PUBLIC AND PRIVATE RESPONSES TO DEFAULT AND FORECLOSURE

By

Nicholas Brian Smith

(Under the Direction of Henry Munneke)

This dissertation focuses on responses to mortgage default and foreclosure. Foreclosures generate negative spillover effects on surrounding households and are a costly process for the borrower and lender. As a result, lenders and governments attempt to minimize the costs due to foreclosure. Lenders identify borrowers likely to self-cure, or cure without lender intervention, in order to reduce costs while governments place limits on foreclosures and monitor to upkeep of bank owned REO. This dissertation first examines the effect of a private form of governance, Homeowner's Associations, on foreclosure spillovers. Using a border-discontinuity design to study foreclosures inside and outside HOAs, I find that foreclosures occurring inside HOAs generate fewer spillovers. In the second essay, I study lender reactions to defaulters signaling a likelihood of curing the delinquency. Utilizing a multinomial logit model, results show that lenders strategically delay acting on delinquent loans of borrowers signaling self-cure via payments while delinquent. Policies extending foreclosure timelines are also studied and I find that the costs of these policies are borne by the lender.

INDEX WORDS: Foreclosure, Default, Signaling, Spillovers, Private Government

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Nicholas Smith

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By

Nicholas Smith

Major Professor: Henry J. Munneke

Committee: James B. Kau
Richard W. Martin
Darren K. Hayunga
James N. Conklin
Ruchi Singh

Electronic Version Approved:

Ron Walcott
Vice Provost for Graduate Education and Dean of the Graduate School
The University of Georgia
May 2022

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CHAPTER 1

The Effect of Private Governance on Localized Externalities: A Study of Homeowners Associations and Foreclosure

1.1 Introduction

Housing capital is durable and suffers high transaction costs. Because of these traits, Turnbull (1993) notes that homeowners have difficulty adjusting housing consumption for uncertainty and riskiness of future externality effects. Turnbull coins this as endogenous housing consumption risk and notes this risk can be abated through private land use contracts. Some neighborhoods are better able to abate consumption risk, and households select into neighborhoods based on preferences for consumption risk abatement. In other words, risk-averse buyers pay premiums for homes in neighborhoods that better control for these risks; these households accept restrictions in exchange for the consumption risk abatement of homogeneity. The literature supports the idea of a price premium for the reduction of consumption risk as Hughes and Turnbull (1996) shows that more numerous and stricter deed restrictions lead to higher prices. Homeowners Associations (HOAs) are one type of neighborhood that enforces land use restrictions and neighborhood regulation to reduce uncertainty. Literature shows a price premium for homes located in HOAs (e.g. Meltzer and Cheung (2014); Cheung et al. (2014); Clarke and Freedman (2019)).

This study contributes to the literature by analyzing the ability of private governance, (HOAs), to reduce foreclosure spillovers. Foreclosures induce negative spillovers by creating vacancies and negative house price pressure on nearby homes (Harding et al. 2009). Private land use contracts and HOAs may impact the magnitude and duration of the foreclosure price effect by restricting the preferences of new homeowners to that of existing homeowners and forcing upkeep on vacant bank owned homes (REO). I also explore whether variations in neighborhood age and strictness of HOAs impacts the ability to reduce consumption risk and foreclosure spillovers. Results indicate that foreclosures inside HOAs generate smaller foreclosure spillovers. Proxies for enforcement level indicate that stricter HOA enforcement leads to an even lower price effect.

While the literature on the impact of foreclosure and, separately, the impact of HOAs is plentiful, work studying a neighborhood's impact on foreclosure, as done in the current study, is less common. Groves and Rogers (2011) studies the effectiveness of Residential Community Associations (RCAs) at reducing externalities due to foreclosures. The authors utilize a propensity score matching paradigm like the current study as well as using rings to identify foreclosure proximity. A key data limitation in this study is the inability to identify precise HOA boundaries. Like other studies on HOAs, Groves and Rogers (2011) identify RCA membership via parcel identifiers. Rogers and Groves also note that their results are mean results across all RCA types as they do not have data on individual RCAs. The current study can identify HOAs by type and age which Groves and Rogers note is needed for further study. Cheung et al. (2014) also study HOAs and foreclosure. This study is conducted at a more geographically aggregated level. It shows that zip codes with greater HOA prevalence abate the effect of greater foreclosure rates. This study is again limited by the level of data aggregation and inability to identify HOAs by type.

The current study extends the literature by further exploring the interaction of consumption risk, via foreclosure or neighborhood age, and consumption risk abatement, via

HOAs. In addition, the current study's dataset includes granular location data on HOA boundaries and foreclosure sales allowing for precise measures of distance between sales. This data allows me to conduct my analysis at a finer geographic level to study the interaction of HOAs, foreclosure, and other associated effects. My data also contains greater detail on individual HOAs which identifies HOAs by age and enforcement level. Groves and Rogers (2011) note that their results are limited to mean estimates of the RCA effect and state a research need to study HOAs by type and enforcement level. The current study's dataset permits the study of HOAs by enforcement level and contributes to the literature by showing that active HOAs generate greater premiums and better abate foreclosure effects.

A Border Discontinuity Design (BBD) framework is combined with a matching paradigm to address issues of selection, endogeneity, and simultaneity. Homes just outside of the HOA's boundary compete with homes inside the HOA. The BDD framework restricts the current study's sample of arms-length, non-foreclosure, sales to being within 0.5-miles of an HOA border. Properties within this restricted border area are expected to have been developed within a similar time frame and have similar demographics and structural characteristics. As evidence of this, the building size covariate balanced on the unmatched BDD sample.

To further refine the sample, I match non-HOA and HOA homes within the BDD sample to create a balanced sample of homes near HOA boundaries. I employ a propensity score matching process using logistic regression to pair non-HOA homes with similar HOA transactions. HOA homes (the treatment group) are matched with non-HOA homes that have the nearest propensity score. These matches are limited to homes within 0.5-miles, 2-years of sale, and 2-years of structure age relative to the HOA transaction.

Prior studies tend to examine the magnitude of the price effect of nearby foreclosures in the absence of a time dimension. The current study replicates prior results on the magnitude of foreclosure spillovers. A one-unit increase in the number of nearby foreclosures leads to a significant (0.58%) decline in house price. However, I also incorporate a measure of foreclosure timing, which is found to have a significant price impact. Foreclosures one-month further into the past have 0.08% less of a negative spillover. In other words, more recent and greater numbers of nearby foreclosures lead to more intense spillover effects.

As in prior studies, the current study finds a price premium for home sales within an HOA. The estimates indicate a price premium of approximately 2.92%. The impact of nearby foreclosures in HOAs have a different price impact than nearby foreclosures outside of HOAs. Specifically, the results demonstrate that nearby foreclosures inside HOAs impact prices less than foreclosures outside HOAs. One contribution of this paper shows that the timing of foreclosures is important in understanding foreclosure effects. Nearby foreclosures within HOAs occurring near the time of sale have a greater impact than those outside of HOAs. These results provide evidence that foreclosures in HOAs lead to less spillovers. HOAs abate consumption risk through enforcement of upkeep and neighborhood preferences, which reduces spillovers from foreclosure.

The current study also examines HOA premiums over time. In newly developing neighborhoods, services and neighborhood restrictions are promised by the builder to develop a homogenous product. Original HOA homeowners buy into the HOA if the developer's plan satisfies their preferences. Poorly developed, new subdivisions may suffer if the developer doesn't meet homeowner demands and/or fill the subdivision. After the developer transitions the HOA to member households, HOAs ensure new and existing homeowners adhere to existing restrictions as structures age. Therefore, aging neighborhoods may benefit more from HOA restrictions compared to similarly aged non-HOA neighborhoods as the homogeneity of houses are preserved even as properties age.

The results seem to support this variation in price premium associated with the age of the HOA. The HOA premium grows until the HOA reaches 15-20 years of age. At this point it declines, though the oldest HOAs still exhibit a premium. The ability of HOAs to mitigate the effect of foreclosure also seems to vary with the age of the HOA. Middle-aged HOAs best abate foreclosure spillovers and generate the greatest premiums. Lesser mitigation and a lower HOA price premium may reflect the increased risk associated with foreclosures in yet to be completed neighborhoods. Given the variation in the premium as the association ages, I also expect that the strictness of enforcement matters.

HOAs that more strictly enforce community preferences further abate consumption risk and sell for even greater premiums. I utilize two proxies for enforcement: Active and Gated HOAs[1]. HOA liens in Nevada receive super lien status[2], and HOAs may foreclose on delinquent HOA dues. Active HOAs are defined as any HOA which foreclosed on a member. HOA foreclosure protects dues-paying members by replacing delinquent homeowners with new homeowners that buy into neighborhood norms. HOA foreclosure also may protect HOAs from insolvency, which ensures maintenance of HOA amenities. Gated HOAs also abate consumption risk but through structure (greater amenities and security). McCabe et al. (2006) shows that

[1] Active HOAs enforce strictness by foreclosing on members for non-payment of dues to satisfy preferences of dues paying members. Gated HOAs typically have additional security measures and amenities which may indicate greater enforcement.

[2] Super lien status means HOA liens receive priority above all other liens including the first mortgage. Nevada is also a non-judicial foreclosure state meaning HOAs do not need to go through courts to foreclose. Prsha (2016) provides a legal background of Nevada super lien laws.

Gated HOAs provide more amenities and security, even beyond the gate, than non-Gated HOAs. The results related to an HOA's strictness show that Active HOAs effectively diminish the housing consumption risks similarly to Gated HOAs. Actively managed communities may help protect these neighborhoods from foreclosure spillovers and other risks.

Taken collectively, the results show that homes in HOA neighborhoods sell for a premium, which varies with the age of the neighborhood, and experience less negative price impacts from foreclosure. HOAs which more strictly enforce contracts appear better able to abate consumption risk. Overall, these results are consistent with private market reactions to endogenous housing consumption risk and foreclosure spillovers. Homebuyers inherently commit to a location and neighborhood due to the durability and high transaction costs of housing. Risk-averse buyers pay premiums for homes in neighborhoods that better control for these risks. Homeowners Associations control risk by enforcing member preferences through restrictive covenants. Thus, these neighborhoods should be less impacted by foreclosure and time.

The current study contributes to the literature by examining the ability of HOAs to reduce consumption risk in the presence of foreclosures. I utilize detailed boundary definitions of HOAs which allows me to identify the true edge of an HOA. I also examine if stricter HOAs better mitigate the foreclosure spillover effect. I use actively managed HOAs and those that are gated communities to proxy for strictness of covenant enforcement.

The next section explores relevant HOA and foreclosure literatures. Section 3 discusses data and methodology testing my hypotheses unifying these literatures, and Section 4 reports my findings. This is followed by concluding remarks in Section 5.

1.2 Review of Literature

Given the nature of housing, the characteristics of a neighborhood affect individual home values. Turnbull (1993) first identifies the risk that neighbors may have on nearby homes through the differences between expected and actual housing consumption. Turnbull shows that higher variance distributions of potential neighbors lead to lower house prices and coins this variation as endogenous housing consumption risk. The spillover effects of foreclosures induce housing consumption risk, so housing consumption risk controls should also control for foreclosure. Rogers and Groves (2011) and Cheung et al. (2014) first connected the HOA and foreclosure literatures. The current study further expands and explores the connections between the foreclosure and private governance literatures.

A. Foreclosure

Extensive research exists on lender foreclosure, which consistently shows a foreclosure discount. Aroul and Hansz (2014) study foreclosures during the late 2000's financial crisis and find that foreclosure discounts are time-varying based on market conditions. Foreclosure discounts increased during 2008 and 2009, but then fell during 2010. Using data from Las Vegas, Clauretie and Daneshvary (2009, 2011) find foreclosure discounts of 7.9% to 11%. This discount has largely been attributed to lenders seeking quick liquidation (ibid), information asymmetries relating to quality risks (Campbell et al. 2011), and stigma relating to buying or living near foreclosed homes (Harding et al. 2009). Regardless of the cause, the literature consistently shows a discounted selling price for foreclosed homes.

Literature also indicates negative spillover effects on neighboring properties due to foreclosure (Immergluck and Smith (2006); Schuetz et al. (2008); Harding et al. (2008); Lin et al. (2009); Rogers and Winter (2009); Campbell et al. (2011); Biswas (2012); Anenberg and Kung (2014); Gerardi et al. (2015)). Campbell et al. (2011) shows that this negative externality exists on a neighborhood level at roughly 1/10th of a mile from the foreclosed property. It should be noted that these studies did not differentiate the foreclosure effect by neighborhood type.

Huang, Nelson, and Ross (2018) document the effect of foreclosure spillovers on future foreclosure risk. A necessary condition for default is that house value declines below mortgage value, which means foreclosure and house prices are highly correlated. This study develops an exogenous proxy, a prediction for negative equity external to housing prices or LTV ratios, to show the aggregate effect of expected foreclosure activity on the likelihood of future foreclosures. The proxy exploits the timing of a home purchase to determine likelihood of negative equity. Homes purchased near the top of the market are expected to have a higher likelihood of negative equity.

Towe and Lawley (2013) study how one's nearest neighbors affect the default decision. Defining near neighbors as the 13 nearest homes, a near neighbor in foreclosure increases the likelihood of foreclosure by 18 percent. The evidence suggests a negative social multiplier effect of foreclosure. Manski (1995) documents three ways social interactions impact economic decision making. Correlated effects occur when consumers with similar characteristics and preferences behave similarly. Contextual effects occur when consumer behavior is impacted by exogenous events in their neighbor's lives. Finally, endogenous interactions are when the actions of others in a group causes other members to behave similarly. These effects influence homeowners to default if a neighbor defaults. Given the homogeneous nature of HOAs, this may imply a greater social multiplier effect if HOAs are more tight-knit than non-HOA neighborhoods. The opposite would be true if HOAs are less tight-knit.

Munroe and Wilse-Samson (2013) study foreclosure spillovers, and find that a completed foreclosure causes between 0.5 and 0.7 additional filings within 1/10th of a mile. An instrumental variables approach uses the random assignment of a foreclosure case to chancery-courts as an instrument. This effect was not caused by neighboring borrowers being in negative equity, but rather by borrowers learning from neighboring foreclosures. This supports the social multiplier effect of foreclosure.

Biswas et al. (2021) study how government regulation affects foreclosure externalities. They study Vacant Property Registration Ordinances (VRPO) in Florida, which require registration and upkeep of vacant/foreclosed homes by lenders. The results find that cities enacting these ordinances had lower foreclosure spillovers. HOAs act as substitutes for VPROs by enforcing upkeep on REO properties.

B. Endogenous Housing Consumption Risk and HOAs

Hughes and Turnbull (1996) empirically study homes in Baton Rouge, LA, and find a premium for homes in neighborhoods with more restrictive covenants. The legal foundation for HOAs lies within restrictive covenants and amenities designed at the outset of the HOA. HOAs are charged with enforcement of these restrictions and neighborhood preferences. The HOA premium found in prior literature comes from this enforcement of member preference.

HOAs are private governments that act as private, membership organizations providing government-like services. Private governments fill a gap between the demands of private citizens and the provision of government services by the public sector (Helsley and Strange 1998). HOAs are a common form of private government that levy fees and utilize courts to close this preference gap between public provision and private demand. Areas with increasing planned development units have been found to have decreasing local public government spending (Cheung 2008). One consequence of private governments may be under provision of government-services to non-HOA members.

Meltzer and Cheung (2014) provide evidence of an HOA house price premium in Florida HOAs. This study also documents a declining premium with neighborhood age and attributes this to capitalization of HOA amenities. This result is contradicted in Cheung et al. (2014)'s work on HOAs and foreclosure, which shows that middle aged HOAs sell for the greatest premium. Studying the formation tendencies of HOAs, Cheung and Meltzer (2014) find that HOAs form in predominantly white, wealthy, less dense neighborhoods further from the city center.

C. HOAs and Foreclosure

Two key papers studying the effects of HOAs on foreclosure are Groves and Rogers (2011) and Cheung et al. (2014). Groves and Rogers (2011) studies the effect of RCAs on foreclosures in St. Louis. This study finds that foreclosures inside RCAs generate less of a foreclosure discount and that RCAs reduce local externalities due to foreclosure. Cheung et al. (2014) proposes competing hypotheses regarding HOAs and foreclosure. Foreclosures may have a greater impact in HOAs if they deprive the HOA of the dues needed to satisfy member preferences. Alternatively, intimate knowledge of members may offer HOAs a path to triage foreclosures early. To test these hypotheses, the authors measure delinquency and HOA membership rates by zip code. Both studies suffer from a lack of precise HOA boundaries and greater HOA detail which is remedied in the current study.

1.3 Data and Methods

The sales data for this study are drawn from the Clark County, NV Assessor's office. The City of Las Vegas and Henderson provide GIS maps of HOAs boundaries within their respective cities. This data allows for the mapping of each parcel to determine if a sale is located within an HOA, as well as distance to the nearest HOA boundary. Recall that the current study employs a border discontinuity design (BDD), in the vein of Biswas et al. (2021), which requires precise distances to boundary.

Border discontinuity designs exploit geographical boundaries as the treatment for a regression discontinuity (RD) framework. Non-HOA homes near an HOA border compete with the HOA, which may encourage similar characteristics. The assumption is that the only difference in homes at a boundary is the treatment of being in an HOA. Thus, the sample is restricted to sales within 0.5-miles from an HOA boundary.[3] The BBD Sample consists of 105,920 market sales of primary residence, detached houses within 0.5-miles of an HOA boundary with sales occurring between 2000 and 2020.

One issue in studying HOAs is selection bias in the typical HOA homeowner. Cheung and Meltzer (2014) find that HOAs form in predominantly white, wealthy, and suburban areas in addition to other factors. Lee (2018) notes that a sufficient, though not necessary, condition for regression (or border) discontinuity designs is that the treatment is as good as random at the threshold (or border). To address randomness of HOA presence, I employ a matching paradigm.

[3] Observations with missing sales price or relevant variable data were deleted. Non-residential (non-detached houses) parcel codes, rental property, and non-arm's length transactions were also removed. The sample was further narrowed to sales less than $20,000 or greater than $1,000,000.

This matches non-HOA sales to HOA sales in the BDD Sample within 0.5-miles in straight-line distance. This creates a balanced sample[4] of HOA and non-HOA homes.

A. Matching

To properly identify the treatment effect of HOAs, I implement a propensity score matching process in addition to the border discontinuity framework. To preserve the border discontinuity framework, I form the matched sample from the BDD sample. To estimate the needed propensity scores, I estimate a logistic regression of a property being in an HOA versus outside of an HOA. Such a model can be written as:

$$Z_{ilt} = \kappa + \varphi \boldsymbol{A}_{ilt} + \psi \boldsymbol{X}_{it} + \eta \tag{1.1}$$

where Z_{ilt} equals 1 if the property is inside an HOA. The vector $\boldsymbol{A}_{ilt}$ contains neighborhood demographics at the census tract level including white population, total population, and number of homes as provided by the U.S. Census Bureau. The vector $\boldsymbol{X}_{it}$ includes house characteristics. The explanatory variables used in the estimation of the logit model include the structure's age, log of structure size, log of lot size, distance to nearest highway, and distance to Las Vegas CBD. Cheung and Meltzer (2014) note HOAs form in less dense areas with higher concentrations of non-minority residents. To account for this, I include census tract data on non-minority population, total population, and the total houses in the observation's tract. The probability of being in an HOA is calculated as follows:

$$\Pr(HOA) = \Pr(Z_{ilt} = 1) = \frac{(e^{\kappa + \varphi\, Ailt + \psi\, Xit})}{1 + e^{\kappa + \varphi\, Ailt + \psi\, Xit}} \tag{1.2}$$

[4] See Table 1 for tests of balance.

Using the logit estimates, the probability a property being located within an HOA is estimated. Nearest neighbor 1-to-1 matching with replacement generates the propensity score calipers and pairs HOA and non-HOA sales. These matches are limited to properties within 2-years in transaction time and structure age. Matches are also limited spatially to within 0.5-miles of the HOA transaction.

Matching with replacement allows for matching each treated sale to the nearest in propensity score control sale, even if the control sale has been matched already. Matching without replacement may lead to matching of two sales of very different in propensity scores if all potential matches are exhausted, which would increase bias (Dehejia and Wahba 2002). Matching without replacement also introduces bias as it is dependent on the order in which treatment units are matched (Rosenbaum 2011). This may be especially true when including calipers for structure age if most potential matches within a treated sale's age bracket are exhausted. As a result, matching with replacement is preferred for the current study.

In testing for sample balance, Imai et al. (2008) and (Austin 2008b, 2009b) note inadequacies of using the mean difference t-test as a determinant of sample balance. As an alternative, Rubin (2000) proposes using the standardized difference in means and the ratio of variances for each variable between groups. The standardized difference in means is calculated as:

$$SDM = \frac{(\overline{X_H} - \overline{X_N})}{\sqrt{\frac{S_H^2 + S_N^2}{2}}} \quad (1.3)$$

where $\bar{X}_H$ and $\bar{X}_N$ and S_H^2 and S_N^2 represent the means and standard deviations of covariate *X* for the subsamples of HOA and non-HOA sales, respectively. Following Rubin (2000), a variable is well balanced if and only if the standardized difference of means falls in the range of (-0.25, 0.25), and the ratio of the variance falls in the range of (0.5, 2).

B. HOA Classification and Age

In Nevada, HOAs can foreclose on their own members if they are past due on association dues. HOA liens in Nevada are treated as "super-liens" meaning HOA liens are given higher priority than the first mortgage. As a result, an HOA can expect a high likelihood of recovering delinquent dues through foreclosure (legal fees are covered as part of the lien). I use this information as a proxy for strictness of convent enforcement by HOAs. HOAs observed in the data foreclosing on properties within the HOA are defined as Active HOAs. The data for the City of Las Vegas also includes an indicator for Gated HOAs.

HOA Age is determined as the time since the HOA was registered with Clark County, NV. The primary source of this information is Nevada's Business Registry, which provides registration dates for all business entities in Nevada. A search of this site provided original registration dates for HOAs in the sample. To verify and supplement the registry data, additional data was collected from HOA websites and the limited information provided in the GIS file. These data clarify the business registry data.

C. Foreclosure

The data do not specify the date when the foreclosure process begins; however, it does indicate the date of the foreclosure sale. The current study considers foreclosure sales occurring within the 24 months prior as nearby in time. On average, foreclosures in Las Vegas typically take 120 days from the notice of default to a final auction sale. Nearby foreclosures are further defined spatially and foreclosures within 0.25-miles of the observation are considered "nearby".

The literature supports this definition as Gerardi et al. (2015) find that foreclosure spillovers extend up to 0.25-miles from an REO property.

It is hypothesized that, in addition to the number of nearby foreclosures, the timing of foreclosures may also impact price. To control for the timing effect of nearby foreclosures, I find the mean number of months that have passed for each foreclosure in the prior 24 months. For example, if a market transaction had three foreclosures in the prior 24 month, with 2 occurring 12 months ago, and the remaining occurring 18 months ago, the average timing (AVG_TIME_i) of these events would be the simple average or 14 months. The implicit assumption of the 24-month window is that foreclosures beyond the 24-month window have no price impact. The absence of a price impact is also true for market sales never having a nearby foreclosure. As the mean timing of the foreclosure events approach 24 months, the price impact is hypothesized to fully dissipate. To allow the variable to capture this restriction, I define a variable $MEANTIME_i$ in the form of a spline function of the average timing of nearby foreclosures as defined above. This variable is defined as:

$$\text{If } AVG\_TIME_i > 0 \text{ then } MEANTIME_i = AVG\_TIME_i - 25$$

$$\textit{Otherwise, } MEANTIME_i = 0. \tag{1.4}$$

Based on this definition, $MEANTIME_i$ increases to zero as the average timing of nearby foreclosures (AVG_TIME_i) nears 24 months. Thus, a home sale with no nearby foreclosures or foreclosures occurring greater than 24 months into the past would have a meantime of 0 and a home sale with near in time foreclosure would have a high absolute value in meantime. A significantly positive coefficient on meantime implies that spillover effects decline with a one-month average increase in time which is the expected result.

Table 1.1 depicts summary statistics for the matched BBD sample. It also presents evidence of the tests of balance. The mean sales price of HOA homes ($301,584) is less than non-HOA homes ($360,769) with HOA homes also showing less variance in house price. For the control variables, the means and standard deviations are all similar which would be expected. Mean building sizes in HOAs (2,450 sf) are similar in mean with non-HOA homes (2,463) though non-HOA homes vary more. I note that the unmatched BDD sample also showed similarity in building sizes and balanced prior to matching. This lends credence to Meltzer and Cheung's (2014) assertion that boundary non-HOA homes compete with HOAs and thus build similar sized houses. Turning to variables related to foreclosure, HOA homes tend to have fewer nearby foreclosures that happen nearer in time.

D. Hedonic Model

To capture the price effects of HOAs and foreclosures, I estimate hedonic house price models in the vein of Rosen (1974). A generalized hedonic price function for arms-length transactions of detached single family homes can be written as:

$$\ln (SP_{ilt}) = \alpha + \gamma X_{it} + \tau_t + \lambda_l(\tau) + \beta FH_{it} + \varepsilon \qquad (1.5)$$

where SP_{ilt} is the selling price, X_{it} a matrix of house characteristics, λ_l represents fixed effects for location, τ_t represents the fixed effects for time, α is the regression constant, and ε is the stochastic error term. FH_{it} is a generalized set of variables related to Homeowner Association characteristics and transaction (e.g., foreclosure) characteristics. Variables in FH_{it} will test the primary hypotheses of the paper. The household characteristics in the model are the natural logs of both building and lot sizes, as well as the building's age. In addition to the size and age effects, the model also includes a spatial variable measuring the distance from "the Strip," which is defined as the intersection of Flamingo Road and Las Vegas Boulevard. The Strip is the hub of most tourist draw in Las Vegas, which is the key industry of the city. A variable measuring the distance to the nearest highway is also included.

Figure 1.1 depicts foreclosure scenarios relative to a market transaction with three foreclosure transactions falling either inside or outside an HOA boundary. An "X" represents the observed market sale. The hollow dots represent nearby foreclosure sales as previously defined. The dashed circle represents the 0.25-mile radius for nearby foreclosures. These four scenarios represent the possible outcomes based on market and foreclosure sale location and serve as the basis for the hypotheses tested in this study. The key difference studied is whether the foreclosure falls within an HOA as HOAs are expected to limit the impacts of these foreclosure through the enforcement of private land contracts.

Comparing Scenario 1 and 2, the price of the market transaction in Scenario 1 (V_1) would be greater than in Scenario 2 (V_2) if foreclosures inside HOAs are less impactful than those on the outside. Scenarios 3 (V_3) and 4 (V_4) represent situations where the market sales occur outside an HOA. The expected price of V_3 would be greater than V_4 because two of the foreclosures fall outside of the HOA in Scenario 4. Scenarios 2 and 3 have higher expected values compared to Scenarios 1 and 4, as two of the three foreclosures occur inside an HOA.

Simultaneity of house price declines and foreclosures present a central challenge to studying foreclosure spillovers. In the vein of Biswas et al. (2021) as well as other literature, the current study addresses this challenge through time and location fixed effects. Location fixed effects by U.S. Geological Survey (USGS) townships[5] control for location. Time fixed effects by sale year control for timing. These fixed effects make the timing effectively random outside a given township in a given year.

1.4 Results

To confirm prior studies' results of the negative impact of nearby foreclosures (Harding et al. (2009); Campbell et al. (2011); Gerardi et al. (2015) among others), I also estimate such a model and confirm that higher numbers of nearby foreclosures lead to lower house prices. I further explore if foreclosures nearer in time to an arms-length sale are most impactful. Table 1.2 contains the estimation results of the hedonic model controlling for the number of nearby foreclosures and the timing of the prior foreclosures. Nearby foreclosures are found to negatively impact the price of a nearby market sale by 0.56% – 0.58% for each additional nearby foreclosure.

The current study's matching paradigm allows for a more precise identification of the foreclosure effect. The estimated magnitude of this impact is consistent with, albeit slightly less than, results from other studies. Harding et al. (2009) finds a contagion effect of nearby foreclosures equal to roughly 1% per nearby foreclosed property that lingers for a year. Campbell et al. (2011) studies the forced sale of homes either through death or foreclosure, and their preferred specification shows that each foreclosure that takes place nearby lowers house prices by about 1%. Gerardi et al. (2015) finds that properties in distress lower nearby transaction prices by 2.6% on average starting from the moment a borrower becomes seriously delinquent until well after the bank sells the property in foreclosure.

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[5] Clark County, NV uses USGS Townships as the basis for most land descriptions.

Model 1.2.2 includes a measure of the timing of nearby foreclosures. The positive and significant coefficient indicates that the average timing of nearby foreclosures within the last 24 months being closer to the sale date leads to a greater price impact. Holding the number of nearby foreclosures constant, for each month the average timing of nearby foreclosures approaches the market sale date, the market sale price of the property is reduced by 0.08%. These results are consistent in sign with expectations.

The coefficients associated with housing and locational controls are generally consistent with prior literature. Building size and lot size both exhibit a non-proportional price-size relationship; prices increase as size increases but at a decreasing rate. The structural age coefficient is negative and significant, indicating older homes sell for lower prices. The coefficient on distance from the Las Vegas strip is also significantly negative indicating that homes further from the CBD sell at a discount. Finally, the distance to a highway coefficient is significantly positive. This variable is measured as straight-line distance to the highway not an onramp. This result may be due to noise pollution from highways.

A. HOA Premiums and Risk Abatement

The primary hypothesis of this paper is that HOAs' abate consumption risk related to foreclosure and other neighborhood changes. HOAs reduce the spillover effect of foreclosure by requiring upkeep and enforcing neighborhood norms. To test these hypotheses, several HOA related variables are entered into the foreclosure model previously estimated. HOA_{it} is an indicator variable equal to one if an observation is in an HOA and zero otherwise. This variable is also interacted with measures of foreclosure intensity and timing. If HOAs mitigate consumption risk, then homes in HOAs are expected to sell at a premium. If HOAs abate consumption risk, HOAs should alleviate foreclosure spillovers and thus properties within an HOA should be impacted less by foreclosure.

The estimates from the models in Table 1.3 confirm a positive and significant price premium impact of roughly 2.6% - 2.9% for homes within an HOA. The number of nearby foreclosures continues to have a negative estimated effect on price. It is important to note that foreclosures within an HOA have a marginally lower impact relative to those outside of the HOA. The coefficient on the average time to foreclosure variable ($Meantime_i$) remains positive and significant in Model 1.3.2, but is of lower magnitude than the coefficient on the average time to foreclosure variable inside the HOAs (*Meantime of Foreclosures in HOAs*$_i$) which is also significantly positive at 0.0008. This indicates that foreclosures inside HOAs generate a greater negative price impact if closer in time to the sales date than those outside. Taken together, these results confirm a price premium for HOAs and an abatement effect on the magnitude of foreclosure spillovers. In addition, results also indicate that the timing of foreclosures is an important pricing consideration.

B. Variation in Abatement Effects

According to Meltzer and Cheung's capitalization of amenities theory, it is hypothesized that HOA price premiums initially decline with respect to neighborhood age. Extending this, I conjecture that as neighborhoods age further, HOA premiums actually rise as the value of the HOAs enforcement of the original preferences becomes more important as physical capital is renovated and new members replace the old. Finally, price premiums for well-aged HOAs may decline as the original tastes of a neighborhood become outdated and enforcement of covenants wanes. Meltzer and Cheung (2013) provides support for a declining premium capitalized early in the life of a home, and Cheung et al. (2014) find that middle aged HOAs (5 years≤HOA Age<15 years) have the greatest premium.

To explore the ability of HOAs to reduce consumption risk as they age, I divide the HOA sales into sub-samples (buckets) based on the age of the HOA. I then use nearest neighbor 1-to-1 matching with replacement to form propensity score calipers to pair HOA and non-HOA sales.[6] Each bucket is matched separately, which creates unique subsamples by bucket of matched non-HOA sales and HOA sales. Since neighborhood age is unknown for non-HOA sales, it is impossible to match non-HOA observations with the same neighborhood age. Thus, when matching the sales, I add an additional restriction that requires the age of the non-HOA property sale to be within two years of age of the HOA property. This reduces the matching of properties of different ages, which may confound my estimates. Table 1.4 provides balanced sample test results. Note, I once again follow Rubin (2000) and define a variable as balanced if the standardized difference of means is between (-0.25, 0.25) or the ratio of covariate variances falls in the range (0.5, 2). As evidenced in Table 1.4, all neighborhood age subsamples balance utilizing Rubin's criterion. These subsamples test for the impact of HOAs conditional on the age of the neighborhood.

Using the balanced subsamples, I estimate the same model employed in Model 1.3.2. The initial pattern of the estimates of the HOA age price impact, presented in Table 1.5, is consistent with Meltzer and Cheung's capitalization of amenities theory. The coefficients on HOA for each of the models are positive and significant. The magnitude of the HOA coefficient generally

[6] As with prior matching, to determine probability of being inside an HOA, the following criteria are used: structure age, log of structure size, log of lot size, distance to nearest highway, distance to Las Vegas CBD, and census tract data on white population, total population, and the total houses in the observation's tract. The same time and distance calipers are also applied.

increases each interval, reaches a maximum with the 15 to 20 age interval, and then declines. I believe the low impact of the first HOA interval (1 year or less) reflects the protections that already exist in an HOA in the early phase of development, reflecting the developers desire to signal buyers about a relatively homogeneous product. For each model, nearby foreclosures have a negative impact on the market price of homes in the sample. Interestingly, no measurable abatement was found for homes the oldest HOAs. The intervals younger than 20 years all indicate that nearby foreclosures in HOA have a lower impact (positive coefficient) relative to foreclosures outside the HOA. The marginal impact of the HOA in the over 20-year interval, the oldest HOAs, is insignificant. The overall (the sum of nearby foreclosures and nearby foreclosures in an HOA) pattern of the impact of the nearby foreclosures shows an increased impact until the 5-to-10-year interval followed by decline, with the older HOA age intervals indicating the greatest decline. This pattern is depicted in Figure 1.2.

Foreclosures occurring nearer in time impact the sales price of homes in early and late stage HOAs more than homes in more established HOAs. This effect is significantly greater when the foreclosure near in time occurs within the HOA. Combined, I believe this supports the conjecture that additional consumption risk occurs when foreclosures occur in the developmental stages of a neighborhood as well as during neighborhood decline.

C. HOA Strictness

To explore if the "strictness" of enforcement of member preferences better abates consumption risk, I introduce two indicator variables that proxy for unobservable covenant enforcement: Active and Gated HOAs.[7] An Active HOA is defined as any HOA which

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[7] I have removed all active and gated HOAs from the sample to simplify the interpretation of the estimates.

foreclosed on a member. During a portion of the study period, HOA liens in Nevada receive super lien status. This means HOA liens receive priority over first mortgages and HOAs may foreclose on delinquent HOA dues. HOA foreclosure protects dues-paying members by replacing delinquent homeowners with new homeowners that buy into neighborhood norms. Foreclosure by HOAs also may protect HOAs from insolvency, which ensures maintenance of HOA amenities. Thus, Active HOAs enforce strictness by foreclosing on members for non-payment of dues to satisfy preferences of dues paying members and reduce lingering foreclosures. Gated HOAs enforce strictness through additional security measures and amenities. If HOAs abate consumption risk, then it is hypothesized that the strictest HOAs would further mitigate these risks.

Table 1.6 presents results of the HOA strictness tests. The results indicate that Active HOAs sell at a premium (3.5%-5.0%) above and beyond non-Gated, inactive HOAs. A significantly positive coefficient on the interaction of Active HOAs and Nearby Foreclosures in an HOA show that Active HOAs further abate foreclosure risk above inactive HOAs. Gated HOAs also sell at a premium (2.9%-3.5%) above non-Gated, inactive HOAs. A positive and significant coefficient on the interaction of Gated HOAs and Nearby Foreclosures in an HOA indicates that Gated HOAs also abate foreclosure spillovers more so than non-Gated HOAs. Interestingly, the coefficient on this interaction term is greater for Active HOAs than for Gated HOAs.

These results support the hypothesis that stricter HOAs generate greater house price premiums through stricter enforcement of neighborhood preferences. Active HOAs signal covenant enforcement and actively manage their HOA through the foreclosure process. The results seem to indicate that these active HOAs better abate foreclosure spillovers and the actions are not taken to stave off financial problems of the HOA.

The Gated HOA community structure appears less able to internalize (abate) the spillover effects of foreclosures within their neighborhood. It might be that abandoned or unkempt homes also require greater security demands further exacerbating the pressure these vacancies put on HOA resources. The coefficient on the *Meantime* interaction with HOA types are all positive indicating the impact of average foreclosure time for properties in HOAs is greater than those outside of HOAs.

D. Robustness

The current study addresses endogeneity using border discontinuity designs, matching, and fixed effects for location and time. This section explores the robustness of the results using techniques varying the border discontinuity and foreclosure ring specifications. I identify Model 1.3.2 in Table 1.3 as the primary specification of interest and conduct my robustness tests using this specification. To determine the foreclosure ring and matching distance calipers used in the current study, I employ a grid search, nonparametric method that varies these calipers. I report a portion of these results as robustness and note that the results do not change in sign or significance across the unreported models.

A nonparametric regression model determined the 0.5-mile radius. Four matched samples were created utilizing matching with replacement and distance calipers of 0.25-, 0.5-, 0.75-, and 1.0-miles. In addition to varying the match distances, I also vary the definition of nearby foreclosure. I redefine nearby utilizing distance radii of 0.1-, 0.2-, 0.25-, 0.3-, 0.4-, and 0.5-miles. My specification of interest was then modeled using the various nearby foreclosure definitions on each of the four matched samples. The regression results were consistent in sign and significance across all models. The model that best fit the data on an adjusted R-squared basis matched sales with 0.5-miles and defined nearby foreclosure as 0.25-miles.

Varying the Border Buffer. The BBD sample utilized in the current study is restricted to market sales within 0.5-miles of an HOA border. To test the robustness of the boundary, I expand the buffer to 1-mile around an HOA boundary and estimate my primary specification of interest. I also narrow the buffer to 0.25-miles of the boundary in the same fashion as before and estimate the same primary specification. In each of these models, I employ the same matching technique described in Section 3. The results of these estimations are found in Table 1.7. Model 1.7.1 presents results for the widened buffer, while Model 1.7.3 presents the narrow buffer. Please note that model 1.7.2 in this table reports the prior results with the 0.5-mile buffer, already reported in Table 1.3, for ease of comparison.

As the buffer widens, the marginal effect on spillovers of a foreclosure being inside an HOA increases as does the HOA premium. Homes closest to the HOA border compete with HOA homes and receive spillover effects from HOAs. It is reasonable that the effect of HOAs increases as distance increases. Overall, the results are consistent in sign and statistical significance.

Varying the Definition of Nearby. The foreclosure literature provides evidence of the effect of distance on foreclosure spillovers. Gerardi et al. (2015) finds that foreclosures are highly localized with the effect beginning to dissipate at 0.1-miles of distance and completely dissipating at 0.25-miles. To test the robustness of the definition of nearby, I expand the nearby ring to 0.5-miles from the observed sale and then contract to 0.1-miles. The results of these estimations are found in Table 1.8. Model 1.8.1 presents results for the 0.5-mile definition, while Model 1.8.3 presents the 0.1-mile definition. Model 1.8.2 again presents the results from model 1.3.2 for ease of comparison.

As the definition of nearby widens, the coefficient on nearby foreclosures declines as well as the marginal effect of HOAs on foreclosure. It is reasonable that the effect of foreclosure decreases in spatial distance in a similar way to distance in time. Overall, the results are consistent in sign and statistical significance.

1.5 Conclusion

Endogenous housing consumption risk captures the variation in expected versus actual services provided by a home (Turnbull 1996). Home buyers with greater concern for consumption risk, including spillover effects and deterioration, seek controlled neighborhoods that use private land use contracts to mitigate these risks. One such form of a controlled neighborhood is an HOA. HOAs limit risk by enforcing homogeneity and member preferences through these private land use contracts. Neighborhoods which control for these risks may have higher prices and be less impacted by localized externalities such as foreclosure. In this study, I not only explore the price premium associated with HOAs, but I examine if these neighborhood controls also dampen the impact of nearby foreclosures. I also examine the variation in these impacts related to neighborhood age and the strictness of the HOA.

The estimates for this study are generated using a sample of single-family dwellings sold in the Las Vegas area from 2000 to 2020. A border discontinuity design (BDD) controls endogeneity in the estimation of hedonic price models. The sample is restricted to sales within 0.5-miles from an HOA boundary. Meltzer and Cheung (2014) contend that homes near HOAs boundaries tend to be develop at similar times and compete for buyers with the HOA, which encourages similar characteristics in non-HOA homes to the nearby HOA homes. Utilizing this BDD sample, I further address issues of endogeneity by constructing a balanced sample of HOA and non-HOA homes. The primary specification of interest is tested using this matched sample, and these steps should increase the precision of the study's estimates.

The study confirms a price premium for properties within an HOA and a negative price impact due to the number and timing of nearby foreclosures. It also provides clear support for the idea that HOAs reduce negative spillover effects as foreclosures in HOAs are found to impact price less than those outside of an HOA. There is also evidence that HOAs are less impactful for neighborhoods still in development. Foreclosures seem to signal an increase in consumption risk beyond the abatement typically offered by an HOA. Early foreclosures in a neighborhood may signal potential faltering of the neighborhood quality and design.

A key finding in this study relates to the strictness, or management, of HOAs. I can identify properties which fall into Gated HOAs and those in what I term as Active HOAs. Active HOAs are defined as any HOA which foreclosed on a member under Nevada's HOA super lien statute. Under this statute, HOAs may foreclose on homeowners past due on HOA dues and HOA liens receive priority above the first mortgage. By replacing delinquent homeowners with new homeowners that buy into neighborhood norms, HOAs foreclosing may positively impact the HOA by protecting dues-paying members and the HOA's amenities provision. It could also signal financial problems for the HOA. The results show that Gated and Active HOAs command an even greater price premium than HOAs outside these classifications. In addition, Active HOAs seem better able to mitigate the impact of nearby foreclosures. A result which I hope to explore further in future studies.

Robustness tests show that the study's results are robust to variations in the definition of nearby foreclosure and the border discontinuity specification.

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1.7 Tables and Figures

Table 1.1: Summary Statistics of the Matched, BDD Sample

	HOA		Non-HOA		Tests of Balance	
Sale Characteristics	Mean	Std. Dev.	Mean	Std. Dev.	Std. Diff. of Means	Ratio of Var.
Sale Price	301,584	168,782	360,769	199,493	-	-
Nearby Foreclosures (#)	5.15	7.36	3.62	6.27	-	-
Average Time (Months)	17.02	7.92	18.51	7.70	-	-
Controls						
Bldg. Age (Years)	15.38	13.96	15.38	13.98	0.00	1.00
Bldg. Size (SF)	2,450	937	2,463	995	-0.01	0.94
Lot Size (Acres)	0.15	0.10	0.14	0.11	0.11	0.90
Dist. to a Highway (Miles)	1.14	0.96	1.14	0.94	0.00	1.01
Dist. to the LV Strip (Miles)	10.53	3.19	10.52	3.18	0.00	1.00
Observations	33,816		33,816			

Notes: This table presents summary statistics for the sample of Clark County, NV property sales within 0.5-miles of an HOA border constructed by matching non-HOA homes to HOA homes. The final columns in the above table present tests of balance.

The standardized difference of the mean and the ratio of the variance are used for matching balance diagnosis following the matching literature (Rubin, 2001; Austin, 2011). Following Rubin (2000), a variable is well balanced if and only if the standardized difference of means falls in the range of (-0.25, 0.25), and the ratio of the variance falls in the range of (0.5, 2). All covariates balance.

The underlying data is provided by the Clark County, NV Assessor. The City of Las Vegas, NV and Henderson, NV GIS offices provided HOA boundaries. Nearby Foreclosure is defined as the number of homes sold in foreclosure within 0.25-miles and up to two years prior to the observed market sale. Average Time is defined as the average timing in months of all Nearby Foreclosures relative to a given observed sale.

Table 1.2: The Effect of Foreclosures on House Prices

	(1) Magnitude	(2) Magnitude and Timing
Dep. Var.=	ln(SP)	ln(SP)
Nearby Foreclosures (#)	-0.0056**	-0.0058**
	(0.0002)	(0.0002)
Meantime (Months)		0.0007**
		(0.0001)
Bldg. Age (Years)	-0.0109**	-0.0110**
	(0.0001)	(0.0001)
ln(Bldg. Size) (SF)	0.5958**	0.5953**
	(0.0031)	(0.0031)
ln(Lot Size) (Acres)	0.2447**	0.2458**
	(0.0018)	(0.0018)
Distance to Highway (Miles)	0.0145**	0.0145**
	(0.0011)	(0.0011)
Distance to the Strip (Miles)	-0.0033**	-0.0034**
	(0.0006)	(0.0006)
Constant	9.1949**	9.2010**
	(0.0403)	(0.0404)
Township Fixed Effects	X	X
Sale Year Fixed Effects	X	X
Observations	67,632	67,632
R2	0.8711	0.8711
Adj. R2	0.8710	0.8711

Note: This sample consists of properties located within 0.5-miles of an HOA border. A propensity score matching process matches HOA sales with non-HOA sales. Matches are limited to non-HOA transactions within 0.5-miles of an HOA sale. Matching is also limited to properties within +/- 2 years in structure age and transaction timing.

Nearby Foreclosure is defined as properties within 0.25-miles of the observed market sale that sold in foreclosure up to two years prior to the observation.

Meantime is a transformation of the average timing of nearby foreclosures that sets foreclosures nearest in time as further from zero and sets observations with no nearby foreclosures equal to zero. Foreclosures a month ago take a Meantime value of -24, while those 24 months ago take a value of -1. The range of Meantime is [-24, 0] with zero indicating no nearby foreclosures within past 24 months.

Standard errors in parentheses. ** - $p<0.01$, * - $p<0.05$

Table 1.3: The Effect of HOAs on Foreclosure and House Prices

	(1) HOA	(2) HOA and Foreclosure
Dep. Var.=	ln(SP)	ln(SP)
HOA	0.0292**	0.0258**
	(0.0017)	(0.0019)
Nearby Foreclosures (#)	-0.0058**	-0.0064**
	(0.0002)	(0.0003)
Nearby Foreclosures in HOAs (#)		0.0007*
		(0.0003)
Meantime (Months)	0.0008**	0.0002**
	(0.0001)	(0.0001)
Meantime of Foreclosures in HOAs (Months)		0.0008**
		(0.0002)
Bldg. Age (Years)	-0.0112**	-0.0112**
	(0.0001)	(0.0001)
ln(Bldg. Size) (SF)	0.5949**	0.5953**
	(0.0031)	(0.0031)
ln(Lot Size) (Acres)	0.2539**	0.2535**
	(0.0019)	(0.0019)
Distance to Highway (Miles)	0.0130**	0.0131**
	(0.0011)	(0.0011)
Distance to the Strip (Miles)	-0.0036**	-0.0038**
	(0.0006)	(0.0006)
Constant	9.2124**	9.2119**
	(0.0403)	(0.0403)
Township Fixed Effects	X	X
Sale Year Fixed Effects	X	X
Observations	67,632	67,632
R2	0.8717	0.8717
Adj. R2	0.8716	0.8717

Notes: This sample consists of properties that are located within 0.5-miles of an HOA border. A propensity score matching process matches HOA sales with non-HOA sales. Matches are limited to non-HOA transactions within 0.5-miles of an HOA sale. Matching is also limited to properties within +/- 2 years in structure age and transaction timing. Nearby Foreclosure is defined as properties within 0.25-miles of the observed market sale that sold in foreclosure up to two years prior to the observation.

Meantime is a transformation of the average timing of nearby foreclosures that sets foreclosures nearest in time as further from zero and sets observations with no nearby foreclosures equal to zero. Foreclosures a month ago take a Meantime value of -24, while those 24 months ago take a value of -1. The range of Meantime is [-24, 0] with zero indicating no nearby foreclosures within the past 24 months.

Standard errors in parentheses. ** - p<0.01, * - p<0.05

Table 1.4: Balanced Sample Tests Using HOA Age Intervals

	Panel A: HOA Age <= 1		Panel B: 1< HOA Age<=5		Panel C: 5< HOA Age<=10	
	Std. Diff. of Means	Ratio of Var.	Std. Diff. of Means	Ratio of Var.	Std. Diff. of Means	Ratio of Var.
Bldg. Age (Years)	0.00	0.99	0.00	1.00	0.00	0.99
Bldg. Size (SF)	-0.09	0.98	-0.20	0.83	-0.25	0.98
Lot Size (Acres)	-0.11	0.59	-0.20	0.67	-0.09	0.65
Dist. to Hwy (Miles)	-0.11	0.95	-0.22	1.15	0.01	1.61
Dist. to Strip (Miles)	-0.04	1.10	0.04	1.02	0.05	1.11
	Panel D: 10< HOA Age<=15		**Panel E: 15< HOA Age<=20**		**Panel F: 20< HOA Age**	
	Std. Diff. of Means	Ratio of Var.	Std. Diff. of Means	Ratio of Var.	Std. Diff. of Means	Ratio of Var.
Bldg. Age (Years)	0.00	0.99	0.00	1.00	0.04	0.85
Bldg. Size (SF)	-0.22	0.87	-0.18	0.91	0.10	1.11
Lot Size (Acres)	-0.07	0.60	-0.01	0.73	-0.06	0.98
Dist. to Hwy (Miles)	0.14	***2.46***	0.25	1.44	-0.19	0.71
Dist. to Strip (Miles)	0.03	1.06	-0.04	0.96	-0.09	0.76

Notes: The above table presents tests analyzing sample balance for matched samples of HOA and non-HOA sales. HOA Age intervals subsample HOA sales by association age. One-to-one propensity score matching with replacement pairs each inside HOA sale by age interval to any outside HOA sale. The matching paradigm limits matches to non-HOA sales with building age +-2 years of the HOA sale. An HOA property that is 10 years old will be matched with a non-HOA sale that is 8 to 12 years old. The propensity score model finds the probability a sale would be in an HOA based on bldg. age, size, lot size, distance to highway, and distance to the strip, and census tract variables for non-minority population, total population, and total homes in a tract.

The standardized difference of the mean and the ratio of the variance are used for matching balance diagnosis following the matching literature (Rubin, 2001; Austin, 2011). Following Rubin (2000), a variable is well balanced if and only if the standardized difference of means falls in the range of (-0.25, 0.25), and the ratio of the variance falls in the range of (0.5, 2). The samples generally balance excepting Distance to a Highway on the 10<HOA Age<=15 subsample.

Table 1.5: The Effect of Association Age on HOA Premiums and Foreclosure

	(1)	(2)	(3)	(4)	(5)	(6)
HOA Age Interval=	HOA Age <= 1	1< HOA Age<=5	5< HOA Age<=10	10< HOA Age<=15	15< HOA Age<=20	20<HOA Age
Dep. Var.=	ln(SP)	ln(SP)	ln(SP)	ln(SP)	ln(SP)	ln(SP)
HOA	0.0162**	0.0192**	0.0321**	0.0535**	0.0596**	0.0286**
	(0.0036)	(0.0040)	(0.0056)	(0.0043)	(0.0059)	(0.0066)
Nearby Foreclosures (#)	-0.0149**	-0.0163**	-0.0160**	-0.0152**	-0.0162**	-0.0161**
	(0.0005)	(0.0057)	(0.0014)	(0.0011)	(0.0015)	(0.0051)
Nearby Foreclosures in HOAs (#)	0.0016**	0.0026**	0.0029*	0.0025**	0.0011**	-0.0003
	(0.0005)	(0.0006)	(0.0014)	(0.0009)	(0.0003)	(0.0019)
Meantime (Mo.)	0.0006**	0.0006**	0.0010*	0.0006**	0.0001*	0.0003**
	(0.0001)	(0.0002)	(0.0004)	(0.0002)	(0.0001)	(0.0008)
Meantime of Foreclosures in HOAs (Mo.)	0.0008*	0.0007**	0.0013**	0.0008**	0.0002**	0.0008
	(0.0003)	(0.0001)	(0.0005)	(0.0002)	(0.0001)	(0.0008)
Bldg. Age (Years)	-0.0109**	-0.0121**	-0.0115**	-0.0102**	-0.0117**	-0.0105**
	(0.0002)	(0.0003)	(0.0002)	(0.0003)	(0.0003)	(0.0004)
ln(Bldg. Size) (SF)	0.6095**	0.6183**	0.5666**	0.5870**	0.6035**	0.5412**
	(0.0058)	(0.0067)	(0.0065)	(0.0090)	(0.0093)	(0.0103)
ln(Lot Size) (Acres)	0.2480**	0.2381**	0.2457**	0.2712**	0.2645**	0.2828**
	(0.0035)	(0.0039)	(0.0040)	(0.0055)	(0.0058)	(0.0072)
Distance to Highway (Miles)	0.0118**	0.0182**	0.0161**	0.0238**	0.0606**	0.0492**
	(0.0020)	(0.0026)	(0.0023)	(0.0036)	(0.0046)	(0.0056)
Distance to the Strip (Miles)	-0.0058**	-0.0008	-0.0076**	-0.0062**	-0.0057*	-0.0038
	(0.0012)	(0.0013)	(0.0013)	(0.0019)	(0.0023)	(0.0030)
Constant	8.9665**	8.6322**	9.1888**	9.3989**	8.9656**	9.2787**
	(0.0716)	(0.0591)	(0.0592)	(0.0901)	(0.1267)	(0.0996)
Township Fixed Effects	X	X	X	X	X	X
Sale Year Fixed Effects	X	X	X	X	X	X
Observations	21,162	12,802	13,898	8,672	6,394	4,704
R2	0.8726	0.8945	0.8803	0.8664	0.8839	0.8764
Adj. R2	0.8723	0.8942	0.8799	0.8657	0.8832	0.8754

Note: Each column above represents a subsample by association age of the general sample. HOA sales are subset by their age and then matched onto the sample of non-HOA sales located within 0.5-mile from an HOA boundary. The same matching paradigm used in the general sample matches HOA sales by interval. Nearby Foreclosure is defined as properties within 0.25-miles of the observed market sale that sold in foreclosure up to two years prior to the observation. Meantime is a transformation of the average timing of nearby foreclosures that sets foreclosures nearest in time as further from zero and sets observations with no nearby foreclosures equal to zero. Foreclosures a month ago take a Meantime value of -24, while those 24 months ago take a value of -1. Standard errors in parentheses. ** - p<0.01, * - p<0.05

Table 1.6: The Effect of HOA Strictness on House Price

	(1) Strictness	(2) Strictness and Magnitude	(3) Strictness and Timing
Dep. Var.=	ln(SP)	ln(SP)	ln(SP)
HOA	0.0164**	0.0159**	0.0143**
	(0.0018)	(0.0020)	(0.0020)
HOA X Active	0.0502**	0.0346**	0.0374**
	(0.0035)	(0.0042)	(0.0049)
HOA X Gated	0.0339**	0.0292**	0.0349**
	(0.0028)	(0.0033)	(0.0039)
Nearby Foreclosures (#)	-0.0058**	-0.0064**	-0.0063**
	(0.0002)	(0.0003)	(0.0003)
Nearby Foreclosures in HOAs (#)		0.0003*	0.0002*
		(0.0001)	(0.0001)
Nearby Foreclosures in Active HOAs (#)		0.0028**	0.0033**
		(0.0004)	(0.0005)
Nearby Foreclosures in Gated HOAs (#)		0.0013**	0.0021**
		(0.0004)	(0.0004)
Meantime (Months)	0.0008**	0.0008**	0.0002**
	(0.0001)	(0.0001)	(0.0001)
Meantime of Foreclosures in HOAs (Mo.)			0.0011**
			(0.0002)
Meantime of Foreclosures in Active HOAs (Mo.)			0.0007**
			(0.0001)
Meantime of Foreclosures in Gated HOAs (Mo.)			0.0011**
			(0.0004)
Bldg. Age (Years)	-0.0112**	-0.0112**	-0.0112**
	(0.0001)	(0.0001)	(0.0001)
ln(Bldg. Size) (SF)	0.5937**	0.5936**	0.5940**
	(0.0031)	(0.0031)	(0.0031)
ln(Lot Size) (Acres)	0.2559**	0.2553**	0.2551**
	(0.0019)	(0.0019)	(0.0019)
Distance to Highway (Miles)	0.0107**	0.0112**	0.0114**
	(0.0011)	(0.0011)	(0.0011)
Distance to the Strip (Miles)	-0.0024**	-0.0029**	-0.0028**
	(0.0006)	(0.0006)	(0.0006)
Constant	9.2335**	9.2360**	9.2317**
	(0.0402)	(0.0402)	(0.0402)
Township Fixed Effects	X	X	X
Sale Year Fixed Effects	X	X	X
Observations	66,790	66,790	66,790
R2	0.8699	0.8724	0.8725
Adj. R2	0.8698	0.8723	0.8724

Note: Active HOAs are HOAs that foreclosed on members for non-payment of dues. Gated HOAs provide additional security and amenities for residents. These models drop observations in Active Gated HOAs or where Active HOA = 1 and Gated HOA = 1 for ease of comparison. Nearby Foreclosure is defined as properties within 0.25-miles of the observed market sale that sold in foreclosure up to two years prior to the observation.

Standard errors in parentheses. ** - $p<0.01$, * - $p<0.05$

Table 1.7: Robustness Tests Varying HOA Border Bandwidths

	(1)	(2)	(3)
Border Bandwidth=	<1 Mile	<0.50 Mile	<0.25 Mile
Dep. Var.=	ln(SP)	ln(SP)	ln(SP)
HOA	0.0291**	0.0258**	0.0206**
	(0.0022)	(0.0019)	(0.0020)
Nearby Foreclosures (#)	-0.0078**	-0.0064**	-0.0058**
	(0.0004)	(0.0003)	(0.0003)
Nearby Foreclosures in HOAs (#)	0.0014**	0.0007*	0.0006*
	(0.0003)	(0.0003)	(0.0003)
Meantime (Months)	0.0003**	0.0002**	0.0001**
	(0.0001)	(0.0001)	(0.0000)
Meantime of Foreclosures in HOAs (Mo.)	0.0011**	0.0008**	0.0012**
	(0.0002)	(0.0002)	(0.0002)
Bldg. Age (Years)	-0.0110**	-0.0112**	-0.0110**
	(0.0001)	(0.0001)	(0.0001)
ln(Bldg. Size) (SF)	0.6016**	0.5953**	0.5937**
	(0.0031)	(0.0031)	(0.0034)
ln(Lot Size) (Acres)	0.2533**	0.2535**	0.2555**
	(0.0018)	(0.0019)	(0.0020)
Distance to Highway (Miles)	0.0156**	0.0131**	0.0144**
	(0.0011)	(0.0011)	(0.0012)
Distance to the Strip (Miles)	-0.0032**	-0.0038**	-0.0021**
	(0.0006)	(0.0006)	(0.0007)
Constant	9.1469**	9.2119**	9.2140**
	(0.0403)	(0.0403)	(0.0423)
Township Fixed Effects	X	X	X
Sale Year Fixed Effects	X	X	X
Observations	68,092	67,632	58,124
R2	0.8716	0.8717	0.8721
Adj. R2	0.8715	0.8717	0.8720

Notes: Models (1) and (3) provide robustness by widening the Border Discontinuity specification to 1-mile (1) then narrowing to 0.25-mile (3). Model (2) provides the original 0.5-mile specification for ease of comparison with models (1) and (3). Matching of HOA and non-HOA sales was performed similarly to prior models.

Nearby Foreclosure is defined as properties within 0.25-miles of the observed market sale that sold in foreclosure up to two years prior to the observation. Meantime is a transformation of Average Time that sets foreclosures nearest in time as further from zero and sets observations with no nearby foreclosures equal to zero. Foreclosures a month ago take a Meantime value of -24, while those 24 months ago take a value of -1. The range of Meantime is [-24, 0] with zero indicating no nearby foreclosures within 24 months ago.

Standard errors in parentheses. ** - $p<0.01$, * - $p<0.05$

Table 1.8: Robustness Tests Varying Foreclosure Rings Bandwidths

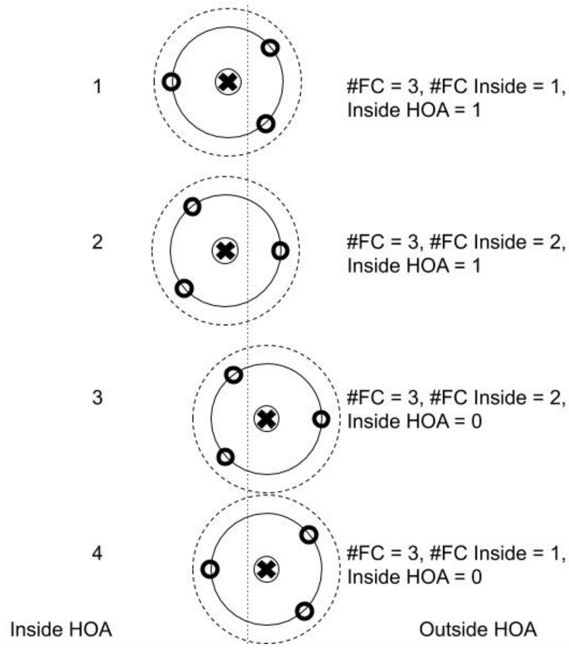
	(1)	(2)	(3)
Foreclosure Ring=	<0.50 Mile	<0.25 Mile	<0.10 Mile
Dep. Var.=	ln(SP)	ln(SP)	ln(SP)
HOA	0.0237**	0.0258**	0.0269**
	(0.0018)	(0.0019)	(0.0018)
Nearby Foreclosures (#)	-0.0027**	-0.0064**	-0.0107**
	(0.0001)	(0.0003)	(0.0009)
Nearby Foreclosures in HOAs (#)	0.0007**	0.0007*	0.0030**
	(0.0001)	(0.0003)	(0.0003)
Meantime (Months)	0.0010**	0.0002**	0.0003**
	(0.0002)	(0.0001)	(0.0002)
Meantime of Foreclosures in HOAs (Mo.)	0.0016**	0.0008**	0.0005**
	(0.0002)	(0.0002)	(0.0002)
Bldg. Age (Years)	-0.0112**	-0.0112**	-0.0112**
	(0.0001)	(0.0001)	(0.0001)
ln(Bldg. Size) (SF)	0.5939**	0.5953**	0.5987**
	(0.0031)	(0.0031)	(0.0031)
ln(Lot Size) (Acres)	0.2538**	0.2535**	0.2633**
	(0.0019)	(0.0019)	(0.0019)
Distance to Highway (Miles)	0.0132**	0.0131**	0.0130**
	(0.0011)	(0.0011)	(0.0011)
Distance to the Strip (Miles)	-0.0043**	-0.0038**	-0.0038**
	(0.0006)	(0.0006)	(0.0006)
Constant	9.2207**	9.2119**	9.2359**
	(0.0402)	(0.0403)	(0.0406)
Township Fixed Effects	X	X	X
Sale Year Fixed Effects	X	X	X
Observations	67,632	67,632	67,632
R2	0.8721	0.8717	0.8697
Adj. R2	0.8720	0.8717	0.8696

Notes: Models (1) and (3) provide robustness by widening the specification of nearby foreclosures to 0.5-mile (1) then narrowing to 0.1-mile (3). Model (2) provides the original 0.25-mile specification in model 3.2 for ease of comparison with models (1) and (3).

Nearby Foreclosure is defined as properties within 0.25-miles of the observed market sale that sold in foreclosure up to two years prior to the observation. Meantime is a transformation of Average Time that sets foreclosures nearest in time as further from zero and sets observations with no nearby foreclosures equal to zero. Foreclosures a month ago take a Meantime value of -24, while those 24 months ago take a value of -1. The range of Meantime is [-24, 0] with zero indicating no nearby foreclosures within 24 months ago.

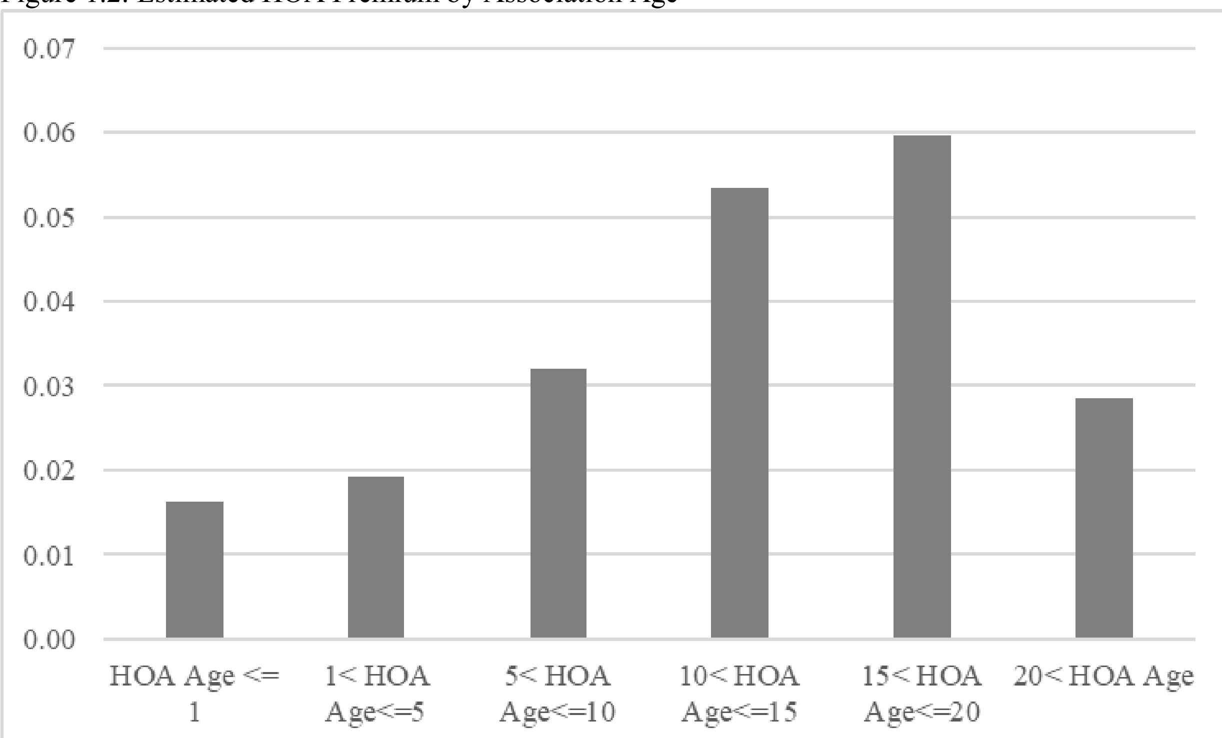
Standard errors in parentheses. ** - $p<0.01$, * - $p<0.05$

Figure 1.1: Diagram of Four Possible Foreclosure and Sale Scenarios



Notes: Each scenario in Figure 1.1 details a market sale with three nearby foreclosures. Scenarios 1 and 2 present a market sale inside an HOA, while 3 and 4 present a sale outside an HOA. Scenarios 1 and 4 have one inside HOA foreclosures, while scenarios 2 and 3 have two inside HOA foreclosures.

Figure 1.2: Estimated HOA Premium by Association Age



Notes: Figure 2 presents Table 1.5 estimated coefficients on HOA for the subsamples by HOA Age Interval (measured in years).

CHAPTER 2

Borrowers Signal, Lenders Respond: The Strategic Value of Foreclosure Delay

2.1 Introduction

Many transactions occur and contracts finalized under conditions of incomplete or asymmetric information. In some cases, it may be beneficial to one party, or both parties, if one party reveals their own private information to the other party. This strategic signaling is an attempt by the signaler to influence the behavior of the party receiving the signal. Real Estate mortgage contracts allow a unique opportunity to observe signaling beyond the information that an initial signal may convey. We specifically study borrower signaling of their intent to pay after a default has occurred. Adelino et al. (2013) notes that information on self-cure is asymmetric and lenders often foreclose rather than negotiate with the borrower due to this asymmetry. However, we observe a significant number of borrowers making full or partial payments after default while still delinquent, assumedly to signal a future intent to pay to stave off present foreclosure. This signaling is in line with the work of Spence (1973) which notes that signaling may address asymmetric information by separating, in our case, high-cure and low-cure borrowers. The signals may convey that the borrower has a high probability of curing the delinquent loan without intervention and/or the borrower's preference to stay in their home. The purpose of this paper is to examine signaling that occurs in the time after default and how this signaling impacts lender actions.

Our primary hypothesis is that lenders respond to signals of self-cure with strategic inaction as the high cost of foreclosure makes strategic inaction attractive for high self-cure defaults. The lender-defaulter dynamic studied is relatively unique in that both agents continually signal their likelihood of future choices as well as their likelihood of cooperation in an iterative and repeated signal framework. Due to the costs of foreclosure, strategic lenders and borrowers benefit from some level of cooperation and delaying foreclosure if the borrower may cure soon. Cooperation by the lender involves delaying foreclosure in exchange for a future cure. Periodic payments while still delinquent signals cooperation by the borrower. In this way, the default-foreclosure process represents an iterated Prisoner's Dilemma. Lenders may foreclose more often if they lack information on self-cure, and signals address this by showing cooperation and an intent to pay.

Brosig (2002) studies the effects of signaling on games such as the Prisoner's Dilemma and finds that the Nash Equilibrium of immediate defection (foreclosure in this case) depends on a lack of information on the other agent. If agents may credibly signal an intent to cooperate in a repeated Prisoner's Dilemma, then both parties cooperate. These results depend on the credibility of the signal and the willingness to cooperate. Payments signal effectively if the payments are large, recent, or frequent enough to credibly signal an intent to pay.

Prior literature shows that signaling influences the profit maximizing or cost minimizing agent. Ndofor and Levitas (2004) study the strategic firm with a knowledge advantage over competitors. Firms use signaling to inform external stakeholders of their knowledge advantage without transferring that knowledge to other firms. Signaling is also a common theme in international politics literatures. Horowitz et al. (2017) show that countries adopting a military conscription policy are more likely to be accepted into alliances. States wishing to join such alliances signal commitment and lower costs to the current alliance members by increasing the size of their own military. In both literatures, an agent/firm/state influences the behavior of external parties by revealing private information to the other party. In much the same way, borrowers signal lower costs to the lender and a commitment to payment.

Ambrose and Capone (1996) note that inaction is a valuable alternative option for loans with a high self-cure probability given the high costs of modification and foreclosure. We identify strategic inaction[8] as lenders strategically allowing loans to linger in delinquency when expecting a near-future cure. While delinquent, the loan also accrues interest and fees for missed payments. Should a borrower self-cure, the cost of inaction is merely the time cost of the delayed principal less any offsetting fees. If the borrower fails to cure, then the cost to the lender is the delayed losses-given-foreclosure[9]. Thus, lenders may strategically delay foreclosing on defaults with sufficiently high self-cure likelihood.

Lenders themselves already recognize the value of delaying foreclosure through a 90-day delinquency standard before initiating foreclosure proceedings. Costs associated with foreclosure are high, and the current study's data indicates that, on average, foreclosure costs constitute over

[8] Strategic inaction is different from formal forbearance agreements which resemble loan modifications.
[9] Delaying these costs would only increase them should house prices fall further. Given that signaling defaulters better preserve their homes, declines may be dampened.

9% of the proceeds from an REO sale. Further, Ambrose and Capone (1996) note that 75% of loans reaching a 90-day delinquency will ultimately cure and completion rates of foreclosures are less than 55%. There appears to be strong incentives for lenders to delay acting on defaults which we tie to self-cure.

We also explore if the level of signaling in an area impacts signal effectiveness. If low-cure borrowers begin signaling as the market recovers, then this may force high self-cure borrowers to signal even stronger to separate their signal from that of the low self-cure borrower. The data (Figure 2.1) clearly shows an increase in the number of payments over time. We provide evidence that lenders foreclose less often on borrowers making more payments than other delinquencies in their Zip 3. This result is in line with labor economics literature which shows that employers require greater educational attainment to increase earnings as more individuals seek education (Lange 2007).

During 2008-2009, government intervention into real estate increased to address a rise in defaults and foreclosures. These laws typically incentivized modification as an alternative to foreclosure without considering strategic inaction. As a result, many laws extended foreclosure timelines and temporarily protected defaulters from foreclosure. These laws are typically universal and do not distinguish borrower by type. This temporary protection may distort the information sent through signals. We specifically examine the impact of California Foreclosure Prevention Laws (CFPLs) to examine how foreclosure prevention laws impact borrower signaling and lender decisions. The first law required upkeep on REO which we refer to as the "Upkeep Law". The second law delayed foreclosures which we refer to as the "Delay Law". The entirety of the Delay Law existed under the Upkeep Law regime.

The Upkeep Law, passed in July 2008 and active until January 2013, required upkeep on homes obtained through foreclosure with fines of up to $1,000 per property per day if not upkept[10]. Our policy of interest is the Delay Law, passed in July 2009 and ending January 2011, that extended a required delinquency period from 90-days from first default to 180-days. Lenders could avoid this additional 90-day moratorium by creating a state-approved modification program. Laws which extend delinquencies, such as the Delay Law, may lead to a build-up of

[10] This law is like Vacant Property Registration Ordinances (VPROs) as studied by Biswas et al. (2021).

delinquent loans. Results show that lenders are more likely to foreclose after this policy ended. Another effect of these protections may be a distortion of the signal. We hypothesize that borrowers that still signal under the Delay Law are signaling an intention and expectation of cure past the protections. After these protections end, we expect lenders foreclose even less often on borrowers that signal. Our results show that, after the Delay Law ends, lenders in California foreclose more often than sand state lenders on borrowers making few payments; however, California lenders foreclosure less often than sand state lenders on borrowers making many payments. This presents evidence that lenders foreclosed primarily on low self-cure defaulters in California after the policy.

We also examine the impact of signaling and policy on the costs associated with foreclosure. Borrowers signaling a high self-cure probability and an intent to retain the home will likely take actions to preserve the home's value. Low self-cure borrowers are likely to lead to greater pecuniary costs of foreclosure and losses to the lender. In addition, laws that universally enforce longer delinquencies also extend the time borrowers with private knowledge of a low probability of self-cure are in possession of an asset they are less likely to preserve. Thus, we hypothesize that CFPLs lead to higher pecuniary costs of foreclosure. Our results show that lenders incur greater costs in the time after foreclosure protections ended.

Gabriel et al. (2021) shows that CFPL laws benefitted the borrower, and our results show that the cost of these benefits were borne by the lender. Results show 11.78% higher foreclosure costs in California after the policy. As there was no significant impact on foreclosure proceeds after the policy, the results suggest the lenders incurred roughly $1,450 more in costs for California loans after the policy. According to RealtyTrac, California had 257,664 foreclosure filings in 2011. Assuming our estimates generalize to other lenders, this implies that lenders suffered an additional $372M in losses-given-foreclosure in 2011 due to the Delay Law. Regardless of the specific numbers, our results further demonstrate that laws benefiting defaulters are paid for by lenders. As our sample includes FNMA loans, these losses were borne by the taxpayer.

The COVID-19 pandemic may indicate lessons learned from the 2008-2009 financial crisis that is supported by our results. Rather than encouraging modifications, government policy in the CARES Act targeted forbearance. As the pandemic unfolded, the CARES Act forced formal forbearance programs and prohibited most foreclosures. Forbearance, rather than modification, was also the primary policy objective. These policies assume that borrowers defaulting during the COVID pandemic have a high self-cure likelihood. Another interesting aspect of the CARES Act is that these were formal forbearance programs rather than inaction.

We test our hypotheses utilizing loan-level data provided by Fannie Mae (FNMA). This panel data includes acquisition and performance data for each month that Fannie Mae held a given loan. This includes a variable for payments outstanding which allows for studying lender responses[11] to delinquencies. We measure the number of payments made by a borrower over the prior 12-months as the signal and then also incorporate timing. We then narrow our sample to sand states, or Arizona, California, Florida, and Nevada, to study lender behavior regarding CFPLs. Prior literature identifies similar housing trends in these states during the 2008-2009 financial downturn, and using these states is common in studies[12] of policy. The data also contain information on the costs incurred for foreclosed loans which we use for tests of lender costs.

A Cox discrete-time hazard model, estimated via a multinomial logit model, studies lender decision making. Deng et al. (2000) identifies the ability of multinomial logit models to capture the exercise of mortgage options. Multinomial logit models are common in the lender literature as they address issues of truncation and censoring in datasets such as ours. Our data contains only loans reaching a severe, 90+day delinquency and we capture whether lenders either foreclose, modify, or do nothing at each delinquency date. Results of our multinomial logit model show that an increase in the number of recent payments significantly decreases the likelihood of modification or foreclosure as compared to inaction. We also find that payments made more recently increase the likelihood of modification and decrease the likelihood of foreclosure. We believe these results support our primary hypothesis that lenders respond to signals of self-cure.

Studying how policy impacts lender decisions, we find a higher likelihood of foreclosure relative to inaction for California loans after the Delay Law ends. Signaling moderates this effect

[11] We note here that the servicer controls these decisions. However, servicers are bound to FNMA by servicing agreements, and we expect them to behave as if they were the lender and will be referred to as the "lender" herein.
[12] Including Gabriel et al. (2021).

as borrowers in California making the greatest number of payments were less likely to experience foreclosure after the policies; however, borrowers only making a few payments were relatively more likely to experience foreclosure relative to sand states. We believe these results capture two important effects. Temporarily extending delinquency timelines leads to a build-up of low-cure loans which the lender promptly forecloses upon after the policy is no longer applicable. In addition, when the foreclosure option is delayed, the power of signals increases as these borrowers already enjoy government protection from foreclosure. The only signalers are borrowers expecting to cure sometime after the mandated delay.

In studying how signals and policy impact the lender costs related to foreclosure, we find that signaling borrowers generate significantly fewer costs in foreclosure, and this effect is again moderated by the recency in time of those signals. These results indicate that signalers better care for their homes which makes sense if these borrowers expect to cure the delinquency. We also find that lenders experienced significantly greater losses-given-foreclosure from foreclosures during and after the CFPL policy. This provides further evidence that lenders pay the costs of borrower friendly policies.

In summary, our results show that lenders strategically do not act on loans signaling a high probability of future cure. However, policies that delay foreclosure distort signals and we find that lenders respond differently to signals under these policies. Borrowers that signal expect to retain their homes and lenders benefit by enjoying lesser costs on loans that signal. Policies extending foreclosure timelines lead to a build-up in delinquencies and lenders incur greater losses due to these laws. Collectively, this shows that these laws benefit the borrower at the expense of the lender.

We now present a discussion of the lender decision making, foreclosure cost, and foreclosure policy literatures in Section 2.2. Section 2.3 follows with a discussion of the data and our empirical methods. Section 2.4 presents results while Section 2.5 presents robustness tests using a propensity score matched sample. We study the effect of signals on lender costs in Section 2.6 and conclude with Section 2.7.

2.2 Literature Review

The current study examines the ability of signaling to address self-cure information asymmetries. Akerlof (1970) first identified that information asymmetries may lead to market failure in the used car market. Spence (1973) followed Akerlof and identified signaling and screening as solutions to asymmetric information. Screening involves the agent without private information obtaining information distinguishing high- and low-quality agents. Signaling, on the other hand, involves the agent with private information exerting costly effort to differentiate themselves from low-quality agents.

For the current study, we identify payments made while remaining delinquent as a signal of self-cure. An important assumption in Spence's model is that these signals must be costly, and the opportunity cost of the signal is less for the high-quality agent. We assume opportunity cost of a payment is higher for the low self-cure borrower relative to high self-cure borrowers. A separating equilibrium emerges for high self-cure agents making payments. We study how these payments, acting as signals, impact lender decision making.

Lender Decision Making

Ambrose and Capone (1996) identify the costs and benefits of five options in response to a default. Specifically, they identify the probability of self-cure as a significant cost for modification and foreclosure. Ambrose and Capone (1998) note the delay between an initial default and eventual foreclosure and identifies characteristics of borrowers likely to reinstate during this delay. This study distinguishes "trigger-event" defaulters or defaults due to some event, such as job loss, rather than price declines. Trigger-event defaulters self-cure if the defaulter remedies the trigger and raises funds necessary to cure amounts owed. Lenders attempt to identify these trigger-event defaulters to reduce costs.

Interest in lender responses to defaults rose along with the rise in defaults and foreclosure during the 2008-2009 financial downturn. Adelino et al. (2013) study the dearth in renegotiation rates for defaults in this period. Their model shows that information asymmetries surrounding self-cure and redefault after modification leads to lower rates of renegotiation. Voicu et al. (2011) studies loans with low documentation and finds that lenders foreclosed more often on these defaulters. Given the lack of information for these loans, it is unsurprising that lenders foreclosed more often on so-called "low-doc" loans. A common theme in the literature is that asymmetries surrounding self-cure impair lender decision making.

Gerardi et al. (2018) investigate causes for defaults and finds that job-loss is equivalent to a 35% drop in home value as a determinant for default. As noted in Ambrose and Capone (1998), these defaults are likely “trigger-event” defaulters. We expect that these would be the type of borrowers that may make payments while delinquent and seeking reemployment in hopes of retaining their home. Foote et al. (2008) study information issues surrounding negative equity defaulters and show that temporary reductions in payment size effectively reduces default probabilities. We identify payments of either the current month’s payment or a fraction of the amounts owed, and this would be like an overall reduction in payment size.

Given the costliness of foreclosure, lenders often delay and seek less costly alternatives (Capozza and Thomson 2006). Pennington-Cross (2010) studies determinants of lender’s delaying foreclosure by studying outcomes of loans which already entered foreclosure proceedings. A multinomial logit model like the one employed in the current study identifies these determinants. Results of this study show that 40% of loans which enter foreclosure proceedings end up as REO while 13% of loans in foreclosure cured and another 27% paid off the delinquent amounts owed prior to foreclosure completion. Interestingly, greater levels of delinquency prior to foreclosure lead to a higher likelihood of a loan becoming REO; however, the longer a loan lingers in a delinquency the more likely it is the loan will be paid. Examining signaling provides additional insights into these prior findings.

The preservation in value of the underlying asset is also a key consideration for the lender. If signalers expect a greater likelihood of retaining their home, then we expect they will exert more effort to maintain and preserve their home. Greater preservation of the underlying asset results in greater proceeds from a foreclosure sale and reduces costs for the lender. Our results support this hypothesis, and we contribute to the lender costs literature by identifying payments as a signal of not only cure but also lower costs.

Lender Costs

Early research into foreclosure costs focuses on the determinants of lender losses. Evans et al. (1985) finds that the loan-to-value ratio best predicts losses-given-foreclosure with race and location also playing significant factors. Thus, signaling may be more effective for borrowers with higher LTVs or in areas with high foreclosure costs. Qi and Yang (2009) extend this literature and find that current LTV is the most important factor for foreclosure losses. This study also shows distressed markets generate the greatest loss severities. Lenders may be more responsive to signals during times of market distress.

Another common theme in the literature studies time costs related to foreclosure. Clauretie (1987) examines government policy and costs, and shows that borrower friendly policies, such as judicial foreclosure, increase legal costs of foreclosure and decrease foreclosure likelihood. Wilson (1995) studies foreclosure costs in California during 1992-1995. For each month of foreclosure delay, their results demonstrate a one percent increase in foreclosure costs. Cordell et al. (2015) creates a model for time-related foreclosure cost severity which is expanded upon in the current study.

Policy

Policy plays a significant role in lender decision making and costs (Clauretie 1987). The policies of focus for the current study are California Foreclosure Prevention Laws. Gabriel et al. (2021) presents a comprehensive study of the effects of these laws and finds that they increase modification rates while decreasing foreclosure rates. In addition, this study estimates that these laws prevented 250,000 foreclosures and generated roughly $300 billion in housing wealth. This study also finds that lenders spent more on property repairs costs while under these laws which it attributes to REO upkeep laws. However, these also could be due to moral hazards for low-cure borrowers remaining in homes they do not expect to retain. The opportunity cost of maintenance is higher for these borrowers, so the increase in costs may be lenders repairing additional damages for neglected homes. We identify the effect of these laws on lender costs inclusive of signaling and provide evidence that costs were significantly lower for signalers under these policies.

Rucker and Alston (1987) show that foreclosure moratoriums on farms during the Great Depression significantly reduced farm foreclosures. Clauretie and Herzog (1990) follow Clauretie's earlier work and show that judicial foreclosure laws lead to a mean five month increase in foreclosure timelines. Ghent and Kudlyak (2011) examine the use of recourse laws and find that lenders use recourse laws less often in judicial foreclosure states. This study also finds that recourse laws only significantly affect lender decisions regarding defaulters deep into negative equity. This highlights the value of signaling as lenders may be less inclined to seek recourse on defaults likely to cure and capture any expected remaining equity.

In the current study, we explore if laws that delay foreclosure, such as CFPLs, lead to moral hazards which affect lender decisions and increase costs. Pennington-Cross (2006) discover that foreclosed homes in judicial foreclosure states sell for 4% less. Pence (2006) studies the effect of defaulter-friendly laws and finds that the laws lead to smaller loan sizes. This indicates that lenders react to such laws with credit restrictions. Demiroglu et al. (2014) demonstrates that borrowers are more likely to default in states with borrower friendly laws. Given the borrower friendly nature of CFPLs, we expect similar effects on lender decision making and costs.

2.3 Data and Methods

Loan-level data are drawn from FNMA's single-family loan performance database which provides data on the initial acquisition as well as monthly observations of the loan's performance. The sample is restricted to 30-year, fixed-rate, fully amortizing mortgages originating between 2000 and 2016. The sample is further restricted to loans which became 90+ days past due and are on properties located in one of the 20 Case-Shiller Indexed cities. This results in a base dataset of 442,832 seriously delinquent loans.

We further restrict our sample to loans with origination LTVs greater than 40% or origination amounts greater than $20,000. We expect these loans are likely second mortgages or have some other sort of financing involved. We remove loans serviced by servicers that service less than 1% of FNMA loans and loans in Zip 3's that contain less than 2,000 monthly loan observations over the entire sample period. We also remove loans which reach greater than 24 payments outstanding or 24 months past due at some point over the life of the loan. The long duration of these delinquencies is believed to be driven by data errors[13]. The above restrictions result in a base dataset of 345,151 loans with 3,772,407 associated monthly loan observations.

[13] A common error in the data is the dropping of the tens digit for payments outstanding which causes an error in the calculation of *Payments Made*. There are random drastic changes in payments outstanding as well. For instance, a loan had the following pattern of payments outstanding over three consecutive months: 0,50,0. Also, at the monthly observation for modification/foreclosure, payments outstanding often take a value of 0. This would result in a *Payments* calculation as if the borrower paid off all payments at modification/foreclosure. We correct for errors such as these in our sample; however, 82% of the errors occurred on loans that reached greater than 24-months.

Lender Decision Making

Our primary hypothesis is that lenders respond to signals of self-cure with strategic inaction relative to modification and foreclosure. We utilize the number of payments a borrower made over the prior 12 months as the signal of self-cure. As the data observes the lender's decision to modify, foreclose, or not act at monthly intervals, we employ a multinomial logit framework to assess the following Cox discrete-time, competing-risks model often used in lender decision literatures (Deng et al. 2000). Such a model may be written as,

$$\ln(p_{ijt}/p_{i0t}) = \delta_0\, \alpha_{ijt} + \delta_j \boldsymbol{x_{ijt}} + \varepsilon_{ijt} \qquad j = 1,2 \tag{2.1}$$

where p_{ijt} is the probability of either modification (j=1) or foreclosure (j=2) relative to the probability of inaction, p_{i0t} (j=0), for loan i at mortgage time t. The variable α_{ijt} represents the baseline probabilities of modification and foreclosure. The vector $\boldsymbol{x_{ijt}}$ represents various covariates expected to influence lender decision making, including both time-varying and time-invariant covariates. Included in these covariates is the number of payments made over the prior 12 months.

Using a multinomial logit[14] framework to study a Cox discrete-time, competing-risks model is common in the mortgage termination literature both in studies of borrower and lender behavior (Ambrose and Capone (1998); Capozza and Thomson (2006); Pennington-Cross (2010); among others). The current study's multinomial logit framework is described as follows:

$$\Psi_{ijt} = \beta_{0ijt} + \beta_{PMT,ijt}\, PMT_{ijt} + \beta_{MT,ijt}\, MT_{ijt} + \beta_{X,ijt}\, \boldsymbol{X}_{ijt} + \beta_{FE,ijt}\, \boldsymbol{FE}_{ijt} + \varepsilon_{ijt} \tag{2.2}$$

where Ψ_{ijt} represents the monthly lender decision of foreclosure (2), modification (1), or inaction (0). The variable of interest, PMT_{ijt}, measures the number of payments made over the prior twelve months for loan i. To attempt to capture/control for the effect of the timing of PMT_{ijt}, we include MT_{ijt} which is the weighted average timing of those payments with payments made nearer in time weighted more heavily. The data contain the current number of payments outstanding each month for each borrower. We take the difference between the current month's payments outstanding and the prior month's payments outstanding as the number of payments made. This allows us to capture if a delinquent loan made only a fraction of the outstanding

[14] This model corrects for left truncation and right censoring issues noted in mortgage literature.

missed payments for a given month. This allows precise identification of the number of payments made each month[15] by each delinquent borrower which we use to calculate PMT_{ijt} and MT_{ijt}. We hypothesize that a greater number of payments made signals a higher likelihood of self-cure.

The vector $\boldsymbol{X}_{ijt}$ denotes loan and borrower controls which includes both time-varying components and static components. For control variables, we include variables for origination loan amount, current LTV, borrower credit score at origination, an indicator for mortgage insurance, the change in the Case-Shiller index over the past six-months, the change in interest rates since origination, the ratio of missed payments to the loan's age, and the number of months delinquent since first delinquency.

A vector of six fixed effects, $\boldsymbol{FE}_{ijt}$, control for location (Zip 3), loan servicer, loan purpose, property type, origination year, and delinquency year. These effects make the lender's decision effectively random for a given servicer by location, time, purpose, and property type which addresses endogeneity issues respective to these fixed effects.

Table 2.1 depicts summary statistics for the full lender decision sample. We report statistics both at the monthly loan observation level as well as at the loan level at the time of first default/origination.

On average, loans lenders did not act upon have the highest number of payments made while foreclosed loans have the lowest. Modified loans most recently made payments on average. Modified loans were also the most concentrated at a FNMA level while foreclosed loans were the least. This is in line with literature suggesting lenders foreclose less often when concentrated. Foreclosed loans have the highest mean LTVs which is as expected. Foreclosed loans also miss the most payments on average while also having the highest credit scores. Foreclosed loans also had the highest percentage of loans with mortgage insurance while loans not acted upon had the least.

[15] For example, a borrower had six payments outstanding in month t-1 and three outstanding in month t. We identify this as having made four payments in month t (inclusive of the month t payment plus three outstanding).

To calculate timing of the payments, MT_{ijt}, we weight monthly payments made for each observation by the nearness in time of those payment. We then divide the weighted sum by the number of payments made over the prior 12 months. Mean timing is defined as:

$$Meantime_{itk} = [\Sigma \{Number\ of\ Payments_{ik} * (13\text{-}k)\}] / PMT_{it} \tag{2.3}$$

where Number of Payments is the number of payments borrower *i* made *k* months ago as of time *t*. The index *k* ranges from 1 to 12 with 1 representing payments made the current month. PMT_{it} represents the simple sum of payments made over the prior 12 months. A one-unit increase in Meantime indicates that payments were made, on average, one month nearer in time to the observation.

As signals become known to a market, more signaling may occur and agents receiving signals may require greater signals to alter behavior. We hypothesize that lenders foreclose less often on borrowers making more payments than the average in their area. Figure 1 presents mean payments made per year over time for our sample.

Overall, the mean number of payments per year increases over time which supports the idea that lenders require more payments to avoid foreclosure as markets absorb this signal. Mean payments made while delinquent falls from 2007 to 2010. This could indicate the level of distress during these periods if more delinquencies were low-self cure delinquencies during the 2008-2009 downturn.

Policy

To study the effect of California Foreclosure Prevention Laws on lender decision making, we create a new sample by limiting loans to those originated in sand states of Arizona, California, Florida, and Nevada. Prior literature identifies these states as experiencing the 2008-2009 housing downturn similarly. We also limit our sample to between July 2008 and July 2012 which covers the period during the Delay Law as well as twelve months before and eighteen months after. We note that this entire period was subject to the Upkeep Law. By subsampling in this way, we identify the effect of the law of interest which is the law delaying foreclosures. This avoids confounders with respect to the Upkeep law.

We then introduce fixed effects for California and the period after the Delay Law ends, *After Policy,* into our model. These fixed effects identify the treatment effect of being a seriously delinquent loan in California after the Delay Law as compared to sand states. Due to collinearity between California and Zip 3 fixed effects, we drop location fixed effects. The policy specification uses the same variables as in equation (2.2) only now we include fixed effects for *California* and the time after the Delay Law ends, named *After Policy*. Such a model can be written as below.

$$\Psi_{ijt} = \beta_{0ijt} + \beta_{AP,ijt}\,(CA_{ij}\ X\ After\ Policy_{it}) + \beta_{APP,ijt}\,(CA_{ij}\ X\ After\ Policy_{it}\ X\ PMT_{ijt}) + \boldsymbol{\beta_{Z,ijt}} \boldsymbol{Z}_{ijt} + \varepsilon_{ijt} \qquad (2.4)$$

For ease of interpretation, we only explicitly write the new policy variables relevant to our policy hypotheses and absorb the original control variables, *PMT, MT*, fixed effects, as well as new fixed effects for California and After Policy into the vector ***Z***. We also interact *After Policy* with *Payments Made* which identifies the effect of policies on signals. The coefficient, $\beta_{AP,}$ captures the effect of being delinquent in California after the Delay Law ends while the coefficient $\beta_{APP,}$ captures the effect of being in California after the policy on signals. If foreclosure prevention laws lead to a build-up in delinquent loans with low self-cure, then we expect a significantly positive coefficient $\beta_{AP,ijt.}$

2.4 Results

Our primary hypothesis is that lenders respond to signals of self-cure by foreclosing less often on these loans. To test this hypothesis, we estimate equation (2.2) in a multinomial logit model inclusive of our signaling variable *Payments Made,* which measures the magnitude of payments made by a delinquent borrower over the past 12 months. The base outcome of our model is strategic inaction which is compared to modification and foreclosure. These estimation results are presented in Table 2.2.

The results indicate that a greater magnitude of payments made in the past 12 months significantly decreases the probability of both foreclosure and modification relative to strategic inaction. To examine the impact of timing, we introduce the variable *Meantime* in Model 2.2.2, which is our base model. This variable is the weighted average timing of *Payments Made* where more recent payments are weighted more heavily (see equation (2.3)). The Model 2.2.2 results indicate that payments occurring on average one-month nearer in time significantly decreases the probability of foreclosure relative to inaction by the lender. However, payments occurring nearer in time significantly increase the likelihood of modification relative to inaction. For Model 2.2.3, we replace *Payments Made* and *Meantime* with a variable, *Time Weighted Payments*, which combines the effects of *Payments Made* and *Meantime*. We find that *Time Weighted Payments* significantly decrease the likelihood of foreclosure relative to inaction. Timing continues to influence modification as *Time Weighted Payments Made* significantly increases the likelihood of modification.

The sign and significance for the control variables are consistent across all models. More concentrated lenders, measured by the number of FNMA loans in an MSA, are significantly more likely to modify relative to inaction. Larger origination amounts significantly increase the relative likelihood of modification while decreasing the relatively likelihood of foreclosure. We expect this result relates to higher income households' ability to renegotiate or cure delinquencies. Income may also signal an ability to pay. Lenders modify less often and foreclose more often on loans with higher current LTVs, higher credit scores, and greater percentages of payments missed relative to inaction. Lenders are also less likely to act on loans with greater numbers of months in delinquency. These results are consistent with prior studies.

To further support our hypotheses, we calculate the predicted probabilities of Model 2.2.2 for each outcome at different levels of *Payments Made* and *Meantime*. We also calculate the Average Marginal Effect (AME) of *Payments Made* at increasing levels of months in delinquency. We use AMEs as these are preferred in the literature over marginal effects at means (Bartus (2005); Cameron and Trivedi (2010))[16]. Figure 2.2 graphs the predicted probability of inaction varying payments from 0 to 12.

The baseline predicted probability of inaction with no *Payments Made* is 93.13%. The probability of inaction increases at a decreasing rate as more payments are made. The overall increase in the predicted probability of inaction from no payment to twelve payments is from 93.13% to 97.64%. Figure 3 charts the predicted probabilities of modification and foreclosure.

[16] The marginal effects at means were also calculated, though not reported, and are consistent with the AME results.

The baseline predicted probabilities of modification and foreclosure with no *Payments Made* are 4.26% and 2.61%, respectively. The probabilities of foreclosure and modification both decline at similar rates with greater numbers of payments made. The probability of foreclosure declines from 4.26% if a borrower made no payments to 0.48% if they made twelve. These results imply a decrease in the likelihood of foreclosure as borrowers signal via payments. Regarding modification, we find a similar effect as payments increase. Lenders are also more likely to modify at all levels of *Payments Made*. Figure 2.4 charts the predicted probabilities of inaction with respect to levels of *Meantime*[17].

The probability of inaction appears to initially increase at a decreasing rate as payments are made nearer in time. However, this effect peaks near *Meantime* values of 3 and 4 which correspond to payments being made, on average, 10 and 9 months ago, respectively. The probability of inaction then declines as *Meantime* approaches twelve, or all payments occurring one month ago. The effect of timing has opposing effects on the probabilities of modification and foreclosure which explains inaction. Figure 2.5 charts the probabilities of modification and foreclosure.

At lower values of *Meantime* or when payments are made far into the past, the probability of foreclosure is greater than the probability of modification. As payments are made nearer in time, the probability of modification increases while the probability of foreclosure declines. These effects cross near a *Meantime* value of 3 which corresponds to a mean timing of payments of 9 months ago. This is also the point when inaction peaks in Figure 2.4. This suggests that lenders are more likely to modify than foreclose if a borrower made payments within the past nine months on average. Figure 2.6 graphs the Average Marginal Effect of Payments Made at increasing amounts of missed payments after first default.

As borrowers miss more payments after first default, the average marginal effect of making payments on the likelihood of inaction declines. Continuing to miss payments also signals to the lender a low-cure likelihood which may impair the credibility of later signaling. For borrowers that have only missed a few payments, making payments marginally decreases the likelihood of modification less than the likelihood of foreclosure. However, as borrowers miss

[17] A one-unit increase in *Meantime* corresponds to payments occurring one-month, on average, nearer in time.

more payments, the average marginal effect of payments on modification and foreclosure converge. Signals must be credible to be effective and missing greater numbers of payments appears to impair that credibility.

These results, combined with the log odds results, clearly demonstrate the power of signaling to reduce the likelihood of foreclosure. The likelihood of foreclosure declines from 2.61% for loans making one payment to 1.13% for borrowers making six or half their required payments over the prior year. The likelihood of foreclosure is nearly 0% for loans which made ten or more payments. Given that a borrower making this many payments must be at least ten months delinquent, this result is assumed to reflect borrowers which were deep in delinquency and made a large payment all at once to reduce their outstanding payments. Timing has an interesting impact as lenders appear to modify loans making payments near in time. We expect this reflects that these borrowers can signal the ability to pay given modification.

We also believe there will be an effect as the market absorbs information on the effectiveness of signals and more borrowers start signaling as markets rebound. We hypothesize lenders require greater signaling to extend a delinquency as more borrowers signal and the signal becomes known. We introduce a variable into our base model, *Mean Payments Made in Zip 3*, which measures the average number of payments made, over the prior twelve months, by all delinquent borrowers in each month and each Zip 3. We also interact a fixed effect, *Above Zip 3 Mean*, that is equal to one if the *Payments Made* by the observed loan is greater than *Mean Payments Made in Zip 3.* We expect a negative coefficient on this interaction indicating that lenders modify and foreclose less often on signalers who make more payments than average in an area. Table 2.3 presents results.

The results show significantly negative coefficients on the interaction *Payments Made X Above Zip 3 Mean Payments.* This indicates that the lender's relative likelihood of inaction is greater on borrowers making more payments than the nearby average. This effect appears especially prominent for foreclosure.

To examine the impact of the California Foreclosure Prevention Law delaying foreclosure, the Delay Law, we narrow our sample to sand states to study the treatment effect of this policy. Another California Foreclosure Prevention Law was in effect at the same time as the

Delay Law. This law, the Upkeep Law, required lenders maintain REO or face fines. To account for this, we further narrow the sand state sample to the time twelve months before and eighteen months after the Delay Law. The Upkeep Law was in effect for this entire time. We drop location fixed effects for this analysis as these create collinearity issues with the California fixed effects. Model 2.4.1 introduces fixed effects for *California* and *After Policy* into our base model and interacts these. Table 2.4 present results.

Results show that lenders were relatively more likely to foreclose and relatively less likely to modify loans in California after the Delay Law. Lenders are more likely to foreclose in California in general. The results are less clear for signalers. Signaling delinquencies were significantly more likely to experience modification relative to inaction after the law. If the Delay Law resulted in a build-up of low self-cure delinquencies, lenders may have been more receptive to renegotiation to process defaults more quickly and mitigate costs.

Overall, these results support our hypothesis that these laws lead to a buildup of delinquencies that the lender foreclosed upon when able. To examine how this policy impacts signaling as well as further explore the overall effect of this policy, we divide the sample into two time periods: before and after the policy (Model 2.4.2) and during and after the policy (Model 2.4.3). We then estimate the model on the subsamples. These results help illuminate differences in lender decisions in the time surrounding the Delay Law.

For the subsample of delinquencies occurring before and after the Delay Law in Model 2.4.2, results show that lenders foreclosed significantly more often relative to inaction in California after the Delay Law. We again find no effect of signals on foreclosure due to the policy. In Model 2.4.3, which includes delinquencies during and after the Delay Law, we find that lenders were more likely to foreclose and less likely to modify delinquencies after the policy ends. In a departure from prior models, signaling moderates the likelihood of foreclosures relative to inaction. This result implies that the only significant difference in signaling occurred directly between the time during the policy and the time after.

To further disentangle these effects, we estimate the predicted probabilities of all three outcomes at levels of *Payments Made* while holding *After Policy* and *California* at 0 or 1. These predictive probabilities allow for the comparison of the effect of payments made at different points in these laws. We then calculate the discrete change in probability of inaction, foreclosure, and modification after the Delay Law. Figure 2.7 presents a graph of the difference in the predicted probability of inaction after the Delay Law versus before.

After the law, sand states experienced a greater increase in the probability of inaction relative to California at all levels of payments made. At certain levels of payments made, the probability of inaction declined between these two time periods for California loans. These results show that lenders became more active in California after these laws ended, particularly for borrowers that recently made between two to eight payments. If the Delay Law led to a build-up of loans, lenders may focus not only on foreclosure, but also on modification as an alternative action to clear this build-up. Figure 2.8 presents the change in predicted probabilities for modification and foreclosure by levels of payments made.

Results in Figure 2.8 show that the likelihood of foreclosure increased by nearly 2% after the policy for borrowers making few payments. This was a greater increase than found in sand states which increased between 0% and 1%. As borrower's make more payments, the change in the probability of foreclosure in sand states overtakes the change in California for borrowers making the greatest numbers of payments. The Delay Law protected all borrowers from foreclosure including low self-cure borrowers. As lenders work through this build-up in delinquencies, their initial focus likely is on the lowest self-cure borrowers while ignoring borrowers who may cure.

The inverse of the foreclosure results was found for modification. The likelihood of modification declines after the policy ends for both California and sand state loans. However, the decline was less in sand state loans for borrowers making few payments while borrowers making many payments in sand states experienced a greater decline in modification likelihood than those making many payments in California. Lenders may be more receptive to modification for signalers after these policies to clear through the excess of delinquencies.

Overall, our study of a policy extending foreclosure timelines paints an interesting picture of how these polices impact lenders. We find evidence that lenders foreclose more often after the Delay Law ended. By studying predictive probabilities, we find that lenders were more likely to act in general on California loans after the policy. Which action lenders take appears influenced by the number of payments the borrower made. These results imply that lenders are foreclosing and modifying on a buildup of delinquencies once the law allows, and their choice depends on signals. These results support our hypotheses regarding policy, signaling, and lender decisions.

2.5 Propensity Score Matching

While we believe our model is well-specified, we utilize propensity score matching of borrowers by type to provide robustness to our estimates. We create a balanced sample of loans of similar borrowers based on borrower characteristics at first default with a division between high self-cure (greater number of payments made) and low self-cure defaulters. To operationalize this paradigm, we identify borrowers that made payments after first default, and then estimate a logistic regression of the likelihood a borrower made payments after first default. Borrower characteristics are taken at first default. The logistic model is as follows:

$$Z_i = \mu_0 + \mu_{BC}\boldsymbol{BC_i} + \mu_{FE}\boldsymbol{FE_i} + \eta \qquad (2.5)$$

where Z_i equals 1 if a borrower i made payments after first default. $\boldsymbol{BC_i}$ is a vector of borrower characteristics measuring origination rate, origination cumulative loan-to-value, origination amount, number of borrowers, borrower credit score, loan age at first default, outstanding mortgage balance at first default, and indicators for first time home buyers and mortgage insurance. $\boldsymbol{FE_i}$ includes the same fixed effects as in the lender decision model.

We employ nearest neighbor 1-to-1 matching with replacement[18] to generate propensity score calipers and pair borrowers that made payments after first default (treated) with those that did not (untreated). We limit matches to loans in the same Zip Code 3 and within 12 months of first default month. In testing for sample balance, Imai et al. (2008) and Austin (2008, 2009) note inadequacies of using the mean difference t-test as a determinant of sample balance. As an alternative, Rubin (2000) proposes using the standardized difference in means and the ratio of

[18] Matching with replacement matches allows control loans to match with multiple treatment loans. Matching without replacement may increase bias by matching loans with very different propensity scores if potential matches are exhausted (Dehejia and Wahba 2002). Matching without replacement also introduces bias as it is dependent on matching order. This may be especially true when including calipers for Zip 3 and time. As a result, matching with replacement is preferred for the current study.

variances for each variable between groups. The standardized difference in means is calculated as:

$$SDM = \frac{(\overline{X_T} - \overline{X_U})}{\sqrt{\frac{S_T^2 + S_U^2}{2}}} \quad (2.6)$$

where $\bar{X}_T$ and $\bar{X}_U$ and S_T^2 and S_U^2 represent the means and standard deviations of covariate X for the subsamples of treated and untreated loans, respectively. Following Rubin (2000), a variable is well balanced if and only if the standardized difference of means falls in the range of (-0.25, 0.25), and the ratio of the variance falls in the range of (0.5, 2). Table 2.5 depicts summary statistics for the balanced sample of seriously delinquent loans. It also presents evidence of the tests of balance.

We first note that all covariates balance using Rubin's tests of balance. The subsample of borrowers that did not make payments after first default had slightly higher credit scores and later loan ages at first default. Borrowers that made payments after first default also appear to have lingered longer in delinquency based on the greater number of observations in the matched sample. Loans are matched at the loan level and then all monthly loan observations are included for the matched loans. This results in a sample including the same number of loans but differing monthly observations across groups.

Our results show that lenders respond to signals of self-cure by foreclosing less often on these loans. To provide robustness, we now estimate Models 2.2.1 to 2.2.3 using a balanced sample of loans that did nor did not make payments after first default. Table 2.6 provides results.

The results in Table 2.6 are like prior results in sign and significance for control variables and our variables of interest. We again find that *Payments Made* significantly decreases the relative likelihood of foreclosure. Foreclosures nearer in time significantly increase the relative likelihood of modification while decreasing the relative likelihood of foreclosure. We also calculate the predicted probabilities of Model 2.6.2 for each outcome at different levels of *Payments Made* and *Meantime* in a similar manner to calculations for Model 2.2.2. Figure 2.9 graphs the predicted probability of inaction varying payments from 0 to 12 for the balanced sample.

The baseline predicted probability of inaction with no *Payments Made* is 92.85% which is like the baseline probability of 93.13% found in Model 2.2.2. The probability of inaction increases at a decreasing rate as more payments are made which is also like Model 2.2.2 and provides evidence that increasing numbers of payments leads to a greater likelihood of inaction. Figure 2.10 charts the predicted probabilities of modification and foreclosure.

The baseline predicted probabilities of modification and foreclosure with no *Payments Made* are 4.61% and 2.54%, respectively. For Model 2.2.2, these probabilities were similar at 4.26% and 2.61%, respectively. The probabilities of foreclosure and modification both decline at similar rates with greater numbers of payments made which is consistent with prior models. Lenders are also more likely to modify at all levels of *Payments Made* which was found in prior models as well.

Figure 2.11 charts the predicted probability of inaction with respect to levels of *Meantime.* The probability of inaction appears to initially increase as payments are made nearer in time. However, this effect peaks near *Meantime* values of 3 and 4. The probability of inaction then declines as *Meantime* approaches twelve, or all payments occurring one month ago. A similar effect was also observed in Model 2.2.2. Figure 12 charts the probabilities of modification and foreclosure with respect to greater levels of *Meantime*.

At lower values of *Meantime* or when payments are made far into the past, the probability of foreclosure is greater than the probability of modification. This effect reverses are payments are made nearer in time. These effects cross near a *Meantime* value of 3 which corresponds to a mean timing of payments of 9 months ago. These results are also like Model 2.2.2. Overall, results using a balanced sample of loans are consistent in sign, significance, and predicted probabilities with prior models. We now turn to foreclosure proceeds and costs to further study the effects of signals and policy.

2.6 Lender Proceeds and Costs

Our results show that lenders alter their decisions based on the number of payments a borrower recently made. We attribute this effect to payments acting as signals of self-cure. Borrowers who signal self-cure should take better care of their homes than low self-cure borrowers. Thus, the signal should also signal less costs to the lender if the property is ultimately foreclosed upon. For robustness, we study the foreclosure proceeds and costs related to completed foreclosures. We hypothesize greater proceeds and fewer costs on foreclosures where borrowers signaled self-cure via payments. We also study policy to examine how policies impact costs.

Regarding lender costs, our hypothesis is that defaulters that signal expect to retain their home and thus better maintain and preserve this asset. If policies delaying foreclosure reduce the incentive to signal and introduce moral hazard, then we expect greater lender losses under these regimes. Prior literature, such as Cordell et al. (2015), study lender losses as the net losses-given-default of the foreclosure sale proceeds less the outstanding mortgage balance. However, payments made reduce the outstanding mortgage balance of the loan which may confound our analysis if we study losses-given-default. As a result, we instead study the realized costs and proceeds associated with the foreclosure separately rather than as one figure net of outstanding mortgage balance. The data identify realized proceeds and costs from foreclosure sales which we use to test our hypotheses. Thus, our sample is narrowed to only loans that foreclosed[19]. This results in a sample of 136,870 foreclosed loans and a subsample of 39,476 foreclosed loans in sand states. Table 1.7 depicts summary statistics for the foreclosed loan sample.

The data indicate that foreclosure costs are 9.23% of the foreclosure proceeds and slightly lower in sand states at 6.62%. Foreclosure costs are also 7.27% of the outstanding mortgage balance on average and 4.72% for the sand states. This is slightly lower than prior literature which finds foreclosure costs of 11% - 16% of outstanding mortgage balance. Lenders recover, on average, 71.46% of the outstanding mortgage balance via foreclosure net proceeds. This is slightly lower in sand states at 66.50%.

We study both foreclosure proceeds and costs to identify the effect of signals and policy on these. A simultaneity issue of payments and outstanding mortgage balance provides rationale for focusing on proceeds and costs separately. Data on foreclosure sale proceeds and costs are only observed in the month of foreclosure, so our sample only includes the monthly observation

[19] We note that some foreclosures were missing data on costs and proceeds which is why the number of loans in the cost sample is fewer than the total number of foreclosed loans in the lender decision sample.

when a foreclosure occurs. A cost regression model studies signals, foreclosure proceed, and costs. This model is defined as:

$$Y_{it} = \lambda_0 + \lambda_{PMT} PMT_{it} + \lambda_{MT} MT_{it} + \lambda_{\boldsymbol{X}} \boldsymbol{X}_{it} + \lambda_{\boldsymbol{FE}} \boldsymbol{FE}_{it} + \varepsilon_{it} \tag{2.7}$$

where Y_{it} is a lender's foreclosure proceeds or costs for foreclosure i at foreclosure calendar time t. PMT_{it} and MT_{it} measure *Payments Made* and *Meantime*, respectively, for loan i at foreclosure time t. The vectors $\boldsymbol{X}_{it}$ and $\boldsymbol{FE}_{it}$ include the same control variables as in the lender decision model. Time-varying controls as well as the variables of interest are taken as of the month of the foreclosure.

We expect that a greater number of payments made results in fewer costs indicated by a significantly negative coefficient on *PMT*. Further, we expect a significantly negative coefficient on *MT* indicating that payments made nearer in time result in fewer costs.

If signals impact lender costs and losses, then factors impacting signals should also impact lender costs. Like lender decision making, we study the effect of being in an area of greater signaling as well as CFPLs on costs. Introducing the same *Zip 3 Mean* variable from before (taken at foreclosure sale month) into equation (2.7) captures this effect. We expect borrowers making more payments than the Zip 3 average generate fewer costs. We then introduce the same *California* and *After Policy* fixed effects and interactions from equation (2.4) into equation (2.7) to study the effect of policy. We expect these policies lead to greater losses to lenders.

As noted in the lender decision model, we expect that a market may learn of the effectiveness of signals which would increase the number of signalers. We thus expect the level of signaling in an area to also impact the costs incurred by the lender. Table 2.8 presents the results of our base lender costs model as well as the results studying the level of signaling in a Zip 3 on proceeds and costs.

Results in Table 2.8 indicate that a greater magnitude of payments made in the past 12 months significantly decreases both the proceeds and costs related to foreclosure sales. The reduction in costs supports our hypothesis that signalers better care for their homes as these costs include the costs of repairs on the REO. Results also indicate that the timing of these payments is important, and payments occurring nearer in time lead to significantly greater proceeds and fewer costs.

Studying the effect of areas with greater amounts of signaling, we find a significantly positive effect on proceeds and a significantly negative effect on costs for the *Mean Payments Made in a Zip 3* variable. Lenders suffer fewer losses in areas with greater numbers of payments being made which may indicate an economic effect. With regards to the interaction of *Payments Made* and *Above Zip 3 Mean,* we find that lenders suffer fewer costs for borrowers signaling more than average in an area but no significant difference in foreclosure proceeds. This provides evidence that the type of home being foreclosed upon is similar for borrowers signaling more on average as the sale proceeds are not significantly different between high and low levels of signaling. However, high signalers preserve their homes better which leads to lower costs and losses to the lender.

With regards to the control variables, we find that greater origination loan amounts lead to significantly greater proceeds and costs which makes sense given the larger loan size. We also find that lenders suffer greater costs and fewer proceeds when concentrated. The decline in foreclosure proceeds may be due to negative foreclosure spillovers effects which also would explain the greater losses. Higher current LTVs also lead to significantly fewer proceeds and losses while mortgage insurance leads to significantly greater proceeds and fewer losses. In addition to the effect of payments on foreclosure losses, we also provide robustness to our policy results by studying the effect of California Foreclosure Prevention Laws on proceeds and costs.

CFPLs may induce a moral hazard by protecting borrowers from a timely foreclosure. These policies allow low self-cure borrowers to remain in homes they know they will lose which we hypothesize lead to greater lender losses. We narrow our sample in the same manner as the lender decision models and study the effects of these policies. Table 2.9 presents results of the policy regressions.

Results for Model 2.9.1 show that foreclosure costs were significantly higher for California loans after the Delay Law ended. After the policy, lenders suffer marginally 11.78% more in foreclosure costs from foreclosures occurring in California after the policy ended relative to foreclosures in sand states. Interestingly, we find no significant effect on proceeds for foreclosures. This indicates that lenders sold properties for similar amounts in California after the law ended but suffered greater losses due to the costs incurred from those sales. A crucial cost included is the maintenance and repair costs of the home. This provides evidence that lenders bore the costs of borrower benefits noted in Gabriel et al. (2021), and that this build-up in delinquent loans during the policy was of higher cost borrowers.

Turning now to signaling, we find no significant effect on costs for signalers after the policy; however, we do find significantly fewer proceeds on signaling loans after the policy. This may be due to spillovers from the build-up of delinquent loans. As in the lender decision model, we now subsample the sand state foreclosure sample by timing related to the Delay Law. Model 9.2 presents results studying foreclosure net proceeds of foreclosure occurring before and after the Delay Law and Model 2.9.2 subsamples foreclosures occurring during and after the law.

Results demonstrate a significantly positive coefficient on the interaction of *California* and *After Policy*. There was no significant effect on proceeds in California after the policy ended in any model. Foreclosures occurring after the Delay Law generate costs to the lenders, but do not impact proceeds which implies that these foreclosures were more costly. These foreclosures were particularly more costly related to before the policy as the coefficient on the interaction in Model 2.9.3 is nearly three times the coefficient in Model 2.9.2. These results show provide evidence that lenders suffered greater losses in the immediate aftermath of the policy, as well as during, which we attribute to the moral hazard generated by laws extending foreclosure timelines.

2.7 Conclusion

This paper extends the robust line of literature on lender decision making by identifying how signaling may address information asymmetries related to a borrower's ability to cure a delinquency. For various reasons such as job loss or divorce, borrowers may default while hoping to quickly cure the delinquency prior to foreclosure. However, information on a borrower's cure likelihood, or self-cure, is asymmetric between borrower and lender. Lenders may unnecessarily suffer significant costs if they modify or foreclose on a high self-cure delinquency (Ambrose and Capone 1996). Spence (1973) details the ability of signaling to overcome such asymmetries. We define the signal to be borrowers making payments while delinquent. If these signals are effective, then we hypothesize lenders are more likely to use the option of strategic inaction in these situations.

An important aspect of signaling is the costliness of the signal. Borrowers making payments while in default forego using these funds elsewhere. Even after making payments, the lender may still foreclose leaving the borrower with nothing. The opportunity cost of these payments and the risk associated with foreclosure satisfies the conditions noted in Spence (1973) to create a separating equilibrium between high self-cure and low self-cure borrowers. Our results show that greater numbers of recent payments made leads to a lower likelihood of modification or foreclosure. This supports the notion that lenders strategically extend delinquencies on loans signaling self-cure and an intent to pay.

We also hypothesize that the effectiveness of payments will diminish as more people start making payments to delay foreclosure. Lenders thus require greater signaling to avoid foreclosure. We show that borrowers making more payments than the average borrower in their Zip 3 are significantly less likely to experience foreclosure. Further, we also study how policies that force delays on foreclosure timelines impact lender decision making.

With regards to lender decision making, we study how California Foreclosure Prevention Laws (CFPLs) impact signals and lender decisions. California enacted two laws in response to an increase in defaults during 2008-2009. The first law mandated upkeep on bank REO which we name the “Upkeep Law”. The second law, which is named the “Delay Law” and is the policy of interest, created a six-month waiting period for foreclosure which extended an in-place law requiring three-months. To study these laws, we narrow our sample to “sand states” or Arizona, California, Florida, and Nevada and to the time shortly before, during, and shortly after the Delay Law took effect. Because of the similarity of sand states’ experiences prior to and during the 2008-2009 downturn, they are often used to test treatments in one of the respective states including Gabriel et al. (2021). Our results show that lenders foreclosed more often after the Delay Law relative to the prior. We take this as evidence that this law led to a build-up of delinquent loans with low self-cure.

We also examine the effect of signaling and policy on lender costs and losses. We hypothesize that borrowers expecting self-cure better care for their homes. Results show that greater numbers of recent payments lead to fewer lender losses. With regards to policy, we find that lenders suffer greater costs after the Delay Law ended. These results support the notion that lenders bear the cost of laws benefiting borrowers.

While government policy during the pandemic imposed forced forbearance on government backed loans, we show that lenders use strategic inaction (as a form of forbearance) to avoid unnecessary costs both to themselves and to the borrower. The cost of strategic inaction is quite low if a borrower cures as the lender merely incurs the time cost of delaying repayment. Government policies enforcing forbearance, such as CFPLs or the CARES Act, provide more time for low-cure borrowers and seem to increase the costs to the lender/taxpayer. Our results show that lenders would already have extended forbearance to high self-cure borrowers. The question for lawmakers comes down to whether the costs borne by lenders/taxpayers due to enforced forbearance is worth the benefit extended to low self-cure borrowers. Given the suddenness and unexpectedness of the pandemic, laws benefitting low self-cure borrowers make sense if policy makers consider the present value of the benefits of forbearance outweigh the long-term costs associated with such programs, such as a build-up of delinquencies.

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2.9: Tables and Figures

Table 2.1: Summary Statistics for Lender Decision Sample

	Full Sample		Inaction		Modification		Foreclosure	
At Monthly Loan Observation	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Payments Made (#)	7.10	4.76	9.31	5.46	8.18	4.53	5.19	3.96
Meantime (mo)	4.71	2.67	5.29	2.41	5.69	2.48	3.50	2.45
Time Weighted Payments Made (#)	37.60	30.96	52.17	36.67	45.12	30.08	24.61	23.90
FNMA Loans in MSA (# of Loans/100,000)	1.76	1.00	1.87	1.09	2.00	1.10	1.46	0.76
Current LTV (%)	92.26	29.90	72.31	23.51	88.94	26.98	102.87	30.34
Change in Case Shiller (% past 6 mo)	-0.18	6.53	0.83	5.89	0.37	5.81	-1.12	7.29
Change in Mortgage Rate (% since orig)	-23.97	13.16	-21.28	15.31	-26.13	11.72	-22.74	13.36
Payments Missed to Loan Age (%)	23.78	15.48	22.45	16.59	23.15	13.44	24.90	16.87
Months Delinquent	9.99	9.48	9.45	10.71	11.47	10.68	8.65	7.21
At First Default								
Current LTV (%)	90.75	29.52	71.50	22.36	90.46	26.83	102.34	29.55
Payments Missed to Loan Age (%)	13.41	12.02	16.23	15.30	12.47	8.85	12.60	12.02
At Origination								
Origination Amount ($100,000)	2.10	0.96	2.01	0.98	2.36	0.96	1.92	0.92
Credit Score	690.86	56.57	685.67	59.08	683.97	55.05	700.07	55.11
Mortgage Insurance Indicator	24.76	43.16	18.45	38.79	22.03	41.45	30.91	46.21
Number of Loans	345,151		81,941		124,078		139,132	
Monthly Loan Observations (#)	3,772,407		572,741		1,618,703		1,580,963	

Notes: This table presents summary statistics for the sample of FNMA 90+day delinquent loans on properties in Case-Shiller Cities. Payments Made represents the sum of payments made over the past twelve months. Meantime is the weighted average timing of Payments Made where 12 means all payments were made the prior month and 1 means all payments were made 12 months ago. A one-unit increase in Meantime means payments occurred, on average, one-month nearer in time. Payments Missed to Loan Age is the percentage of possible payments missed over the life of the loan at that point.

Table 2.2: Lender Decision Model Studying the Effect of Signals and Timing

Log Odds of Modify or Foreclose Relative to Inaction	2.2.1: Payments		2.2.2: Payments and Time		2.2.3: Weighted Payments	
	Modify	Foreclose	Modify	Foreclose	Modify	Foreclose
Payments Made (#)	-0.0157*	-0.3204*	-0.0723*	-0.1445*		
	(0.0007)	(0.0011)	(0.0008)	(0.0019)		
Meantime (mo)			0.2168*	-0.3000*		
			(0.0010)	(0.0028)		
Time Weighted Payments Made (#)					0.0053*	-0.0632*
					(0.0001)	(0.0002)
FNMA Loans in MSA (# of Loans/100,000)	0.1531*	-0.0007	0.1291*	0.0197	0.1123*	0.0383
	(0.0182)	(0.0220)	(0.0185)	(0.0220)	(0.0182)	(0.0220)
Origination Amount ($100,000)	0.1153*	-0.1050*	0.0948*	-0.0922*	0.1076*	-0.0996*
	(0.0038)	(0.0043)	(0.0038)	(0.0043)	(0.0038)	(0.0043)
Current LTV	-0.3520*	0.7249*	-0.3272*	0.7429*	-0.2550*	0.7418*
	(0.0190)	(0.0186)	(0.0192)	(0.0188)	(0.0190)	(0.0186)
Credit Score (per 10)	-0.0183*	0.0252*	-0.0148*	0.0218*	-0.0115*	0.0245*
	(0.0005)	(0.0006)	(0.0006)	(0.0006)	(0.0005)	(0.0006)
Mortgage Insurance FE	0.1037*	0.0132	0.1034*	0.0137	0.0945*	0.0057
	(0.0081)	(0.0077)	(0.0082)	(0.0078)	(0.0081)	(0.0077)
Change in Case Shiller (past 6 mo)	0.1355*	0.0433*	0.1073*	0.0519*	0.1408*	0.0661*
	(0.0059)	(0.0052)	(0.0060)	(0.0052)	(0.0059)	(0.0052)
Change in Mortgage Rate (since orig)	-0.0010	-0.0241*	-0.0056	-0.0222*	-0.0005	-0.0312*
	(0.0048)	(0.0051)	(0.0049)	(0.0052)	(0.0048)	(0.0051)
Payments Missed to Loan Age (%)	-0.0729*	0.0886*	-0.1134*	0.0943*	-0.0108*	0.1266*
	(0.0026)	(0.0025)	(0.0027)	(0.0025)	(0.0024)	(0.0025)
Months Delinquent (#)	-0.0439*	-0.1058*	-0.0494*	-0.1035*	-0.0465*	-0.1018*
	(0.0004)	(0.0006)	(0.0004)	(0.0006)	(0.0004)	(0.0006)
Zip 3 FE	X	X	X	X	X	X
Servicer FE	X	X	X	X	X	X
Origination Year FE	X	X	X	X	X	X
Delinquency Year FE	X	X	X	X	X	X
Property Type FE	X	X	X	X	X	X
Loan Purpose FE	X	X	X	X	X	X
Observations			3,772,407			

Notes: The estimates above reflect the estimation of a hazard model for lender decision making. The dependent variable is defined by the decision to modify, foreclose, or take no action (the base category). Payments Made represents the sum of payments made over the past twelve months. Meantime is the average timing of payments with greater weight placed on payments made near in time. Time Weighted Payments Made combines payments made and meantime into one weighted payment variable with heavier weighting by nearness in time. Standard errors in parentheses. *-Indicates significance at a 5% threshold.

Table 2.3: Lender Decision Model Studying Levels of Signaling Nearby

	2.3.1: Zip Mean	
Log Odds of Modify or Foreclose Relative to Inaction	Modify	Foreclose
Payments Made (#)	-0.0418*	-0.0142*
	(0.0020)	(0.0026)
Payments Made (#) X Above Zip 3 Mean FE	-0.0253*	-0.1174*
	(0.0015)	(0.0015)
Mean Payments Made in Zip 3 (#)	-0.0211*	-0.0212*
	(0.0040)	(0.0044)
Meantime (mo)	0.2150*	-0.3516*
	(0.0011)	(0.0031)
FNMA Loans in MSA (# of Loans/100,000)	0.1339*	0.0199
	(0.0189)	(0.0220)
Origination Amount ($100,000)	0.0953*	-0.0898*
	(0.0038)	(0.0043)
Current LTV	-0.3348*	0.7718*
	(0.0195)	(0.0190)
Credit Score (per 10)	-0.0148*	0.0212*
	(0.0006)	(0.0006)
Mortgage Insurance FE	0.1043*	0.0047
	(0.0082)	(0.0078)
Change in Case Shiller (past 6 mo)	0.1071*	0.0700*
	(0.0060)	(0.0052)
Change in Mortgage Rate (since orig)	-0.0044	-0.0232*
	(0.0049)	(0.0051)
Payments Missed to Loan Age (%)	-0.1137*	0.1142*
	(0.0027)	(0.0026)
Months Delinquent (#)	-0.0494*	-0.1014*
	(0.0004)	(0.0006)
Zip 3 FE	X	X
Servicer FE	X	X
Origination Year FE	X	X
Delinquency Year FE	X	X
Property Type FE	X	X
Loan Purpose FE	X	X
Observations	3,772,407	

Note: The estimates above are based on the estimation of a hazard model for lender decision making. The dependent variable is defined by the servicer's decision to modify or foreclose or take no action (the base category). Mean Payments Made in Zip 3 measures the mean Payments Made by all delinquent borrowers in each month for each Zip 3. Above Zip 3 Mean FE is a fixed effect equal to one if the observation's Payments Made is greater than the Mean Payments Made in Zip 3. Standard errors in parenthesis. *-Indicates significance at a 5% threshold.

Table 2.4: Lender Decision Model Studying the Effect of Signals and Policy Over Time

Log Odds Modify or Foreclose Relative to Inaction	2.4.1: Sand States		2.4.2: Before and After Policy		2.4.3: During and After Policy	
	Modify	Foreclose	Modify	Foreclose	Modify	Foreclose
Payments Made (#)	-0.0337*	-0.1530*	-0.1345*	-0.2104*	-0.0310*	-0.1414*
	(0.0026)	(0.0043)	(0.0157)	(0.0090)	(0.0027)	(0.0045)
California	-0.0162	0.5054*	0.5552*	0.4102*	0.0038	0.4376*
	(0.0358)	(0.0302)	(0.2052)	(0.0829)	(0.0363)	(0.0319)
After Policy	-0.1858*	-0.0024	1.3429*	-0.2101*	-0.1471*	-0.0727*
	(0.0350)	(0.0263)	(0.1283)	(0.0547)	(0.0352)	(0.0270)
California X After Policy	-0.1475*	0.1596*	-0.8417*	0.3421*	-0.1806*	0.2370*
	(0.0467)	(0.0360)	(0.2081)	(0.0871)	(0.0471)	(0.0372)
Payments Made (#) X California	-0.0392*	-0.1066*	-0.0753*	-0.1116*	-0.0389*	0.0634*
	(0.0039)	(0.0063)	(0.0272)	(0.0182)	(0.0039)	(0.0039)
Payments Made (#) X After Policy	-0.0421*	0.0712*	0.0532*	0.1213*	-0.0444*	-0.0032
	(0.0037)	(0.0038)	(0.0158)	(0.0082)	(0.0037)	(0.0088)
Payments Made (#) X California X After Policy	0.0389*	-0.0043	0.0771*	0.0014	0.0386*	-0.2609*
	(0.0059)	(0.0085)	(0.0275)	(0.0192)	(0.0059)	(0.0050)
Other Controls	X	X	X	X	X	X
Zip 3 FE						
Servicer FE	X	X	X	X	X	X
Origination Year FE	X	X	X	X	X	X
Delinquency Year FE	X	X	X	X	X	X
Property Type FE	X	X	X	X	X	X
Loan Purpose FE	X	X	X	X	X	X
Observations	947,230		436,146		850,663	

Notes: The estimates above reflect the estimation of a hazard model for lender decision making. The sample is restricted to loans in sand states or Arizona, California, Florida, and Nevada. In Model 2.4.1, observations are restricted to delinquencies between 12 months before and eighteen months after the second CFPL, the Delay Law, period. The first CFPL, the Upkeep Law, was in effect this entire period. Models 2.4.2 and 2.4.3 further restrict the sample to monthly loan observations occurring either before or after (2.4.2) or during and after (2.4.2) the Delay Law. Model 2.4.2 thus excludes observations while the Delay Law was in effect and Model 2.4.3 excludes observations before the law. After Policy is a fixed effect for a monthly loan observation occurring after the policy ends. The same control variables used in prior models are included but not reported. Standard errors in parentheses. *-Indicates significance at a 5% threshold.

Table 2.5: Summary Statistics and Tests of Balance of the Matched Samples

	No Payments After Default		Payments After Default		Tests of Balance	
	Mean	Std. Dev.	Mean	Std. Dev.	Std. Diff. of Means	Ratio of Var.
Origination Rate (%)	6.16	0.59	6.15	0.58	-0.02	0.95
Origination CLTV (%)	77.84	12.40	76.78	12.59	-0.09	1.03
Origination Amount ($)	225,988	103,127	224,102	95,079	-0.02	0.85
Credit Score	686.14	53.53	676.21	54.33	-0.18	1.03
Number of Borrowers	1.41	0.50	1.44	0.51	0.05	1.01
Loan Age 1st Default (yr)	4.86	5.42	2.57	2.68	0.21	1.09
Outstanding Mortgage Balance ($)	213,703	101,400	212,164	93,333	-0.02	0.85
Mortgage Insurance (% of Loans)	24.98	43.29	23.20	42.21	-0.04	0.95
Number of Loans	162,364		162,364			
Monthly Loan Observations	1,281,259		2,363,991			

Notes: This table presents summary statistics and tests of balance for a matched sample drawn from a sample 90+ day delinquent Fannie Mae loans. A propensity score matching process matches borrowers that made payments after first default with borrowers which did not. Matches are limited to loans in the same Zip 3 and within 12 months of first default. Time varying traits are taken at first default.

The standardized difference of the mean and the ratio of the variance are used for matching balance diagnosis following the matching literature (Rubin, 2001; Austin, 2011). Following Rubin (2000), a variable is well balanced if and only if the standardized difference of means falls in the range of (-0.25, 0.25), and the ratio of the variance falls in the range of (0.5, 2). All covariates balance according to this criterion.

Table 2.6: Robustness Tests Using a Balanced Sample

Log Odds of Modify or Foreclose Relative to Inaction	2.6.1: Payments		2.6.2: Payments and Time		2.6.3: Weighted Payments	
	Modify	Foreclose	Modify	Foreclose	Modify	Foreclose
Payments Made (#)	-0.0119*	-0.3421*	-0.0715*	-0.1627*		
	(0.0007)	(0.0013)	(0.0008)	(0.0020)		
Meantime (mo)			0.2144*	-0.2964*		
			(0.0010)	(0.0029)		
Time Weighted Payments Made (#)					0.0055*	-0.0671*
					(0.0001)	(0.0003)
FNMA Loans in MSA (# of Loans/100,000)	0.0743*	0.0088	0.0610*	0.0270	0.0449*	0.0383
	(0.0181)	(0.0229)	(0.0183)	(0.0230)	(0.0180)	(0.0229)
Origination Amount ($100,000)	0.0594*	-0.0381*	0.0610*	-0.0443*	0.0580*	-0.0380*
	(0.0037)	(0.0045)	(0.0037)	(0.0045)	(0.0037)	(0.0045)
Current LTV	-0.2975*	0.7814*	-0.3021*	0.8272*	-0.2088*	0.8040*
	(0.0190)	(0.0215)	(0.0192)	(0.0218)	(0.0190)	(0.0215)
Credit Score (per 10)	-0.0072*	0.0167*	-0.0077*	0.0166*	-0.0019*	0.0176*
	(0.0005)	(0.0006)	(0.0005)	(0.0006)	(0.0005)	(0.0006)
Mortgage Insurance FE	0.1083*	0.0132	0.1072*	0.0111	0.0990*	0.0071
	(0.0081)	(0.0088)	(0.0081)	(0.0088)	(0.0081)	(0.0087)
Change in Case Shiller (past 6 mo)	0.1558*	0.0445*	0.1251*	0.0605*	0.1586*	0.0702*
	(0.0059)	(0.0060)	(0.0060)	(0.0061)	(0.0059)	(0.0060)
Change in Mortgage Rate (since orig)	-0.0040	-0.0307*	-0.0067	-0.0303*	-0.0029	-0.0427*
	(0.0048)	(0.0057)	(0.0048)	(0.0057)	(0.0048)	(0.0057)
Payments Missed to Loan Age (%)	-0.0803*	0.0875*	-0.1220*	0.0981*	-0.0211*	0.1362*
	(0.0026)	(0.0028)	(0.0027)	(0.0028)	(0.0024)	(0.0027)
Months Delinquent (#)	-0.0466*	-0.0948*	-0.0526*	-0.0922*	-0.0492*	-0.0913*
	(0.0004)	(0.0006)	(0.0005)	(0.0006)	(0.0004)	(0.0006)
Zip 3 FE	X	X	X	X	X	X
Servicer FE	X	X	X	X	X	X
Origination Year FE	X	X	X	X	X	X
Delinquency Year FE	X	X	X	X	X	X
Property Type FE	X	X	X	X	X	X
Loan Purpose FE	X	X	X	X	X	X
Observations			3,645,250			

Notes: The estimates above reflect the estimation of a hazard model for lender decision making using a balanced sample of loans which made payments after first default with those that didn't. A propensity score matching model pairs loans based on borrower characteristics at first default. The dependent variable is defined by the decision to modify, foreclose, or take no action (the base category). Meantime is the average timing of payments with greater weight placed on payments made near in time. Time Weighted Payments Made combines payments made and meantime into one weighted payment variable with heavier weighting by nearness in time. Percent payments missed is the percentage of possible payments missed at a given point in time. Standard errors in parentheses. *-Indicates significance at a 5% threshold.

Table 2.7: Summary Statistics for Foreclosure Cost Sample

	Full Sample		Sand States	
	Mean	SD	Mean	SD
Foreclosure Proceeds ($)	143,940	96,015	154,993	97,175
Foreclosure Costs ($)	13,292	12,222	10,264	10,302
Foreclosure Net Proceeds ($)	130,648	93,569	144,729	94,695
Outstanding Mortgage Balance (OMB) ($)	182,829	89,881	217,645	87,620
Losses-Given-Foreclosure ($)	52,181	52,454	72,916	58,467
Ratio of Costs to Proceeds (%)	9.23	-	6.62	-
Ratio of Costs to OMB (%)	7.27	-	4.72	-
Ratio of Net Proceeds to OMB (%)	71.46	-	66.50	-
Foreclosed Loans (# of loans)	136,870		39,476	

Notes: This table presents the sample of the monthly loan observation when the foreclosure took place which is used for the lender cost regressions. Sand States are defined as Arizona, California, Florida, and Nevada. Foreclosure Net Proceeds is defined as Foreclosure Proceeds – Foreclosure Costs. Losses-Given-Foreclosure is defined as LGF = Foreclosure Net Proceeds – Outstanding Mortgage Balance. The absolute value of LGF is used for ease of interpretation.

Table 2.8: Lender Costs Model Studying Signals and Foreclosure Sale Proceeds and Costs

	2.8.1: Signals		2.8.2: Zip Means	
Dep. Var.=	ln(Proceeds)	ln(Cost)	ln(Proceeds)	ln(Cost)
Payments Made (#)	-0.0035*	-0.0637*	-0.0034*	-0.0348*
	(0.0010)	(0.0016)	(0.0012)	(0.0020)
Payments Made (#) X Above Zip 3 Mean FE			-0.0010	-0.0294*
			(0.0008)	(0.0013)
Mean Payments Made in Zip 3 (#)			0.0141*	-0.0092*
			(0.0011)	(0.0018)
Meantime (mo)	0.0090*	-0.0300*	0.0067*	-0.0424*
	(0.0014)	(0.0023)	(0.0015)	(0.0024)
ln(FNMA Loans in MSA)	-0.1088*	0.0201*	-0.1094*	0.0217*
	(0.0031)	(0.0049)	(0.0031)	(0.0049)
ln(Origination Amount)	1.5137*	0.1327*	1.5150*	0.1370*
	(0.0030)	(0.0049)	(0.0030)	(0.0048)
Current LTV	-0.0065*	-0.0033*	-0.0064*	-0.0033*
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Credit Score	0.0005*	-0.0014*	0.0005*	-0.0014*
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Mortgage Insurance FE	0.3806*	0.1484*	0.3782*	0.1479*
	(0.0032)	(0.0051)	(0.0032)	(0.0051)
Change in Case Shiller (past 6 mo)	0.0022*	-0.0017*	0.0024*	-0.0015*
	(0.0002)	(0.0004)	(0.0002)	(0.0004)
Change in Mortgage Rate (since orig)	-0.0007*	-0.0033*	-0.0014*	-0.0038*
	(0.0001)	(0.0002)	(0.0001)	(0.0002)
Payments Missed to Loan Age (%)	0.0033*	0.0059*	0.0032*	0.0061*
	(0.0001)	(0.0002)	(0.0001)	(0.0002)
Months Delinquent (#)	0.0007*	0.0230*	0.0010*	0.0238*
	(0.0003)	(0.0005)	(0.0003)	(0.0005)
Intercept	-5.9175*	8.1302*	-6.0410	8.0630
	(0.0471)	(0.0761)	(0.0479)	(0.0773)
Zip 3 FE	X	X	X	X
Servicer FE	X	X	X	X
Origination Year FE	X	X	X	X
Delinquency Year FE	X	X	X	X
Property Type FE	X	X	X	X
Loan Purpose FE	X	X	X	X
Adj. R2	0.69	0.20	0.68	0.20
Foreclosures	136,870	136,870	136,870	136,870

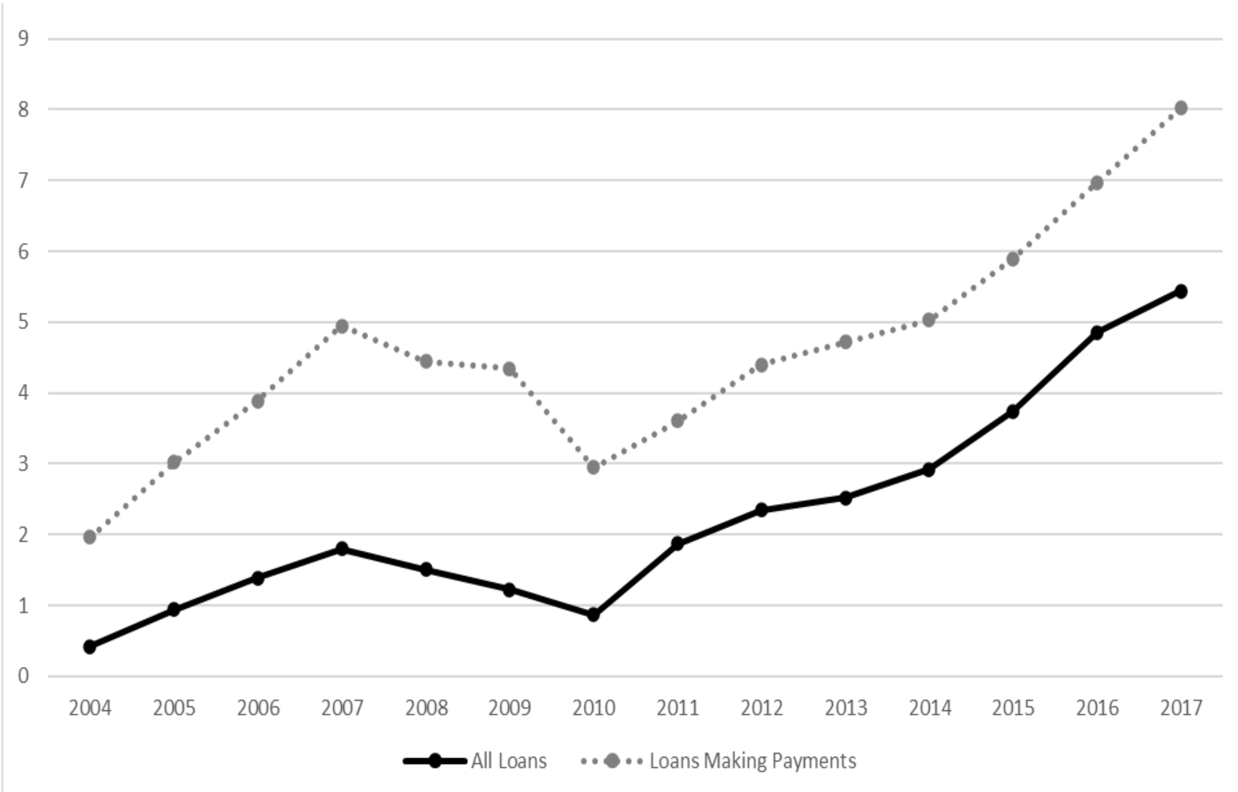
Notes: The estimates above are based on the estimation of a model studying costs and proceeds of foreclosure sales. The dependent variables in the models are the natural logarithms of either proceeds or costs from the foreclosure sale . Mean Payments Made in Zip measures the mean Payments Made by all delinquent borrowers in each month for each Zip 3. Above Zip 3 Mean is a fixed effect equal to one if the observation's Payments Made is greater than the Mean Payments Made in Zip 3 Standard errors in parenthesis. *-Indicates significance at a 5% threshold.

Table 2.9: Lender Cost Model Studying the Signals, Policy, and Costs Over Time

	2.9.1: Sand States		2.9.2: Before and After Policy		2.9.3: During and After Policy	
Dep. Var.=	ln(Procs)	ln(Cost)	ln(Procs)	ln(Cost)	ln(Procs)	ln(Cost)
Payments Made (#)	0.0006	-0.0873*	-0.0010	-0.0968*	0.0007	-0.0775*
	(0.0019)	(0.0041)	(0.0032)	(0.0076)	(0.0021)	(0.0046)
California	-0.1538*	-0.1153*	-0.1452*	-0.1561*	-0.1620*	-0.1100*
	(0.0120)	(0.0266)	(0.0267)	(0.0628)	(0.0130)	(0.0289)
After Policy	-0.0351*	0.0616*	-0.0601*	-0.1091*	-0.0228*	0.0613*
	(0.0070)	(0.0154)	(0.0152)	(0.0357)	(0.0076)	(0.0168)
California X After Policy	-0.0128	0.1178*	-0.0245	0.2921*	-0.0031	0.1033*
	(0.0134)	(0.0297)	(0.0280)	(0.0659)	(0.0143)	(0.0317)
Payments Made (#) X California	0.0068*	-0.0003	0.0066	-0.0007	0.0065	-0.0013
	(0.0033)	(0.0073)	(0.0066)	(0.0156)	(0.0037)	(0.0083)
Payments Made (#) X After Policy	-0.0024	-0.0029	-0.0026	0.0179*	-0.0024	-0.0109*
	(0.0017)	(0.0037)	(0.0030)	(0.0071)	(0.0019)	(0.0041)
Payments Made (#) X California X After Policy	-0.0108*	0.0081	-0.0123	-0.0032	-0.0103*	0.0088
	(0.0038)	(0.0084)	(0.0070)	(0.0163)	(0.0042)	(0.0093)
Other Controls	X	X	X	X	X	X
Zip 3 FE						
Servicer FE	X	X	X	X	X	X
Origination Year FE	X	X	X	X	X	X
Delinquency Year FE	X	X	X	X	X	X
Property Type FE	X	X	X	X	X	X
Loan Purpose FE	X	X	X	X	X	X
Adj. R2	0.73	0.20	0.76	0.29	0.73	0.26
Observations	39,476		20,865		36,966	

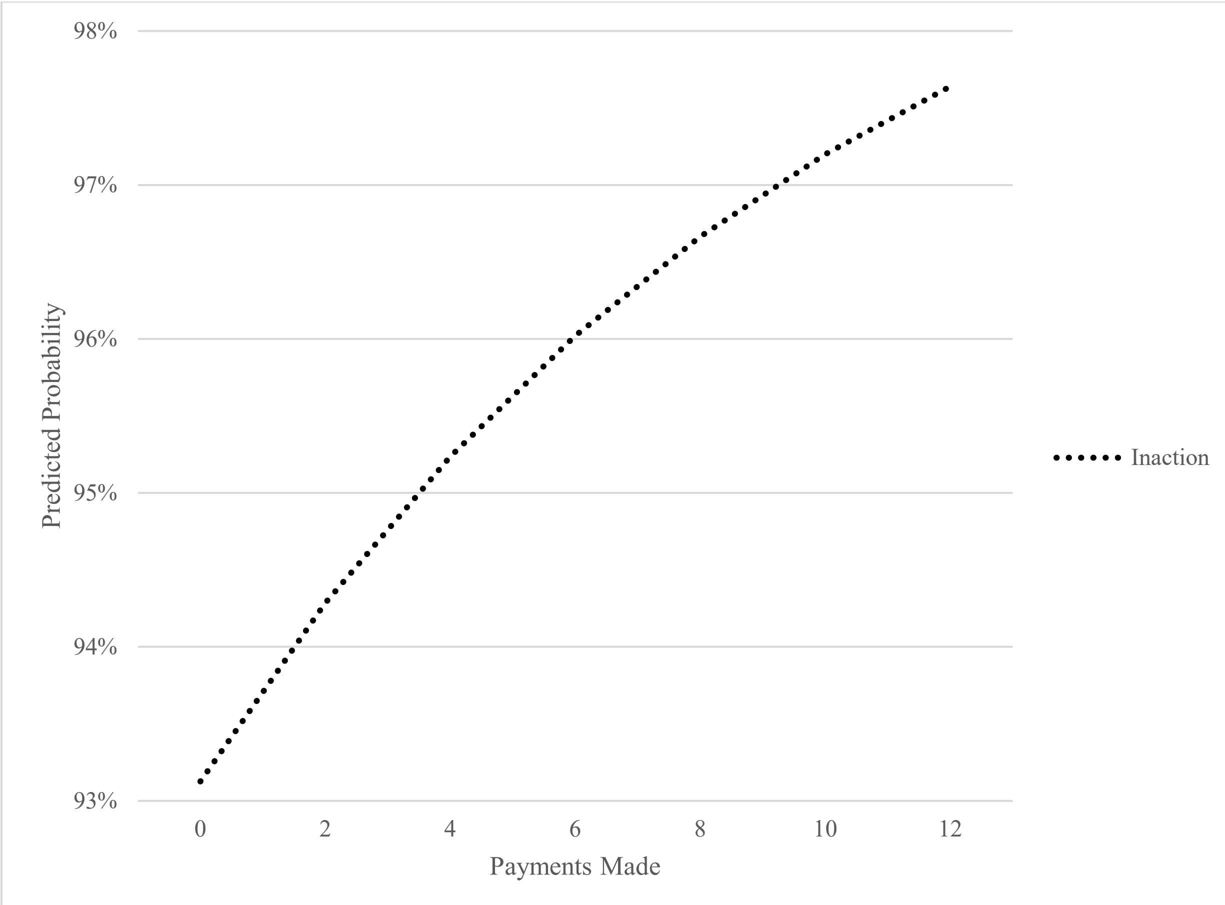
Notes: The estimates above are based on the estimation of a model studying costs and proceeds of foreclosure sales. The dependent variables in the models are the natural logarithms of either proceeds or costs from the foreclosure sale. The sample is restricted to loans in sand states or Arizona, California, Florida, and Nevada. In Model 2.9.1, observations are restricted to delinquencies between 12 months before and eighteen months after the second CFPL, the Delay Law, period. The first CFPL, the Upkeep Law, was in effect this entire period. Models 2.9.2 and 2.9.3 further restrict the sample to monthly loan observations occurring either before and after (2.9.2) or during and after (2.9.2) the Delay Law. Model 2.9.2 thus excludes observations while the Delay Law was in effect and Model 2.9.3 excludes observations before the law. After Policy is a fixed effect for a monthly loan observation occurring after the policy ends. The same control variables used in prior models are included but not reported. Standard errors in parentheses. *-Indicates significance at a 5% threshold.

Figure 2.1: Graph of Mean Payments Made Over Time



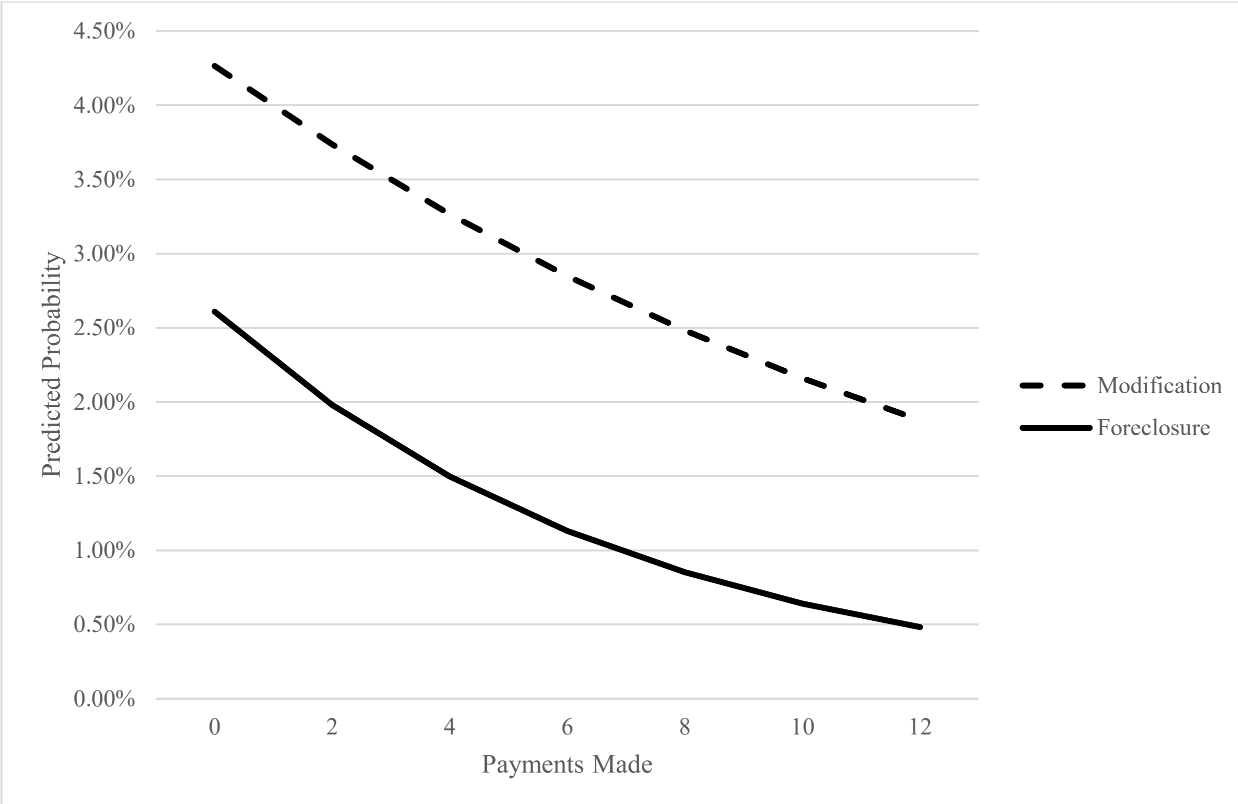
Notes: The above Graph represents the mean number of payments made while delinquent each year. The solid line indicates all loans while the dashed line is the mean payments only for loans that made a payment after first delinquency.

Figure 2.2: Graph of the Predicted Probability of Inaction at Levels of Payments Made



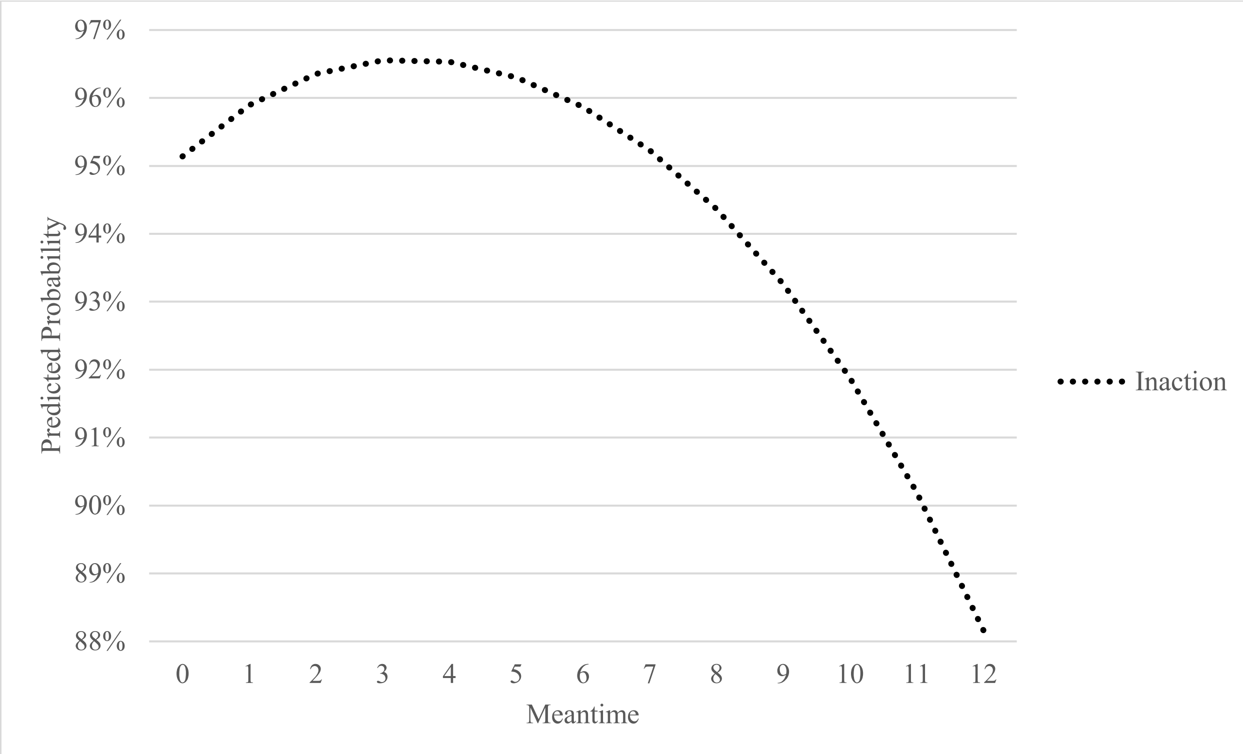
Notes: Fig. 2.2 depicts the predicted probability of strategic inaction by number of payments made.

Figure 2.3: Graph of the Predicted Probability of Action at Levels of Payments Made



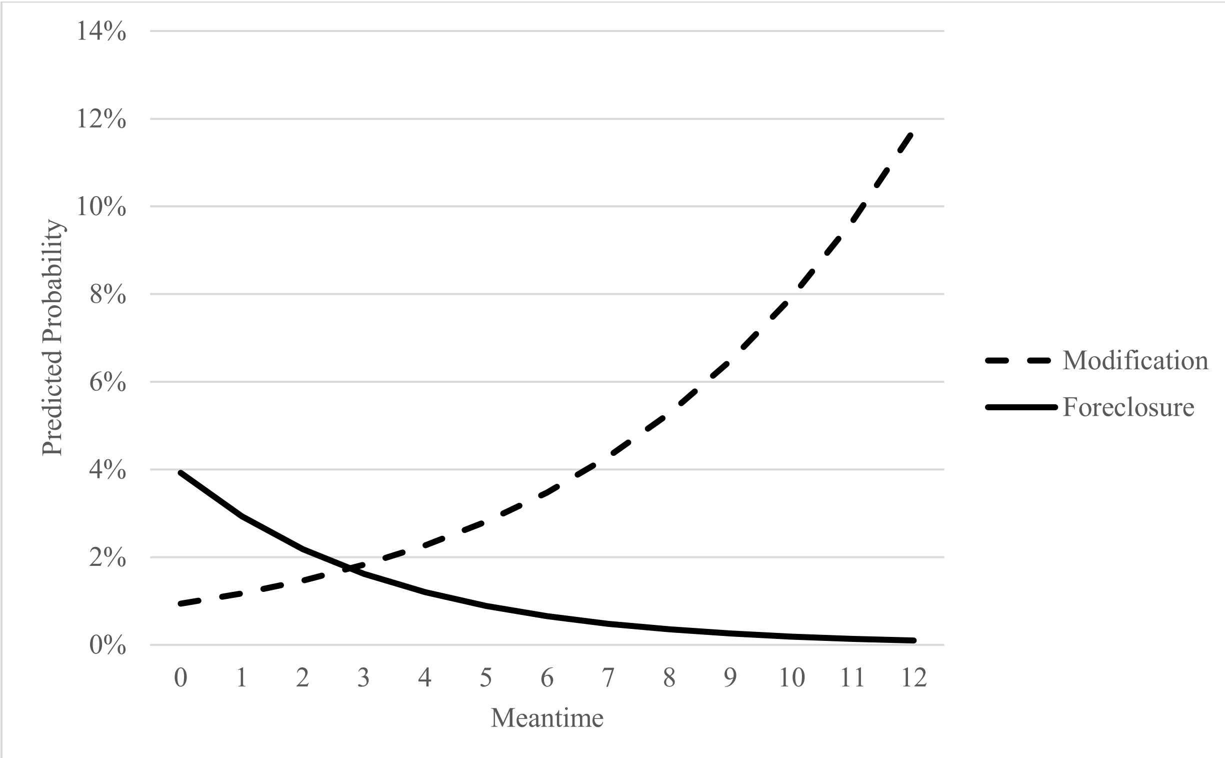
Notes: Fig. 2.3 depicts the predicted probability of modification and foreclosure by number of payments made.

Figure 2.4: Graph of the Predicted Probability of Inaction at Levels of Meantime



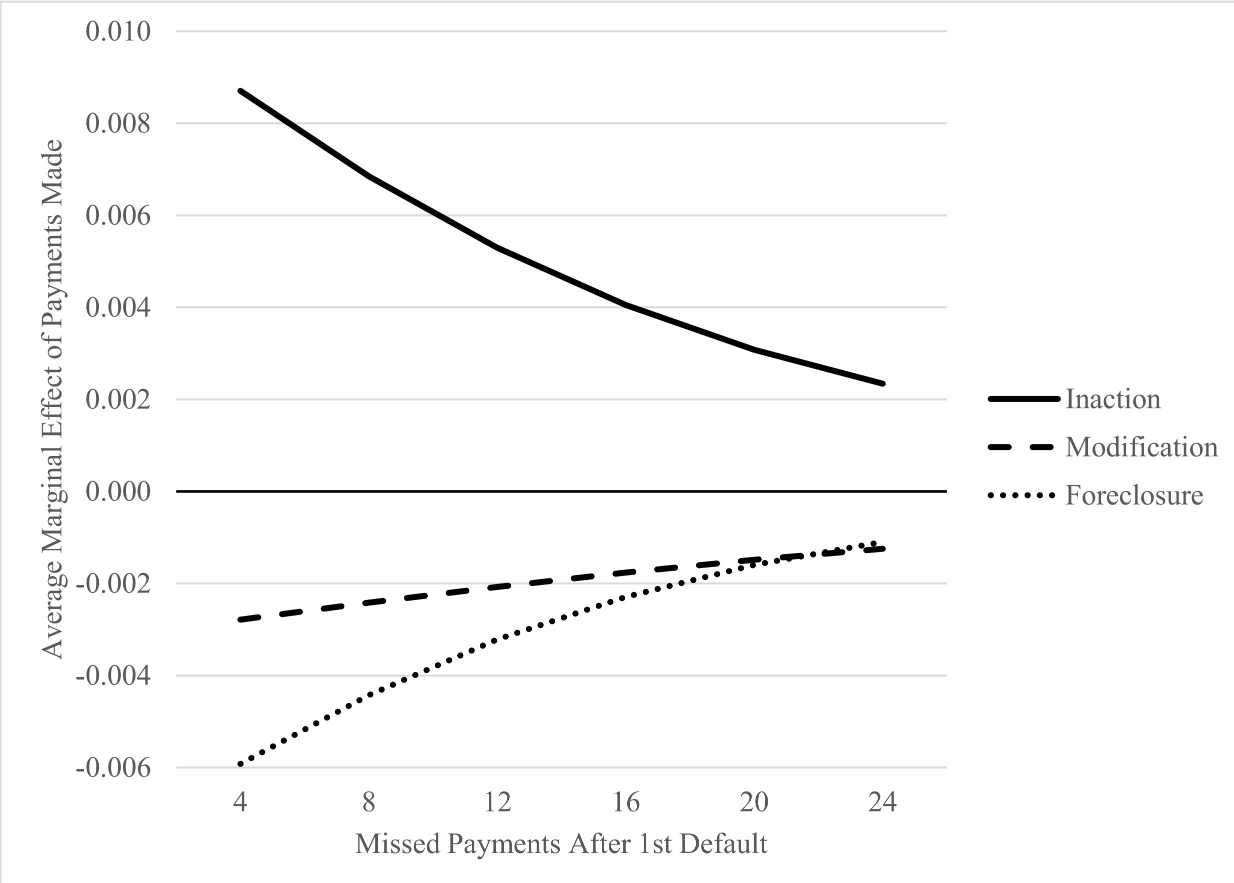
Notes: Fig. 2.4 depicts the predicted probability of strategic inaction by mean timing of payments.

Figure 2.5: Graph of the Predicted Probability of Action at Levels of Meantime



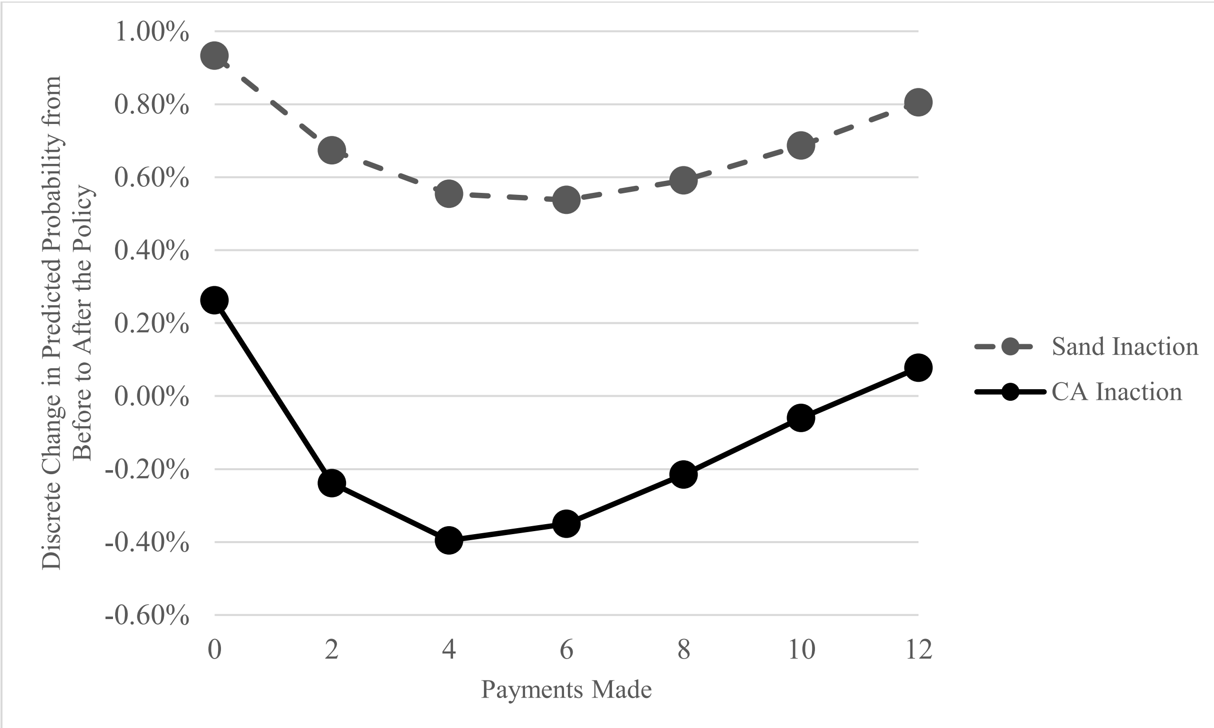
Notes: Fig. 5 depicts the predicted probability of modification and foreclosure by mean timing of payments.

Figure 2.6: Graph of the Average Marginal Effect of Payments Made



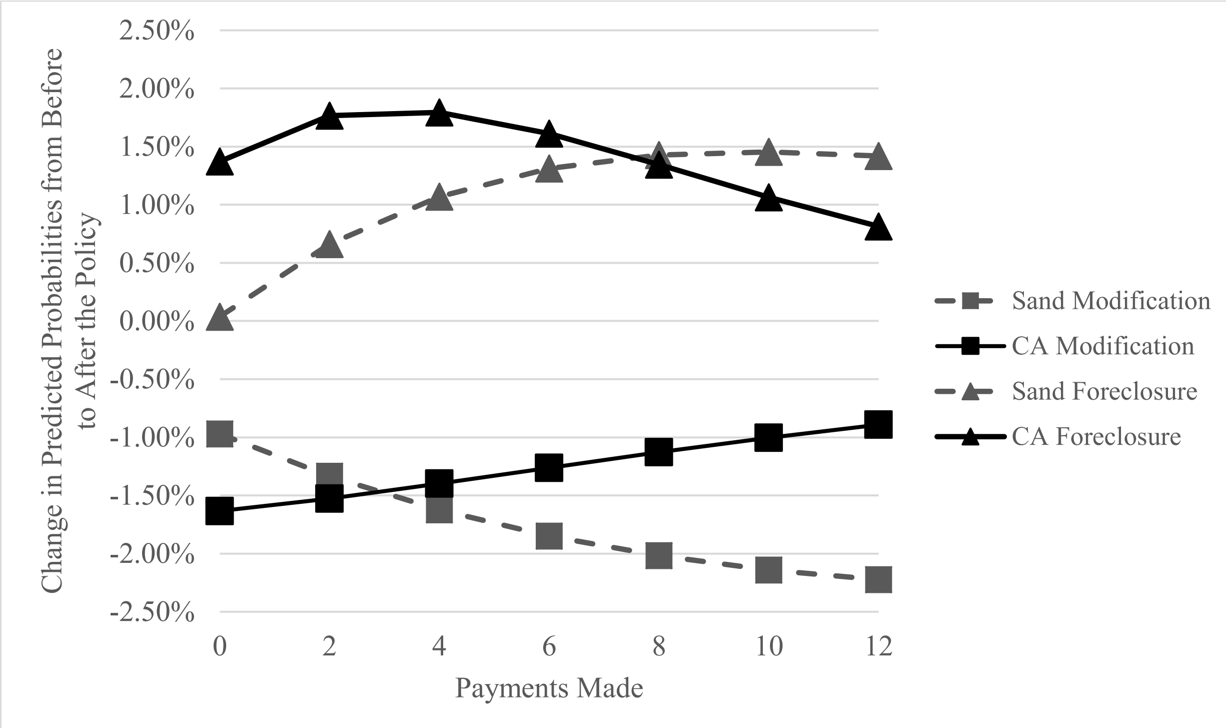
Notes: Fig. 2.6 depicts the average marginal effect of Payments Made at increasing amounts of Missed Payments After 1st Default. The solid line represents the Average Marginal Effect relative to Inaction, the dashed line represents Modification, and the dotted line represents Foreclosure.

Figure 2.7: Change in the Predicted Probability of Inaction After the Delay Law



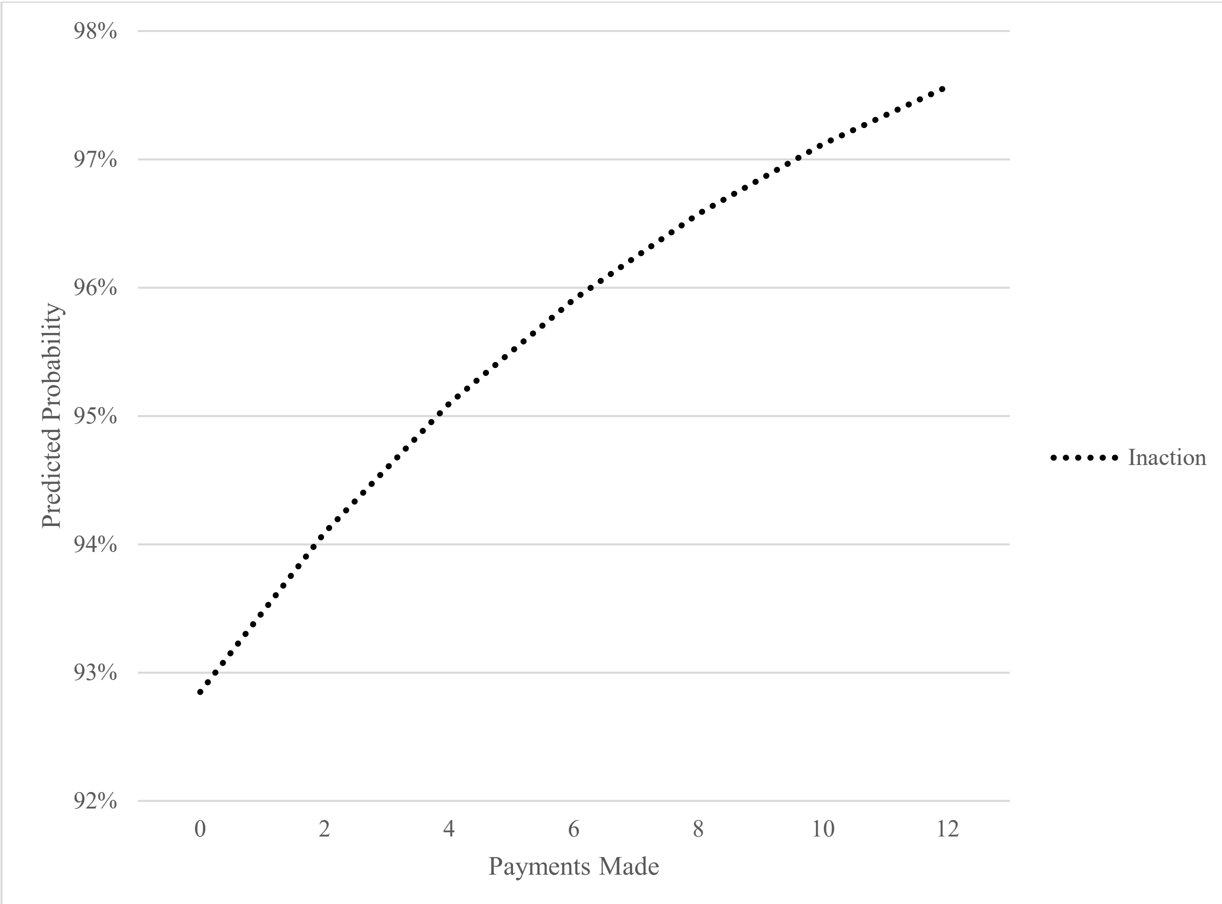
Notes: Fig. 2.7 depicts the discrete change in predicted probability of inaction for the time after the policy ends. The solid line represents the change for loans in California while the dashed line represents loans from other sand states. A value of 0.50% would mean that the predicted probability of inaction increased an absolute 0.50% from before the policy to after.

Figure 2.8: Change in the Predicted Probabilities of Action After the Delay Law



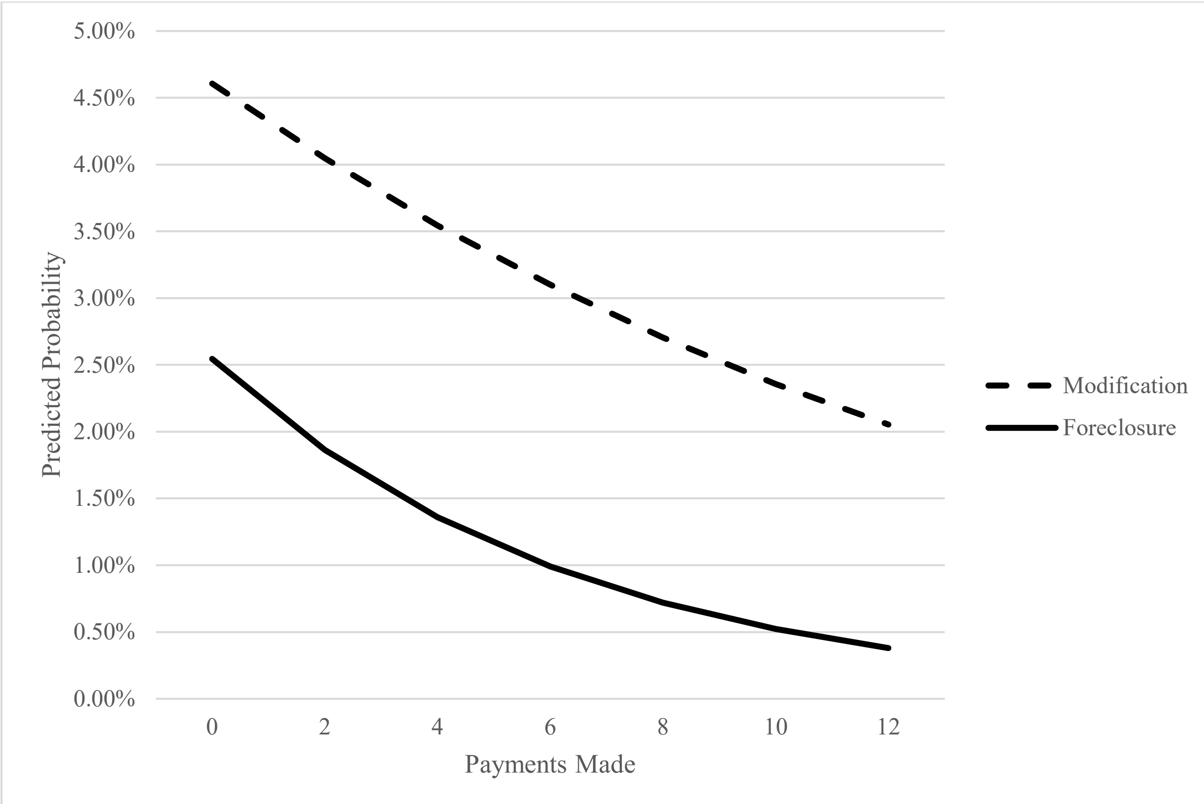
Notes: Fig. 2.8 depicts the discrete change in predicted probability of modification or foreclosure for after the policy ends. The solid line represents the change for loans in California while the dashed line represents loans from other sand states. A value of 0.50% would mean that the predicted probability of modification or foreclosure increased an absolute 0.50% from before the policy to after.

Figure 2.9: Graph of the Predicted Probability of Inaction for the Balanced Sample



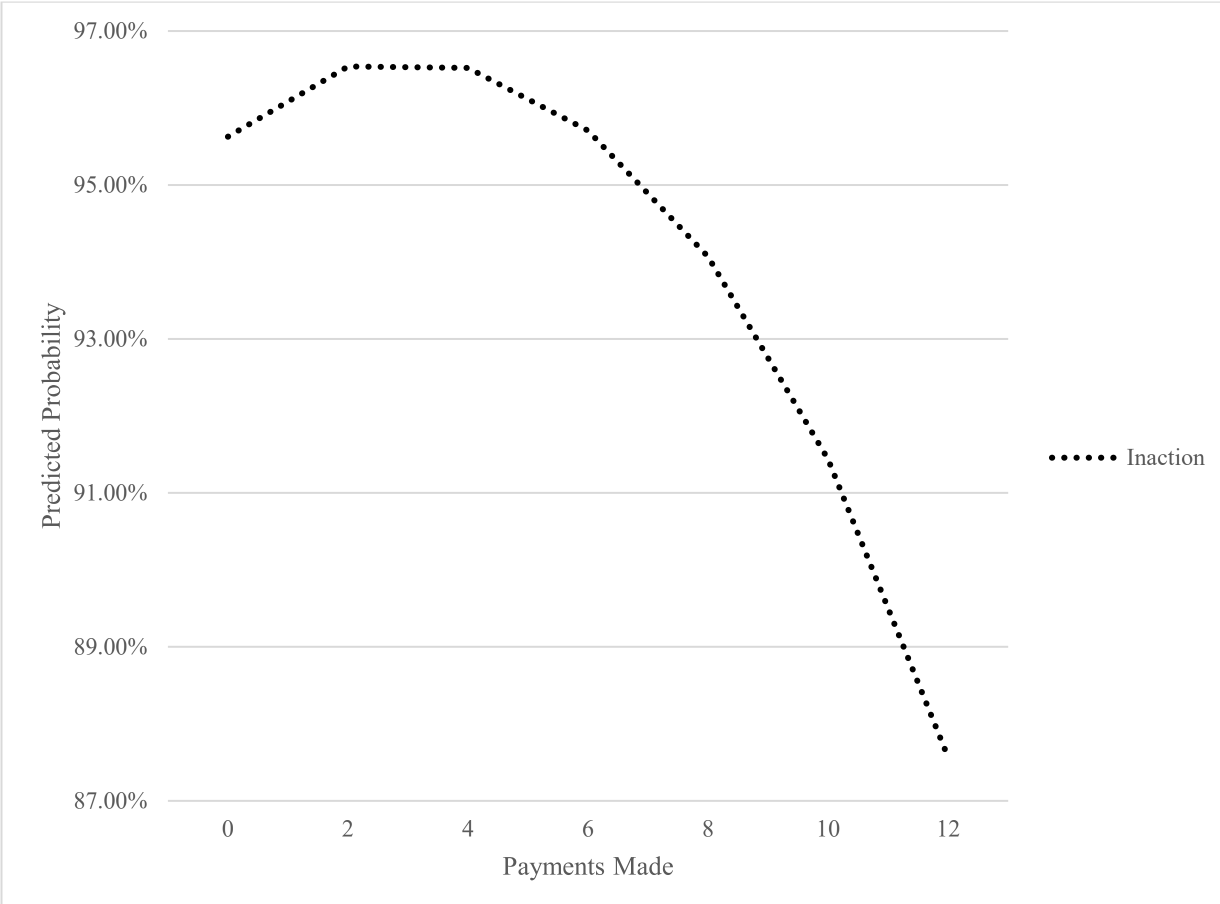
Notes: Fig. 2.9 depicts the predicted probability of strategic inaction by number of payments made for the model estimated on the propensity score matched sample.

Figure 2.10: Graph of the Predicted Probability of Action for the Balanced Sample



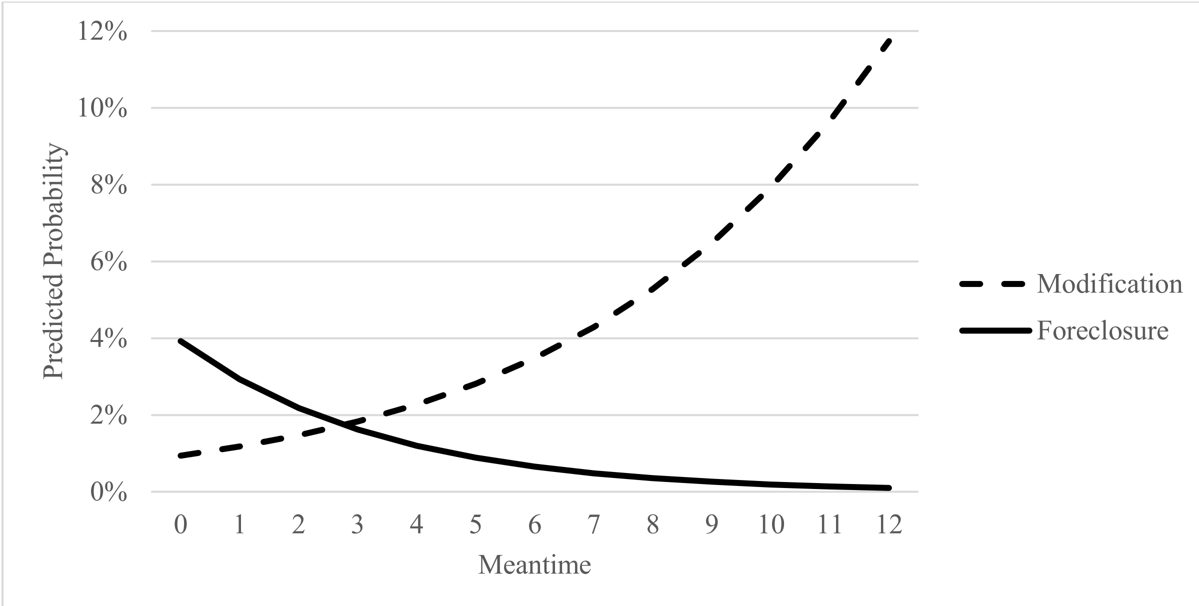
Notes: Fig. 2.10 depicts the predicted probability of strategic inaction by number of payments made for the model estimated on the propensity score matched sample.

Figure 2.11: Graph of the Probability of Inaction on Meantime for the Balanced Sample



Notes: Fig. 2.11 depicts the predicted probability of strategic inaction by mean timing of payments for the balanced sample robustness tests.

Figure 2.12: Graph of the Probability of Action on Meantime for the Balanced Sample



Notes: Fig. 12 depicts the conditional predicted probability of modification and foreclosure by mean timing of payments for the balanced sample robustness tests.