across the eight events. Requiring annual assessment leaves a median of 282, stable coverage across the window 222, enough block groups to sort homes by value 145, and no thin or empty quartile-quarter 98. Between 90 and 109 counties remain, depending on the event.

The screen governs the placebo distribution as well as the comparison pool. Inference compares the treated county's divergence after its assessment with the divergence of each comparison county treated as if it had been assessed. A county whose deed record is filling in shows a compressed path before the assessment and a rising one after it, so it registers a large apparent effect for reasons unrelated to any assessment and displaces the treated county in the ranking. Excluding such a county from the weights while retaining it as a placebo would leave the comparison distorted.

Each event admits between 90 and 109 comparison counties (Table 3), but the estimator does not use them equally. Weights are fitted separately for every event and outcome, so each estimate has its own comparison group, and Appendix Figure A1 and Table A1 report which counties those are. The filing fits draw on 41 to 70 counties per event, and the largest single county carries between 4.2 and 8.4 percent of an event's fit. Across the eight events, 123 counties carry filing weight in at least one fit.

Table 3: Comparison-county screening, eight events.

	Counties remaining		
	Median across events	Fewest	Most
Counties screened	367	302	382
Annual assessment only	282	253	290
Coverage stable across the window	222	215	248
Enough distinct areas to sort on	145	143	160
No thin or empty quartile-quarters	98	90	109
Eligible donors	**98**	90	109

Notes. Each row counts the counties remaining after a condition, as the median across the eight events, with the fewest and most. Counties screened are those with an outcome series. A county failing more than one condition is charged to the first.

[15] Coverage in several states improves across the sample for administrative reasons, which produces a rising sales series that has nothing to do with housing. Measuring against the county's own best stretch keeps counties whose sales fell during the crisis.

6 Results

6.1 Synthetic difference-in-differences estimates

Figure 3 sets the treated counties beside their synthetic comparisons, averaged over the eight events. The weights are chosen to make the two paths parallel before the assessment, and the time weights beneath each panel fall mostly on the last pre-period quarter. After the assessment, filings in the treated counties stay between 0.21 and 0.26 per 100 homes a quarter while the synthetic comparison falls from 0.21 to 0.12. Completed foreclosures and distressed exits separate from about the third quarter.

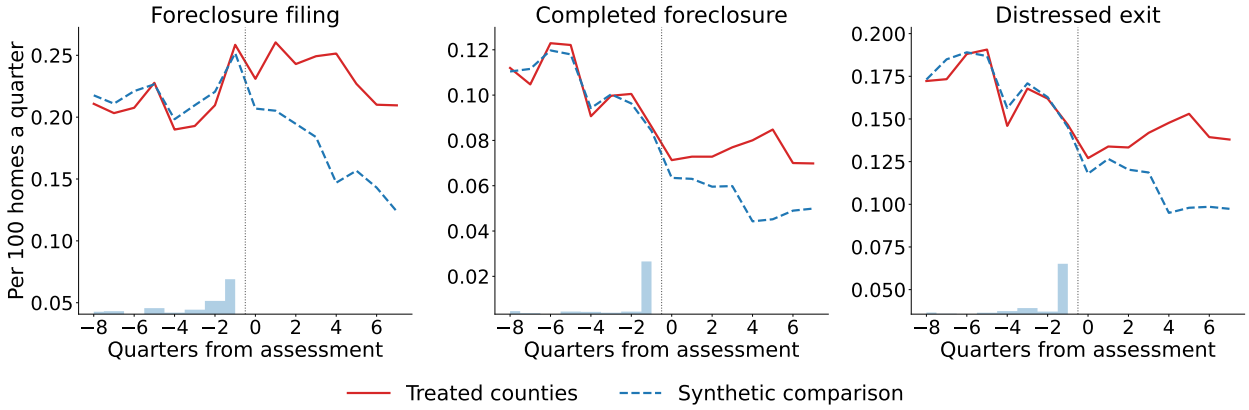


Figure 3: Treated counties and their synthetic comparisons, average over eight events.
Notes. Each line averages the eight assessments in quarters relative to the assessment. The synthetic comparison applies each event's comparison-county weights for that outcome and is shifted by the time-weighted pre-period gap, the level difference the county effect absorbs. Bars are the time weights, averaged over events. Outcomes are quarterly rates per 100 owner-occupied homes. The dotted line marks the assessment.

Table 4 reports the average effect of the eight assessments on all owner-occupied homes.

Table 4: The effect of an assessment, average over eight events, all homes.

	Foreclosure filing	Completed foreclosure	Distressed exit
	0.065**	0.021	0.030
	(0.028)	(0.018)	(0.019)
Pre-period base	0.213	0.105	0.168
Parcels (median)	10,464,499	10,397,814	10,464,499

Notes. Each assessment and outcome is estimated separately by synthetic difference in differences, with its own comparison-county and time weights. Each column averages the eight assessments' estimates with equal weight. Outcomes are quarterly rates per 100 owner-occupied homes, eight quarters before and after. Standard errors are the standard deviation of averages from comparison counties treated as if assessed, with normal critical values; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Each event uses 89–109 comparison counties.

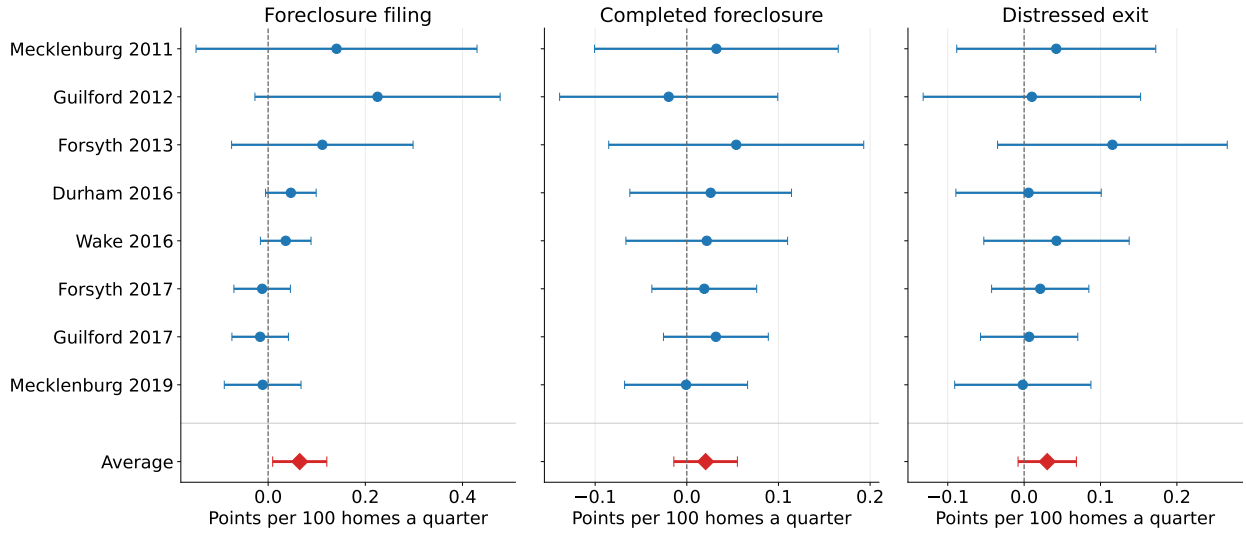
An assessment raises the probability of every stage of mortgage distress, as the first prediction of Section 3 implies (Table 4). In the two years after an assessment, a home's quarterly probability of a foreclosure filing

rises by 0.065 points, 31 percent of the pre-period rate of 0.213. Over the eight quarters that follow, this accumulates to 0.52 additional filings per 100 owner-occupied homes, or about 610 filings in the median treated county of 118,000 homes. Completed foreclosures rise by 0.021 points a quarter, 20 percent of their base, and distressed exits by 0.030 points, 18 percent of theirs. These amount to 0.16 and 0.24 homes per 100 over two years, about 190 and 280 homes in the median county. The additional filings end in completed foreclosure at about one in three, close to the share of all filings in these counties that end in a completed foreclosure within two years (Figure A4), so the assessment adds filings that resolve like the ordinary ones.

The filing estimate is the only one that clears placebo inference. Against averages built from comparison counties treated as if assessed, the filing effect is exceeded 3.7 percent of the time. The completed foreclosure and distressed exit effects are exceeded 24 and 12 percent of the time, so they are consistent with the filing response but not distinguishable from chance on their own.

The synthetic comparisons track the treated counties closely before each assessment. The root mean squared gap over the pre-period averages 0.018 points for filings, 8 percent of the base, and 7 percent for completed foreclosures and distressed exits (Appendix Table A3). The county weights are dispersed: the largest weight in the median fit is 4 to 5 percent, equivalent to 42 to 55 equally weighted comparison counties, so no single county drives an estimate. The time weights concentrate on the quarters just before each assessment, with 53 to 80 percent on the final pre-period quarter, so each estimate compares the post-period with the treated county's most recent trajectory. Difference in differences, which weights every comparison county and pre-period quarter equally, gives similar estimates for completed foreclosures (0.023) and distressed exits (0.039), and a larger one for filings (0.096). The larger filing estimate is consistent with filings in the treated counties already rising relative to the average comparison county, the trend the synthetic weights remove.

Figure 4: The effect of each assessment.



Notes. Each point is one assessment's synthetic difference-in-differences estimate, in points per 100 owner-occupied homes a quarter over the eight quarters after the assessment. Bars are 95 percent intervals from each event's placebo standard error, the standard deviation of its estimates with each comparison county treated as if assessed. The diamond is the equal-weight average, with the placebo standard error of Table 4. Every assessment closed an eight-year cycle except Forsyth 2013 and 2017 (four years) and Guilford 2017 (five years).

Figure 4 shows the estimates behind each average. The filing effect is largest after the three assessments of 2011 to 2013, at 0.11 to 0.23 points a quarter, against 0.04 to 0.05 for Durham and Wake in 2016 and slightly below zero for the three assessments of 2017 and 2019.[16] The comparison counties absorb the crisis itself, so this pattern reflects a larger response to an assessment that arrived when more owners had little equity. It is consistent with the bill change pushing owners who were already close to default. Cycle length does not sort the events as cleanly. Forsyth 2013 closed a four-year cycle and still produced one of the larger filing effects; Section 6.2 estimates the relation directly.

Completed foreclosures do not share the filing pattern. They rise by 0.02 to 0.05 points a quarter in six of the eight events, in the later assessments as much as the earlier ones, and Guilford 2012, the largest filing effect, shows a small decline. Filings made in Guilford late in its window would complete after the eight quarters end, which fits the larger completion effects of the twelve-quarter window (Appendix Table A4). Distressed exits are positive in seven events and largest after Forsyth 2013, at 0.12 points. No single assessment's interval excludes zero for any outcome. The filing evidence rests on the average across events, and the completed foreclosure and distressed exit averages are not distinguishable from zero.

Table 5 reports the same estimates by value quartile.

[16] Mecklenburg's 2019 post-period runs into the 2020 foreclosure moratoria, so only its first year after the assessment could show filings, and its estimate near zero says little about an eight-year cycle.

Table 5: The effect of an assessment by home-value quartile, average over eight events.

	Q1 (cheapest)	Q2	Q3	Q4 (most expensive)
A. Foreclosure filing				
	0.088**	0.075**	0.063**	0.046*
	(0.039)	(0.033)	(0.030)	(0.025)
Pre-period base	0.306	0.262	0.174	0.109
B. Completed foreclosure				
	0.020	0.016	0.027	0.019
	(0.025)	(0.023)	(0.019)	(0.016)
Pre-period base	0.159	0.126	0.083	0.051
C. Distressed exit				
	0.029	0.030	0.052**	0.028
	(0.028)	(0.026)	(0.023)	(0.020)
Pre-period base	0.229	0.197	0.143	0.105

Notes. Each cell averages, with equal weight, eight synthetic difference-in-differences estimates, one per assessment, each with its own comparison-county and time weights. Outcomes are quarterly rates per 100 owner-occupied homes in the quartile, eight quarters before and after. Quartiles are cut within county on the block-group median of past sale prices. Standard errors in parentheses are the standard deviation of averages from comparison counties treated as if assessed, with normal critical values; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Foreclosure filings rise in every value quartile, and the number of additional filings declines steadily with home value (Table 5), as the second prediction implies. The filing rate rises by 0.088 points a quarter in the cheapest quartile and by 0.075, 0.063 and 0.046 in the higher ones, which accumulate to 0.70, 0.60, 0.50 and 0.37 additional filings per 100 homes over two years. Relative to each quartile's own pre-period rate the increases are similar, 29 percent in the cheapest quartile and 42 percent in the most expensive, because cheap homes start from a filing rate nearly three times higher. Against placebo averages from comparison counties, the filing estimates are significant at the 5 percent level in the three cheaper quartiles and at the 10 percent level in the most expensive. Completed foreclosures and distressed exits rise by similar amounts across quartiles, 0.016 to 0.027 points a quarter for completed foreclosures and 0.028 to 0.052 for distressed exits, peaking in the third quartile, and only the third quartile's distressed exit estimate is significant. Larger filing effects among cheaper homes are consistent with more of their owners being close to default, with thinner equity and less liquid savings to absorb a higher payment. Testing the cheapest quartile against the most expensive directly gives a gap that is positive in seven of the eight events but imprecise (Appendix Table A5).

6.2 Does the effect grow with the length of the cycle?

Longer cycles leave more appreciation untaxed, so the assessment that ends one should correct a larger gap. Figure 5 plots each assessment's effect against the years since the county's previous assessment. Filing effects average 0.088 points a quarter after the five eight-year cycles and 0.028 after the three cycles of four or five years. The fitted slope is 0.014 points a quarter per extra year (standard error 0.015, placebo p 0.29), about 7

percent of the pre-period base, or roughly one filing per thousand homes over the eight post-period quarters. The slopes for completed foreclosures and distressed exits are slightly negative and also indistinguishable from zero. The filing slope comes from Mecklenburg 2011 and Guilford 2012, the two eight-year assessments that fell in the foreclosure crisis. Without them, long and short cycles produce nearly the same filing effect, 0.024 against 0.028. The eight assessments take only three cycle lengths, and Forsyth supplies both four-year cycles, so the comparison cannot separate cycle length from differences across counties, housing markets and periods. The pattern in filings is consistent with longer cycles producing larger responses, and I read it as descriptive.[17]

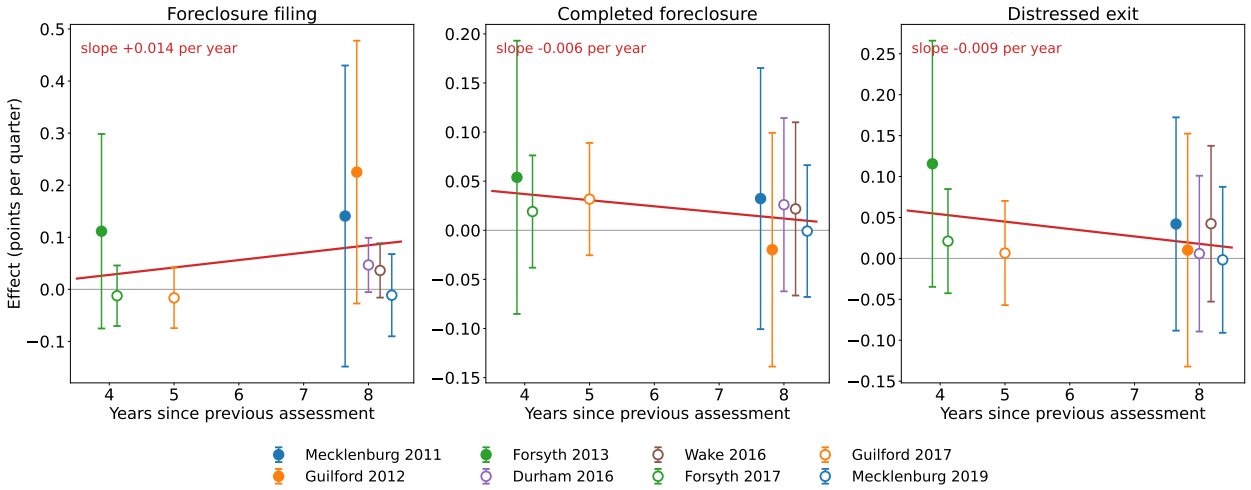


Figure 5: The effect of each assessment by the length of the cycle it closed.

Notes. Each point is one assessment's synthetic difference-in-differences effect on all owner-occupied homes over eight post-period quarters, in points per quarter, plotted against years since the county's previous countywide assessment. Bars are 95 percent intervals from the placebo distribution of comparison-county estimates. The red line is the least-squares fit across the eight assessments. Filled markers are assessments in 2011–2013 and hollow markers those in 2016–2019.

6.3 Scaling the Effect by the Tax Bill

This section tests the hypotheses of Section 3 by asking whether the effect of each assessment scales with the bill change it produced, and whether completed foreclosures respond as filings do. The test requires the bill on both sides of the comparison. In four of the eight events, Mecklenburg 2011 and 2019 and Guilford 2012 and 2017, the county rolls record each parcel's assessed value and tax rate in every year of the window, and Florida's statutory rolls record the same for its counties, so these four events are estimated again against Florida donors only. The approach follows studies that identify the effect of payment size on default from payment changes set by rule (Fuster and Willen, 2017; Anderson and Dokko, 2016): the assessment date is fixed by statute, and the bill change it produces differs across events and value quartiles.

[17] Appendix Figure A2 repeats the comparison with a twelve-quarter post-period and separately for the cheapest and most expensive quartiles.

For each event e and value quartile q, the synthetic difference-in-differences estimate $\hat{\tau}_{eq}$ is the change in the quarterly rate after the assessment in the North Carolina county relative to its weighted Florida donors. The bill change is the same comparison applied to the tax bill,

$$\Delta b_{eq} = \left(\bar{b}_{eq}^{\text{post}} - \bar{b}_{eq}^{\text{pre}}\right)_{\text{NC}} - \sum_{j} \omega_{jeq} \left(\bar{b}_{jq}^{\text{post}} - \bar{b}_{jq}^{\text{pre}}\right), \tag{8}$$

where $\bar{b}$ is the mean log bill over the eight quarters before or after the assessment and ω_{jeq} is the weight on Florida donor j. Dividing the effect by the bill change gives the change in the quarterly rate per unit of bill change, with the assessment acting as an instrument for the bill. The four events are pooled as the ratio of averages,

$$\hat{\beta}_q = \frac{\frac{1}{4}\sum_e \hat{\tau}_{eq}}{\frac{1}{4}\sum_e \Delta b_{eq}}, \tag{9}$$

and I report $\hat{\beta}_q \times 0.1$, the change per 10 percent increase in the bill. North Carolina bills are assessed value times the parcel's combined county, municipal and district rate; Florida bills are school taxable value times the county's total millage. The bill change is measured with each outcome's own donor weights, so it differs slightly across outcomes. Standard errors are the standard deviation of placebo averages, each built from one randomly drawn Florida comparison county's placebo estimate per event, divided by the average bill change. The estimate attributes the whole effect of the assessment to the bill, so any effect that runs through the value the county states for the home is counted as a bill effect.

Table 6: Assessment effects scaled by the tax-bill change, four North Carolina events against Florida donors.

	All homes	Q1	Q2	Q3	Q4
Foreclosure filings					
Per 10% bill	+0.019	+0.331***	+0.059	+0.008	−0.020
	(0.036)	(0.103)	(0.057)	(0.036)	(0.028)
Bill change vs. Florida (%)	5.6	2.1	4.4	6.6	7.5
Completed foreclosures					
Per 10% bill	+0.015	+0.018	+0.003	+0.013	+0.021
	(0.031)	(0.053)	(0.049)	(0.030)	(0.020)
Bill change vs. Florida (%)	7.0	5.9	5.7	7.6	8.1
Distressed exits					
Per 10% bill	+0.027	+0.036	+0.031	+0.049	+0.034
	(0.041)	(0.068)	(0.064)	(0.045)	(0.030)
Bill change vs. Florida (%)	6.7	5.5	5.5	6.9	7.9

Notes. Each entry is the average synthetic difference-in-differences estimate over Mecklenburg 2011 and 2019 and Guilford 2012 and 2017, divided by the average bill change (equation 9), in points of the quarterly rate per 100 owner-occupied homes per 10 percent bill increase. The bill change is the post-minus-pre change in the mean log bill, North Carolina less Florida, times 100. Filings fill Guilford's record before 2012. Standard errors are the spread of placebo averages, with the bill change treated as known. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6 reports the estimates. A larger bill increase raises the probability of a foreclosure filing among the

cheapest homes, and the response declines steadily with home value. In the cheapest quartile, a 10 percent larger bill increase raises the quarterly filing probability by 0.331 points (standard error 0.103), about 112 percent of the pre-period rate of 0.295 filings per 100 owner-occupied homes, or 2.6 additional filings per 100 homes over the eight quarters after the assessment. The response falls to 0.059 points in the second quartile, 0.008 in the third and −0.020 in the most expensive, where it is indistinguishable from zero. Across all homes the estimate is 0.019 points (standard error 0.036), 9 percent of a base of 0.211. The gradient does not depend on the scaling. Before dividing by the bill change, the assessment raises the cheapest quartile's filing rate by 0.074 points (standard error 0.023), a quarter of its base, against −0.016 in the most expensive, and the main design, with all eight events and the full comparison pool, orders the quartiles the same way (Table 5). The magnitude in the cheapest quartile is less certain than its sign, because the cheapest homes received the smallest average bill change relative to Florida, 2.1 percent against 7.5 percent in the most expensive, and that average includes a relative decline in Guilford 2017. Leaving that event out gives 0.143 points per 10 percent (standard error 0.044), still 45 percent of the base and significant at the 1 percent level. Completed foreclosures and distressed exits rise with the bill as well, though less precisely. A 10 percent larger bill increase raises the probability of a completed foreclosure by 0.015 points (standard error 0.031), 11 percent of a base of 0.129, and of a distressed exit by 0.027 (standard error 0.041), 14 percent of a base of 0.191, and no quartile's estimate is distinguishable from zero. Relative to their bases, exits respond about twice as much in the top two quartiles, 28 to 31 percent, as in the bottom two, 14 percent, consistent with owners of more expensive homes leaving through a sale or deed in lieu more often than through a filing.

7 Conclusion

Long assessment cycles hold a home's tax bill fixed while its value moves and then deliver the accumulated change in a single year. Across eight countywide assessments in North Carolina, that year raises a home's quarterly probability of a foreclosure filing by 31 percent, or about 0.52 additional filings per 100 owner-occupied homes over the following two years. The additional filings decline steadily with home value, from 0.70 per 100 in the cheapest quartile to 0.37 in the most expensive, and the response is largest after the assessments that arrived as the foreclosure crisis wound down. Completed foreclosures and distressed exits rise by 20 and 18 percent of their pre-period rates, estimates that are positive in six and seven of the eight events but not distinguishable from zero on their own. Where bills can be measured, filings among the cheapest homes rise with the size of the bill increase, and filings among the most expensive do not. The pattern is consistent with a payment shock that reaches every owner but turns into distress mainly for those with the least equity and savings to absorb it.

Whether longer cycles do more harm is harder to establish with eight assessments. Filing effects are larger after eight-year cycles than after shorter ones, though the difference comes from the two crisis-era assessments, and the cycles in the sample take too few values to separate cycle length from differences across counties and periods. A comparison within each assessment, across neighborhoods that accumulated different amounts of untaxed appreciation, would answer the question more directly. For policy, the estimates measure the cost of timing a correction that the county collects in any case. Shorter cycles, phased increases or longer repayment of escrow shortages would spread the same tax over smaller steps, and the estimates suggest the gain would go mostly to owners of the cheapest homes. That gain has to be weighed against the administrative cost of assessing more often, which the estimates here do not measure.

A Appendix

A.1 Comparison-county weights

Each assessment and outcome has its own comparison-county weights. Figure A1 sums the foreclosure filing weights over the eight assessments, and Table A1 lists each county's filing weight in every assessment with its mean weight for each outcome. All 131 comparison counties carry weight in at least one fit, and no county averages more than 2.3 percent of the filing comparison, so the weight is spread across many counties, most of them in Florida, Michigan, Alabama, Minnesota and Arizona.

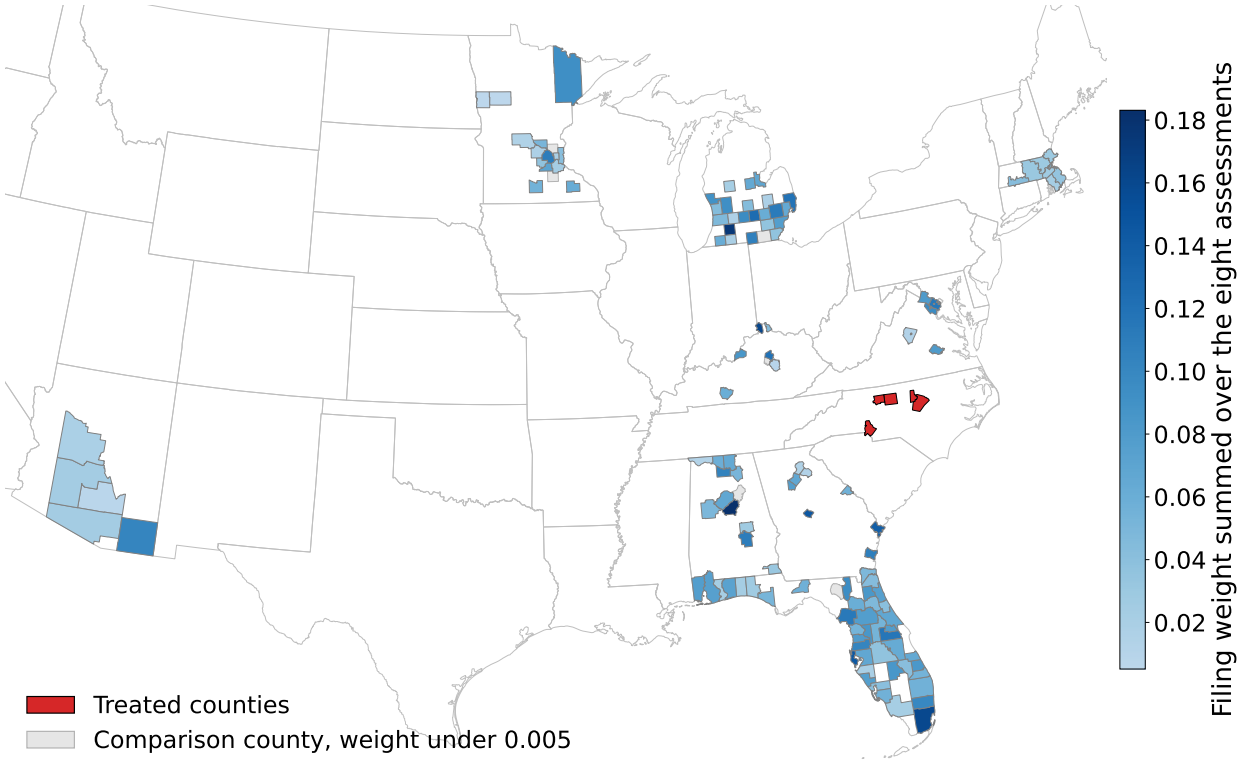


Figure A1: Comparison-county weights for foreclosure filings, summed over eight assessments.

Notes. Each comparison county is shaded by its filing weight summed over the eight assessments; each assessment's weights sum to one. Treated counties are in red. Grey counties carry less than 0.005.

Table A1: Comparison-county weights by assessment and outcome.

Notes. Filing weights in percent for each assessment, with dashes below 0.5. The last three columns give each county's mean weight over the eight assessments, in percent, for foreclosure filings, completed foreclosures and distressed exits. Counties are sorted by mean filing weight.

	Filing weight by assessment (%)								Mean over assessments (%)		
County	Meck. 2011	Guil. 2012	Fors. 2013	Durh. 2016	Wake 2016	Fors. 2017	Guil. 2017	Meck. 2019	Filing	Compl. fc.	Distr. exit
Shelby, AL	2.4	–	1.0	7.9	6.3	–	–	0.7	2.3	0.7	0.8
Kalamazoo, MI	–	4.9	2.4	1.2	0.9	3.6	3.2	1.1	2.2	0.6	0.6
Boone, KY	2.0	3.4	1.3	2.7	2.2	–	–	4.5	2.0	1.1	0.7
Miami-Dade, FL	–	2.0	1.0	5.0	3.3	1.4	3.2	–	2.0	0.8	0.8
Pinellas, FL	–	1.8	1.6	5.9	3.3	–	1.6	–	1.8	0.8	0.7
Bibb, GA	–	2.8	1.9	–	–	2.9	2.9	4.0	1.8	3.9	3.6
Chatham, GA	5.3	0.8	–	–	–	4.4	2.8	–	1.7	0.8	0.7
Ingham, MI	1.8	–	–	–	–	2.8	2.8	5.2	1.6	0.5	0.7
Fayette, KY	–	2.5	0.9	–	1.4	2.6	3.6	–	1.5	0.0	1.3
St. Clair, MI	8.4	–	–	–	–	–	–	3.5	1.5	0.3	0.4
Orange, FL	2.3	1.1	1.2	3.2	1.5	1.0	1.3	–	1.5	1.2	1.0
Fairfax, VA	–	1.3	1.7	–	1.4	3.0	3.3	0.8	1.4	1.1	1.0
Levy, FL	–	1.4	1.8	–	2.7	1.1	2.8	1.6	1.4	1.9	0.4
Oakland, MI	2.6	–	–	–	1.0	2.6	2.7	1.8	1.4	1.0	0.8
Montgomery, AL	–	1.2	0.5	–	1.7	3.1	2.1	2.0	1.4	0.5	1.1
Hennepin, MN	–	2.5	0.5	–	1.4	3.6	1.5	1.1	1.4	1.2	1.4
Glynn, GA	2.0	3.9	–	5.0	–	–	–	–	1.4	0.9	1.0
Hillsdale, MI	–	–	–	–	2.0	4.5	4.3	–	1.3	1.0	2.2
Alexandria, VA	–	–	2.7	–	–	3.2	2.8	2.0	1.3	0.9	1.0
Morgan, AL	1.3	1.9	–	–	–	2.7	–	4.3	1.3	0.5	0.5
Cochise, AZ	–	0.5	1.1	–	–	1.9	2.8	3.5	1.3	1.5	0.7
Pasco, FL	–	1.0	1.0	2.9	1.9	2.1	1.3	–	1.3	0.4	0.5
Broward, FL	–	–	1.2	4.8	3.0	–	–	–	1.2	1.0	0.9
Prince William, VA	–	1.4	0.7	1.4	2.3	1.8	1.6	0.5	1.2	1.5	1.6
Eaton, MI	1.4	–	–	–	0.8	3.0	0.7	3.7	1.2	1.6	2.5
Columbia, FL	–	–	2.1	3.2	1.6	–	0.9	1.6	1.2	0.7	0.6
St. Louis, MN	2.4	0.6	1.3	1.1	1.0	0.9	1.9	–	1.2	1.2	1.2
Kent, MI	3.9	–	1.2	–	–	1.8	1.4	0.8	1.2	1.6	2.3
Muskegon, MI	0.6	–	–	–	–	2.7	3.3	1.9	1.1	0.6	0.8
Jefferson, KY	2.2	0.9	0.7	3.3	1.3	–	–	–	1.1	1.1	0.8
Highlands, FL	–	0.9	3.2	1.9	1.5	–	–	1.0	1.1	0.6	0.8
Sumter, FL	–	0.5	1.4	–	1.2	2.8	2.5	–	1.1	1.0	1.0
Clay, FL	–	1.5	0.9	3.3	2.7	–	–	–	1.1	0.5	0.3
St. Lucie, FL	–	0.5	–	5.5	2.3	–	–	–	1.0	0.7	0.9
Chesterfield, VA	1.1	1.1	1.4	–	1.2	1.4	1.1	0.8	1.0	0.8	1.3
Loudoun, VA	–	0.9	1.9	–	1.2	0.8	1.9	1.2	1.0	1.6	1.6
Hernando, FL	–	1.9	0.7	2.3	1.1	–	1.5	–	1.0	1.4	1.3
Seminole, FL	–	1.5	3.0	1.5	1.2	–	–	–	1.0	0.7	0.9
Mobile, AL	2.5	3.2	–	–	1.7	–	–	–	1.0	0.4	1.0

Table A1: Comparison-county weights by assessment and outcome.

Notes. Filing weights in percent for each assessment, with dashes below 0.5. The last three columns give each county's mean weight over the eight assessments, in percent, for foreclosure filings, completed foreclosures and distressed exits. Counties are sorted by mean filing weight.

	Filing weight by assessment (%)								Mean over assessments (%)		
County	Meck. 2011	Guil. 2012	Fors. 2013	Durh. 2016	Wake 2016	Fors. 2017	Guil. 2017	Meck. 2019	Filing	Compl. fc.	Distr. exit
DeKalb, GA	6.3	–	–	–	–	–	–	1.5	1.0	0.1	0.2
Marion, FL	–	1.8	1.2	3.6	1.1	–	–	–	1.0	0.5	0.4
Wayne, MI	2.9	–	0.8	–	1.5	–	–	2.0	1.0	0.8	0.5
Sarasota, FL	–	–	0.6	0.6	1.1	2.7	2.2	–	1.0	0.9	0.7
Baldwin, AL	–	–	1.3	1.2	1.3	1.9	1.8	–	0.9	0.6	0.8
Arlington, VA	–	1.1	1.6	–	–	1.9	2.4	–	0.9	1.0	0.9
St. Johns, FL	–	1.1	1.5	–	1.2	1.7	1.6	–	0.9	0.9	0.5
Santa Rosa, FL	–	2.7	1.2	–	–	–	–	3.4	0.9	0.7	0.4
Scott, MN	–	–	2.1	1.3	0.9	1.1	1.7	–	0.9	2.0	0.9
Bay, MI	0.9	–	4.2	–	0.8	–	–	0.7	0.9	1.1	0.6
Volusia, FL	–	1.7	1.1	2.4	1.6	–	–	–	0.8	1.5	1.3
Jefferson, AL	3.1	–	–	–	1.1	1.4	1.1	–	0.8	1.6	1.2
Hillsborough, FL	–	0.9	0.9	2.5	2.0	–	–	–	0.8	0.7	0.9
Gwinnett, GA	4.7	0.6	–	0.6	0.8	–	–	–	0.8	0.9	1.0
Midland, MI	–	–	–	1.3	1.0	2.0	2.1	–	0.8	0.9	1.1
Macomb, MI	1.2	–	0.6	–	1.0	–	0.5	2.8	0.8	1.0	0.7
Indian River, FL	0.9	1.2	0.9	1.1	1.4	–	1.0	–	0.8	1.8	2.8
Madison, AL	1.5	2.2	1.6	–	1.2	–	–	–	0.8	0.6	0.8
Osceola, FL	–	–	0.7	1.5	1.3	–	1.1	1.6	0.8	0.8	0.6
Cass, MI	–	–	–	–	1.5	–	–	4.7	0.8	0.5	0.1
Olmsted, MN	3.5	–	1.9	–	–	–	–	0.5	0.8	1.5	1.1
Livingston, MI	–	–	1.3	–	–	1.9	1.4	1.0	0.8	0.7	0.5
Alachua, FL	0.5	1.3	1.0	1.1	1.6	–	–	–	0.8	0.6	0.6
Warren, KY	–	–	–	–	–	2.9	3.1	–	0.8	0.3	0.3
Limestone, AL	–	–	–	–	–	1.6	2.6	1.8	0.7	0.3	0.3
Leon, FL	–	1.9	1.3	–	0.6	–	–	2.0	0.7	0.5	0.5
Palm Beach, FL	–	0.7	2.3	1.1	1.4	–	–	–	0.7	0.9	0.8
Richmond, GA	1.7	3.9	–	–	–	–	–	–	0.7	0.1	0.1
Lee, FL	–	0.6	1.1	–	1.4	1.1	1.1	–	0.7	0.7	0.6
Blue Earth, MN	–	–	–	–	–	2.5	2.8	–	0.7	0.4	0.9
Martin, FL	–	0.9	2.2	1.6	–	–	–	–	0.7	0.7	0.8
Citrus, FL	1.0	1.2	0.8	–	–	–	–	2.3	0.7	0.7	1.0
Lake, FL	–	1.9	1.1	0.7	0.7	0.8	–	–	0.7	1.5	0.9
Bay, FL	0.6	0.7	1.9	–	1.2	–	0.5	–	0.7	0.6	0.7
Marshall, AL	–	–	–	1.5	0.7	–	–	2.9	0.6	0.8	0.8
Sherburne, MN	–	–	3.0	1.9	–	–	–	–	0.6	1.1	1.6
Tuscaloosa, AL	1.6	–	2.0	–	–	–	–	1.1	0.6	0.4	0.7
Nassau, FL	–	1.1	1.0	2.1	0.7	–	–	–	0.6	0.7	0.6
Putnam, FL	–	1.9	1.6	–	–	–	–	–	0.6	0.9	0.7

Table A1: Comparison-county weights by assessment and outcome.

Notes. Filing weights in percent for each assessment, with dashes below 0.5. The last three columns give each county's mean weight over the eight assessments, in percent, for foreclosure filings, completed foreclosures and distressed exits. Counties are sorted by mean filing weight.

	Filing weight by assessment (%)								Mean over assessments (%)		
County	Meck. 2011	Guil. 2012	Fors. 2013	Durh. 2016	Wake 2016	Fors. 2017	Guil. 2017	Meck. 2019	Filing	Compl. fc.	Distr. exit
Allegan, MI	2.2	–	1.4	–	–	–	–	1.0	0.6	1.7	1.1
Campbell, KY	1.5	1.1	–	–	–	–	–	2.0	0.6	0.3	0.3
Clinton, MI	0.8	2.8	–	–	0.6	–	–	–	0.6	0.4	0.2
Suffolk, MA	3.4	–	0.9	–	–	–	–	–	0.6	0.3	0.4
Ottawa, MI	–	–	1.3	–	–	1.2	1.2	0.8	0.6	1.1	1.2
Duval, FL	–	1.6	–	2.0	0.8	–	–	–	0.5	0.7	0.5
Hampden, MA	3.2	0.8	–	–	–	–	–	–	0.5	0.6	0.7
Okeechobee, FL	–	–	–	2.9	–	–	–	1.3	0.5	0.5	0.3
Washington, MN	–	–	1.6	–	–	1.1	–	1.3	0.5	0.9	0.6
Flagler, FL	–	–	1.3	0.6	2.1	–	–	–	0.5	0.3	0.8
Charlotte, FL	–	0.9	0.6	0.7	1.2	–	0.7	–	0.5	0.7	0.6
Monroe, MI	–	–	–	–	–	2.0	–	1.7	0.5	0.0	0.2
Carver, MN	–	–	–	2.0	1.6	–	–	–	0.5	0.6	0.8
Polk, FL	–	0.9	1.6	1.0	–	–	–	–	0.5	0.8	0.7
Washtenaw, MI	–	–	0.7	–	–	–	–	2.6	0.4	0.7	0.4
Plymouth, MA	2.9	–	–	–	–	–	–	–	0.4	0.3	0.4
Houston, AL	–	–	–	–	–	3.3	–	–	0.4	0.2	0.1
Worcester, MA	2.4	0.7	–	–	–	–	–	–	0.4	0.3	0.3
Middlesex, MA	1.5	–	1.0	–	–	–	–	–	0.4	0.3	0.3
Essex, MA	2.7	–	–	–	–	–	–	–	0.4	0.1	0.2
Elmore, AL	–	–	–	–	–	–	–	2.8	0.3	0.1	0.1
Norfolk, MA	1.9	–	–	–	–	–	–	–	0.3	0.3	0.4
Walton, FL	–	–	1.0	–	1.2	–	–	–	0.3	1.2	0.8
Maricopa, AZ	–	–	–	–	0.7	0.8	1.0	–	0.3	1.3	1.4
Pima, AZ	–	–	–	–	–	0.5	1.5	–	0.3	1.1	1.2
Dakota, MN	–	–	–	1.1	0.9	–	–	–	0.3	1.1	1.2
Bristol, MA	1.9	0.5	–	–	–	–	–	–	0.3	0.1	0.2
Okaloosa, FL	–	1.8	0.6	–	–	–	–	–	0.3	0.5	0.6
Mecosta, MI	–	–	–	–	–	–	–	1.9	0.3	0.2	0.3
Collier, FL	–	–	0.7	–	–	0.8	–	–	0.3	1.1	0.9
Escambia, FL	–	1.0	0.9	–	–	–	–	–	0.3	0.7	0.8
Manatee, FL	–	1.2	–	–	–	–	–	–	0.3	1.4	1.1
Ramsey, MN	–	–	–	–	0.8	0.8	–	–	0.3	0.1	0.2
St. Joseph, MI	–	–	–	–	–	0.7	1.3	–	0.2	0.3	0.6
Yavapai, AZ	–	–	–	–	–	0.5	1.2	–	0.2	1.5	1.6
Genesee, MI	–	–	–	–	–	–	–	1.8	0.2	0.1	0.1
Wright, MN	–	1.8	–	–	–	–	–	–	0.2	0.2	0.2
Barry, MI	–	–	–	–	–	–	0.6	0.5	0.2	2.0	2.0
Hall, GA	–	1.1	–	–	–	–	–	–	0.2	0.7	0.9

Table A1: Comparison-county weights by assessment and outcome.

Notes. Filing weights in percent for each assessment, with dashes below 0.5. The last three columns give each county's mean weight over the eight assessments, in percent, for foreclosure filings, completed foreclosures and distressed exits. Counties are sorted by mean filing weight.

	Filing weight by assessment (%)								Mean over assessments (%)		
County	Meck. 2011	Guil. 2012	Fors. 2013	Durh. 2016	Wake 2016	Fors. 2017	Guil. 2017	Meck. 2019	Filing	Compl. fc.	Distr. exit
Stearns, MN	–	1.5	–	–	–	–	–	–	0.2	0.1	0.2
Jackson, GA	–	–	–	–	–	–	1.4	–	0.2	0.4	1.1
Albemarle, VA	–	–	–	–	–	–	–	1.4	0.2	0.1	0.2
Lauderdale, AL	–	–	–	–	–	–	–	1.3	0.2	0.2	0.1
Madison, KY	–	–	–	–	–	–	–	1.0	0.1	0.1	0.1
Pinal, AZ	–	–	–	–	–	–	–	–	0.1	0.9	0.8
Clay, MN	–	–	–	–	0.5	–	–	–	0.1	0.4	0.2
Becker, MN	–	–	–	–	–	–	–	–	0.1	0.5	0.5
Lenawee, MI	–	–	–	–	–	–	–	–	0.1	0.1	0.1
Jessamine, KY	–	–	–	–	–	–	–	–	0.0	0.7	0.5
Suwannee, FL	–	–	–	–	–	–	–	–	0.0	0.1	0.0
St. Clair, AL	–	–	–	–	–	–	–	–	0.0	0.1	0.1
Anoka, MN	–	–	–	–	–	–	–	–	0.0	0.1	0.1
Rice, MN	–	–	–	–	–	–	–	–	0.0	0.1	0.2

A.2 Tax bills between assessments

Table A2: The tax rate and the change in the property tax bill by value quartile, Mecklenburg, 2007–2015.

	Millage	Change in tax bill (%)			
	(per $100)	Q1	Q2	Q3	Q4
2007	1.237	1.76	2.62	2.37	2.06
2008	1.235	0.19	0.23	0.52	0.35
2009	1.245	0.19	3.26	2.25	1.39
2010	1.243	0.12	0.08	0.18	0.28
2011	1.203	-0.87	-2.43	8.07	14.03
2012	1.178	-2.30	-2.25	-2.21	-2.19
2013	1.205	1.95	2.03	2.03	1.53
2014	1.225	-0.11	1.46	1.48	1.81
2015	1.225	0.87	0.77	0.76	0.80

Notes. Mean year-over-year change in the property tax bill, in percent, for owner-occupied Mecklenburg homes by value quartile (Q1 cheapest, on the block-group sort of Section 5), and the effective rate per $100 of assessed value, the levy divided by assessed value. Changes are nominal and winsorized at the 1st and 99th percentiles. The rule marks the 2011 assessment. Between assessments the rate moves by less than three cents a year and no quartile's bill changes by more than 4 percent.

A.3 Fit diagnostics for the main estimates

Table A3: Fit diagnostics, average over eight events, all homes.

	Foreclosure filing	Completed foreclosure	Distressed exit
Pre-period fit			
Pre-period base	0.213	0.105	0.168
Pre-period RMSE	0.018	0.008	0.012
Pre-period RMSE, % of base	8%	7%	7%
Comparison-county weights			
Largest county weight	0.050	0.036	0.042
Effective number of counties	42	55	49
Estimator			
Synthetic DID	0.065	0.021	0.030
Difference in differences	0.096	0.023	0.039
Synthetic control	0.032	-0.005	0.006

Notes. Quarterly rates per 100 owner-occupied homes. Pre-period RMSE is the root mean squared gap between each treated county and its synthetic comparison over the eight pre-period quarters, averaged over events. Weight statistics are medians over events; the effective number of counties is the inverse of the sum of squared weights. Estimators are averaged over the eight events.

A.4 Length of the post-period

The estimates grow with the length of the post-period (Table A4). The filing effect is 0.048 points a quarter over four quarters, 0.065 over eight and 0.084 over twelve, accumulating to 0.19, 0.52 and 1.00 filings per 100 homes. Completed foreclosures rise from 0.013 to 0.021 and 0.029, and distressed exits from 0.013 to 0.030 and 0.046. The twelve-quarter estimates omit Mecklenburg's 2019 assessment, so part of that increase reflects the change in events. On the same seven events the eight-quarter estimates are 0.076 for filings, 0.024 for completed foreclosures and 0.035 for distressed exits, and each twelve-quarter estimate still exceeds them. Because each estimate is an average per quarter, a larger average over a longer window means the effect builds after the assessment and does not fade. Completed foreclosures and distressed exits gain the most relative to their four-quarter estimates, consistent with filings made soon after the assessment reaching completion later. The longer windows are a weaker check than the main estimates. With a twelve-quarter post-period, Forsyth's 2013 window runs through 2015 and overlaps the pre-period of its 2017 assessment, so the 2013 estimate partly compares quarters the 2017 fit treats as a baseline.

Table A4: The effect of an assessment by length of the post-period, all homes.

	4 quarters	8 quarters	12 quarters
A. Foreclosure filing			
	0.048*	0.065**	0.084**
	(0.025)	(0.028)	(0.036)
Pre-period base	0.213	0.213	0.228
B. Completed foreclosure			
	0.013	0.021	0.029
	(0.016)	(0.018)	(0.021)
Pre-period base	0.105	0.105	0.114
C. Distressed exit			
	0.013	0.030	0.046*
	(0.018)	(0.019)	(0.024)
Pre-period base	0.168	0.168	0.179
Events	8	8	7

Notes. Each cell averages, with equal weight, synthetic difference-in-differences estimates, one per assessment, each with its own comparison-county and time weights. The pre-period is eight quarters in every column, and the post-period is four, eight or twelve. Outcomes are quarterly rates per 100 owner-occupied homes. The twelve-quarter column omits Mecklenburg's 2019 assessment, whose post-period would run past the data and into the 2020 foreclosure moratoria. Standard errors in parentheses are the standard deviation of averages from comparison counties treated as if assessed, with normal critical values; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Figure A2 shows the cycle-length slope of Section 6.2 under a longer post-period and by quartile. With a twelve-quarter post-period the filing slope rises to 0.031 points a quarter per year, 14 percent of the base (placebo p of 0.10), while the completed foreclosure and distressed exit slopes move toward zero. That pattern is consistent with longer cycles producing more filings that have not yet resolved eight quarters after the assessment. In the cheapest and most expensive quartiles the filing slopes are 0.016 and 0.004 points, and neither is distinguishable from chance.

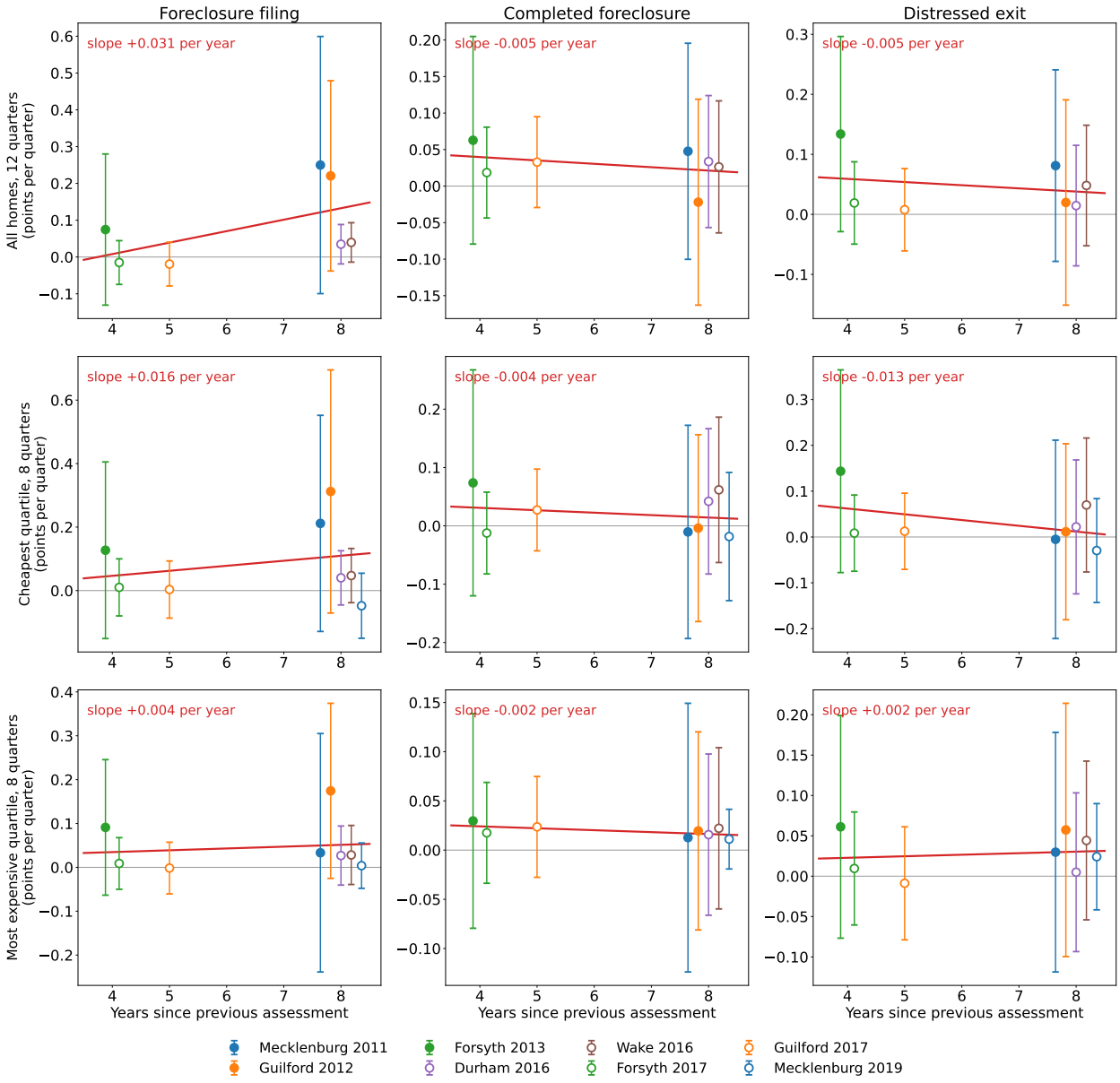


Figure A2: The effect of each assessment by cycle length, other windows and quartiles.

Notes. Each panel repeats Figure 5 under another specification. The top row measures each effect over twelve post-period quarters for all homes, and the lower rows over eight quarters within the cheapest and most expensive quartiles. The twelve-quarter row omits Mecklenburg's 2019 assessment, whose post-period would run past the data and into the 2020 foreclosure moratoria. Bars are 95 percent placebo intervals and red lines are least-squares fits.

A.5 The gap between the cheapest and most expensive quartiles

The cheapest quartile's filing effect exceeds the most expensive quartile's in seven of the eight events, and on average by 0.042 points a quarter (Table A5). Against placebo gaps from comparison counties the gap is not significant (standard error 0.030) and is exceeded 14 percent of the time, so the evidence that filings respond more in cheaper homes is suggestive. Completed foreclosures and distressed exits show no gap, 0.001 points

a quarter for each.

Table A5: The cheapest quartile's effect less the most expensive quartile's, average over eight events.

	Foreclosure filing	Completed foreclosure	Distressed exit
Q1 (cheapest)	0.088	0.020	0.029
Q4 (most expensive)	0.046	0.019	0.028
Q1 − Q4	0.042	0.001	0.001
	(0.030)	(0.020)	(0.027)
Events with Q1 > Q4	7 of 8	4 of 8	4 of 8

Notes. Each event's gap is its cheapest-quartile estimate less its most-expensive-quartile estimate, both from synthetic difference in differences with their own weights. The table averages the eight gaps with equal weight. Outcomes are quarterly rates per 100 owner-occupied homes. Standard errors in parentheses are the standard deviation of averages of placebo gaps, in which one comparison county, treated as if assessed, plays the treated county in both quartiles, with normal critical values; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

A.6 What follows a foreclosure filing

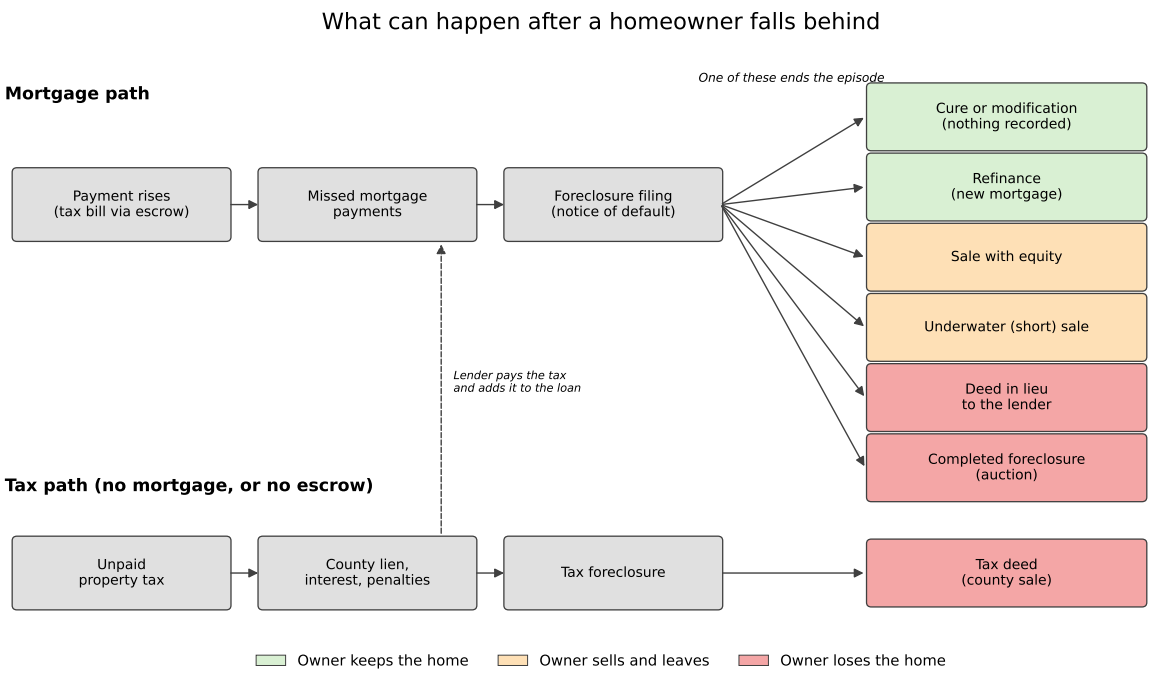


Figure A3: Paths from a missed payment to a recorded outcome.

Notes. Schematic, not estimated. On the mortgage path, a foreclosure filing opens an episode that ends in one of six ways: a cure or loan modification, which leaves no deed on record; a refinance; a sale with equity; an underwater sale; a deed in lieu; or a completed foreclosure. On the tax path, which applies to homes with no mortgage or no escrow account, unpaid property tax leads to a county lien and a tax deed without a foreclosure filing; where a lender holds the loan, it usually pays the tax and adds it to the balance, which moves the case to the mortgage path.

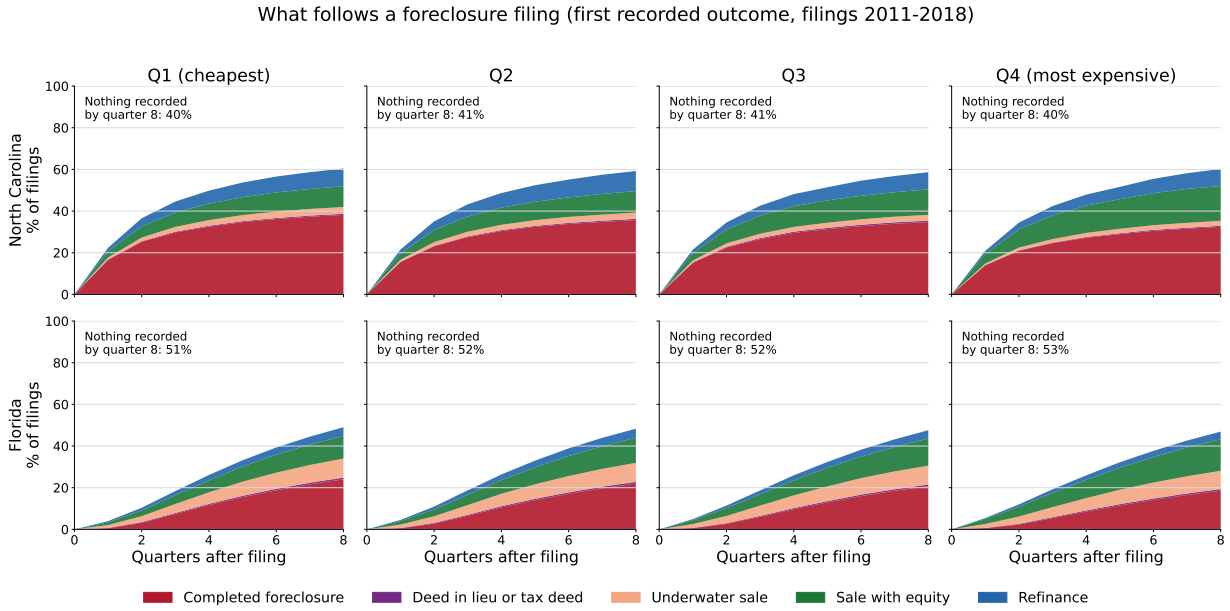


Figure A4: First recorded outcome after a foreclosure filing, by value quartile.

Notes. Cumulative share of filing episodes on owner-occupied homes whose first later document is each outcome, by quarter after the filing. North Carolina pools Mecklenburg, Guilford, Forsyth, Durham and Wake; Florida pools its counties. Filings from 2011 to 2018, followed through 2020. An episode is a filing with no filing on the same parcel in the preceding eight quarters. An underwater sale is an arm's-length sale below 95 percent of the estimated mortgage debt; a refinance is a new mortgage with no change of title before it, and includes recorded modifications. The unfilled share has no recorded outcome by that quarter.

References

Alfaro, Fernanda, Dusan Paredes, and Mark Skidmore, "Assessment of Property Tax Reductions on Tax Delinquency, Tax Foreclosure, and Home Ownership," Working Paper WP21FA1, Lincoln Institute of Land Policy January 2021.

Amornsiripanitch, Natee, "Why Are Residential Property Tax Rates Regressive?," Working Paper, Federal Reserve Bank of Philadelphia April 2024. Revised version of the 2020 working paper; dated April 19, 2024.

Anderson, Nathan B. and Jane K. Dokko, "Liquidity Problems and Early Payment Default Among Subprime Mortgages," *The Review of Economics and Statistics*, December 2016, *98* (5), 897–912.

Arkhangelsky, Dmitry, Susan Athey, David A. Hirshberg, Guido W. Imbens, and Stefan Wager, "Synthetic Difference-in-Differences," *American Economic Review*, 2021, *111* (12), 4088–4118.

Berry, Christopher and Qining Wang, "Property Tax Assessment and Housing Market Cycles," February 2024. University of Chicago, Harris School of Public Policy; draft of 24 February 2024, presented in the Syracuse-Chicago Webinar Series on Property Tax Administration and Design.

Berry, Christopher R., "Reassessing the Property Tax," Working Paper, Harris School of Public Policy, University of Chicago March 2021. Available on SSRN.

Cabral, Marika and Caroline Hoxby, "The Hated Property Tax: Salience, Tax Rates, and Tax Revolts," NBER Working Paper 18514, National Bureau of Economic Research November 2012.

Campbell, John Y. and João F. Cocco, "A Model of Mortgage Default," *The Journal of Finance*, 2015, *70* (4), 1495–1554.

Cavallo, Eduardo, Sebastian Galiani, Ilan Noy, and Juan Pantano, "Catastrophic Natural Disasters and Economic Growth," *Review of Economics and Statistics*, 2013, *95* (5), 1549–1561.

Foote, Christopher L., Kristopher Gerardi, and Paul S. Willen, "Negative Equity and Foreclosure: Theory and Evidence," *Journal of Urban Economics*, 2008, *64* (2), 234–245.

Fraenkel, Rebecca, "Property tax-induced mobility and redistribution: Evidence from mass reappraisals," *Public Budgeting & Finance*, August 2024. Uses ZTRAX (Zillow Transaction and Assessment Dataset) — parcel-level Ohio assessment and sales data, 2002–2017. Identification exploits the staggered timing of mandatory mass reappraisals across Ohio's 88 counties.

Fuster, Andreas and Paul S. Willen, "Payment Size, Negative Equity, and Mortgage Default," *American Economic Journal: Economic Policy*, November 2017, *9* (4), 167–191.

Ganong, Peter and Pascal Noel, "Liquidity versus Wealth in Household Debt Obligations: Evidence from Housing Policy in the Great Recession," *American Economic Review*, 2020, *110* (10), 3100–3138.

Gindelsky, Marina, Jeremy Moulton, Kelly Wentland, and Scott Wentland, "When do property taxes matter? Tax salience and heterogeneous policy effects," *Journal of Housing Economics*, September 2023, *61*, 101951.

Goodman-Bacon, Andrew, "Difference-in-differences with variation in treatment timing," *Journal of Econometrics*, 2021, *225* (2), 254–277.

Jappelli, Tullio, "Who Is Credit Constrained in the U.S. Economy?," *Quarterly Journal of Economics*, 1990, *105* (1), 219–234.

Kim, Yusun and Yilin Hou, "Property Valuation – Cycle Length and Assessment Outcome," *The Journal of Real Estate Finance and Economics*, November 2025, *71* (4), 545–586.

Landvoigt, Tim, Monika Piazzesi, and Martin Schneider, "The Housing Market(s) of San Diego," *American Economic Review*, 2015, *105* (4), 1371–1407.

Lutz, Byron F., "The Connection Between House Price Appreciation and Property Tax Revenues," *National Tax Journal*, September 2008, *61* (3), 555–572.

McMillen, Daniel and Ruchi Singh, "Assessment Regressivity and Property Taxation," *The Journal of Real Estate Finance and Economics*, 2020, *60*, 155–169.

Skidmore, Mark, Timothy Hodge, Gary Sands, and James Alm, "The Effect of Property Assessment Reductions on Tax Delinquency and Tax Foreclosure," *National Tax Journal*, 2025, *78* (2). Earlier version: Lincoln Institute of Land Policy Working Paper.