Climate Risk, Insurance Premiums, and the Effects on Mortgage Outcomes[*]

Shan Ge[†] Stephanie Johnson[‡] Nitzan Tzur-Ilan[§]

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Abstract

As climate change exacerbates natural disasters, homeowners' insurance premiums are rising dramatically. We examine the impact of premium increases on borrowers' mortgage and credit outcomes using a novel dataset on home insurance policies for 6.7 million borrowers. We find that higher premiums significantly raise the probability of mortgage delinquency and prepayment. These results hold using a novel instrumental variable. The mortgage delinquency effect is larger for higher loan-to-value mortgages, while the prepayment effect is smaller for these loans. The delinquency effects are present in both GSE and non-GSE mortgages. Our findings unveil a channel through which climate change can erode household financial health and potentially impact the stability of the financial system.

JEL Classification: G21, G22, G5, G52, G53, R21, Q54, D14, R3

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[†]Stern School of Business, New York University, 44 W 4th St, New York, NY 10012. E-mail: sg3634@stern.nyu.edu.

[‡]Jones Graduate School of Business, Rice University, 6100 Main Street, Houston, TX 77005. E-mail: stephanie.g.johnson@rice.edu.

[§]Federal Reserve Bank of Dallas, 2200 N Pearl St, Dallas, TX 75201. E-mail: nitzan.tzurilan@dal.frb.org.

1 Introduction

Climate change is intensifying natural disasters, making homeowners' insurance increasingly crucial for households' financial resilience. Concurrently, insurance premiums in the U.S. have surged dramatically in recent years, with projections indicating further escalation due to climate change. With average annual premiums exceeding $5,000 in some states, the rising insurance costs can pose a growing financial burden on households. This can be a channel through which climate change can adversely affect households' financial outcomes.

Since mortgages account for the largest portion of debt on households' balance sheet, it is a natural question how insurance premiums affect mortgage outcomes. The surge in insurance premiums can squeeze household liquidity available to meet mortgage obligations, potentially leading to more delinquencies. Conversely, some homeowners might opt to prepay their mortgages to avoid the required insurance. Given the significant role mortgages play in the financial market, rapid increases in insurance costs can have far-reaching ripple effects throughout the financial sector.

Despite its importance, the question of how insurance costs affect households' liquidity or credit outcomes remains largely unanswered. One challenge is a lack of data. Another challenge is identification. To fill this critical gap in the literature, we use a newly available dataset that links detailed information on insurance policies with mortgage outcomes for 6.7 million borrowers. We also address the identification challenge by constructing a novel instrumental variable for insurance premium increases.

We confirm the findings in Keys and Mulder (2024) that climate risk is associated with larger insurance premium increases. Following that, we have six main findings. First, we demonstrate that increases in insurance premiums are associated with higher delinquency and prepayment probabilities in the 12 months after premium changes at policy renewals. With zip fixed effects, we compare households within the same zip code who renewed insurance policies between July 2022 and June 2023, which controls for local economic factors correlated with mortgage defaults. The effect on delinquency is especially large. When premiums increase by one standard deviation, the probability of delinquency rises by 0.6 percentage points, equivalent to 16% of the mean probability (3.7%). The increase in delinquency rate is approximately half of this size, if we interpret the economic magnitude based on the average premium increases homeowners experienced between July 2022 and June 2023.

Importantly, these results are robust to an instrumental variable approach, which address potential endogeneity concerns. Our instrument is the average three-digit zip-level premium change in the 12 months prior to the renewal of each policy. With zip fixed effects, we essentially compare borrowers within the same zip code who renewed their policies between July 2022 and June 2023. The variation in the instrument is driven by the difference in when borrowers' prior year's insurance policy expires. Insurance policies are renewed at policy anniversaries, which are determined when households first purchase the policy. Thus, the timing of renewals is exogenous, and this instrument likely satisfies the exclusion restriction.

Our instrument is highly relevant, predicting borrower-level premium changes with a positive and highly significant coefficient, as well as large first-stage F-statistics. The second-stage results closely align with our OLS estimates, suggesting that premium changes causally influence the probabilities of mortgage delinquency and prepayment.

Second, we find that the effect of premium increases on delinquencies is more pronounced for borrowers with high loan-to-value (LTV) ratios. Such borrowers are likely more financially constrained and have less liquidity to cope with rising insurance premiums. This result is consistent with the hypothesis that higher insurance premiums strain household liquidity and negatively impact mortgage outcomes.

Third, the effect on delinquencies is three times larger for non-jumbo than jumbo mortgages. Since jumbo borrowers are less likely to be constrained, this is consistent with our previous finding that more constrained borrowers are more sensitive to premium increases in their delinquencies. This implies that the Federal Government ultimately bears some of the costs of rising insurance premiums through mortgage delinquencies. Relatedly, we find that the effect of delinquency is present in private-label securitized mortgages and those on banks' portfolios, indicating risks for the private financial system. The effect also exists in the subsample of GSE mortgages, implying risks to the government from rising insurance premiums.

Fourth, we find that the prepayment effect of premiums is larger for loans with lower loan-to-value ratios and only exists for non-jumbo loans. This can be explained by the fact that such loans have a smaller amount of balance and are more easily paid off. Or, these loans are associated with median- or low-value properties that are more liquid, making it easier for homeowners to sell and move.

Fifth, we find that the premium increases have a smaller effect on delinquencies if borrowers increase their insurance coverage. When insurance premiums increase, some homeowners increase coverage potentially due to an increase in either actual or perceived disaster risk. Those who purchase more coverage may have more financial liquidity and are thus less likely to be delinquent as a result of rising insurance premiums.

Our findings underscore the significant impact of climate change on household financial resilience. As insurance rates are driven higher by increasingly severe disasters attributable to climate change, we demonstrate that households face a heightened risk of becoming delinquent. This result emphasizes the substantial financial burden climate change imposes on households.

Importantly, our paper also highlights risks associated with insurance prices in mortgages and mortgage-backed securities, with implications for the stability of the financial sector. Delinquencies represent negative shocks to holders of mortgages, which constitute a large part of the financial sector. Consequently, our findings not only illuminate the direct effects on households but also reveal implications for the broader impact of climate change and insurance on financial stability.

Our findings carry significant implications for policymakers grappling with the issue of insurance affordability. The results suggest that insurance costs are severely constraining households' liquidity, to the extent that some households are becoming delinquent on their mortgages as a result. Considering that mortgage defaults can have large spillover effects on the wider economy, our research underscores the potential benefits of policy interventions, such as means-tested insurance subsidies[1] for existing homehomers. Such measures may have a limited net effect on the government budget, given that our results suggest that the Federal Government may be bearing much of the delinquency risk associated with rising insurance costs.

To the best of our knowledge, we are the first to identify the effect of property insurance premiums on households' financial outcomes. We contribute to the literature on property insurance and mortgages, which focuses on different perspectives. Sastry (2021) argues that lenders require higher downpayment for borrowers who under-insure, potentially due to concerns about post-disaster default. Sastry, Sen and Tenekedjieva (2023)

[1] See a related proposal studied by the Congressional Budget Office, https://www.cbo.gov/publication/59918.

find that mortgage defaults are higher in areas after disasters with higher levels of insurer insolvency. We find that increases in premiums alone, orthogonal to disasters, can also increase the risk of default. Ge, Lam and Lewis (2024) document that buyers of homes that experience exogenous flood insurance premium increases are less likely to take up mortgages. Our result can potentially explain their finding: banks may be concerned about default risks associated with higher insurance premiums. An, Gabriel and Tzur-Ilan (2024) explore the effect of wildfires on housing and mortgage outcomes and discuss the role of insurance. By highlighting the important effect of insurance premiums on mortgage outcomes, we also contribute to a growing literature studying trends and patterns in home and flood insurance pricing.[2]

Our study contributes to the growing body of literature examining the intersection of climate change, natural disasters, and mortgage markets. Prior papers explore the impact of disasters on mortgage delinquencies (Gallagher and Hartley, 2017; Kousky, Palim and Pan, 2020; Billings, Gallagher and Ricketts, 2022; Issler, Stanton, Vergara-Alert and Wallace, 2024; Biswas, Hossain and Zink, 2023), pricing of mortgage-related securities (Gete, Tsouderou and Wachter, 2024), and securitization (Ouazad and Kahn, 2022). We highlight a different channel—insurance costs—through which disaster and climate risks can affect mortgage outcomes. In so doing, we also complement recent work on climate risk in housing markets (Bernstein, Gustafson and Lewis, 2019; Baldauf, Garlappi and Yannelis,

[2] Liao and Mulder (2021) study the effect of home equity on flood insurance demand. A few papers study the effect of insurance premiums on the housing market with mixed findings, including Georgic and Klaiber (2022) Hennighausen, Liao, Nolte and Pollack (2023), Gibson and Mullins (2020), Bakkensen and Barrage (2021), Nyce, Dumm, Sirmans and Smersh (2015), and Hino and Burke (2021). Papers on home insurance pricing include Keys and Mulder (2024), Boomhower, Fowlie, Gellman and Plantinga (2024), Oh, Sen and Tenekedjieva (2022), and Sastry et al. (2023). Papers on the National Flood Insurance Program pricing include Wagner (2022), Weill (2022), Mulder and Kousky (2023), and Mulder (2021). A few other papers study other effects of flood insurance reform, including Wagner (2022) and Mulder (2021). Jung, Engle, Ge and Zeng (2023) measure insurers' exposure to climate risk.

2020; Murfin and Spiegel, 2020; Keys and Mulder, 2020; Giglio, Maggiori, Rao, Stroebel and Weber, 2021; Lopez and Tzur-Ilan, 2023).

Our paper also contributes to the literature on how physical climate risk affects financial markets. Acharya, Berner, Engle, Jung, Stroebel, Zeng and Zhao (2023) summarize in their review of the literature that physical risks, such as rising sea levels, extreme weather events, and heat stress, can lead to direct damages to assets and disruptions to business operations, potentially resulting in loan defaults and losses for banks. We highlight a new channel, i.e., insurance premiums, through which climate change can impose substantial risks on the financial market.

2 Institutional background

2.1 Background

Homeowners insurance is a critical component of the U.S. housing market. Sastry, Sen, Tenekedjieva and Scharlemann (2024) estimate that 80% of homeowners hold such policies. This high adoption rate is likely driven by mortgage lenders requiring insurance coverage as a precondition for loans. Around 30% of homeowners reported being impacted by weather events in the last 5 years, highlighting the importance of such coverage.[3]

The most common policy for owner-occupied residences is the "HO-3" type, which provides comprehensive coverage, including the structure, contents, legal expenses, and temporary living costs if the home becomes uninhabitable due to damage. These multi-peril policies typically have one-year terms with automatic renewal, subject to potential changes in rates or terms communicated through annual statements. However, it's crucial

[3]See Homeowners Perception of Weather Risks 2023Q2 Consumer Survey, https://www.iii.org/sites/default/files/docs/pdf/2023_q2_ho_perception_of_weather_risks.pdf.

to note that standard policies often exclude certain perils, such as floods and earthquakes. Specialized policies are available to cover these excluded risks.[4] In areas where private insurance is difficult to obtain, homeowners may resort to state-sponsored "insurers of last resort," such as Citizens Property Insurance in Florida or the California FAIR plan.

2.2 Coverage

Homeowners' insurance policies typically include several key components that define the scope and extent of coverage.

Coverage types in a standard policy usually include dwelling coverage (for the structure of the home), personal property coverage (for belongings), liability protection, and additional living expenses.[5] In terms of structure coverage, there are two dominant types: "Actual Cash Value" (ACV) and "Replacement Cost Value" (RCV). ACV reimburses policyholders for the depreciated value of damaged property, meaning it deducts for age and wear. For example, if a 10-year-old roof is damaged, ACV would pay the current market value of that roof, not the cost of a new one. In contrast, RCV covers the full cost to repair or replace the damaged property without depreciation deductions. This means that a policyholder would receive enough to replace the old roof with a new one of similar quality. Overall, RCV typically provides higher payouts but comes with higher premiums compared to ACV policies.

Deductibles are the amount the policyholder must pay out-of-pocket before insurance coverage kicks in. In our data, many policyholders choose a deductible of 0.5% of the total insured value. The total insured value represents the maximum amount the insurer

[4]See https://content.naic.org/sites/default/files/publication-hoi-pp-consumer-homeowners.pdf.

[5]https://content.naic.org/sites/default/files/publication-hmr-zu-homeowners-insurance.pdf.

will pay in the event of a total loss, typically set to the estimated cost to rebuild the home.[6] Homeowners can often customize their policies by adjusting coverage limits, adding endorsements for specific valuables, or opting for higher deductibles to lower premiums.[7]

2.3 Pricing

The cost of homeowners insurance is primarily determined by location-specific risks, with states prone to natural disasters such as hurricanes, tornadoes, and wildfires typically having higher premiums. For instance, Florida and Louisiana have some of the highest average annual premiums, exceeding $5,700, while states like Hawaii and Vermont have much lower average costs, around $500 to $800 per year.[8] Other factors affecting pricing include the home's age, construction materials, proximity to fire stations, and the homeowner's claims history and credit score. Insurance companies use complex actuarial models to assess risk and set premiums, leading to variations in pricing among different insurers (Boomhower et al. 2024). Homeowners insurance rates in the United States are subject to regulatory oversight and approval processes, which vary by state. Insurance companies must typically submit rate change requests to state insurance departments or commissions for review and approval before implementing new premiums.

3 Data

3.1 Residential Mortgage Servicing (ICE McDash Analytics)

The Residential Mortgage Servicing Database contains information from ICE McDash data. The data are comprised mainly of the servicing portfolios of the largest residen-

[6] https://scholarship.law.umn.edu/faculty_articles/589/.
[7] https://www.journals.uchicago.edu/doi/abs/10.1086/699982.
[8] https://www.bankrate.com/insurance/homeowners-insurance/home-insurance-statistics/.

tial mortgage servicers in the US. It covers approximately two-thirds of installment-type loans in the residential mortgage servicing market. Loan-level attributes include borrower characteristics (credit scores, owner occupancy, documentation type, and loan purpose); collateral characteristics (LTV, property type, zip code); and loan characteristics (product type, loan balance, and loan status). We restrict our sample to loans secured by single-family homes with non-missing zip code, occupancy, origination date, LTV, DTI, and credit score.

We use two loan outcomes from this dataset. The first is whether a mortgage is delinquent for at least 30 days. The second is whether a mortgage is prepaid. It is important to note that we focus on voluntary payoffs. This measure does not include foreclosures. We drop loans that were transferred to a different servicer during our sample period or that were terminated for an unknown reason. Voluntary prepayment, in principle, includes refinancing. However, given that we examine mortgage outcomes between July 2022 and June 2024, a period characterized by high interest rates, the proportion of borrowers opting to refinance during this time would likely be minimal. Indeed, in the first half of 2023, refinancing activity is the lowest in almost 30 years.[9] We anticipate that the response to a premium increase should primarily reflect the borrower selling the property or repaying without taking out a new loan.

In order to include a loan in our sample, we need to be able to compute the change in premium between policy renewals. As the insurance data is provided along with December loan performance data, a loan that was prepaid in June after a premium increase in March, say, would be dropped from the dataset. Figure A1 plots the share of mortgages that are prepaid reported by the calendar month of the insurance policy expiration date.

[9] See, https://www.freddiemac.com/research/pdf/Freddie_Mac_Outlook_August_2023.pdf.

The share is around 7% for policies that renew January, then drops down to around 1% for February renewals, then rises monotonically to more than 6% for December renewals. It is very unlikely these patterns are due to actual prepayment ratios changing with insurance renewal month. Thus, we interpret the pattern in Figure A1 as being due to under-reporting of prepayment that is more severe between February and August. Therefore, in our empirical analyses, we report the results using samples with different policy renewal months and choose those with Sep-Jan renewal month as our main sample for the prepayment analysis.[10] Note that the delinquency reporting does not have this issue.

3.2 ICE McDash Property Insurance Module

We obtain data on insurance at the loan level from ICE McDash. The property insurance module contains a loan identifier allowing insurance information to be matched with ICE McDash Residential Mortgage Servicing Data. Insurance data are obtained from a subset of mortgage servicers who agreed to participate and cover around three-quarters of mortgages in the servicing data.

If insurance coverage is not maintained, the servicer is liable for any damages that may result. Because of these legal responsibilities and liability risks, servicers maintain detailed data on insurance coverage and enter these data into the servicing system. When a mortgage is closed, and every year thereafter, borrowers must submit proof of homeowner's insurance.

The ICE McDash Property Insurance data include the following variables: Coverage amount per loan, deductible amount, the date when the policy expires, and "Replacement Cost Value" or "Actual Cash Value" coverage flag (which indicates whether the primary

[10]In a previous draft, we do not make this sample restriction.

insurance coverage is equal to the replacement cost of the property. We restrict our sample to loans with annual insurance policies that also appeared in the ICE McDash sample in the previous calendar year. We further require that the loan is current in the month before the insurance policy expires.

3.3 CoreLogic Climate Risk

The CoreLogic Climate Risk Data contains structure-level data on measures of current and future climate risk for properties in the U.S. CoreLogic uses their proprietary climate model to generate measures of climate risk on nine perils. For each structure within a parcel or property, data include a measure of Average Annual Loss (AAL) at various return periods. AAL is the expected annual loss to structure and contents generated by simulating many possible iterations of a given year and then calculating the average loss across all iterations. Thus, AALs account for the magnitude of damage resulting from events of different severity as well as the likelihood of events of different severity occurring. CoreLogic reports AALs as a share of total insurable value (TIV), which can be understood as the replacement cost of the structure (Amornsiripanitch and Wylie, 2023).

These risk measures are estimated under four climate scenarios. First is the base scenario, which reflects current climate conditions. Estimates calculated using the base scenario give measures of current climate risk. The other three are based on Representative Concentration Pathway (RCP) scenarios which are greenhouse gas concentration trajectories that are published by the Intergovernmental Panel on Climate Change (IPCC). CoreLogic uses RCP 2.6, RCP 4.5, RCP 8.5 as the three future scenarios, with RCP 2.6 being the least and RCP 8.5 being the most severe scenarios of greenhouse gas concentration trajectories, corresponding to higher levels of global temperature rise through time. For more details, see IPCC (2014).[11]

4 Climate Risk Associated with Larger Premium Increases

In Figure 1, we examine how premiums have evolved in recent years. We estimate the following regression at the zip-by-year level.

$$\log((Premium/TIV)_{z,t}) = \gamma_z + \delta_{c,t} + \sum_{t=2016}^{2023} \beta_t \log(ClimateRisk_z) + \alpha_t Controls_z + \epsilon_{z,t},$$

where z denotes zip code, c denotes the county, and t the year. The dependent variable is premiums relative to the total insured value, averaged at the zip-year level. The main independent variable is CoreLogic's composite measure of climate risk aggregated at the zip level. We use only policies with deductibles being 0.5% of total insured value (TIV) in this analysis so that changes in deductibles do not drive the results. Panel A plots the estimates of β_t.

Panel B repeats A, replacing the dependent variable with the cumulative change, relative to 2014, in the premium as a percentage of TIV for policies where the deductible (as a percentage of % TIV) and coverage type (ACV or RCV) do not change. This measure is constructed using within-loan changes in premium only. The figures show that starting in 2021, insurance premiums have experienced faster growth in areas with higher levels of climate risk, consistent with Keys and Mulder (2024).

In Figure 2, we replace the dependent variable with the percentage of homes with "Actual Cash Value" as coverage in Panel A and average deductible as a percentage of

[11] The AAL Risk Score transforms specific values of AAL into scores of 1-100 representing "quasi-quantile" bins and 0 representing AAL = 0. The "quasi-quantile" bins are delineated using base scenario AAL distribution within the peril and risk score group. Thus, the scores can be used to compare across timeframes and RCP scenarios within perils and risk score groups.

total insured value in Panel B. "Actual Cash Value" policies subtract depreciation in claim payouts and are thus considered to offer less coverage. Both dependent variables are at the zip-year level. We again plot the estimates of the coefficients, β_t.

Figure 2 suggests that starting from 2021, households in areas with higher levels of climate risk experienced a larger drop in coverage. This is consistent with the idea that increases in insurance costs impose financial burdens on households. Our results echo those in Sastry et al. (2024). The subsequent analyses evaluate the impact of premium increases on mortgage outcomes.

5 Effects of Premiums on Mortgage Outcomes

5.1 OLS Results

5.1.1 Mortgage Delinquency

Table 2 presents our main results using OLS. In Columns (1) and (2), the dependent variable is an indicator of whether the household is delinquent on the mortgage for at least 30 days. The main independent variable is the increase in premiums per dollar of coverage from prior to the current renewal for each household. This variable is assigned a value of zero if a policy's premium decreased or remained unchanged. We control for loan age, defined as the number of months since the mortgage origination.[12] In Column (1), we control for a battery of fixed effects: zip code, mortgage origination year, insurance policy renewal year-month (labeled as "Start Month"), loan-to-value ratio bin, FICO at origination bin, and debt-to-value ratio bin. In Column (2), we replace the zip-fixed effects with

[12]Because we control for mortgage origination year fixed effects, the estimated coefficient on loan age is identified using variation of mortgages that originated within the same year, but different months and/or renewed their insurance policies in different months.

zip-by-insurance renewal year-month fixed effects.

The coefficients on premium changes are consistently positive, suggesting that when premiums increase, households are more likely to be delinquent on their mortgages. Our estimates indicate that a one standard deviation increase in premiums is associated with a 0.6 percentage points, equivalent to 16% of the mean probability (3.7%). The increase in delinquency rate is approximately half of this size, if we interpret the economic magnitude based on the average premium increase homeowners experienced between July 2022 and June 2023. With a total of 51 million mortgages outstanding in the U.S.,[13] The average premium increase is associated with an increase of around 207,000 mortgages being delinquent within 12 months after the premium increase.

Figure 3 plots the response of mortgage delinquency to premium increases over time. The figure suggests that the effect of premiums becomes larger as more time passes since the policy renewal. Figure 4 presents bin-scatter plots illustrating the relationship between delinquency probability and premium changes. The upper figure uses premium increases in dollars, while the lower figure uses increases in premiums as a percentage of total insured value. We incorporate controls identical to those employed in Columns (1) and (3) as described previously. Both figures demonstrate a positive relationship between delinquency probability and premium changes.

5.1.2 Mortgage Prepayment

Next, we test our hypothesis that when insurance premiums increase, borrowers are more likely to prepay their mortgages to lower their cost of insurance. As discussed in Section 3.1, because the insurance data is provided along with December loan performance information, loans that are prepaid prior to December are typically are missing insurance data

[13]See, https://www.fhfa.gov/data/dashboard/nmdb-aggregate-statistics.

for that year. This issue should have little effect on our estimates for loans with policies renewing in December and January, and only a modest effect on renewals late in the year.

In Table A1, we repeat Column (1) of Table 2, replacing the dependent variable with an indicator of whether the mortgage is prepaid. We use the full sample in Column (1), borrowers who renewed insurance policies between September and January in (2), and those who renewed in December in (3)—the most accurate sample. The estimated coefficient on *Premium Increase* is much smaller using the full sample, and highly similar between Columns (2) and (3). Since the larger sample used in Column (2) provide us with more power, we use that as our main sample.

In Column (3) of Table 2, we present the prepayment result using borrowers with renewal months between September 2022 and January 2023 (repeating Column (2) of Table A1). Our estimate indicates that a one standard deviation increase in premiums is associated with the probability of prepayment increases by 0.2 percentage points, corresponding to 4% of the mean. Because we use a much smaller sample in Column (3) with insurance renewal timing within a 5-month period, we do not use the zip-by-insurance renewal month fixed effects as in Column (2).

Figure 5 plots the response of mortgage prepayment to premium increases over time. The figure suggests that the effect of premiums again becomes larger as more time passes since the insurance policy renewal. Given the data limitation discussed above, Figure 5 uses only loans with December or January policy renewal months to avoid biasing the prepayment response at short horizons. Figure 6 replicates Figure 4, substituting delinquency with prepayment probability. These visualizations indicate a positive relationship between prepayment probability and premium changes, with the slope largely driven by larger premium increases.

5.2 Instrumental Variable for Premium Change

Our OLS results do not establish a causal relationship. The observed association between higher insurance premiums and increased mortgage delinquencies could be attributed to omitted variables. For instance, households experiencing financial distress may be more likely to have homes in disrepair and exhibit lower credit scores. These factors could potentially lead insurers to charge such households higher insurance premiums. Concurrently, the households' financial distress may independently contribute to mortgage delinquency. To address this identification challenge and mitigate potential endogeneity concerns, we instrument for the premium changes households face.

Our instrument for the premium increase relies on three key components. First, the timing of when households' previous insurance policy expires is most likely random. Homeowners' insurance policies are typically of one-year duration. Households renew their insurance policies when their old policy expires, i.e., on policy anniversaries, which depends on when they first purchased an insurance policy. Second, there are location-level trends that can drive the increase in premiums. A significant factor driving such trends could be insurers' evolving perception of location-specific risks. Additionally, state regulators' willingness to approve rate increases may play a crucial role (Oh et al. (2022)). Third, within a location (i.e., a three-digit zip code), insurance premiums likely have increased more for houses that are riskier, which we can proxy using the lagged premiums of each house. The intuition is related to the findings in our Figure 1 and Keys and Mulder (2024).

We construct our instruments as follows. We first compute each policy's change in premium as a percentage of the total insured value at policy renewal. For each policy, the first instrument is the average premium change at the three-digit zip level in the 12 months immediately before the expiration of the previous year's policy. To mitigate potential confounding factors, when computing the average change, we only use policies whose deductibles and coverage type remained the same as the previous policy year. Furthermore, to eliminate any effect stemming from endogenous renewal timing, we utilize the expiration date of the previous year's policy, although, for simplicity, we often refer to this as the renewal timing.

We add a second instrument, which is an interaction between the aforementioned, first instrument with the lagged premiums (as a percentage of total insured value). We use both instruments simultaneously in the first stage, while controlling for the lagged premiums in both the first and second stages.

The underlying rationale is that as insurers adjust premiums in a location, it will only affect a homeowner upon policy renewal. The magnitude of the homeowner's premium change should be strongly correlated with the recent average premium change in the local area. Houses that are riskier, proxied by higher lagged premiums, should experience a larger premium increase. The intuition here is related to Keys and Mulder (2024), who find that location and risk are critical factors in insurance pricing trends.

In our regressions, after controlling for state fixed effects, we essentially compare borrowers within the same state who renewed their policies between July 2022 and June 2023. The variation in the instrument is driven by the difference in when borrowers' prior year's insurance policies expire, as well as its interaction with the lagged house-level premiums. Because the policy renewal timing was determined years ago when borrowers initially purchased home insurance and is thus likely exogenous, its interaction with lagged premiums should also be exogenous. Therefore, our instrument likely satisfies the exclusion restriction.

5.3 Instrumental Variable Results

Table 3 uses our instrument in a two-stage least square (2SLS) setting.[14] Columns (1) and (3) present the first-stage results. The dependent variable is premium changes, as described above. The two instruments are the average premium change at the three-digit zip level in the 12 months immediately before each policy's renewal, as well as its interaction with the lagged house-level premiums. The first-stage result indicates that both instruments predict premium increases with positive and statistically significant coefficients. The result suggests that a borrower is likely to experience large premium increases if the three-digit zip code experiences larger premium increases in the 12 months prior to policy renewal. The borrower will experience a even larger premium increase if her previous premiums were high, which likely corresponds to higher disaster risks. The large Kleibergen-Paap Wald F statistic suggests that the first stage is sufficiently strong.

Columns (2) and (4) present the second-stage results. The dependent variable is an indicator of mortgage delinquency in Column (2) and an indicator of prepayment in (4). The coefficients on the instrumented premium increases are positive and significant in all of the columns. The second-stage effects are highly similar to the OLS results. Given our arguments in Section 5.2 on the exogeneity of the instruments, these results strongly suggest that premium changes lead to an increase in mortgage delinquency and prepayment.

Two different mechanisms can potentially explain the observed increase in mortgage delinquency. First, rising insurance costs may cause households' liquidity constraints to be more binding, potentially leading to higher delinquency rates. Second, as Ge et al. (2024) document, house prices, on average, decrease in response to exogenous increases

[14] In calculating local average premium changes in the instrument construction, we restrict our analysis to policies that did not change the amount of deductibles or the type of coverage from the previous year. The deductible and coverage information is missing in some zip codes, resulting in the loss of observations.

in insurance premiums. Consequently, a decline in house market value could induce household default, although this channel is arguably less probable.

The increase in mortgage prepayment can also be attributed to two different mechanisms. First, when insurance becomes more costly, the overall costs of homeownership increase. This may prompt some homeowners to sell their current properties and transition to smaller homes or those with lower disaster risks, thereby reducing insurance costs. Second, as insurance costs rise, households may reduce their demand for insurance. Given that mortgage lenders typically require home insurance, borrowers may be incentivized to prepay their mortgages to avoid the increased insurance costs.

6 Heterogeneous Effects Across Financial Constraints

6.1 Delinquency Effect is Larger for More Constrained Borrowers

If insurance premium increases present a negative liquidity shock to households, and thus lead to more delinquencies, we would expect the effect to be stronger for more financially constrained households. We examine this hypothesis in Table A4.

We use the loan-to-value (LTV) ratio to proxy for households' financial constraints. Column (1) uses a subsample of households with LTV ratios above 80, while Column (2) uses those below 80. The estimated coefficient for the high-LTV subsample is approximately twice that of the low-LTV subsample. In Column (3), we assess the statistical significance of this difference by analyzing the entire sample and adding an interaction term between premium change and a high-LTV indicator. The estimated coefficient is positive and statistically significant on the interaction term, suggesting that the difference between the two subsamples is statistically significant.

These results indicate that high-LTV borrowers exhibit a greater sensitivity to premium increases in terms of delinquency probability compared to low-LTV borrowers. Our findings align with the hypothesis that rising insurance premiums impose significant financial pressure on households. This mechanism may represent a crucial channel through which climate risks impact households' financial resilience and the broader mortgage market.

6.2 Prepayment Effect is Smaller for More Constrained Borrowers

We posit that insurance premium increases may induce borrowers to increase prepayment probability due to two potential mechanisms. First, borrowers with substantial liquidity may prepay their mortgages to avoid mandatory insurance requirements. Second, borrowers may opt to sell their current home and relocate to a property with lower insurance costs, either due to reduced location-specific disaster risks or a more disaster-resilient structure. Even though moving and saving on insurance costs can be positive NPV, moving is costly in terms of liquidity (e.g., fees to real estate agents). Consequently, financially less constrained borrowers are more likely to pursue this option. During our sample period of July 2022 to June 2024, the prevailing high interest rates create a more favorable environment for those requiring smaller loans to purchase new homes compared to those needing larger loans.

Given these considerations, we hypothesize that financially less constrained borrowers exhibit a higher likelihood of prepaying their mortgages in response to insurance premium increases. We test this hypothesis in Table 5. We repeat the analysis from Table A4, replacing the dependent variable with an indicator for mortgage prepayment.

The estimated coefficient on premium increases is smaller for the high-LTV subsample compared to the low-LTV subsample, with both coefficients being statistically significant. These findings are consistent with our hypothesis that financially less constrained borrowers are more prone to respond to premium increases by prepaying their mortgages. However, Column (3) demonstrates that the difference between the two subsamples is not statistically significant at the conventional levels, with a t-stat of 1.46.

7 Delinquency & Prepayment Effects are Larger for Non-Jumbo Mortgages

In Table 6, we split the sample into mortgages above and below the conforming loan limit and repeat the structure of tests as in Table A4. Column (1) uses the sample of jumbo mortgages, and (2) uses non-jumbo mortgages. We find that the effect of premiums on mortgage delinquencies is stronger for non-jumbo mortgages. Because non-jumbo borrowers are, on average, more financially constrained, this result is consistent with our previous finding that more constrained borrowers respond more strongly to premium increases.

Table 7 repeats Table 6, replacing the dependent variable with the prepayment indicator. The estimates indicate that the effect of premium increases on prepayment is predominantly observed among non-jumbo borrowers. There are several potential reasons for this. First, non-jumbo mortgages are smaller in size. Thus, it may be easier for borrowers to come up with the cash to repay compared to jumbo mortgages for borrowers within the same LTV, FICO, and DTI bins as specified by our fixed effects. Second, the real estate associated with jumbo mortgages may exhibit lower liquidity, potentially impeding the ability of jumbo borrowers to sell their properties and relocate in response to premium increases. Third, jumbo borrowers may be better able to absorb an increase in insurance expenses, consistent with the smaller delinquency effect in Table 6.

8 Delinquency & Prepayment Effects Across Investors

A natural question is whether the effect of insurance premiums on mortgage delinquencies is present for GSE loans. This would imply a risk for the Federal Government, particularly if insurance premiums keep rising. We investigate this question in the following analysis.

In Table 8, we repeat the Column (1) described above using different subsamples based on the investor. We use mortgages guaranteed by Ginnie Mae in Column (1), by Fannie Mae in (2), by Freddie Mac in (3), private mortgages that are secularized in (4), and those remain in banks' portfolio in (5). The results suggest that the effect exists in each subsample. It is the largest for mortgages guaranteed by Ginnie Mae and for private mortgages that are secularized and smallest for those guaranteed by Freddie Mac. The fact that the delinquency effect exists for loans guaranteed by the GSEs suggests implies imply a risk for the GSEs and the Federal Government from rising insurance premiums. Banks and investors in private-label MBS are similarly exposed.

Table 9 repeats Table 8, using mortgage prepayment as the outcome variable. The coefficients on *Premium Increase* are positive and statistically significant in all columns except (4). In Column (4), the magnitude of estimate is within the range of other columns. The lack of statistical significance could be due to a much smaller sample. The results suggest that the prepayment effect is much larger for mortgages guaranteed by the GSEs than those held in banks' portfolios.

9 Delinquency Effect is Smaller When Coverage Increases

If insurance premium increases lead to higher delinquency by straining household liquidity, we hypothesize that this effect would be more pronounced for borrowers whose liquidity is more severely impacted by such increases. When insurance premiums rise, some homeowners may increase coverage, potentially due to an increase in either actual or perceived disaster risk. However, those facing greater liquidity constraints due to premium increases are less likely to increase their coverage.

In Table 10, we split the sample into two subgroups and repeat our main delinquency analysis. Column (1) uses the subsample of borrowers who transitioned their coverage from Actual Cash Value (ACV) to Replacement Cost Value (RCV). Under ACV, insurers compensate for the depreciated cost to repair or replace damaged properties, while RCV coverage provides reimbursement for the full repair or replacement cost without deducting for depreciation. Thus, this subsample of borrowers increased their coverage. Column (2) examines the other subsample, which comprises borrowers whose coverage type remained unchanged and those who switched from RCV to ACV.

The estimated coefficient on premium increases in the subsample that increased coverage is 0.063, which is 25% smaller than that in the other sample (0.084). In Column (3), we analyze the full sample, adding an interaction term between premium increase and an indicator for coverage being increased. The interaction term exhibits a negative and statistically significant coefficient, indicating that the difference between the two subsamples is significant. These findings suggest that the effect of premiums on delinquency is smaller for borrowers who increased coverage, likely due to the greater liquidity these borrowers have.

This result also counters an alternative explanation for our main OLS results on delinquency, which posits that increased disaster risks simultaneously drive insurance premium increases and higher delinquencies (e.g., through higher risks lowering home value). Homeowners who increase coverage are more likely to perceive heightened disaster risks. However, they experience a smaller delinquency effect of premiums, suggesting that this alternative explanation is unlikely to be true. This finding complements our instrumental variable results in demonstrating a causal effect of premiums on delinquencies.

If a borrower decreases coverage from Replacement Cost Value to Actual Cash Value, that indicates the borrower tries to limit the liquidity impact of the premium increase. Thus, we hypothesize that such change in coverage, which effectively lowers coverage, should be associated with a smaller increase in delinquency. We test this hypothesis in Table A3. The results confirm our hypothesis. However, the effect of premiums on delinquency is still substantial, representing 93% of the benchmark result in Table 2. Given that such borrowers actively respond to premium changes by reducing coverage, this result offers evidence against an alternative explanation for our delinquency result. This explanation argues that borrowers may be inattentive to premium increases and not transferring enough funds to their (escrow) account that pays for both mortgage and insurance, which triggers mortgage delinquencies somewhat mechanically. The fact that when borrowers actively reduce their premiums, they still experience large delinquency effect, argues against this alternative explanation.

10 Conclusion

As climate change intensifies the frequency and severity of natural disasters, homeowners' insurance premiums are rising sharply. This study investigates how increasing insurance premiums influence mortgage delinquencies and prepayments by leveraging a novel dataset that links insurance policies to mortgage outcomes of 6.7 million borrowers. The analysis shows that higher premiums significantly elevate the chances of mortgage delinquency and prepayment. These findings are robust to using an instrumental variable for premium changes. The effect of delinquency is more pronounced for mortgages with higher loan-to-value ratios, while the prepayment effect is smaller for these loans. Additionally, we find that delinquency effects are present in both GSE and non-GSE mortgages, implying risks for both the Federal Government and the private financial sector.

Our findings highlight an understudied effect of climate change on household financial resilience. As more severe disasters linked to climate change push insurance premiums higher, we demonstrate that households are at greater risk of financial distress, especially those that are more financially constrained. This underscores the considerable financial strain that climate change imposes on homeowners.

The paper also points to the risks that rising insurance costs pose for mortgages and mortgage-backed securities. Delinquencies represent negative shocks for mortgage holders, a significant portion of the financial sector. Thus, our findings not only illustrate the direct impact on households but also uncover broader implications for financial stability as insurance costs rise due to climate change.

For policymakers addressing the issue of insurance affordability, our findings carry critical implications. The results suggest that escalating insurance premiums are severely limiting household liquidity, driving some into mortgage delinquency. Given the broader economic consequences of mortgage defaults, our research underscores the potential value of policy measures like means-tested insurance subsidies to mitigate these effects.

We intend to investigate several follow-up questions. First, do mortgage lenders incorporate the observed delinquency and prepayment effects of insurance premiums into their pricing and approval decisions for new mortgages? Second, does the insurance-induced effect on delinquency adversely impact borrowers' credit scores and subsequently limit their access to credit? Third, does the Mortgage-Backed Securities (MBS) market adequately price risks related to insurance costs? Stroebel and Wurgler (2021) find that 60% survey respondents believe the stock market underprices climate risk. Insurance costs may facilitate the incorporation of climate risks into asset prices.

Fourth, considering mortgage financing's crucial role in property transactions, how do insurance premiums impact the prices and liquidity of housing?[15] Finally, our results suggest insurance costs disproportionately burden financially constrained households. Could these differential impacts drive demographic shifts in climate-risky areas, replacing financially constrained households with more resilient ones?

[15] Ge et al. (2024) demonstrate that house prices decline with an exogenous change in insurance premiums in the National Flood Insurance Program.

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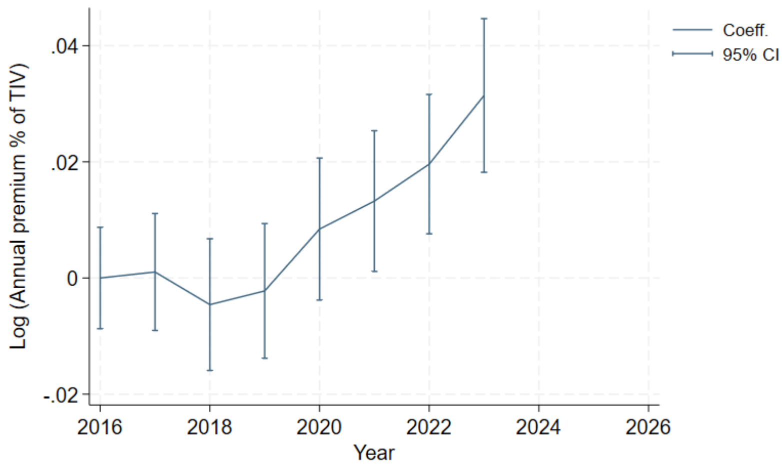
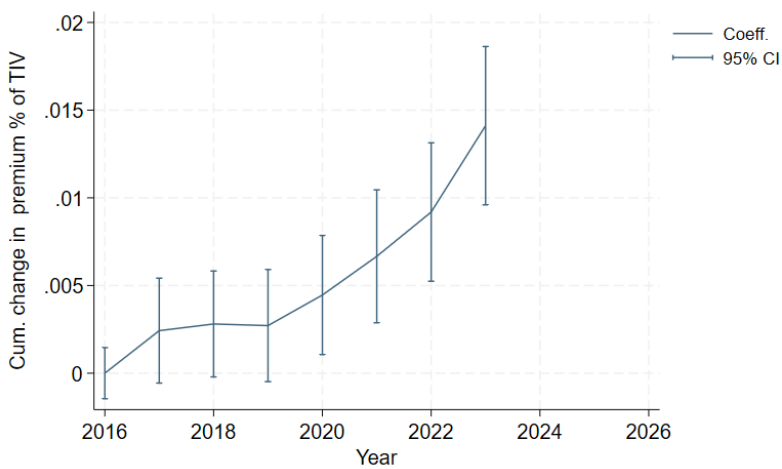
FIGURE 1

PREMIUMS HAVE GONE UP MORE IN HIGH-CLIMATE-RISK AREAS

Panel A. Premium Trend of Riskier vs Safer Zips
(All policies with 0.5% deductible)



Panel B. Premium Trend of Riskier vs Safer Zips
(Repeat measure using existing owners)

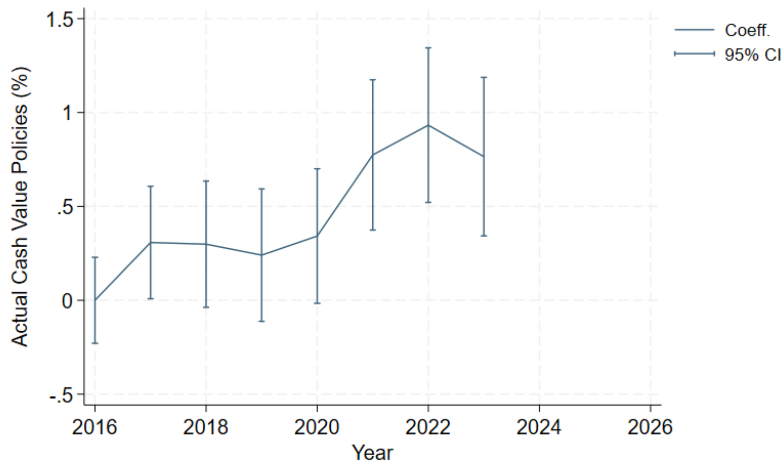


NOTES: Source: ICE McDash, decennial census (controls).
In Figure 1, we examine how premiums have evolved in recent years. We estimate the following regression at the zip-by-year level. $\log((Premium/TIV)_{z,t}) = \gamma_z + \delta_{c,t} + \sum_{t=2016}^{2023} \beta_t \log(ClimateRisk_z) + \alpha_t Controls_z + \epsilon_{z,t}$, where z denotes zip code, c denotes the county, and t the year. The dependent variable is premiums relative to the total insured value, averaged at the zip-year level. The main independent variable is CoreLogic's composite measure of climate risk aggregated at the zip level. We use only policies with deductibles being 0.5% of total insured value (TIV) in this analysis so that changes in deductibles do not drive the results. Panel A plots the estimates of β_t. Panel B repeats A, replacing the dependent variable with the cumulative change, relative to 2014, in the premium as a percentage of TIV for policies where the deductible (as a percentage of % TIV) and coverage type (ACV or replacement cost) do not change. This measure is constructed using within-loan changes in premium only.

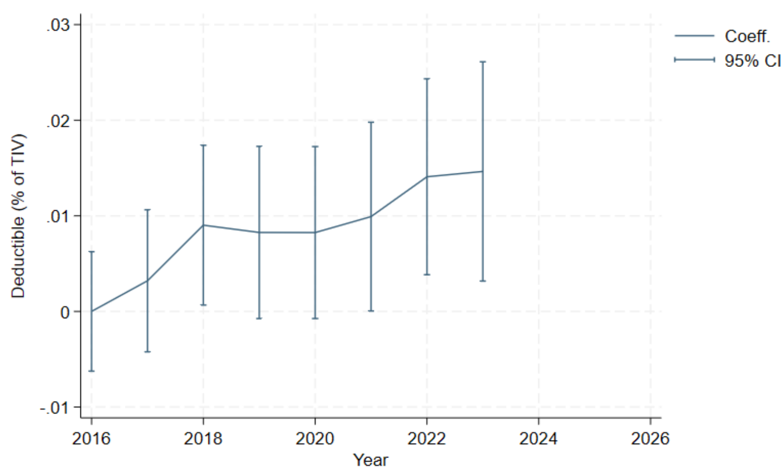
FIGURE 2

ACV & HIGH DEDUCTIBLE POLICIES INCREASINGLY PREVALENT IN HIGH-CLIMATE-RISK AREAS

Panel A. % of Homes with "Actual Cash Value" Coverage, Riskier vs Safer Zips



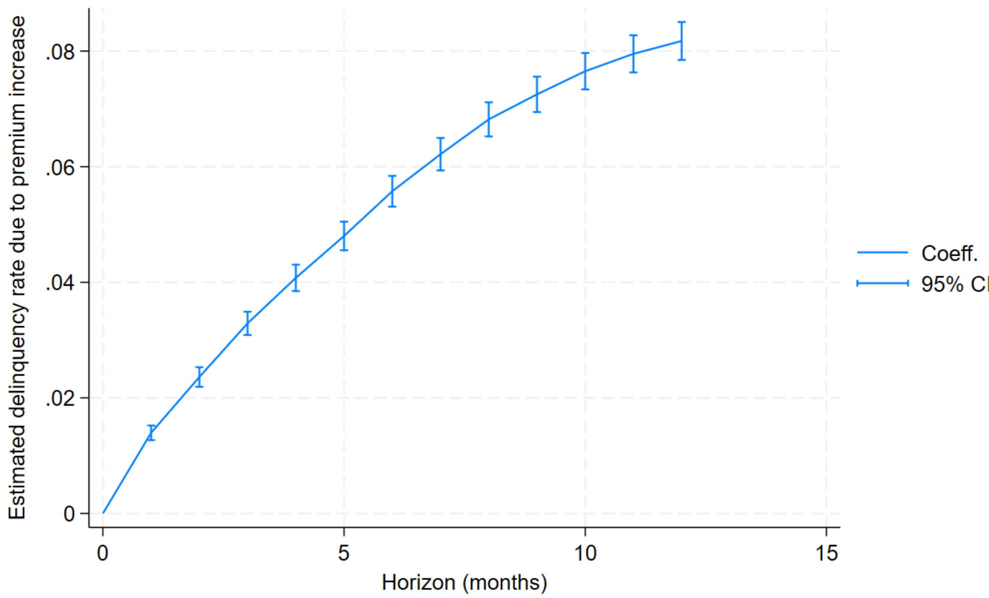
Panel B. Deductible, Riskier vs Safer Zips



NOTES: Source: ICE McDash, decennial census (controls).
Figure 2 repeats Figure 1, replacing the dependent variable with the percentage of homes with "Actual Cash Value" as coverage in Panel A and average deductible as a percentage of total insured value in Panel B. "Actual Cash Value" policies subtract depreciation in claim payouts and are thus considered to offer less coverage. Both dependent variables are at the zip-year level. We again plot the estimates of the coefficients, β_t.

FIGURE 3

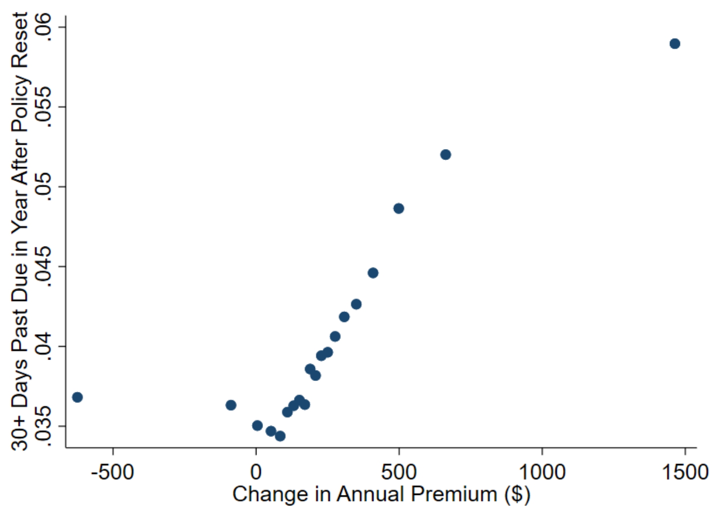
MORTGAGE DELINQUENCY DYNAMIC RESPONSE TO PREMIUM INCREASES



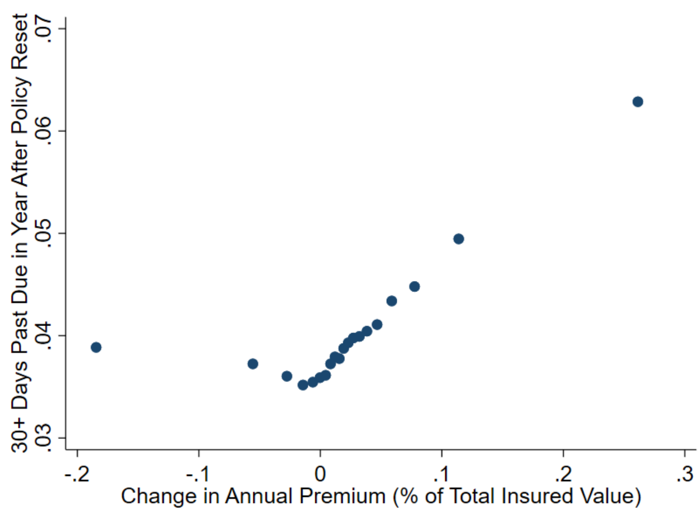
NOTES: Source: ICE McDash.
This figure plots the dynamic response of mortgage delinquency to insurance premium increases by the number of months after the insurance policy renewal. We plot the coefficients and the confidence interval.

FIGURE 4
MORTGAGE DELINQUENCY AND PREMIUM INCREASES

Panel A. Delinquency Increases with Change in Premium ($)



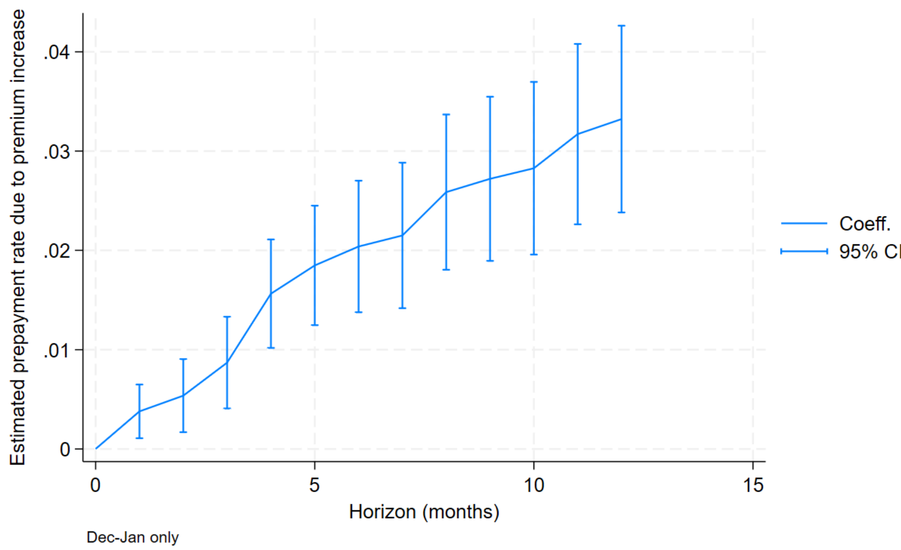
Panel B. Delinquency Increases with Change in Premium (% of Total Insured Value)



NOTES: Source: ICE McDash.
These figures are bin-scatter plots of mortgage delinquency against changes in annual insurance premiums in dollars (top figure) and delinquency against changes in annual insurance premiums as a percentage of total insured value (bottom figure). We control for loan age (the number of years since mortgage origination), and the following fixed effects (FE): insurance policy start month FE, mortgage origination year FE, LTV bin FE, DTI bin FE, FICO bin FE, 5-digit zip FE. We drop loans where the servicing is transferred within a year of policy reset and where the loan was not current as of the reset month.

FIGURE 5

MORTGAGE DELINQUENCY DYNAMIC RESPONSE TO PREMIUM INCREASES



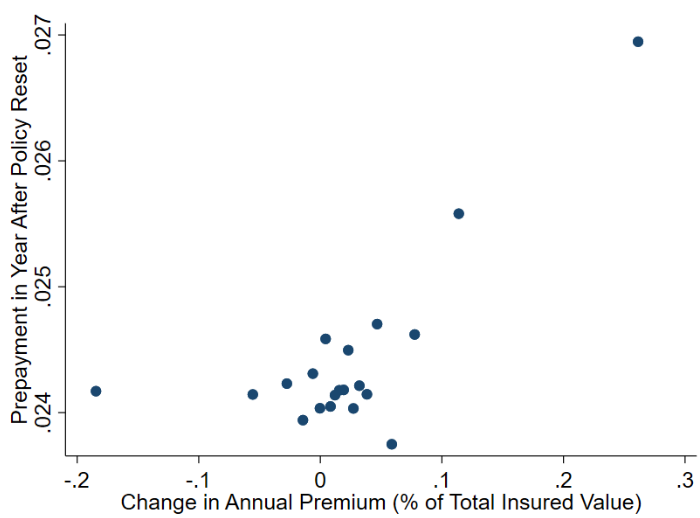
NOTES: Source: ICE McDash.
This figure plots the dynamic response of mortgage prepayment to insurance premium increases by the number of months after the insurance policy renewal. We plot the coefficients and the confidence interval.

FIGURE 6

MORTGAGE PREPAYMENT AND PREMIUM INCREASES

Panel A. Prepayment Increases with Change in Premium ($)

Panel B. Prepayment Increases with Change in Premium (% of Total Insured Value)



NOTES: Source: ICE McDash.
These figures are bin-scatter plots of mortgage prepayment against changes in annual insurance premiums in dollars (top figure) and prepayment against changes in annual insurance premiums as a percentage of total insured value (bottom figure). We control for loan age (the number of years since mortgage origination), and the following fixed effects (FE): insurance policy start month FE, mortgage origination year FE, LTV bin FE, DTI bin FE, FICO bin FE, 5-digit zip FE. We drop loans where the servicing is transferred within a year of policy reset and where the loan was not current as of the reset month.

TABLE 1
SUMMARY STATISTICS

	Mean	SD	25 Pctl	Median	75 Pctl
Delinquent	0.04	0.20	0.00	0.00	0.00
Prepayment (Dec-Jan)	0.02	0.15	0.00	0.00	0.00
Zip Avg Prem Chg in 12 months before Renewal	0.02	0.12	-0.01	0.01	0.04
Insurer Other-State Loss	0.05	0.01	0.04	0.05	0.05
Insurer Market Share Sum	0.64	0.06	0.60	0.64	0.67
Premium Increase	0.04	0.07	0.00	0.01	0.04
Annual Premium (dollars)	1,926.41	1,659.83	1,068.00	1,524.00	2,268.00
Climate Risk	0.18	0.15	0.10	0.13	0.21
DTI	33.26	10.79	25.00	34.00	42.00
FICO	741.54	65.73	705.00	756.00	789.00
LTV	71.51	19.54	59.01	75.00	86.27
Income	44,230.74	14,850.20	33,964.00	41,189.00	50,883.00
Home Value	406,938.72	313,038.26	211,100.00	312,600.00	483,200.00
Minority	0.23	0.22	0.07	0.15	0.32
Replacement Change	0.02	0.24	0.00	0.00	0.00

NOTES: Source: ICE McDash, CoreLogic Climate, Census ACS., S&P Capital IQ Pro, Claritas Financial CLOUT.
This table presents summary statistics of relevant variables.

TABLE 2
DELINQUENCY AND PREPAYMENT PROBABILITIES INCREASE WITH PREMIUMS, OLS

	Delinquency		Prepayment
	(1)	(2)	(3)
Premium Increase	0.081***	0.082***	0.034***
	(48.70)	(47.88)	(13.56)
Loan Age	-0.001***	-0.001***	0.016***
	(-4.52)	(-4.06)	(33.69)
Method	OLS	OLS	OLS
Sample	All	All	Sep-Jan
Zip FE	Y	N	Y
Zip×Start Month FE	N	Y	N
Orig Yr FE	Y	Y	Y
Start Month FE	Y	N	N
LTV FE	Y	Y	Y
FICO FE	Y	Y	Y
DTI FE	Y	Y	Y
Y Mean	0.037	0.037	0.057
Y SD	0.188	0.188	0.231
X Mean	0.036	0.036	0.033
N	6719309	6670212	2517168

NOTES: Source: ICE McDash.
This table presents correlation between mortgage delinquency (prepayment) and premium increases at the borrower level. The dependent variable is an indicator for whether the mortgage is delinquent in Columns (1)-(2) and is repaid in Columns (3)-(4). The main independent variable is the change in premium as a % of TIV. In Columns (1) and (3), we control for loan age (the number of years since mortgage origination), and the following fixed effects (FE): insurance policy start month FE, mortgage origination year FE, LTV bin FE, DTI bin FE, FICO bin FE, 5-digit zip FE. In Columns (2) and (4), we replace zip FE with zip-by-insurance policy start mont FE. Standard errors are corrected for clustering at the zip code level. ***$p<0.01$, **$p<0.05$, *$p<0.1$.

TABLE 3
INSTRUMENTAL VARIABLE RESULTS ON MORTGAGE DELINQUENCY AND PREPAYMENT

	Prem Increase	Delinquency	Prem Increase	Prepayment
	(1)	(2)	(3)	(4)
Zip Avg Prem Chg	0.501***		0.311***	
	(12.81)		(5.88)	
Zip Avg Premium Chg ×	0.450***		0.507***	
Lagged Premium (% of TIV)	(10.12)		(9.34)	
Premium Increase		0.103***		0.035**
		(9.29)		(2.26)
Lagged Premium (% of TIV)	-0.004***	0.001	-0.005***	-0.000
	(-3.52)	(1.28)	(-6.83)	(-1.37)
Loan Age	-0.001***	-0.001***	-0.002***	0.008***
	(-10.09)	(-5.25)	(-13.53)	(14.46)
2SLS Stage	1st Stage	2nd Stage	1st Stage	2nd Stage
Sample	All	All	Sep-Jan	Sep-Jan
State FE	Y	Y	Y	Y
Orig Yr FE	Y	Y	Y	Y
Start Month FE	Y	Y	Y	Y
LTV FE	Y	Y	Y	Y
FICO FE	Y	Y	Y	Y
DTI FE	Y	Y	Y	Y
Y Mean	0.036	0.037	0.032	0.057
Y SD	0.074	0.188	0.069	0.231
X Mean	0.025	0.036	0.021	0.032
X SD	0.029	0.074	0.024	0.069
N	6656878	6656878	2505567	2505567
Kleibergen-Paap Wald F stat		3,890.408		1,099.242

NOTES: Source: ICE McDash.
This table presents instrumental variable regression results, demonstrating the causal effect premium increases on mortgage delinquency and prepayment. Observations at the borrower level. Column (1) presents the first-stage result. The dependent variable is premium increase as a percentage of total insured value. The two instruments are the average premium change at the three-digit zip level in the 12 months immediately before each policy's renewal, as well as its interaction with the lagged house-level premiums. Columns (2) and (3) present the second-stage results. The dependent variable is an indicator for whether the mortgage is delinquent in Column (2) and is repaid in Column (3). We control for loan age (the number of years since mortgage origination), and the following fixed effects (FE): insurance policy start month FE, mortgage origination year FE, LTV bin FE, DTI bin FE, FICO bin FE, 5-digit zip FE. In Columns (2) and (4), we replace zip FE with zip-by-insurance policy start mont FE. Standard errors are corrected for clustering at the zip code level. ***p<0.01, **p<0.05, *p<0.1. "K-P Wald F stat" stands for Kleibergen-Paap Wald F statistic.

TABLE 4
DELINQUENCY EFFECT IS LARGER FOR HIGH-LTV MORTGAGES

	Delinquent		
	(1)	(2)	(3)
Premium Increase	0.111***	0.055***	0.056***
	(39.48)	(33.84)	(35.87)
Premium Increase × $LTV \geq 80$			0.054***
			(19.46)
$LTV \geq 80$			0.000
			(.)
Loan Age	-0.002***	-0.001***	-0.001***
	(-2.98)	(-2.76)	(-4.75)
Constant	0.067***	0.026***	0.042***
	(15.48)	(15.98)	(24.67)
Method	OLS	OLS	OLS
Sample	$LTV \geq 80$	LTV<80	All
Zip FE	Y	Y	Y
Orig Yr FE	Y	Y	Y
Start Month FE	Y	Y	Y
LTV FE	Y	Y	Y
FICO FE	Y	Y	Y
DTI FE	Y	Y	Y
Y Mean	0.059	0.024	0.037
Y SD	0.235	0.152	0.188
X Mean	0.042	0.033	0.036
X SD	0.083	0.071	0.076
Sort Var Mean	90.144	60.179	71.336
Sort Var SD	7.122	15.790	19.626
N	2499771	4215988	6719309

NOTES: Source: ICE McDash.
This table presents results testing whether the effect of premium increases on mortgage delinquency differs between High- and Low-LTV mortgages. The dependent variable is an indicator for whether the mortgage is delinquent in the 12 months after insurance policy renewal. The main independent variable is the change in premium as a % of TIV. Column (1) uses the sample of mortgages with LTV ratios higher than the median. Column (2) uses the those with LTV lower than the median. Column (3) uses the full sample. We control for loan age (the number of years since mortgage origination), and the following fixed effects (FE): insurance policy start month FE, mortgage origination year FE, LTV bin FE, DTI bin FE, FICO bin FE, 5-digit zip FE. In Columns (2) and (4), we replace zip FE with zip-by-insurance policy start mont FE. Standard errors are corrected for clustering at the zip code level. ***p<0.01, **p<0.05, *p<0.1.

TABLE 5
PREPAYMENT EFFECT IS SMALLER FOR HIGH LTV MORTGAGES

	Prepayment		
	(1)	(2)	(3)
Premium Increase	0.023***	0.037***	0.035***
	(6.45)	(10.44)	(10.12)
Premium Increase × $LTV \geq 80$			-0.007
			(-1.46)
$LTV \geq 80$			0.000
			(.)
Loan Age	0.010***	0.008***	0.008***
	(10.21)	(11.34)	(15.15)
Method	OLS	OLS	OLS
Sample	$LTV \geq 80$	LTV<80	All
	(Sep-Jan)	(Sep-Jan)	(Sep-Jan)
Zip FE	Y	Y	Y
Orig Yr FE	Y	Y	Y
Start Month FE	Y	Y	Y
LTV FE	Y	Y	Y
FICO FE	Y	Y	Y
DTI FE	Y	Y	Y
Y Mean	0.052	0.059	0.057
Y SD	0.223	0.236	0.231
X Mean	0.039	0.030	0.033
X SD	0.078	0.066	0.071
Sort Var Mean	90.188	60.189	71.430
Sort Var SD	7.093	15.846	19.661
N	940650	1572231	2517168

NOTES: Source: ICE McDash.
This table presents results testing whether the effect of premium increases on mortgage prepayment differs between High- and Low-LTV mortgages. The dependent variable is an indicator for whether the mortgage is prepaid in the 12 months after insurance policy renewal. The main independent variable is the change in premium as a % of TIV. Column (1) uses the sample of mortgages with LTV ratios higher than the median. Column (2) uses the those with LTV lower than the median. Column (3) uses the full sample. We control for loan age (the number of years since mortgage origination), and the following fixed effects (FE): insurance policy start month FE, mortgage origination year FE, LTV bin FE, DTI bin FE, FICO bin FE, 5-digit zip FE. In Columns (2) and (4), we replace zip FE with zip-by-insurance policy start mont FE. Standard errors are corrected for clustering at the zip code level. ***p<0.01, **p<0.05, *p<0.1.

TABLE 6
DELINQUENCY EFFECT IS LARGER FOR NON-JUMBO MORTGAGES

	Delinquent		
	(1)	(2)	(3)
Premium Increase	0.029***	0.082***	0.082***
	(5.05)	(48.51)	(48.45)
Premium Increase × Jumbo			-0.041***
			(-7.36)
Jumbo			0.001**
			(2.00)
Loan Age	0.001	-0.001***	-0.001***
	(0.82)	(-4.61)	(-4.53)
Method	OLS	OLS	OLS
Sample	Jumbo	Non-Jumbo	All
Zip FE	Y	Y	Y
Orig Yr FE	Y	Y	Y
Start Month FE	Y	Y	Y
LTV FE	Y	Y	Y
FICO FE	Y	Y	Y
DTI FE	Y	Y	Y
Y Mean	0.012	0.037	0.037
Y SD	0.111	0.190	0.188
X Mean	0.029	0.036	0.036
X SD	0.065	0.076	0.076
N	186798	6530498	6719309

NOTES: Source: ICE McDash.
This table presents results testing whether the effect of premium increases on mortgage prepayment differs between conforming and jumbo mortgages. The dependent variable is an indicator for whether the mortgage is prepaid in the 12 months after insurance policy renewal. The main independent variable is the change in premium as a % of TIV. Column (1) uses jumbo mortgages. Column (2) uses conforming mortgages. Column (3) uses the full sample. We control for loan age (the number of years since mortgage origination), and the following fixed effects (FE): insurance policy start month FE, mortgage origination year FE, LTV bin FE, DTI bin FE, FICO bin FE, 5-digit zip FE. In Columns (2) and (4), we replace zip FE with zip-by-insurance policy start mont FE. Standard errors are corrected for clustering at the zip code level. ***$p<0.01$, **$p<0.05$, *$p<0.1$.

TABLE 7
PREPAYMENT EFFECT IS LARGER FOR NON-JUMBO MORTGAGES

	Prepayment		
	(1)	(2)	(3)
Premium Increase	-0.012	0.032***	0.032***
	(-0.88)	(12.63)	(12.78)
Premium Increase × Jumbo			-0.034***
			(-2.63)
Jumbo			0.001
			(0.81)
Loan Age	0.013***	0.008***	0.008***
	(4.77)	(14.77)	(15.14)
Method	OLS	OLS	OLS
Sample	Jumbo	Non-Jumbo	All
	(Sep-Jan)	(Sep-Jan)	(Sep-Jan)
Zip FE	Y	Y	Y
Orig Yr FE	Y	Y	Y
Start Month FE	Y	Y	Y
LTV FE	Y	Y	Y
FICO FE	Y	Y	Y
DTI FE	Y	Y	Y
Y Mean	0.033	0.057	0.057
Y SD	0.178	0.233	0.231
X Mean	0.027	0.033	0.033
X SD	0.060	0.072	0.071
N	69355	2446112	2517168

NOTES: Source: ICE McDash.
This table presents results testing whether the effect of premium increases on mortgage prepayment differs between conforming and jumbo mortgages. The dependent variable is an indicator for whether the mortgage is prepaid in the 12 months after insurance policy renewal. The main independent variable is the change in premium as a % of TIV. Column (1) uses jumbo mortgages. Column (2) uses conforming mortgages. Column (3) uses the full sample. We control for loan age (the number of years since mortgage origination), and the following fixed effects (FE): insurance policy start month FE, mortgage origination year FE, LTV bin FE, DTI bin FE, FICO bin FE, 5-digit zip FE. In Columns (2) and (4), we replace zip FE with zip-by-insurance policy start mont FE. Standard errors are corrected for clustering at the zip code level. ***p<0.01, **p<0.05, *p<0.1.

TABLE 8
DELINQUENCY EFFECT ACROSS INVESTOR TYPES

	Delinquent				
	(1)	(2)	(3)	(4)	(5)
Premium Increase	0.136***	0.061***	0.054***	0.111***	0.074***
	(30.01)	(29.15)	(25.52)	(6.16)	(16.34)
Method	OLS	OLS	OLS	OLS	OLS
Sample	GNMA	FNMA	FHLMC	Private Securitized	Portfolio
Zip FE	Y	Y	Y	Y	Y
Orig Yr FE	Y	Y	Y	Y	Y
Start Month FE	Y	Y	Y	Y	Y
LTV FE	Y	Y	Y	Y	Y
FICO FE	Y	Y	Y	Y	Y
DTI FE	Y	Y	Y	Y	Y
Y Mean	0.084	0.026	0.025	0.082	0.035
Y SD	0.278	0.158	0.155	0.274	0.183
X Mean	0.046	0.035	0.035	0.036	0.031
X SD	0.089	0.074	0.073	0.084	0.069
N	9.75e+05	2.64e+06	2.21e+06	66092.000	7.74e+05

NOTES: Source: ICE McDash.
This table presents the effect premium increases on mortgage delinquency across investor types. Column (1) uses mortgages guaranteed by Ginnie Mae, (2) by Fannie Mae, (3) by Freddie Mac, (4) private mortgages that are secularized, and (5) those remain in banks' portfolio. The main independent variable is the change in premium as a % of TIV. In Columns (1) and (3), we control for loan age (the number of years since mortgage origination), and the following fixed effects (FE): insurance policy start month FE, mortgage origination year FE, LTV bin FE, DTI bin FE, FICO bin FE, 5-digit zip FE. In Columns (2) and (4), we replace zip FE with zip-by-insurance policy start mont FE. Standard errors are corrected for clustering at the zip code level. ***p<0.01, **p<0.05, *p<0.1.

TABLE 9
PREPAYMENT EFFECT ACROSS INVESTOR TYPES

	Prepayement				
	(1)	(2)	(3)	(4)	(5)
Premium Increase	0.028***	0.033***	0.037***	0.029	0.018**
	(5.14)	(7.63)	(7.98)	(0.88)	(2.32)
Method	OLS	OLS	OLS	OLS	OLS
Sample	GNMA (Sep-Jan)	FNMA (Sep-Jan)	FHLMC (Sep-Jan)	Private Securitized (Sep-Jan)	Portfolio (Sep-Jan)
Zip FE	Y	Y	Y	Y	Y
Orig Yr FE	Y	Y	Y	Y	Y
Start Month FE	Y	Y	Y	Y	Y
LTV FE	Y	Y	Y	Y	Y
FICO FE	Y	Y	Y	Y	Y
DTI FE	Y	Y	Y	Y	Y
Y Mean	0.050	0.060	0.058	0.063	0.050
Y SD	0.218	0.238	0.233	0.243	0.219
X Mean	0.042	0.032	0.032	0.032	0.029
X SD	0.084	0.070	0.068	0.077	0.065
N	3.61e+05	9.90e+05	8.32e+05	16751.000	2.92e+05

NOTES: Source: ICE McDash.
This table presents the effect premium increases on mortgage prepayment across investor types. Column (1) uses mortgages guanrateed by Ginnie Mae, (2) by Fannie Mae, (3) by Freddie Mac, (4) private mortgages that are secularized, and (5) those remain in banks' portfolio. The main independent variable is the change in premium as a % of TIV. In Columns (1) and (3), we control for loan age (the number of years since mortgage origination), and the following fixed effects (FE): insurance policy start month FE, mortgage origination year FE, LTV bin FE, DTI bin FE, FICO bin FE, 5-digit zip FE. In Columns (2) and (4), we replace zip FE with zip-by-insurance policy start mont FE. Standard errors are corrected for clustering at the zip code level. ***p<0.01, **p<0.05, *p<0.1.

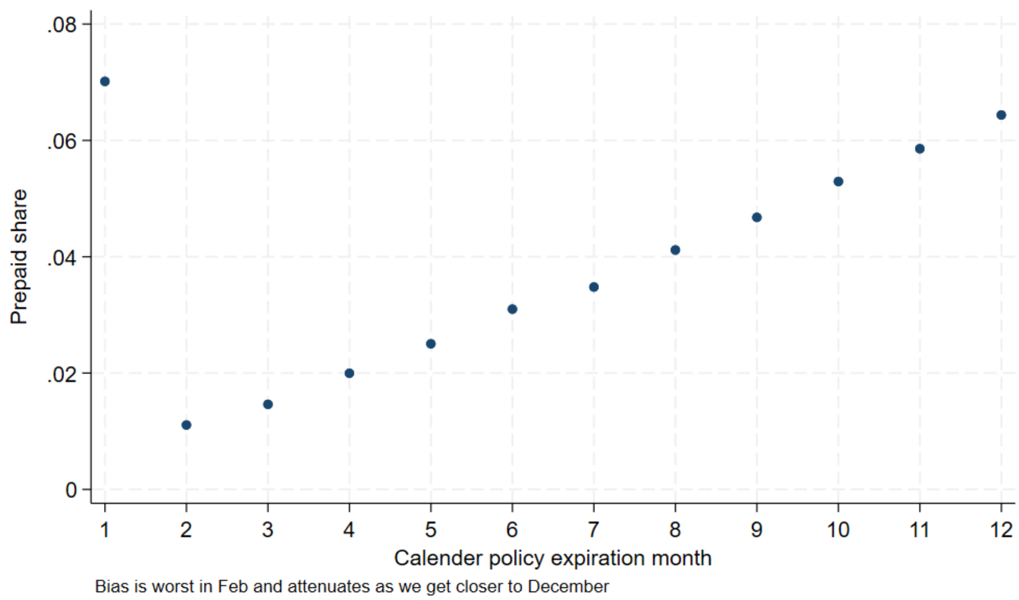
TABLE 10
DELINQUENCY EFFECT IS SMALLER WHEN COVERAGE INCREASES

	Delinquent		
	(1)	(2)	(3)
Premium Increase	0.063***	0.084***	0.083***
	(14.96)	(43.99)	(44.01)
Premium Increase × Cov Increased			-0.015***
			(-3.71)
Cov Increased			0.000
			(0.13)
Loan Age	-0.001	-0.001***	-0.001***
	(-1.36)	(-3.80)	(-4.05)
Method	OLS	OLS	OLS
Sample	Cov Increased	Cov Not Increased	All
Zip FE	Y	Y	Y
Orig Yr FE	Y	Y	Y
Start Month FE	Y	Y	Y
LTV FE	Y	Y	Y
FICO FE	Y	Y	Y
DTI FE	Y	Y	Y
Y Mean	0.036	0.036	0.036
Y SD	0.185	0.187	0.187
X Mean	0.041	0.034	0.035
X SD	0.084	0.072	0.073
N	640913	5360478	6005789

NOTES: Source: ICE McDash.
This table presents results testing whether the effect of premium increases on mortgage delinquency differs between borrowers who increased coverage and the rest. The dependent variable is an indicator for whether the mortgage is delinquent in the 12 months after insurance policy renewal. The main independent variable is the change in premium as a % of TIV. Column (1) uses borrowers who changed coverage from "Actual Cash Value" to "Replacement Cost Value". Column (2) uses the rest of the sample. Column (3) uses the full sample. We control for loan age (the number of years since mortgage origination), and the following fixed effects (FE): insurance policy start month FE, mortgage origination year FE, LTV bin FE, DTI bin FE, FICO bin FE, 5-digit zip FE. In Columns (2) and (4), we replace zip FE with zip-by-insurance policy start mont FE. Standard errors are corrected for clustering at the zip code level. ***p<0.01, **p<0.05, *p<0.1.

FIGURE A1

SHARE OF PREPAID MORTGAGES REPORTED BY INSURANCE RENEWAL MONTH



NOTES: Source: ICE McDash.
This figure plots the share of mortgages that are prepaid reported by the calendar month of the insurance policy expiration date.

TABLE A1

ACCURACY IN PREPAYMENT REPORTING: EFFECT OF PREMIUM INCREASES ON PREPAYMENT IN DIFFERENT SAMPLES

	Prepayment		
	(1)	(2)	(3)
Premium Increase	0.018***	0.034***	0.033***
	(15.40)	(13.56)	(5.61)
Loan Age	0.006***	0.016***	0.008***
	(21.27)	(33.69)	(7.03)
Method	OLS	OLS	OLS
Sample	All	Sep-Jan	Dec
Zip FE	Y	Y	Y
Zip×Start Month FE	N	N	N
Orig Yr FE	Y	Y	Y
Start Month FE	Y	N	N
LTV FE	Y	Y	Y
FICO FE	Y	Y	Y
DTI FE	Y	Y	Y
Y Mean	0.038	0.057	0.064
Y SD	0.191	0.231	0.246
X Mean	0.036	0.033	0.035
N	6719309	2517168	492868

NOTES: Source: ICE McDash.
This table presents the effect premium increases on mortgage prepayment using different samples. Column (1) uses the entire sample. Column (2) uses the sample with Sep-Jan policy expiry dates. Column (3) uses the sample with Dec policy expiry dates. The main independent variable is the change in premium as a % of TIV. In Columns (1) and (3), we control for loan age (the number of years since mortgage origination), and the following fixed effects (FE): insurance policy start month FE, mortgage origination year FE, LTV bin FE, DTI bin FE, FICO bin FE, 5-digit zip FE. In Columns (2) and (4), we replace zip FE with zip-by-insurance policy start mont FE. Standard errors are corrected for clustering at the zip code level. ***p<0.01, **p<0.05, *p<0.1.

TABLE A2

PREPAYMENT EFFECT NOT DIFFERENT WHEN COVERAGE INCREASES

	Prepayment		
	(1)	(2)	(3)
Premium Increase	0.026***	0.032***	0.033***
	(3.50)	(10.77)	(11.06)
Premium Increase × Cov Increased			-0.008
			(-1.16)
Cov Increased			0.003***
			(5.01)
Loan Age	0.006***	0.008***	0.008***
	(3.44)	(13.60)	(14.04)
Method	OLS	OLS	OLS
Sample	Cov Increased (Sep-Jan)	Cov Not Increased (Sep-Jan)	All (Sep-Jan)
Zip FE	Y	Y	Y
Orig Yr FE	Y	Y	Y
Start Month FE	Y	Y	Y
LTV FE	Y	Y	Y
FICO FE	Y	Y	Y
DTI FE	Y	Y	Y
Y Mean	0.055	0.057	0.057
Y SD	0.229	0.232	0.232
X Mean	0.038	0.031	0.032
X SD	0.078	0.067	0.068
N	240818	1999595	2245128

NOTES: Source: ICE McDash.
This table presents results testing whether the effect of premium increases on mortgage prepayment differs between borrowers who increased coverage and the rest. The dependent variable is an indicator for whether the mortgage is prepaid in the 12 months after insurance policy renewal. The main independent variable is the change in premium as a % of TIV. Column (1) uses borrowers who changed coverage from "Actual Cash Value" to "Replacement Cost Value". Column (2) uses the rest of the sample. Column (3) uses the full sample. We control for loan age (the number of years since mortgage origination), and the following fixed effects (FE): insurance policy start month FE, mortgage origination year FE, LTV bin FE, DTI bin FE, FICO bin FE, 5-digit zip FE. In Columns (2) and (4), we replace zip FE with zip-by-insurance policy start mont FE. Standard errors are corrected for clustering at the zip code level. ***p<0.01, **p<0.05, *p<0.1.

TABLE A3

DELINQUENCY EFFECT SMALLER WHEN COVERAGE DECREASES

	Delinquent		
	(1)	(2)	(3)
Premium Increase	0.075***	0.084***	0.084***
	(14.69)	(43.99)	(44.41)
Premium Increase × Cov Decreased			-0.009**
			(-1.98)
Cov Decreased			0.000
			(0.75)
Loan Age	0.001	-0.001***	-0.001***
	(0.85)	(-3.80)	(-3.59)
Method	OLS	OLS	OLS
Sample	Cov Decreased	Cov Not Decreased	All
Zip FE	Y	Y	Y
Orig Yr FE	Y	Y	Y
Start Month FE	Y	Y	Y
LTV FE	Y	Y	Y
FICO FE	Y	Y	Y
DTI FE	Y	Y	Y
Y Mean	0.036	0.036	0.036
Y SD	0.186	0.187	0.187
X Mean	0.061	0.034	0.035
X SD	0.122	0.072	0.074
N	196991	5360478	5562366

NOTES: Source: ICE McDash.

This table presents results testing whether the effect of premium increases on mortgage delinquency differs between borrowers who decreased coverage and the rest. The dependent variable is an indicator for whether the mortgage is delinquent in the 12 months after insurance policy renewal. The main independent variable is the change in premium as a % of TIV. Column (1) uses borrowers who changed coverage from "Replacement Cost Value" to "Actual Cash Value". Column (2) uses the rest of the sample. Column (3) uses the full sample. We control for loan age (the number of years since mortgage origination), and the following fixed effects (FE): insurance policy start month FE, mortgage origination year FE, LTV bin FE, DTI bin FE, FICO bin FE, 5-digit zip FE. In Columns (2) and (4), we replace zip FE with zip-by-insurance policy start mont FE. Standard errors are corrected for clustering at the zip code level. ***p<0.01, **p<0.05, *p<0.1.

TABLE A4
PREPAYMENT EFFECT NOT DIFFERENT WHEN COVERAGE DECREASES

	Prepayment		
	(1)	(2)	(3)
Premium Increase	0.026**	0.032***	0.033***
	(2.44)	(10.77)	(11.03)
Premium Increase × Cov Decreased			-0.006
			(-0.62)
Cov Decreased			0.004***
			(3.69)
Loan Age	0.016***	0.008***	0.009***
	(3.94)	(13.60)	(14.04)
Method	OLS	OLS	OLS
Sample	Cov Decreased	Cov Not Decreased	All
	(Sep-Jan)	(Sep-Jan)	(Sep-Jan)
Zip FE	Y	Y	Y
Orig Yr FE	Y	Y	Y
Start Month FE	Y	Y	Y
LTV FE	Y	Y	Y
FICO FE	Y	Y	Y
DTI FE	Y	Y	Y
Y Mean	0.063	0.057	0.057
Y SD	0.243	0.232	0.232
X Mean	0.057	0.031	0.032
X SD	0.117	0.067	0.069
N	61077	1999595	2065310

NOTES: Source: ICE McDash.
This table presents results testing whether the effect of premium increases on mortgage prepayment differs between borrowers who decreased coverage and the rest. The dependent variable is an indicator for whether the mortgage is prepaid in the 12 months after insurance policy renewal. The main independent variable is the change in premium as a % of TIV. Column (1) uses borrowers who changed coverage from "Replacement Cost Value" to "Actual Cash Value". Column (2) uses the rest of the sample. Column (3) uses the full sample. We control for loan age (the number of years since mortgage origination), and the following fixed effects (FE): insurance policy start month FE, mortgage origination year FE, LTV bin FE, DTI bin FE, FICO bin FE, 5-digit zip FE. In Columns (2) and (4), we replace zip FE with zip-by-insurance policy start mont FE. Standard errors are corrected for clustering at the zip code level. ***$p<0.01$, **$p<0.05$, *$p<0.1$.