When Insurers Exit: Climate Losses, Fragile Insurers, and Mortgage Markets

Pari Sastry (Columbia), Ishita Sen (HBS), Ana-Maria Tenekedjieva (Fed Board)

Summary of Novel Data

We combine data from several sources to obtain a comprehensive view of lending and insurance markets. While our mortgage data is standard (HMDA), the data we use on *homeowners insurance* is, to our knowledge, novel to the literature in household finance. We describe each in detail, below.

- **QUASR:** The most novel dataset we use comes from a *publicly available* dataset on homeowners' insurance underwriting. All homeowner insurers that operate in the state of Florida must report their county-level underwriting operations to the Florida Office of Insurance Regulation (FLOIR). The insurers report data on total premiums written, number of policies written, total coverage of the written policies, cancelled/nonrenewed policies, as well as policy transfers between insurers. This gives us detailed granular information on both the stocks and flows of homeowners insurance at the insurer-county-quarter level. These granular county level stocks and particularly flows are important in the current environment of heightened climate risk.

- **Insurer Financial Statements and Operations Data**: Every year, property and casualty (P&C) insurers file annual reports, which we access through the Standard & Poor's Market Intelligence database. From these filings, we access four categories of information on each insurer:

    - Underwriting data: Insurers report their underwriting activities for each state and business line that they operate in. This underwriting data contains information on total homeowners' premiums sold (which refers to the total sale of homeowners' policies) and total losses incurred (i.e., total amount spent on claims).
    - Balance sheet data: Insurers also report detailed financial statements as part of their regulatory filings, including balance sheets, regulatory capital positions, and the part of insurance liabilities ceded to or assumed from other insurers and reinsurers. These variables are all available at an insurer-year level.
    - Examinations and restatements: We collect data on regulatory scrutiny the company faces from the insurers' annual filings. Insurers must report annually the state which is responsible for their financial regulation (state of domicile), year of their last financial exam, and whether that financial exam resulted in restatement. A restatement occurs if the regulator finds errors in reported financial statements, and triggers the issuance of a new, corrected, financial statement. These variables are all available at an insurer-year level.
    - Reinsurance relationships: Insurers also report information about the reinsurance contracts they maintain active. S&P MI further matches each reinsurer to their AM Best financial rating. We collect data on all reinsurance contracts for insurers that sell HO insurance in Florida in 2019.

- **Insurers' Financial Strength Ratings:** We obtain insurer financial stability ratings from each of the three rating agencies accepted by the GSEs in our sample period: AM Best, S&P and Demotech. We collect each rating issued by Demotech from 2012 to 2021, and by AM Best and S&P from 2000 to 2021 from S&P Market Intelligence. We further hand collected Demotech ratings for Florida insurers from 2006 to 2012 using online archives. To our knowledge, these financial stability ratings are also a new to the household finance literature.

- **Link to mortgages:** While HMDA is standard, to our knowledge we are the first to link it to data on homeowners insurance at a granular, sub-state, level. While this has been done for flood insurance, it seemingly has not been done for homeowners insurance.

When Insurers Exit: Climate Losses, Fragile Insurers, and Mortgage Markets*

Parinitha Sastry
Columbia GSB

Ishita Sen
Harvard Business School

Ana-Maria Tenekedjieva
Federal Reserve Board

September 2023

Abstract

This paper studies how homeowners insurance markets respond to growing climate losses and how this impacts mortgage market dynamics. Using Florida as a case study, we show that traditional insurers are exiting high risk areas, and new lower quality insurers are entering and filling the gap. These new insurers service the riskiest areas, are less diversified, hold less capital, and 20 percent of them become insolvent. We trace their growth to a lax insurance regulatory environment. Yet, despite their low quality, these insurers secure high financial stability ratings, not from traditional rating agencies, but from emerging rating agencies. Importantly, these ratings are high enough to meet the minimum rating requirements set by government-sponsored enterprises (GSEs). We find that these new insurers would not meet GSE eligibility thresholds if subjected to traditional rating agencies' methodologies. We then examine the implications of these dynamics for mortgage markets. We show that lenders respond to the decline in insurance quality by selling a large portion of exposed loans to the GSEs. Our results show that the GSEs bear a large share of insurance counterparty risk, which is driven by their mis-calibrated insurer eligibility requirements and lax insurance regulation.

Keywords: Climate Risk, Property Insurers, Banks, GSEs, Mortgage Securitization, Credit Rating Agencies, Insurance Regulation.

*For helpful comments we thank Robin Greenwood and Tomek Piskorski. We thank Kris Shen for excellent research assistance. The views in this paper are solely the authors' and do not reflect the views of the Board of Governors or the Federal Reserve System. All errors are our own. Sastry: prs2107@columbia.edu; Sen: isen@hbs.edu; Tenekedjieva: ana-maria.k.tenekedjieva@frb.gov

1. Introduction

The last few decades have seen an unprecedented growth in property damage from natural disasters. Forecasters expect losses to accelerate further as climate change brings an increase in the frequency and intensity of natural disasters (Davenport et al., 2021). Households bear large exposures to climate risk through their homes. Insurance provides a first line of defense against losses from most natural disasters for households, covering at least 60% of all property damage by some estimates.[1] However, there are a handful of states where these insurance markets are beginning to unravel – particularly high climate risk states. We study this unraveling and the direct risks it poses for mortgage markets.

Mortgage markets bring a range of different financial institutions together. Banks and non-banks originate loans. The government-sponsored enterprises (GSEs) purchase, guarantee and securitize mortgages. Property insurers help households rebuild after these disasters. By preserving collateral values and reducing the likelihood that a borrower defaults, insurance directly reduces risks for banks and the GSEs. Unsurprisingly, banks require insurance for all mortgages, and the GSEs only purchase loans backed by good quality insurers. Despite being ubiquitous, the role that property insurers play in mortgage markets is understudied in the literature. This paper shows how banks and insurers interact to influence mortgage market outcomes and the distribution of climate risk to the wider economy.

Our paper makes two contributions. First, we flesh out how exactly insurance markets are evolving in the face of growing natural disaster losses. We show that the well-established traditional insurers are cancelling policies and exiting high risk areas. Instead of insurance disappearing completely, as is widely believed, the gap left by traditional insurers is filled by poor quality insurers, who disproportionately service the riskiest areas. Despite being low quality, these insurers secure good financial stability ratings on their liabilities from emerging rating agencies which we show have laxer standards for high ratings than the traditional ones.[2] Second, we examine how banks respond to the changing insurance market dynamics. We find that banks manage the increase in counterparty risk from insurers by selling a large portion of loans to GSEs, whose eligibility criteria, as we argue, are not sufficiently sensitive to insurer quality. The high financial stability ratings obtained by these low quality insurers are often high enough to meet the GSE's minimum rating requirements for purchase and

[1] Swiss Re, "How big is the protection gap from natural catastrophes where you are?", October 2023. See here.

[2] Financial stability ratings are central to insurance companies' operations. Ratings convey information about insurers' future solvency and ability to pay claims. As a result, insurance demand tends to be sensitive to ratings (Froot and Stein, 1991). However, in addition to households, GSEs also care about insurers' ratings and they impose minimum rating requirements to screen insurers.

securitization.

While we document the widespread deterioration in the quality of insurance intermediation across a number of states, our paper mainly focuses on the mortgage market in Florida for the following reasons. First, Florida ranks among the top states in terms of both past and projected future climate losses and therefore serves as an early case study of the risks climate change poses to insurance and mortgage markets.[3] Second, we have granular insurance underwriting data available for Florida, while these data are primarily only available at the state level for other states. Third, we can exploit a unique policy that allows us to examine plausibly exogenous variation in insurance provision. The state of Florida ran programs that shifted insurance policies from the balance sheet of the state-run insurer-of-last-resort to the balance sheet of these lower quality private insurers. These programs deliver an exogenous change in insurer quality that is plausibly unrelated to the fundamentals of the underlying loan and borrower characteristics, as we describe in more detail below.

Our paper uses a number of novel data to obtain a comprehensive picture of insurance and mortgage markets. First, we collect granular county-level underwriting data for each insurer operating in Florida, which are reported directly to the state of Florida. This data has the unique feature that we can observe precise flows of insurance policies, including new policies underwritten and policies transferred between insurers at a granular level. Second, we combine the underwriting data with insurers' financial and operational statements collected from statutory filings. We observe detailed accounts of assets, liabilities, reinsurance relationships, and key operation metrics, providing us a comprehensive picture of insurers' financial strength across their entire underwriting portfolio. Third, we collect the financial stability ratings histories of property insurers made by both traditional and emerging rating agencies. Historically, insurance companies have primarily been rated by traditional rating agencies, such as AM Best and Standard & Poor's (S&P). More recently, several new rating agencies have emerged, in particular Demotech Inc. Fourth, we compile detailed data on insurers' supervisory examinations. Finally, we combine this information with mortgage originations and securitization data from the Home Mortgage Disclosure Act (HMDA).

We start by documenting three new facts on the dynamics of property insurance markets and rating agencies. First, there is a large decline in the market share of insurers rated by traditional rating agencies (traditional insurers henceforth). This is a direct result of traditional insurers pulling back from underwriting, especially in the more risky and loss-prone areas. However, instead of insurance becoming completely scarce, the gap is filled by two separate types of insurers: the state-run insurer-of-last resort known as Citizens

[3]CoreLogic Climate Risk Analytics. May 17, 2023. See here.

Property Insurance Corporation (Citizens)[4] and, more importantly, new insurers, primarily rated by emerging rating agencies such as Demotech (Demotech insurers henceforth). We document a dramatic increase in the market share of Demotech insurers. From having a negligible presence in the 1990s, when they entered the market, their share rises to over 50% in 2018. We show that this is not unique to Florida and part of a broader country-wide trend, especially in states more prone to weather- and climate-related disasters.

Second, we show that Demotech insurers are of significantly lower quality than traditional insurers across most observable measures of financial and operational risks. (a) Demotech insurers have riskier liabilities and operate in high risk areas. (b) They are under-diversified: they are smaller in size by total assets; they operate in fewer states with a large majority only selling in a single state; they predominantly sell homeowners' insurance while traditional insurers have many other product lines; and are part of an insurance group with few other operating companies. (c) They have riskier and concentrated reinsurance relationships and are more exposed to counterparty risk of reinsurers. (d) They have higher leverage and lower risk based capital ratios, and thus appear under-capitalized relative to underlying risks.

Third, in contrast to Demotech, ratings assigned by traditional agencies have higher dispersion spanning the full range of the distribution, including ratings low enough to not meet GSE minimum eligibility requirements. This is despite the fact that traditional insurers are higher quality on average. We develop an AM Best rating replication model by mapping observable insurer characteristics to numeric ratings. Using the model, we predict counterfactual AM Best ratings for Demotech insurers. Our replication shows that a vast majority of Demotech insurers would be rated "junk" by AM Best and not meet GSE eligibility. Our results are validated by the fact that Demotech insurers have a much higher likelihood of insolvency. 19% of Demotech insurers entered rehabilitation proceedings in the past decade, while none of the traditional insurers did.

We next explore how banks and mortgage lenders respond to the deterioration in insurers' quality. We first analyze this question by showing that securitization shares in a county strongly covary with the market share of Demotech insurers. We find that, on average, a 1 percentage point increase in the market share of Demotech insurers is associated with an 0.08 percentage point increase in the share of mortgages that are securitized. Our specification includes county and year specific effects, and the estimate is robust to controlling for average loan characteristics including borrower income, FICO credit score, and property values. This result suggests that the GSE's have large counterparty risk exposures to Demotech insurers.

However, this specification does not identify whether banks strategically securitize mort-

[4]More broadly, the insurer-of-last resort is referred to as "residual market".

gages to offload counterparty risk, since it does not account for the fact that borrowers are likely not randomly assigned to Demotech versus traditional insurers. It is possible that borrowers with high default risk are also more likely to obtain insurance from Demotech insurers, and so the correlation between securitization share and the market share of Demotech insurers could be explained by underlying shifts in borrower characteristics rather than the causal effect of insurance. The ideal experiment would look at the securitization outcomes for two otherwise identical borrowers who only differ in terms of which insurance policy they obtain.

We address this endogeneity issue by studying the Florida Depopulation Program. Starting in the 90s, the Florida residual market repeatedly expanded after particularly bad hurricane seasons. This led to the adoption of a "depopulation" policy in the early 2000s, where the state of Florida incentivized private insurers to "take out" Citizens' policies (i.e., borrower policies were transferred from Citizens to a private insurer). The Demotech insurers dominated the depopulation effort, with over 95% of participating insurers having a financial stability rating from this emerging rating agency. The depopulation effort ultimately led to over 18% of Citizens policies being sold to the private market serviced by Demotech insurers; at its peak in 2012, over 200,000 policies were depopulated. By using these policy flows, we can focus on what happens to existing mortgage borrowers that switch from the state-run insurer to a private insurer of lawer required.

On the mortgages side, we can similarly separate flows into new mortgage originations that are sold to the GSEs in the same calendar year that they are originated, and older mortgages that are sold in a subsequent calendar year. We then examine securitization dynamics of older mortgages and test whether there is a change in the likelihood that these mortgages are subsequently sold to a GSE following a switch from Citizens to a private insurer in that same county. At its core, our identification strategy tries to trace the same borrower before and after their insurance policy is sold, allowing us to obtain variation in insurer quality that is plausibly exogenous to other characteristics of the mortgage borrower. In studying this program, we find that a 1% increase in policies transferred to Demotech insurers in a given county brings a .03% increase in mortgages that are sold to the GSEs. To interpret the magnitude of this elasticity, we consider a counterfactual program where Citizens conducts a takeout of 100,000 policies in 2020, similar to the depopulation efforts in 2013 or 2014. Our elasticity suggests that such a program would lead to a 24% increase in the dollars securitized with the GSEs. Overall, our results suggest that mortgage lenders actively manage insurer counterparty risk by offloading mortgages with high insurer counterparty risk to the GSEs.

To make our findings concrete, consider the following illustrative example. The property

insurer Magnolia Inc., began its Florida operations in April 2008 with a financial stability rating of "A" (Exceptional) from Demotech. In the same month, it received regulatory approval to participate in Citizens depopulation program and took over more than 100,000 policies from the state-run insurer by the end of the year.[5] These policies came disproportionately from Florida's highest risk, coastal counties. Despite Magnolia's thin capitalization, its high financial stability rating ensured that GSEs could purchase any mortgages whose underlying properties were insured by Magnolia. However, our estimates show that its predicted AM Best rating would have been a B- and thus Magnolia should have been ineligible. Indeed, almost immediately after entering Florida, it experienced losses and reinsurance costs that were dramatically higher than its projections.[6] By the end of 2009, it stopped filing quarterly financial reports, was placed under state supervision, and had its "A" rating suspended. It was liquiditaed in April 2010. Our results imply that banks sold many of the 100,000 mortgages transferred to Magnolia in its two years of operation to the GSEs as GSEs were willing to assume the counterparty risk exposure to Magnolia.

A key question is what sustains the emergence of poor quality insurers in Florida. We provide three pieces of the puzzle. First, we show that the GSE eligibility requirements are not properly calibrated across rating agencies. In particular, as our rating replication exercise shows, the requirements of emerging rating agencies such as Demotech appear too lax relative to traditional rating agencies such as AM Best and S&P. Poor quality insurers select into the emerging rating agencies, allowing them to meet the GSE's eligiblity thresholds. Second, we show that insurance regulation is lax on two fronts. (i) Demotech insurers experience similar levels of supervision as traditional insurers despite observable differences in quality. (ii) The risk-based capital ratios do not adequately capture the risks embedded in the liabilities of under-diversified insurers that operate in fewer states. Third, we document that the office of insurance regulation provides direct cash incentives to the private sector bringing down their required returns for operating in the riskiest areas of Florida.

Related Literature: This paper contributes to three strands of the literature. First, we add to the literature documenting supply-side frictions in climate risk insurance markets. Froot and O'Connell (1999) and Jaffee and Russell (1997) study the role of capital market frictions; Oh et al. (2023) study the role of state-level price regulation, Boomhower et al. (2023) study the role of information asymmetry for pricing of homeowners' insurance.[7] Our

[5] Magnolia's Insolvency Report and Citizens Depopulation Report, 2008.

[6] Its projected loss ratio was 25%, but ended up being 47%; projected reinsurance costs were 38%, but ended up being 55%; projected investment income was 5%, but ended up being 1%. Florida Office of Insurance Regulation. Magnolia Insolvency Report, p.7

[7] A separate literature also studies insurance demand in the context of the federal flood insurance market (e.g., (Wagner, 2022)).

paper also relates to the broader insurance literature on supply side frictions, including financial, regulatory, and legal frictions, and their effects on product markets and asset selection (Koijen and Yogo, 2015, 2016, 2022; Ellul et al., 2015, 2022; Ge, 2022; Sen and Humphry, 2018; Sen, 2021; Sen and Sharma, 2020; Barbu, 2021; Tang, 2023; Tenekedjieva, 2021; Oh, 2020; Gennaioli et al., 2021; Egan et al., 2021). We identify a new source of friction – one coming from GSE requirements – that affects the I/O of homeowners' insurance market. Our results emphasize how insurers are connected to other intermediaries through the mortgage market and how incentives and constraints of these intermediaries spill over to insurance markets.

Second, this paper contributes to the growing literature on the capitalization of climate risk in real-estate markets.[8] A new set of papers study the connection between real estate and insurance markets in the context of growing climate risk, e.g., how flood insurance market affects mortgage lending (Sastry, 2022) and real estate prices (Ge et al., 2023), and how insurance pricing can guide adaptation (Boomhower et al., 2023). The literature shows that climate events create financial losses for lenders through increases in defaults, and that insurance payments offset much of the rise in delinquencies after disasters (Gallagher and Hartley, 2017; Kousky et al., 2020; Billings et al., 2019; Issler et al., 2019; An et al., 2023; Biswas et al., 2023). We show how property insurers create counter-party risk for mortgage lenders and that lenders react to increasing insurer counterparty risk by offloading risks to the GSEs. To our knowledge, this is the first paper drawing such a link between private insurance and mortgage markets.

Third, we add to the large literature on adverse selection in mortgage securitization (Downing et al., 2009; Keys et al., 2010; Demyanyk and Van Hemert, 2011; Adelino et al., 2013, 2016). Several papers show that the ability to offload risks through securitization distorts lender incentives to screen and monitor mortgages and that mortgages that end up securitized are of lower quality and perform worse compared to mortgages with similar observable characteristics. A recent paper by (Ouazad and Kahn, 2021) shows this pattern holds even in the climate risk context – that lenders are more likely to originate loans below the conforming loan limit after a large hurricane strikes, and that these mortgage have worse ex-post delinquency outcomes. A number of papers also show that the pricing of guarantee fees by the GSEs ignores important component of risks, such as local house price

[8]There are now a large number of papers broadly exploring whether climate risks are capitalized in house prices (Baldauf et al., 2020; Bernstein et al., 2019; Gibson and Mullins, 2020; Giglio et al., 2021; Keenan et al., 2018; Murfin and Spiegel, 2020; Mulder and Keys, 2020). A handful of papers have explored whether lenders screen for climate disaster risk by adjusting where they originate mortgages (Garmaise and Moskowitz, 2009; Cortés and Strahan, 2017; Gropp et al., 2019) and mortgage pricing (Garbarino and Guin, 2021; Mulder and Keys, 2020; Sastry, 2022; Santos and Blickle, 2022).

risk (Hurst et al., 2016). We contribute to this literature by showing a new type of adverse selection coming from exposure to counterparty risk of insurers. We document significant heterogeneity in insurer quality, and that lenders seek to offload this counterparty risk to the GSEs because of inconsistencies in GSEs rating requirements across agencies.

2. Institutional Details

2.1. Homeowners Insurance and Mortgages

A well-operating mortgage market depends on a fully functional homeowners insurance market. Mortgage lenders require borrowers to maintain homeowner (HO) insurance for the duration of their mortgage to make sure the underlying property is protected against physical damage. Doing so helps preserves the collateral value of the property that secures the lien. As a result, the insurance product is ubiquitous, with insurers selling annually over $15 trillion in homeowners multi-peril insurance coverage to almost 85% of all U.S. homeowners (Jeziorski et al., 2021).

The standard contract is annual and covers damages from most climate-related disasters, except those from floods.[9] If the insured property experiences physical damage due to an insured event, the insurer pays out to cover losses up to the coverage limit specified in the contract. Both households and lenders are beneficiaries of the insurance policy, meaning that they both have claims to the insurance proceeds in loss events.[10] If the loan is sold or securitized, the ultimate mortgage owner most often still requires homeowners insurance.[11]

Lenders and mortgage owners are keenly aware of the importance of insurance markets for managing risks. Homeowners often rely on insurance proceeds to repair their homes and make mortgage payments after large loss events (Gallagher and Hartley, 2017). Several studies show that being uninsured or underinsured increases the propensity of household default after large climate events (Kousky et al., 2020; Issler et al., 2019). If insurers become insolvent at the same time that the households experience the financial shock of the disaster, lenders may face both an increase in borrower default rates and increased losses given default, since the disaster event can destroy the collateral value of the property used to secure the

[9]Flood insurance is carved out and mostly provided from the federal government through the National Flood Insurance Program.

[10]Insurance checks are made out to both the household and the lender; therefore, cashing a check requires the endorsement of both the lender and the household, meaning that lenders play a role in determining how insurance proceeds are used. Insurance payments are often used to repair physical damage, helping to preserve the collateral value of the property.

[11]Insurance requirements are then monitored and processed by the institution that services the mortgage on behalf of the ultimate owner.

mortgage.

Financial Stability Ratings: Given the counter-party risk that insurer insolvency poses to mortgage owners, lenders often set precise guidelines on which type of private insurance policies they are willing to accept. For example, the GSEs Fannie Mae and Freddie Mac require that the mortgaged property is covered by a homeowner insurance policy as a condition for the mortgage to be securitized by them. In addition, they require that the insurer underwriting the policy meets a minimum financial stability rating (FSR) threshold.[12] FSRs intend to measure an insurers' ability to meet ongoing insurance policy and contract obligations. They are given at the individual insurer level, not the group level, consistent with the level at which financial regulation of insurance takes place.[13]

FSRs are provided by third parties in exchange for payment by the insurers. For homeowners' insurance, the government-sponsored enterprises accept FSRs from three rating agencies: AM Best, S&P Global, and Demotech.[14] Table 1 shows the minimum acceptable FSR for insurers by the GSEs. Notably, the threshold varies by the issuing rating agency.

The three rating agencies have important differences in their business models. The traditional rating agencies, AM Best and S&P, have longer histories, larger market share, and rate companies all over the U.S..[15] In contrast, Demotech, an emerging rating agency, is relatively newer and concentrated mostly in Florida. Figure A.2 shows that Demotech's footprint in Florida, which is currently at more than 60%, dwarfs its market share in the other top five states in which it operates. The agencies also differ by rating methodologies and the type of insurer they rate. Demotech targets single-state insurers that tend to be smaller than the multi-state insurers rated by the traditional rating agencies. For example, Demotech states in its promotional materials that "financial stability can be independent of size" and that "well-managed, properly reinsured, regional and specialty insurers can be as financially stable as larger insurers".

2.2. Insurer-of-last-resort: Citizens Property Insurance Corporation

Homeowners insurance markets have been under increasing stress in recent years. In high-risk states like Florida, losses between 2003 and 2018 increased by 206% compared to the

[12]The government agency Ginnie Mae has a similar requirement based on FSRs.

[13]Therefore, if an insurance group consists of two individual insurers – a large, diversified multi-state insurer and a insurer that operates only in the Florida market – the two insurers would have separate financial strength ratings.

[14]Starting 2018, KBRA (formerly, Kroll) was added to this list, but given the time frame of the study, we only focus on the other three.

[15]AM Best has been issuing FSRs for over a hundred years, while Demotech entered the homeowners market in the 90s.

previous 15 years.[16] Large insurers are reportedly choosing to exit Florida by cancelling policies and refusing to originate new ones (Nicholson et al., 2020). Exiting insurers point to growing natural disaster risks. These exits occur despite the fact that Florida makes up 10% of the U.S. HO market and has the highest average price in the country.

Florida was one of the first states to experience a rapid increase in insurance losses. In fact, Florida's insurance markets have been under stress since at least 1992, when Hurricane Andrew caused record-breaking losses and led to 11 outright insurer insolvencies and large-scale insurer exits. The deterioration of the market resulted in close to 1 million coastal properties that could not find insurance. To address this issue, after Andrew Florida created a residual insurance market, i.e. a market of last resort to provide insurance to homeowners who could not otherwise obtain a policy through the private market. Since 2002, the residual market in Florida has been the state-run Florida Citizens corporation (Citizens).

While 31 other states and DC also have residual markets, Florida (and Louisiana) are unique in that their residual market is a fully state-run insurance provider, with liabilities borne by the state. Any losses in excess of premiums collected are funded through a combination of surcharges on Florida insurance consumers and general funds. For example, to cover Citizens' deficit in the 2004-2005 hurricane season, Florida's state legislature approved a one-time $715 million revenue appropriation. In addition, there were surcharges passed on to consumers through their insurance premiums, spread over a 10-year period (Hartwig and Wilkinson, 2016). In contrast, for the other 31 states, any losses in excess of the collected premiums are distributed among insurers licensed to do business in the state, meaning that taxpayers do not directly back the program. Notably, before 2002, Florida's residual market was funded in a similar way, but as losses grew, the funding source shifted from insurers to consumers. The funding structure of Florida's residual market may become more popular if losses continue to grow nationwide.

As an insurer of last resort, Citizens has eligibility requirements: A consumer is eligible to purchase a policy from Citizens if she can prove she is unable to find a private insurance coverage or if the private market charges significantly more than the residual market rate (the threshold as of 2020 is 20% more, according to Citizens' website). Several featured of Citizens can make it an attractive option to consumers. It has a price growth cap, and it cannot cancel policies following loss events, so it is often more reliable alternative than the private market. However, the disadvantage of Citizens is that its policies provide more minimal coverage than private insurers – they pay out for fewer loss events, and they have a coverage limit which varies over time.

[16] Estimated using SHELDUS for the states with highest amount of property damages – California, Florida, Texas, Louisiana and Mississippi. The numbers are adjusted for inflation.

Although intended to function as an insurer of last resort, Citizens has a uniquely large market share, even among residual markets. Over time, Citizens' market share has varied greatly: at its peak in 2011, it was 23%, then it gradually dropped to 4% in 2019, and has been again increasing since. An article by ABC Action News from January 11, 2023 reports that by the end of the year, Citizens is expected to reach a new record – 1.7 million policies.

Depopulation: Since the early 2000s, Florida has sought to decrease Citizens' market share using a "depopulation" campaign, which encourages private insurers to take on Citizens policies–meaning that the policy is transferred from Citizens to the private insurer. Insurers must be approved by the Florida Office of Insurance Regulation to participate in the Depopulation program. Between 2003 and 2019, Citizens' depopulation efforts resulted in 18% of all Citizens' policies being transferred to the private market, with only around 400,000 individuals remaining on Citizens' balance sheets. Private companies are offered financial incentives to take on the policies, receiving bonuses of up to $100 per policy (Nicholson et al., 2020). Initially, consumers could refuse to switch to the private insurer; however, after 2022, consumers were forced to accept the transfer if certain conditions were met.[17] While the Depopulation is an ongoing effort, in this paper we focus on the depopulation efforts of the early 2010s.

2.3. The Government-Sponsored Enterprises and Securitization

The government-sponsored enterprises (GSE) Fannie Mae and Freddie Mac directly own or guarantee the majority of $12 trillion US mortgage markets. To sell a mortgage to the government-sponsored enterprises, a mortgage must meet criteria that are set out in the GSE's origination guides. Furthermore, the GSE's servicing guides maintain requirements that must be maintained throughout the life of the loan. The most well-studied criteria are the GSE's conforming loan limits, which limit mortgages based on the size of the loan balance at origination, and the FICO score criteria (Keys et al., 2010, 2012). Less well known are the financial stability ratings requirements that property insurers must meet, as discussed earlier.

When selling or securitizing a mortgage with the GSEs, lenders have to pay an upfront fee called a guarantee fee (or g-fee). Prior to the financial crisis of 2008, this fee was uniform and did not vary by borrower risk characteristics. Following the crisis, there GSEs added additional charges based on the borrower's credit score and loan-to-value ratio at origination.[18] Importantly, these fees do not vary with other key features of risk. This includes

[17] If the premium offered by the depopulating insurer was within 20% of the Citizens premium, consumers are forced to switch.

[18] See for example Fannie Mae's Pricing Matrix: Fannie Mae's Pricing Ma-

measures of collateral risk or counterparty risk, including local house price risk (Hurst et al., 2016), as well as insurance counterparty risk. For example, lenders do not have additional fees to sell mortgages backed by properties that are insured by riskier property insurers.

3. Data

We combine data from a number of sources to obtain a comprehensive view of lending and insurance markets: (i) insurers' underwriting operations at the county level, financial statements and reinsurance relationships, as well as data on regulatory exams at the insurer level, (ii) insurers' financial strength ratings, and (iii) mortgage data.

3.1. Insurance Data

Insurer-County-Level Data: We use a novel data on homeowner underwriting operations in Florida. All homeowner insurers that operate in the state must report their *county-level* underwriting operations to the Florida Office of Insurance Regulation (FLOIR). We access this data through FLOIR's Quarterly and Supplemental Reporting System – Next Generation (QUASRng). The insurers report total premiums written, number of policies written, total coverage of the written policies, as well as policies transferred to and assumed from other insurers. The data are available at a quarterly frequency, so to bring it to the annual level, we use Q4 data for stock variables (e.g. total premiums, number of policies), and sum across all quarters in a year for flow variables (e.g. new policies, transferred policies, cancelled policies).

The data are publicly available for all companies doing business in Florida between 2009 and 2013, after which a court decision allowed companies to request that their information is not released to the public due to trade secret limits. After the decision, we do not observe the QUASR filings for State Farm Florida starting from 2014 Q1, and of three more companies starting 2017 Q1 (United P&C, Family Security and American Coastal). Starting 2019, we no longer observe the data for 19 more companies, and the number further grows. In Figure A.1 we show the percent of the premiums written by insurers missing from QUASRng, and we see that before 2018, less than 10% of premiums are missing, the number exceeds 36% starting in 2019. Therefore, we consider 2018 the last year for which county-level underwriting data is available.

Insurer Financial Statements and Operations Data: Every year, property and casualty (P&C) insurers file annual reports, which we access through Standard & Poor's

trixhttps://singlefamily.fanniemae.com/media/9391/displayFannie Mae's Pricing Matrix

Market Intelligence (S&P MI) database. From these filings, we access four types of information for each insurer: (i) data on underwriting operations in a given state and line of business, (ii) balance sheet data, (iii) data on regulatory actions against the insurer and (iv) data on reinsurance relationships.

(i) Underwriting data: Insurers report their underwriting activities for each state and business line that they operate in. This underwriting data contains information on total homeowners' premiums sold (which refers to the total sale of homeowners' policies) and total losses incurred (i.e., total amount spent on claims).

(ii) Balance sheet data: Insurers also report detailed financial statements as part of their regulatory filings, including balance sheets, regulatory capital positions, and the part of insurance liabilities ceded to or assumed from other insurers and reinsurers. These variables are all available at an insurer-year level.

(iii) Examinations and restatements: We collect data on regulatory scrutiny the company faces from the insurers' annual filings. Insurers must report annually the state which is responsible for their financial regulation (state of domicile), year of their last financial exam, and whether that financial exam resulted in restatement. These variables are all available at an insurer-year level. Financial exams are a proxy for regulatory strictness and are discussed at length by Tenekedjieva (2021). The domicile state regulators conducts exams to observe the insurers' financial state and assess if they are financially capable of honoring its liability obligations.

Exams must happen at least once every five years, but they can happen more frequently at the discretion of the regulator. The exams can have various outcomes, varying from no recommendations to the company being deemed insolvent and put into state receivership. In this setting, the only outcome we observe is whether the exam forced the firms to restate their financial statements. This outcome happens if during the exam the regulators found inconsistencies in the reported financial statements, and require that the insurer corrects them. Such restatements can trigger automatic review by rating agencies and are considered a bad outcome for the insurer. Thus, to proxy of regulatory strictness we check how often these exams take place, and how likely they are to result in a restatement.

(iv) Reinsurance relationships: Insurers also report information about the reinsurance contracts they maintain active. S&P MI further matches each reinsurer to their AM Best financial rating. Note that reinsurers' rating is separate from the insurers' financial

strengh rating; it captures the ability of reinsurers to honor their contractual liabilities. We collect data on all reinsurance contracts for insurers that sell HO insurance in Florida in 2019.

We supplement the data from insurers' annual filings with a novel hand-collected data set on consumer complaints against each insurer. The information comes from FLOIR's annual reports, and we collect it for the years 2009 to 2018 for all homeowner insurers.

3.2. Insurers' Financial Strength Ratings

We obtain FSRs for all Florida insurers issued by the three rating agencies accepted by the GSEs in the period until 2018: AM Best, S&P and Demotech. Each rating for an individual insurer's includes the date, rating level (a letter) and whether the rating is first for the company, or affirming/upgrading/downgrading existing the most recent rating, and the date an insurer chose to longer be rated by the agency if needed. We collect each rating issued by Demotech from 2012 to 2021, and by AM Best and S&P from 2000 to 2021 from S&P MI. We further hand-collected Demotech ratings for Florida insurers from 2006 to 2012 using online archives.

3.3. Mortgage Data

We use publicly available administrative data on mortgage applications and originations from the Home Mortgage Disclosure Act (HMDA). HMDA data includes the loan amount, location (census tract), an indicator for which entity purchased the mortgage, and some borrower characteristics including income, gender, and race. We limit the sample to first-lien purchase mortgages for single-family, owner-occupied homes. We look at two types of mortgages. First, we refer to "originated mortgages" as those which were originated in the calendar year of HMDA reporting.[19] For these mortgages, a purchaser is reported if it is sold within the same calendar year that it was originated. Second, we refer to "purchased mortgages" as those which were originated in a previous year but then sold in the calendar year of reporting.[20] While most mortgage are sold or securitized within three months of origination, a number of mortgages are retained on balance sheet and sold later.

We then aggregate the data to the county-year-purchaser level for each of these two types. We use the "purchaser type" and "loan type" variables to categorize mortgage purchasers into four groups: GSE, Ginnie Mae, other-private, and on-balance-sheet.[21]

[19] In the data, these are those loans classified as "action type" = 1.

[20] In the data, these loans are classified as "action type" = 6.

[21] Specifically, we identify GSE loans as those that are purchased by Fannie Mae, Freddie Mac, or Farmer

We supplement the HMDA data with county-level information from the BlackKnight McDash dataset, a comprehensive, loan-level dataset on mortgages that includes information on mortgage characteristics, borrower characteristics (including FICO and property values), and mortgage performance. The data is compiled from mortgage servicers and accounts for approximately two-thirds of the overall mortgage market.We aggregate their information on borrower characteristics to the county-year level.

3.4. Final Data Creation

We combine these data to create two final samples. The first is an insurer-level panel on firm characteristics from their regulatory filings and their financial stability ratings. The second data set a county-level panel which combines insurance and mortgage information. We use the insurer-county level data to obtain the relative market shares of the different types of insurers in each county and year. We then merge in the collapsed mortgage data at the county-level. This data covers the 67 counties in Florida and also spans 2009-2018.

4. Insurance Market Dynamics

This section discusses how insurance markets have evolved in Florida, and factors that have contributed to the insurance market changes.

4.1. Broad Insurance Market Trends

We start by documenting how market shares have evolved for the three main types of insurers in Florida.

(i) Exit of traditional insurers. First, there is a large decline in the market share of insurers that only have financial stability ratings from AM Best and/or Standard & Poors (henceforth traditional insurers). Figure 2 shows that, at its peak in 2007, traditional insurers underwrote over $3 billion in premiums, which declines to $2.1 billion in 2018. This is a direct result of traditional insurers pulling back from underwriting. Figure 3 shows that on average 11% of in-force policies are cancelled or not renewed each year by traditional insurers.

(ii) Entry of Citizens and Demotech insurers. Second, we show that insurance does not completely disappear. The gap left by traditional insurers is filled by two types of insur-

Mac (purchaser types 1, 3, and 4). Other-private loans are those that are purchased by private financial companies (purchaser types 5, 6, 7, or 9). On-balance-sheet loans are those that are either not sold, or sold to an affiliate of the same bank (purchaser type missing, 0, or 8). Lasly, Ginnie Mae loans are those that are purchased by Ginnie Mae (purchaser type 2) or are separately classified as FHA- or VA- insured (loan type 2, 3, or 4). This classification is comprehensive, and every loan fits one of these four groups.

ers. (i) Citizens, the state-run insurer-of-last resort, overtakes a large burden of insurance intermediation. At its peak in 2011, Citizens market share was close to 20% of the overall market. It fell thereafter as a result of conducting several rounds of "depopulation", as we discuss in the next section. (ii) New insurers, those with financial stability ratings from the emerging rating agency Demotech (henceforth, Demotech insurers), have rapidly gained market share. We document a dramatic increase in their market share: from having a negligible presence in the 1990s, when they entered the market, their share rises to over 50% by 2018. An important source of Demotech insurers' growth is through policies taken over from Citizens through the depopulation program. In other words, Citizens operates as a temporary stop-gap, a bridge between traditional and new insurers.

The increase in the market share of Demotech insurers is not unique to Florida but is part of a broader country-wide trend. Figure 1 shows the share of Demotech insurers across the US.[22] Demotech insurers have a market share of over one-third in the riskiest states in the US, including states in the south- and mid-atlantic region and the Gulf coast, and over one-fifth in the remaining low risk states.

4.2. Fragility of Demotech Insurers

Quality based on ex-ante metrics: We next compare the Demotech and traditional insurers across a range of financial and operational characteristics. Table 2 shows that Demotech insurers are of significantly lower quality than traditional insurers across most observable measures of financial and operational risks.

(i) Balance sheet and solvency. Panel A shows that Demotech insurers are 10 times smaller by total assets. The average Demotech insurer has $300 million of assets, while the average traditional insurer has $3 billion. Demotech insurers have greater leverage and, importantly, have lower *regulatory* risk based capital (RBC) ratio. RBC ratio, ratio of available capital to required capital, depicts insurers' solvency, i.e. whether an insurer is well capitalized relative to its risks. These risks encompass asset-side, liability-side, and overall business risks. While being above the regulatory cutoff, the average Demotech insurer has 57% lower RBC ratio than the average traditional insurer, and thus appears under-capitalized vis-a-vis underlying risks relative to peers.

(ii) Liabilities. Demotech insurers have riskier liabilities than traditional insurers. We first compare their loss ratios (the ratio of total claims paid to total premiums collected). Loss ratios are higher for Demotech insurers both in Florida (83% vs. 76%) as well as nationally, suggesting that Demotech insurers carry higher risks. However, loss ratio can be

[22] Figure A.2 shows the states with the highest market share of Demotech insurers.

high not only if an insurer insures riskier properties but also if it has lower pricing power. To tell the two apart, we separately examine risk and pricing behavior. We first rank counties by climate risk using FEMA's national risk index classification. We then consider three different measures of exposure to high risk counties: premiums share in high risk counties, policy share, and coverage share. Panel A of Table 3 shows that Demotech insurers have higher exposure to riskier counties in Florida by all three measures.[23] Finally, Table 2 Panel B shows that Demotech insurers sell lower coverage per policy. Since insurance typically covers the full replacement cost of a house, this suggests that Demotech insurers cater to households that have lower value homes.

(iii) Operational diversification. Panel C shows that Demotech insurers are significantly less diversified than the traditional insurers across states and products. The average insurer operates in 3 states only (with 56% selling only in 1 state) and obtains 70% of its premiums from a single business line (homeowners' insurance). In contrast, the average traditional insurer operates in 27 states (with 10% selling only in 1 state), and obtains only 25% of its premiums from homeowners' insurance line, i.e. they operate across many other product lines. Panel C also shows that Demotech insurers belong to insurance groups that are themselves less diversified. In particular, Demotech insurers operate in groups with a small number of other operating companies (6 vs. 18) and where they represent the majority of assets (57% vs. 25%). They are also on average more likely to be stock companies rather than mutuals. In sum, Demotech insurers are less diversified in three dimensions: geographically, across business lines, and in their group structure.

(iv) Assets. Perhaps because of their riskier liabilities, Demotech insurers tend to allocate slightly higher proportion of assets to safer securities. For example, their allocation to equities is slightly smaller than traditional insurers (9% vs. 14.6%). Within bonds, they invest less in high yield bonds (NAIC Level 3+) than the traditional insurers, although both groups have only a small allocation towards riskier bonds. Similarly, the weighted average maturity of their bond portfolio is shorter than traditional insurers (9 vs. 16 years). However, even though the asset-side of Demotech insurers' balance sheet is less risky, overall they have higher risks relative to capital as seen from their significantly lower RBC ratios.

(v) Reinsurance. Panel E shows that Demotech insurers more heavily rely on reinsurance than traditional insurers. The average Demotech insurer cedes close to 50% of its premiums to reinsurers, compared to less than 15% for the average traditional insurer. On the one hand, reinsurance could be an effective way to reduce risk exposures. On the other hand, heavy

[23] We next examine pricing behavior in Panel B, which shows that Demotech insurers also have higher market power, consistent with their greater market share. This potentially explains why loss ratios do not fully reflect the extent to which Demotech insurers' liabilities are riskier than traditional insurers'.

reliance on reinsurance can introduce counterparty risk and pro-cyclicality as reinsurance prices increase substantially after large natural disasters (Froot and O'Connell, 1999). These concerns are particularly relevant here because a smaller proportion of Demotech insurers' reinsurance partners have a good rating themselves.[24] Moreover, Demotech insurers have a larger share of their premiums concentrated in just one reinsurer as seen from significantly larger fraction of premiums ceded to a single reinsurer.

Insurer insolvencies: We next show that the higher ex-ante riskiness of Demotech insurers also translates to higher rates of insolvencies ex-post. We track all insurers that were liquidated in Florida between 2009 and 2022. Demotech insurers have a dramatically higher likelihood of insolvency. Table 4 shows that 19% of Demotech insurers entered rehabilitation proceedings in this period. In contrast, none of the traditional insurers were liquidated.

4.3. Financial Stability Ratings

We next ask whether the large differences in observable characteristics are reflected in the financial stability ratings across rating agencies? Figure 4 shows that there is limited dispersion in the financial stability ratings assigned by Demotech and that these ratings are almost always high enough to meet GSE requirements. Ratings are either A″ (Unsurpassed), A′ (Unsurpassed), or A (Exceptional), which translates into an (ex-ante) 10-year default probability between 2% and 10% according to Demotech's estimates, lower than the actual insolvency rate of close to 20% in Table 4.[25] In contrast to Demotech, ratings assigned by traditional agencies have higher dispersion and span the full range of the distribution, including ratings low enough to not meet GSE minimum eligibility requirements. This is despite the fact that traditional insurers are higher quality on average.

Counterfactual AM Best Ratings of Demotech Insurers: We next develop an AM Best rating replication model by mapping observable insurer characteristics to AM Best financial stability ratings. Using the model, we predict counterfactual AM Best ratings for Demotech insurers. Specifically, as a first step we run the following regression:

$$AMBFSR_i = \alpha + \boldsymbol{\beta}\boldsymbol{X}_i + \epsilon_i, \tag{1}$$

where $AMBFSR_i$ is the AM Best rating of insurer i translated to a numeric scale. $\boldsymbol{X}_i$ is a vector of characteristics and $\boldsymbol{\beta}$ are the corresponding loadings on these characteristics. We estimate a cross-sectional mean specification, in which we regress the timeseries average of ratings for each insurer on the time series average of characteristics. The sample includes

[24] We obtain the AM Best ratings of reinsurers. A "good" rating is defined as "A" or above.
[25] See Demotech Credit Ratings Performance Measurement Statistics (2023).

insurers that were rated by AM Best at least at some point during our sample period.

We choose the characteristics following the literature (Koijen and Yogo, 2015). We include several measures of insurers' risk and capitalization, e.g., total assets, extent of diversification, and leverage. The characteristics also closely overlap with what would be chosen using a LASSO regression. In addition, a large number of the characteristics also correspond to factors AM Best considers in developing ratings, as described in publicly available reports. Table A.1 shows the model. Our model explains close to 60% of the cross-sectional variation in AM Best ratings, thus providing a good representation of AM Best's underlying ratings methodology.

We next predict the counterfactual AM Best ratings for Demotech insurers:

$$\widehat{AMBFSR}_{DEM} = \widehat{\alpha} + \widehat{\boldsymbol{\beta}}\boldsymbol{X}_{DEM}, \tag{2}$$

where $\boldsymbol{X}_{DEM}$ include the time series average of characteristics for a Demotech insurer. Thus, $\widehat{AMBFSR}_{DEM}$ shows the predicted *average* financial stability rating of a Demotech insurer during the period 2009 to 2018 had they been subjected to AM Best's methodology. We construct confidence intervals numerically using bootstrapping.

Figure 5 shows the counterfactual AM Best ratings for Demotech insurers. We find that a large fraction of Demotech insurers would be rated "junk" by AM Best and not meet GSE eligibility. In particular, close to 60% of Demotech insurers would not meet Freddie Mac's eligibility requirement and 24% would not meet Fannie Mae's requirement (at a 90% confidence level). Moreover, only 12% of the Demotech rated insurers (these are depicted in the right hand side of the graph) appear to be comfortably meeting AM Best's GSE eligibility criteria. Overall, these results strongly show inconsistencies in the GSE eligibility requirements across rating agencies. These inconsistencies could encourage ratings shopping, in particular among poor quality insurers who would not otherwise meet GSE eligibility.

4.4. Regulatory Supervision

We next compare the extent of regulatory supervision for Demotech and traditional insurers along two dimensions: financial supervision and market conduct. We focus on financial oversight of insurers domiciled in Florida, using financial exams as a proxy of regulatory supervision (as described in section 3). First, we find suggestive evidence of higher regulatory forbearance over time. Panel A of Table 5 shows that both likelihood of exams, and negative outcomes after the exams, such as financial report restatements, have decreased over time. Second, we find that despite Demotech insurers carrying more risk, they are not subject

to significantly more oversight than traditional insurers. Panel B shows that even though they are more likely to face an exam in a given year and more likely to have restatements than traditional insurers, the differences are not economically or statistically significant. This suggests that Demotech insurers face more lax financial regulation than traditional insurers conditional on quality. Third, Panel C shows that Demotech insurers account for a disproportionately large fraction of consumer complaints, suggesting that they face more lenient market conduct supervision.

5. Results on Depopulation and Mortgage Market Dynamics

In Section 4, we show that Demotech-rated insurers are more fragile than traditional ones and have inflated ratings. In this section, we explore what this fragility means for mortgage markets.

5.1. Incentives to Offload Risk

Demotech-rated insurers are more likely to become insolvent than traditional ones, creating counterparty risk for mortgage lenders. As discussed in Section 2, lenders are listed as beneficiaries to the property insurance contract. Insurance lets lenders hedge disaster risks by preserving the collateral value of properties securing the mortgages. However, unreliable insurance could result in a situation where large climate shocks may cause property damage at the exact time that the property insurer becomes insolvent, increasing household default incentives and losses given default. Therefore lenders have strong incentives to manage their counterparty risk exposure to lower quality insurers.

Securitization is an important way that lenders can mangage their counterparty risk exposure. The key to this strategy is that both Fannie Mae and Freddie Mac accept financial stability ratings from Demotech insurers (Table 1). If lenders are truly worried about collateral risk and insurance quality, we may expect them to sell mortgages that bear more exposure to such insurers.

We first test whether the likelihood that lenders sell mortgages to the GSEs varies with Demotech insurers' market share. To do this, we run the following regression:

$$GSE_Share_{c,t} = Demotech_Share_{c,t} + \delta_c + \gamma_t + X_{ct}\Gamma + \varepsilon_{c,t} \tag{3}$$

The dependent variable $GSE_Share_{c,t}$ refers to the dollar volume of mortgages sold to Fannie Mae or Freddie Mac divided by the dollar volume of all mortgages from county c in year t. This universe spans mortgages that were originated in calendar year t, as well

as mortgages that were originated in prior years that were sold in the calendar year t.[26] The key regressor of interest, *Demotech_Share*, refers to the total premiums collected by Demotech-rated insurers divided by premiums collected by all insurers in county c and year t. We also include county and year fixed effects (δ_c, γ_t), to absorb aggregate trends over time and time-invariant county characteristics. Standard errors are clustered at the county level.

Table 6 reports the results of estimating Equation 3. Column (1) of Table 6 shows that a 100 percentage point increase in the premiums share is associated with a 30 percentage point increase in the share of mortgages sold to Fannie Mae or Freddie Mac. To interpret this coefficient, Demotech's market share grew by 20 percentage points over the period between 2009 and 2019, implying that this brought a 6 percentage point increase in securitization. This coefficient tells us that the GSEs do bear disproportionate exposure to Demotech insurers, but it does not explain what drives this correlation.

To better understand what drives the correlation between Demotech shares and GSE shares, we include additional controls and fixed effects sequentially. The coefficient is similar in Column (2) after adding year fixed effects, which control for any unobservable aggregate trends over time. However, the coefficients shrink in Column (3) when adding county fixed effects, suggesting that much of the relation between property insurers and securitization is between-county, not within-county.

There are a number of competing explanations for the correlation between GSE share and Demotech share. There are two in particular that we would like to tease apart: a) that lenders strategically try to reduce their exposure to Demotech insurers by selling the mortgages to the GSEs, or b) lenders strategically reduce their exposure to higher risk borrowers by selling to the GSEs, and being a high risk borrower is correlated with obtaining an insurance policy from Demotech insurers. We try to address the possibility that a changing borrower composition drives our results by including time-varying county controls for average log income, FICO credit score, and property value of new mortgage borrowers.[27] As Column (4) of Table 6 shows, we see little change to the results when including these controls for borrower quality. The fact that the coefficient does not change much between Column (3) and Column (4) suggests that the correlation is not driven by observable decline in borrower quality, though of course it does not speak to the possibility of unobserved characteristics.

[26] This refers to both "activity type = 1 " and "activity type = 6" mortgages in HMDA.

[27] These variables are county-year average constructed from the loan-level McDash and HMDA data.

5.2. *Citizens Depopulation Natural Experiment*

We also use a natural experiment to more directly address the possibility that we are capturing incentives to offload risk due to borrower selection rather than the causal effect of insurance. To do so, we exploit a time-varying policy instituted by Florida's insurer-of-last-resort (Citizens), and conduct a sharper test based on insurance contract flows.

The policy we study is Citizens' scheme to "depopulate" its balance sheet. As described in Section 2, Citizens provides financial incentives for private insuers to "take out" policies from its balance sheet, meaning that the policy is transferred from Citizens to the private insurer. That is, private insurers assume the policy, receive the premiums paid and are responsible for paying out any claims. While we do not have detailed micro data on the individual policies that are transferred from Citizens to private insurance, we do have aggregate data on insurer participation, and we observe the policy flows in the FLOIR QUASAR data at a county level. Demotech insurers dominate the depopulation program. Of the 40 insurers that participate in the Depopulation Scheme, 39 are Demotech-rated. Furthermore, Figure 6 shows that almost 50% of all Demotech insurers participate in the depopulation scheme. By contrast, less than 5% of traditional firms participate.

The Depopulation program is also very large. Looking at the policy flows in Panel A of Figure 7, we see that at its peak in 2013, Citizens transferred on net more than 200,000 policies. Figure A.4 shows that Citizen's depopulation was concentrated in counties classified by FEMA as being high risk. By using these insurer flows, we can focus on households who switch their insurance from Citizens to a Demotech-rated insurer. In other words, since the insurers which bid on Citizens policies were most likely to be rated by Demotech, we obtain variation in Demotech-share that is driven by existing mortgage borrowers moving into the balance sheets of Demotech insurers.

On the mortgages side, the HMDA data allow us to distinguish between newly originated mortgages that were sold in the same calendar year of origination, and mortgages that were originated in prior years but then sold in a different year. We can therefore look at *existing* mortgages, and see whether lenders are more likely to try and sell those mortgages following a large depopulation effort. For mortgage borrowers that are impacted by the Depopulation scheme, since the mortgages have already been originated, lenders have limited options when it comes to managing that counterparty risk exposure.[28] This is why we focus on the securitization margin; lenders can try to sell the mortgage throughout the life of the loan,

[28] At origination, lenders can try a number of strategies to manage their counterparty risk exposure. For example, they could limit which insurers borrowers can use as a condition of the mortgage; alter the terms of the mortgage (i.e. rate, downpayment) for borrowers that choose to buy from lower quality insurers; or completely pull-back from mortgage origination in high risk areas, where access to insurance is more valuable.

not just at origination.

We consider the following specification:

$$log(GSE)_{c,t} = \alpha + \beta log(Demotech)_{c,t} + \gamma_c + \delta_t + X_{ct}\Gamma + \varepsilon_{c,t} \tag{4}$$

The dependant variable $log(GSE)_{c,t}$ refers to the log of the total dollar value of mortgages that are sold to the GSEs in county c in year t. The independent variable $log(Demotech)_{c,t}$ is the net number of insurance policies transferred to Demotech insurers.[29] The specification includes county fixed effects (δ_c) and year fixed effects (γ_t) to address any aggregate time trends or time-invariant county characteristics. We include as a control X_{ct} the average income of borrowers with existing mortgages that get sold in calendar year t but were originated prior to t. The coefficient β can be interpreted as an elasticity – a 1% increase in policies transferred to Demotech brings a β% increase in the dollar value of mortgages sold to the GSEs.

Identifying Assumptions: With this specification, we seek to isolate variation coming from a switch in insurance policy for *the same* borrower, in order to limit the possibility that the results on GSE purchases are not driven by unobserved differences in the selection of borrowers. To validate this interpretation, we make the following identifying assumptions.

First, we assume that the policies transferred to Demotech insurers comes from Citizens. We validate this assumption in Panel B of Figure 7, which shows that policies transferred away from Citizens in a given county in a given year correspond almost one-for-one to policies transferred to Demotech-rated insurers.

Second, we assume that there is no adverse selection in which types of policies are subject to the Depopulation. This could be an issue if, for example, the same household becomes more risky over time, and the risky households are the ones who are most likely to be subject to the Depopulation. We argue that the structure of the program limits this concern. Insurers can choose which policies to assume from Citizens, and they are unlikely to choose worse quality homeowners that cannot make insurance payments; if anything, they are likely to choose higher quality borrowers. Furthermore, the timing of the switch from Citizens to private insurers is not dictated by the borrower or the insurer–it is governed by the Depopulation schedule set by Citizens. So the timing of the switch is also unlikely to be driven by risk characteristics of the household.

Third, we assume that there is no adverse selection in the timing of securitization. In fact, Adelino et al. (2019) show that timing of securitization matters, but they find that in

[29] Here, net policies refers to policies received by other insurers minus any transferred to other insurers.

fact worse quality mortgages are sold earlier. This suggests that mortgages which were kept on lender balance sheets are in fact positively selected.

Lastly, the specification in some sense assumes that the mortgages which are sold to the GSEs are the ones where there is a switch in the insurance provider from Citizens to Demotech. This assumption cannot be directly validated because the data do not permit us to obtain information on insurance at the loan-level. However, a significant and positive estimate of β even after the inclusion of county fixed effects would suggest that an increase in the number of policies transferred does bring an increase in the value of mortgages sold.

Results: Table 6 shows the results of estimating Equation 4. Column (1) shows that there is a statistically significant raw correlation between policies transferred to Demotech and mortgages sold to the GSEs. A 1% increase in policies sold on average brings a 0.79 percent increase in mortgages sold to the GSEs. This number increases slightly in Column (2) when we include year fixed effects. In Column (3), the coefficient shrinks to a 0.03 percent increase after including county fixed effects. This suggest that between-county variation is important for explaining the raw correlation in Column (1). Finally, the coefficient estimate does not change much in Column (4) after including a control for average borrower income.

To interpret economic magnitude of this elasticity, we consider the following hypothetical scenario. Suppose Citizens conducts a takeout of 100,000 policies in 2020. This number is similar to the depopulation efforts in 2013 or 2014, and far below its peak in 2012 (200,000), and below the number currently being considered by Citizens (300,000).[30] Our elasticity suggests that such a program would lead to a 24% increase in the dollars securitized with the GSEs. This is because 100,000 represents an 800% increase in policies transferred relative to 2019, our last year of data. Multiplying this by 0.03 gives us 24%.

While on its face the estimated magnitude may seem low, the reality is that the sheer size of the Depopulation program is large enough for even a small elasticity to have large effects on the GSE's counterparty risk exposure. Overall, our results suggest that mortgage lenders actively manage insurer counterparty risk by offloading mortgages with high insurer counterparty risk to the GSEs.

6. Conclusion

This paper explores how insurance markets have responded to growing climate losses, and how these dynamics impact mortgage markets. We show that there has been a dramatic decline in the quality of insurance provision. The market share of traditional insurers has

[30] Tampa Bay Times, "Florida Citizens customers: Check mail or face costly insurance switch", September 19, 2023.

declined, driven by their exit from underwriting, particularly in higher risk areas. The gap created by their exit is being filled by new insurers that receive their financial stability rating from Demotech, an emerging rating agency. Second, these new insurers are of significantly lower quality than traditional insurers across most observable measures of financial and operational risk: they have riskier liabilities, are less diversified, have more risky and concentrated reinsurance exposures, and have higher leverage and less risk-based capital. We use a rating replication model to show that the vast majority of these insurers would be rated "junk" if they received their rating from a traditional rating agency rather than Demotech. In fact, we find that their ratings would be so low that they would no longer meet the GSE's requirements for securitization.

In the second part of the paper, we show that this deterioration in insurance quality leads banks to offload more mortgages with the GSEs. We show this correlation holds by looking at overall market shares, as well as in an identified natural experiment that addresses the possibility of adverse borrower selection. In particular, in studying Florida's Depopulation program, we find that a 1% increase in policies transferred to Demotech insurers in a given county brings a .03% increase in mortgages that are sold to the GSEs. These findings highlight the importance of a well-functioning insurance market for mortgage markets, and the increased counterparty risk offloaded to the GSEs.

The paper suggests a few key drivers of the decline in quality across Florida's insurance markets. The first comes from the market for ratings. Insurers have an incentive to minimize and adequately manage risk exposures to maintain a good financial rating, which is key for both GSE eligibility and consumer demand. However, we show that there is a significant heterogeneity in methodologies across agencies, which allows lower quality insurers obtain favorable ratings that maintain their eligiblility for GSE purchase and securitization. Second, financial regulation can play a powerful role in weeding out poor quality insurers. However, we find significant regulatory forbearance both in financial supervision and in market conduct supervision. We see that forbearance has increased over time–likely due to regulators attempts to increase availability of insurance. Third, Florida's Depopulation program is ongoing and expanding, as the state seeks to manage its fiscal exposures and limit taxpayer underwriting of insurance markets. As losses from climate change worsen, the financial stability risks of insurers is likely to become even more pronounced, calling into question the optimal design of such programs. We are likely to see policymakers face difficult tradeoffs in maintaing affordability, availability, and reliability of insurance markets.

Tables and Figures

Figures

Figure 1: Demotech Market Share Across US States

The figure shows the market share of Demotech-rated insurers over time in the top 10 states by climate losses relative to all remaining states.

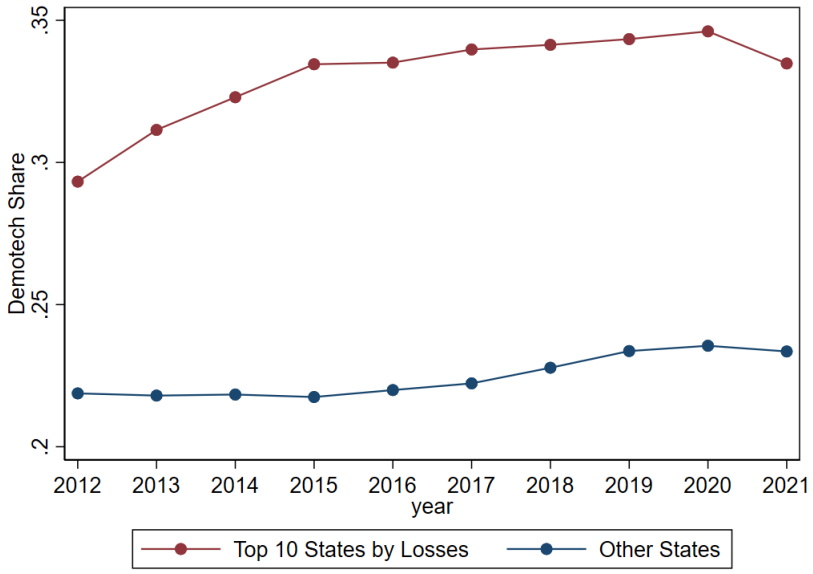


Figure 2: Evolution of Homeowners' Insurance Market in Florida

The figure shows the evolution of homeowners' insurance premiums over time for the different private insurer types (Demotech and Traditional), and for Citizens. Demotech insurers are defined as insurers that have been rated by Demotech at least once during the sample period. Traditional are insurers that are rated by traditional rating agencies (AM Best and S&P). Total premiums are in thousands of dollars. Data are taken from insurers' statutory filings. Start and end dates are dictated by data availability of the QUASAR database.

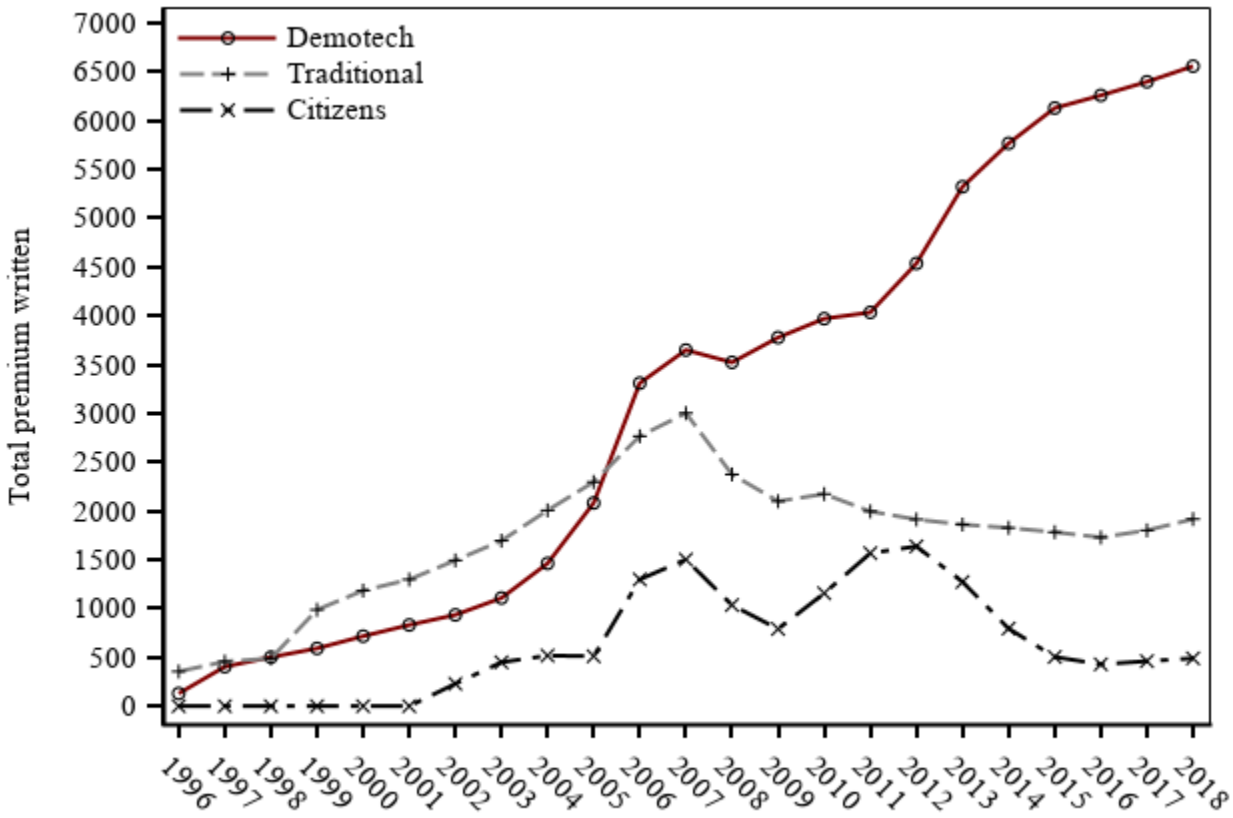
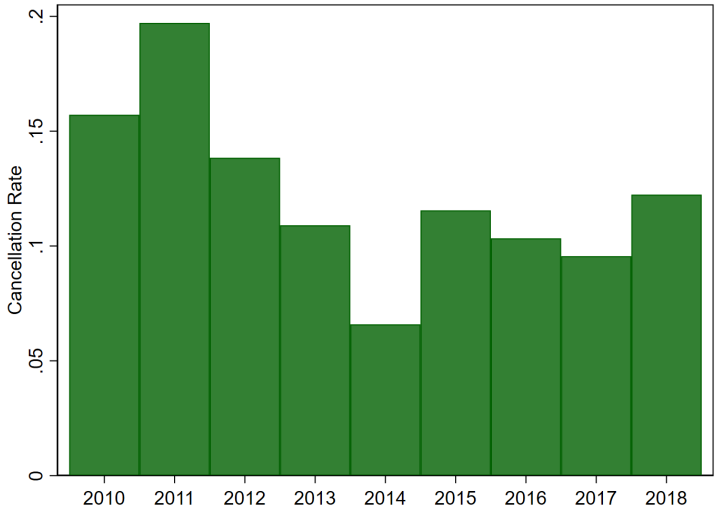


Figure 3: Cancellations and Non-renewals of Insurance Policies by Traditional Insurers

Panel A shows the percent of policies in force that are cancelled or not renewed each year for policies underwritten by traditional insurers, defined as those that receive a financial stability rating from the traditional rating agencies (AM Best or S&P). Panel B decomposes the flows of policies into new policies, cancelled or non-renewed policies, policies transferred to traditional insurers, and policies transferred from other insurers to traditional insurers.

(a) Cancellation Rate



(b) Overall Policy Flows

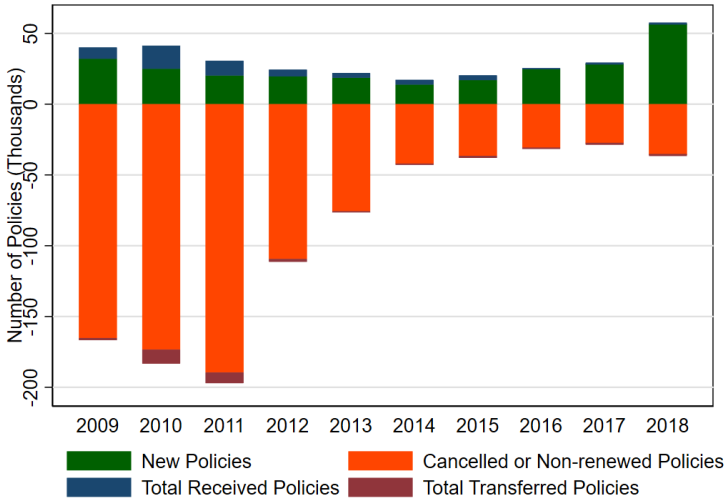
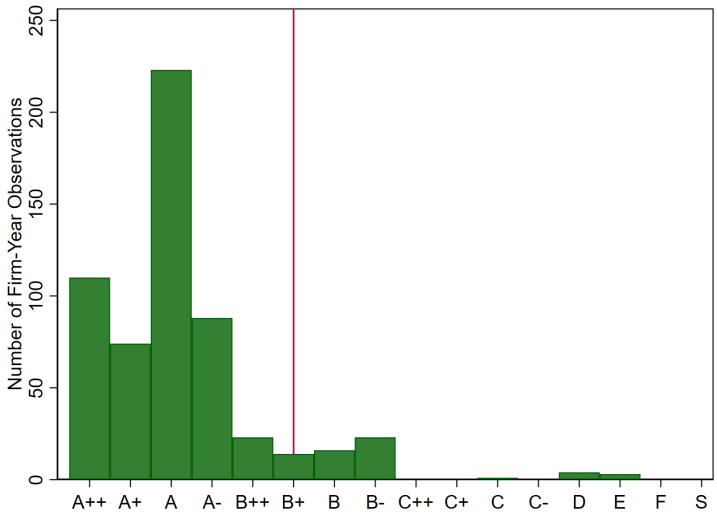


Figure 4: Histograms of Financial Stability Ratings

This figure shows histograms of financial stability ratings assigned by AM Best in panel (a) and Demotech in panel (b). The vertical line in both charts represents the minimum rating required to be eligible for purchase or securitization by Freddie Mac.

(a) AM Best Financial Stability Ratings



(b) Demotech Financial Stability Ratings

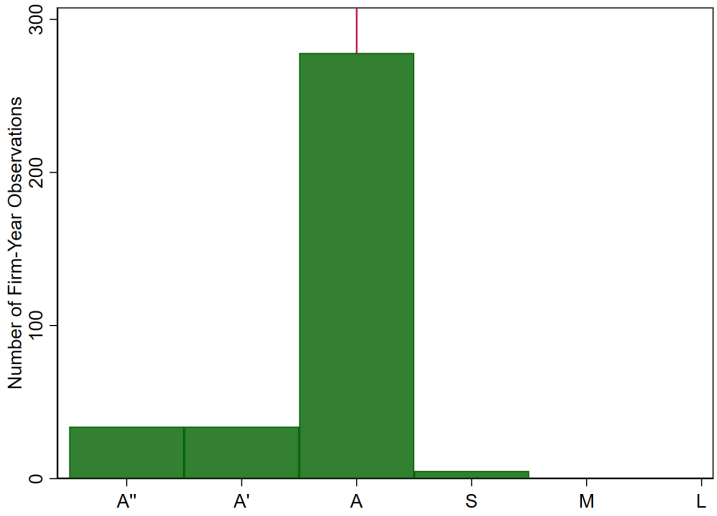


Figure 5: Counterfactual AM Best Ratings of Demotech Insurers

The figure shows the counterfactual AM Best financial stability ratings of Demotech insurers. AM Best replicating model is described in the appendix. We compute 90% confidence intervals by bootstrapping the predicted ratings. The red line shows the GSE eligibility cutoff for Freddie Mac and the blue line shows the GSE eligibility cutoff for Fannie Mae.

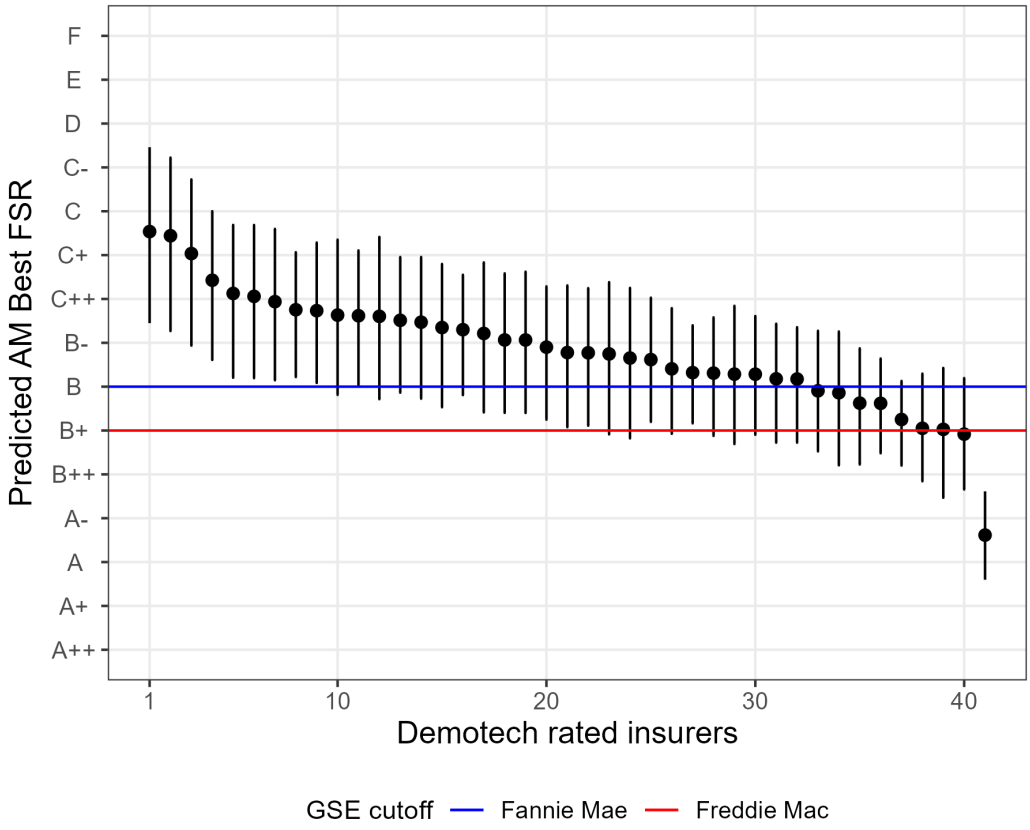


Figure 6: Participation in Citizens' Depopulation Program

The figure shows the fraction of insurers that participated in "takeouts", which refers to whether an insurer took over policies from Citizens during its depopulation program. Data are from Citizens Property Insurance Corporation.

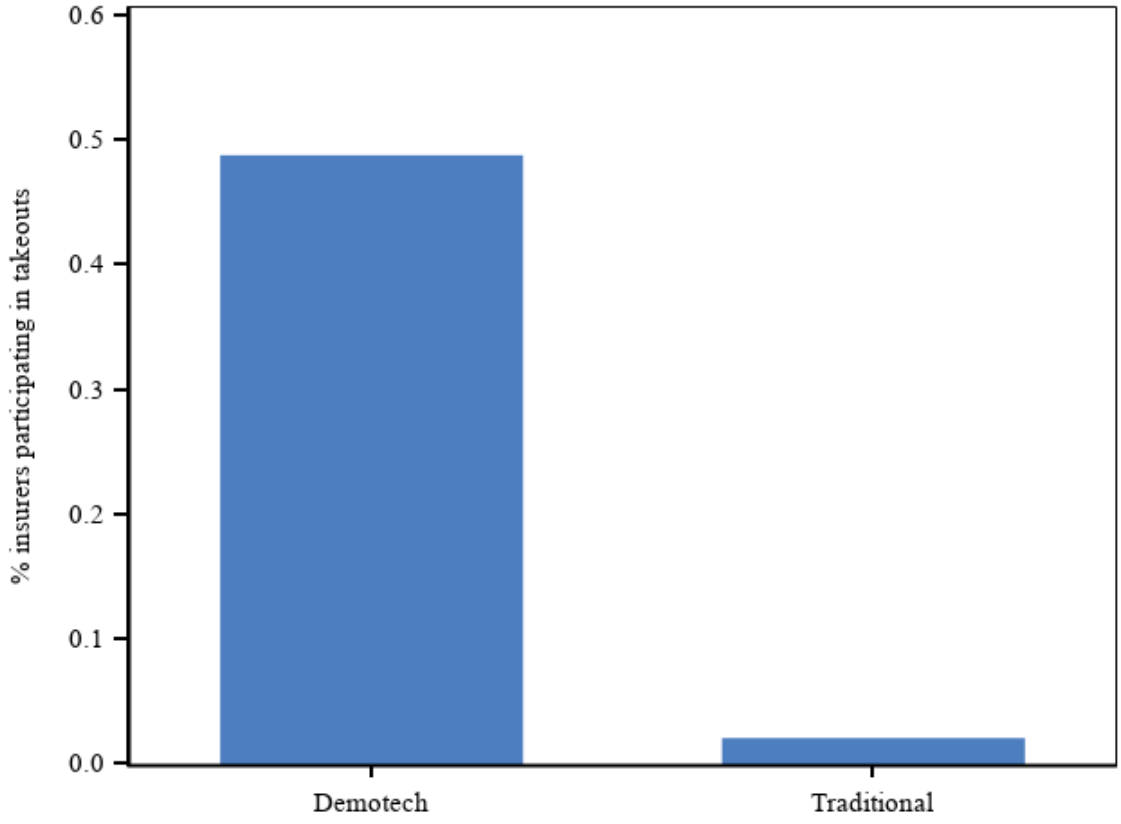
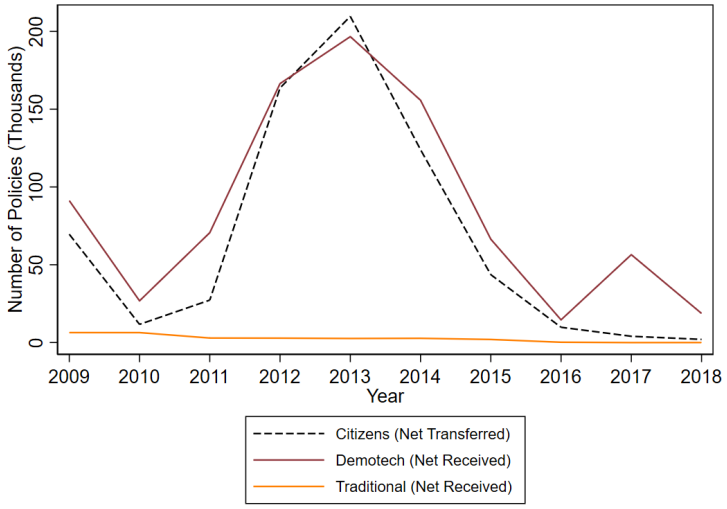


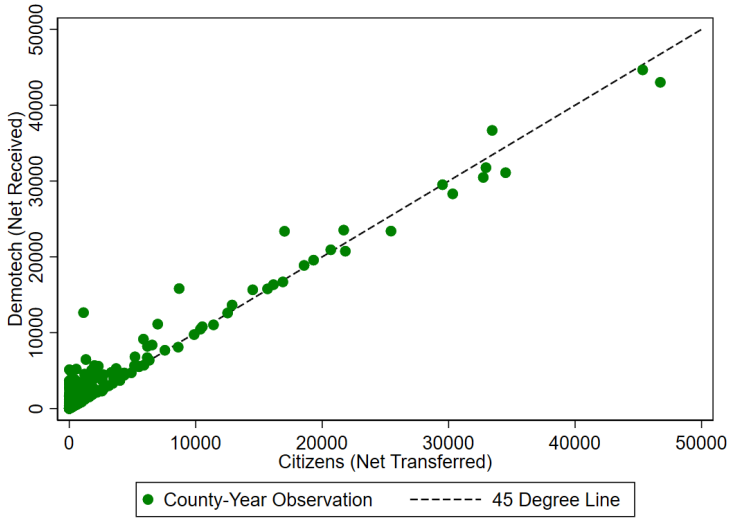
Figure 7: Citizens' Depopulation and Policy Flows

The figure shows the total number of policies away transferred from Citizens insurance, and the total number of policies received by private insurers. We categorize insurers by who provides their financial stability rating. Policies data comes from FLOIR's QUASAR database. Panel A shows overall flows by year, and Panel B shows policy flows at the county-year level.

(a) Annual Flows



(b) Policy Flows from Citizens to Demotech Insurers



Tables

Table 1: Minimum Required Insurance Financial Stability Ratings for Mortgages

The table reports the minimum financial stability rating required of homeowners insurance companies for the mortgage to be eligible for purchase or securitization by Fannie Mae or Freddie Mac.

Type	Rating Agency	Fannie Mae	Freddie Mac
Traditional	AM Best	"B" or better	"B+" or better
Traditional	S&P Global	"BBB" or better	"BBB" or better
Emerging	Demotech, Inc.	"A" or better	"A" or better

Table 2: Financial and Operational Risks by Insurer Types

The table reports the key characteristics for the different insurer types: Demotech (1) and Traditional (2). Demotech are insurers that have been rated by Demotech at least once during the sample period. Traditional are insurers rated by traditional rating agencies (AM Best and S&P). Definitions of financial and operation risk variables are in the Appendix. We report averages for each insurer type after computing average values for each insurer during our sample period from 2009 to 2018. The last column tests for statistical difference between columns (1) and (2). Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Demotech (1)	Traditional (2)	Difference (1) - (2)
Number of insurers	80	50	
(a) Balance sheet and solvency			
Assets ($ million)	312.384	3914.64	-3602.256***
	(150.426)	(1019.99)	
Leverage ratio	0.547	0.516	0.031
	(0.021)	(0.026)	
RBC ratio	2172.77	3789.78	-1617.01*
	(517.105)	(876.289)	
(b) Liabilities			
Loss ratio (Florida)	0.828	0.761	0.067
	(0.1)	(0.121)	
Loss ratio (US)	0.748	0.671	0.077
	(0.086)	(0.057)	
Coverage per policy (in '000)	463.79	1072	-608.21***
	(42.144)	(197.597)	
(c) Operational diversification			
No. states selling HO	3.453	27.68	-24.227***
	(0.731)	(2.874)	
% of insurers selling in only 1 state	0.563	0.1	0.463***
	(0.056)	(0.043)	
% premium from HO	0.697	0.245	0.452***
	(0.034)	(0.032)	
% of assets in the group	0.573	0.246	0.327***
	(0.042)	(0.045)	
No. insurers in the group	5.897	18.494	-12.597***
	(1.002)	(2.176)	
% belonging to a 2 or less insurer group	0.463	0.04	0.423***
	(0.056)	(0.028)	
Stock company	0.938	0.84	0.098*
	(0.027)	(0.052)	

Table 2: Financial and Operational Risks by Insurer Types *(continued)*

	Demotech (1)	Traditional (2)	Difference (1) - (2)
(d) Assets			
% assets in equities	0.09	0.146	-0.056*
	(0.017)	(0.026)	
% bonds in corporates	0.353	0.329	0.024
	(0.024)	(0.029)	
% bonds in NAIC 1	0.846	0.853	-0.007
	(0.026)	(0.014)	
% bonds in NAIC 2	0.187	0.204	-0.017
	(0.021)	(0.017)	
% bonds in NAIC3+	0.01	0.028	-0.018**
	(0.003)	(0.006)	
Wtd avg maturity bonds (years)	9.047	16.023	-6.976**
	(0.557)	(2.634)	
(e) Reinsurance			
% premiums reinsured	0.472	0.149	0.323***
	(0.029)	(0.039)	
% reinsurance partners rated above A	0.328	0.395	-0.067*
	(0.01)	(0.036)	
Fraction of premiums ceded to largest	0.134	0.039	0.095***
partner	(0.017)	(0.014)	
Share of FHCF	0.172	0.136	0.036
	(0.024)	(0.052)	

Table 3: Risk Exposures and Pricing by Insurer Types

This table uses data at the firm-year level to assess how firm-level exposures and pricing in high climate risk counties varies by insurer types. High risk counties are those classified by FEMA as being in risk categories 3, 4, and 5. In Panel (A), we consider three different measures of exposures to high risk counties: premium share in high risk counties (1), policy share (2), and coverage share (3). In Panel (B), we look at firm pricing behavior, where price is defined as premiums per every $10,000 of coverage. Column (1) shows the average price in high risk counties, (2) shows average price in low risk counties, and (3) shows the average price in high risk counties minus the average price in low risk counties. In both panels, we regress each dependent variable on an dummy variable for which rating agency provides that firm's financial stability rating. The omitted dummy is the category for traditional insurers, so all effects can be interpreted relative to the the omitted category. All specifications include year fixed effects. We report heteroskedasticity robust standard errors in parentheses. Note that there are 44 insurers which do not operate at all in low risk counties. This explains the difference in observations in Panel B, columns (2)-(3). Note: * p < 0.10, ** p < 0.05, *** p < 0.01.

Panel A: Climate Risk Exposure			
	Share Underwritten in High Risk Counties		
	Premiums	Number of Policies	Coverage
	(1)	(2)	(3)
Demotech	0.0242***	0.0243***	0.0215***
	(0.00505)	(0.00488)	(0.00504)
Observations	924	924	924
Adjusted R^2	0.022	0.025	0.017
year_fe	Y	Y	Y

Panel B: Pricing of Climate Risk			
	Premiums per $10,000 of Coverage		
	High Risk Counties	Low Risk Counties	High - Low Risk
	(1)	(2)	(3)
Demotech	10.19***	5.646***	4.521***
	(0.826)	(0.710)	(0.588)
Observations	924	880	880
Adjusted R^2	0.160	0.104	0.051
year_fe	Y	Y	Y

Table 4: Insolvency Rates by Insurer Type

The table shows the fraction of insurers that get liquidated and the share of liquidations by insurer type. Data on liquidations come from National Association of Insurance Commissioners (NAIC) Global Receivership Information Database (GRID). We track liquidations between 2009 and 2022.

	Demotech	Traditional
	(1)	(2)
% of insurers that get liquidated	18.7%	0%
% Liquidated insurers by type	100%	0%

Table 5: Regulatory Supervision by Insurer Types

We compare regulatory strictness and consumer complaints among different. Panel A shows differences in overall regulatory strictness between the period 2009 to 2013 and 2014 to 2018. Panel B shows differences in regulatory strictness across various insurer types. Panel C shows differences in consumer complaints across various insurer types. Note: * p < 0.10, ** p < 0.05, *** p < 0.01.

(a) Regulatory supervision over time	2009-2013 (1)	2014-2018 (2)	Difference (1) - (2)
Likelihood of exam in a year (%)	36.2	28.1	8.1
% insurers ever restated	34.4	24.6	9.8
% exams with restatements	37.6	21.3	16.3**
(b) Regulatory supervision across insurers	Demotech (1)	Traditional (2)	Difference (1) - (2)
Likelihood of exam in a year (%)	32.6	25.7	6.9
% insurers ever restated	35.5	28.6	6.9
% exams with restatements	30.8	21.4	9.4
(c) Consumer complaints	Demotech (1)	Traditional (2)	Difference (1) - (2)
Share of complaints	87.9	12.1	75.9***
Likelihood of any complaints in a year (%)	79.7	48.5	31.2***

Table 6: Insurer Quality and GSE Mortgage Purchases: Overall Stock

This table shows the results of estimating Equation 3 in the text. The dependent variable is the share of all originations and purchased mortgages that are sold to Fannie Mae or Freddie Mac, in dollar volumes. The independent variable is the premium share underwritten by Demotech-rated firms. Controls are county-by-year averages from HMDA and McDash, and include log income, FICO score, LTV, and log property value at origination. County and year fixed effects are included where indicated. Our McDash sample ends in 2016, explaining the different number of observations in Column (4). Standard errors are clustered at the county level and reported in parentheses. Note: * p < 0.10, ** p < 0.05, *** p < 0.01

	(1)	(2)	(3)	(4)
	GSE Share	GSE Share	GSE Share	GSE Share
Demotech Share	0.291***	0.224***	0.0820**	0.0837**
	(0.0388)	(0.0599)	(0.0403)	(0.0399)
County FE	N	N	Y	Y
Year FE	N	Y	Y	Y
Controls	N	N	N	Y
Sample Period	2009-2018	2009-2018	2009-2018	2009-2016
Number of Observations	670	670	670	536
Adjusted R-squared	0.255	0.283	0.746	0.767

Table 7: Insurer Quality and GSE Mortgage Purchases: Depopulation Experiment

This table shows the results of estimating Equation 4 in the text. The dependent variable is the log of the dollar volume of mortgages sold to the GSEs that were originated in prior years. The independent variable is the log of the net number of policies transferred to Demotech-rated insurers. The control variables here refers to the average borrower income of mortgages borrowers that are sold in that calendar year. County and year fixed effects are included where indicated. Standard errors are clustered at the county level and reported in parentheses. Note: * p < 0.10, ** p < 0.05, *** p < 0.01.

	(1) log(GSE)	(2) log(GSE)	(3) log(GSE)	(4) log(GSE)
log(Demotech)	0.795***	0.929***	0.0343**	0.0331**
	(0.0367)	(0.0346)	(0.0157)	(0.0162)
County FE	N	N	Y	Y
Year FE	N	Y	Y	Y
Controls	N	N	N	Y
Sample Period	2009-2018	2009-2018	2009-2018	2009-2018
Number of Observations	619	619	619	618
Adjusted R-squared	0.580	0.762	0.974	0.974

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

References

Adelino, M., K. Gerardi, and B. Hartman-Glaser (2019, April). Are lemons sold first? dynamic signaling in the mortgage market. *Journal of Financial Economics 132*, 1–25.

Adelino, M., K. Gerardi, and P. S. Willen (2013). Why Don't Lenders Renegotiate More Home Mortgages? Redefaults, Self-Cures and Securitization. *Journal of Monetary Economics 60*(7), 835–853.

Adelino, M., A. Schoar, and F. Severino (2016, July). Loan Originations and Defaults in the Mortgage Crisis: The Role of the Middle Class. *Review of Financial Studies 29*(7), 1635–1670.

An, X., S. Gabriel, and N. Tzur-Ilan (2023). The effects of extreme wildfire and smoke events on household financial outcomes.

Baldauf, M., L. Garlappi, and C. Yannelis (2020, March). Does Climate Change Affect Real Estate Prices? Only If You Believe In It. *The Review of Financial Studies 33*(3), 1256–1295.

Barbu, A. (2021). Ex-post loss sharing in consumer financial markets.

Bernstein, A., M. Gustafson, and R. Lewis (2019, November). Disaster on the Horizon: The Price Effect of Sea Level Rise. *Journal of Financial Economics 134*(2), 253–272.

Billings, S. B., E. Gallagher, and L. Ricketts (2019, June). Let the Rich Be Flooded: The Unequal Impact of Hurricane Harvey on Household Debt. *SSRN Working Paper No. 3396611*.

Biswas, S., M. Hossain, and D. Zink (2023). California wildfires, property damage, and mortgage repayments. *Federal Reserve Bank of Philadelphia Working Paper No. 23-05*.

Boomhower, J., M. Fowlie, and A. J. Plantinga (2023, May). Wildfire insurance, information, and self-protection. *AEA Papers and Proceedings 113*, 310–15.

Cortés, K. R. and P. E. Strahan (2017, July). Tracing out capital flows: How financially integrated banks respond to natural disasters. *Journal of Financial Economics 125*(1), 182–199.

Davenport, F. V., M. Burke, and N. S. Diffenbaugh (2021, January). Contribution of historical precipitation change to US flood damages. *Proceedings of the National Academy of Sciences 118*(4).

Demyanyk, Y. and O. Van Hemert (2011). Understanding the Subprime Mortgage Crisis. *The Review of Financial Studies 24*(6), 1848–1880. Publisher: [Oxford University Press, Society for Financial Studies].

Downing, C., D. Jaffee, and N. Wallace (2009). Is the Market for Mortgage-Backed Securities a Market for Lemons? *The Review of Financial Studies 22*(7), 2457–2494.

Egan, M., S. Ge, and J. Tang (2021). Conflicting interests and the effect of fiduciary duty: Evidence from variable annuities.

Ellul, A., C. Jotikasthira, L. Christian, and W. Yuhui (2015). Is historical cost a panacea? market stress, incentive distortions and gains trading. *The Journal of Finance 70*, 2489–2537.

Ellul, A., C. Jotikasthira, C. Lundbald, and W. Wagner (2022). Insurers as asset managers and systemic risk. *Review of Financial Studies [Forthcoming]*.

Froot, K. A. and P. G. O'Connell (1999). The pricing of U.S. catastrophe reinsurance. In K. A. Froot (Ed.), *The Financing of Catastrophe Risk*, Chapter 5, pp. 195–232. University of Chicago Press.

Froot, K. A. F. and J. Stein (1991). Exchange rates and foreign direct investment: An imperfect capital markets approach. *Quarterly Journal of Economics 106*(Nov.), 1191–1217.

Gallagher, J. and D. Hartley (2017, August). Household Finance after a Natural Disaster: The Case of Hurricane Katrina. *American Economic Journal: Economic Policy 9*(3), 199–228.

Garbarino, N. and B. Guin (2021, June). High water, no marks? Biased lending after extreme weather. *Journal of Financial Stability 54*.

Garmaise, M. J. and T. J. Moskowitz (2009). Catastrophic Risk and Credit Markets. *The Journal of Finance 64*(2), 657–707.

Ge, S. (2022). How do financial constraints affect product pricing? Evidence from weather and life insurance premiums. *The Journal of Finance 77*(1), 449–503.

Ge, S., A. Lam, and R. Lewis (2023). The costs of hedging disaster risk and home prices in the face of climate change.

Gennaioli, N., R. L. Porta, F. Lopez-De-Silanes, and A. Shleifer (2021). Trust and insurance contracts. *The Review of Financial Studies [Forthcoming]*.

Gibson, M. and J. T. Mullins (2020, November). Climate Risk and Beliefs in New York Floodplains. *Journal of the Association of Environmental and Resource Economists 7*(6), 1069–1111. Publisher: The University of Chicago Press.

Giglio, S., M. Maggiori, K. Rao, J. Stroebel, and A. Weber (2021, August). Climate Change and Long-Run Discount Rates: Evidence from Real Estate. *The Review of Financial Studies 34*(8), 3527–3571.

Gropp, R., F. Noth, and U. Schüwer (2019). What Drives Banks' Geographic Expansion? The Role of Locally Non-Diversifiable Risk. *SSRN Working Paper No. 3347766*.

Hartwig, R. P. and C. Wilkinson (2016). Residual market property plans – from markets of last resort to markets of first choice. Technical report, III.

Hurst, E., B. J. Keys, A. Seru, and J. Vavra (2016). Regional redistribution through the US mortgage market. *American Economic Review 106*(10), 2982–3028.

Issler, P., R. H. Stanton, C. Vergara-Alert, and N. E. Wallace (2019). Mortgage Markets with Climate-Change Risk: Evidence from Wildfires in California. *SSRN Working Paper No. 3511843*.

Jaffee, D. M. and T. Russell (1997). Catastrophe insurance, capital markets, and uninsurable risks. *The Journal of Risk and Insurance 64*(2), 205–230.

Jeziorski, W., S. Ramnath, et al. (2021). Homeowners insurance and climate change. *Chicago Fed Letter* (460), 1–6.

Keenan, J. M., T. Hill, and A. Gumber (2018, April). Climate gentrification: from theory to empiricism in Miami-Dade County, Florida. *13*(5), 054001. Publisher: IOP Publishing.

Keys, B. J., T. Mukherjee, A. Seru, and V. Vig (2010). Did Securitization Lead to Lax Screening? Evidence from Subprime Loans. *The Quarterly Journal of Economics 125*(1), 307–362.

Keys, B. J., A. Seru, and V. Vig (2012, July). Lender Screening and the Role of Securitization: Evidence from Prime and Subprime Mortgage Markets. *The Review of Financial Studies 25*(7), 2071–2108.

Koijen, R. and M. Yogo (2022). The fragility of market risk insurance. *The Journal of Finance 77(2)*, 815–862.

Koijen, R. S. and M. Yogo (2015). The cost of financial frictions for life insurers. *American Economic Review 105*(1), 445–475.

Koijen, R. S. and M. Yogo (2016). Shadow Insurance. *Econometrica 84*(3), 1265–1287.

Kousky, C., H. Kunreuther, M. LaCour-Little, and S. Wachter (2020). Flood Risk and the U.S. Housing Market. *Journal of Housing Research 29*(sup1), S3–S24. Publisher: Routledge _eprint: https://doi.org/10.1080/10527001.2020.1836915.

Kousky, C., M. Palim, and Y. Pan (2020). Flood Damage and Mortgage Credit Risk: A Case Study of Hurricane Harvey. *Journal of Housing Research 29*(sup1), S86–S120.

Mulder, P. and B. Keys (2020, October). Neglected No More: Housing Markets, Mortgage Lending, and Sea Level Rise. *NBER Working Paper #27930*.

Murfin, J. and M. Spiegel (2020, March). Is the Risk of Sea Level Rise Capitalized in Residential Real Estate? *The Review of Financial Studies 33*(3), 1217–1255.

Nicholson, J., P. Born, C. Cole, and C. Nyce (2020). Exposure reduction and depopulation opportunities analysis. *Report ordered by Citizens Property Florida Corporation*.

Oh, S. S. (2020). Social inflation.

Oh, S. S., I. Sen, and A.-M. Tenekedjieva (2023). Pricing of climate risk insurance: Regulation and cross-subsidies.

Ouazad, A. and M. Kahn (2021). Mortgage Finance and Climate Change: Securitization Dynamics in the Aftermath of Natural Disasters. *Review of Financial Studies, forthcoming*.

Santos, J. and K. Blickle (2022, April). Unintended consequences of "mandatory" flood insurance. *FRBNY Staff Report No. 1012*.

Sastry, P. (2022, December). Who bears flood risk? evidence from mortgage markets in florida. *SSRN Working Paper No. 4306291*.

Sen, I. (2021). Regulatory limits to risk management. *The Review of Financial Studies [Forthcoming]*.

Sen, I. and D. Humphry (2018). Capital regulation and product market outcomes. *Bank of England WP 715*.

Sen, I. and V. Sharma (2020). Internal Models, Make Believe Prices, and Bond Market Cornering. *Harvard Business School Working Paper*.

Tang, J. (2023). Regulatory competition in the us life insurance industry.

Tenekedjieva, A.-M. (2021). The revolving door and insurance solvency regulation.

Wagner, K. R. (2022). Adaptation and adverse selection in markets for natural disaster insurance. *American Economic Journal: Economic Policy 14*(3), 380–421.

A. Additional Tables and Figures

Figure A.1: Percent of premiums written by insurers not reported in QUASR

The figure shows the fraction of homeowners' premiums written in Florida by insurers missing from the QUASAR database. QUASAR premiums are benchmarked against premiums reported in statutory filings obtained from S&P MI.

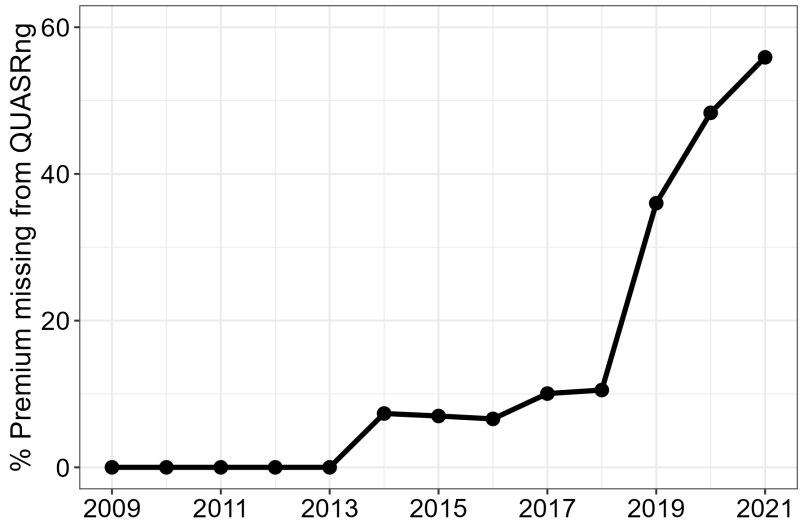


Figure A.2: Top 6 States by Market Share of Demotech-rated firms

The figure shows the fraction of the homeowners insurance premiums written by insurers rated by Demotech in the top six states that Demotech operates in.

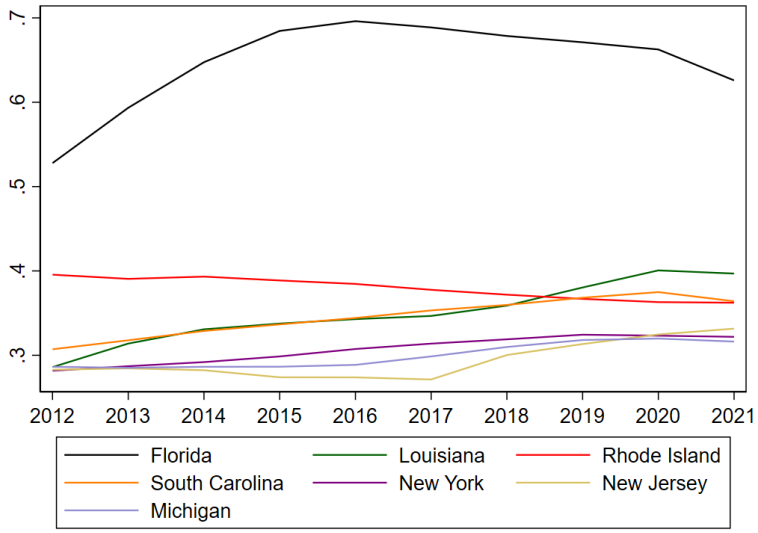


Figure A.3: GSE eligibility of insurers in Florida

We estimate the amount of homeowner insurance sold in Florida that was not eligible under GSE standards, and that was eligibible due to ratings by traditional insurers (trad only), Demotech (DT only), or trough both (DT and trad). In the top panel, the proportions were estimated using total premium sold, and in the bottom panel – using number of policies.

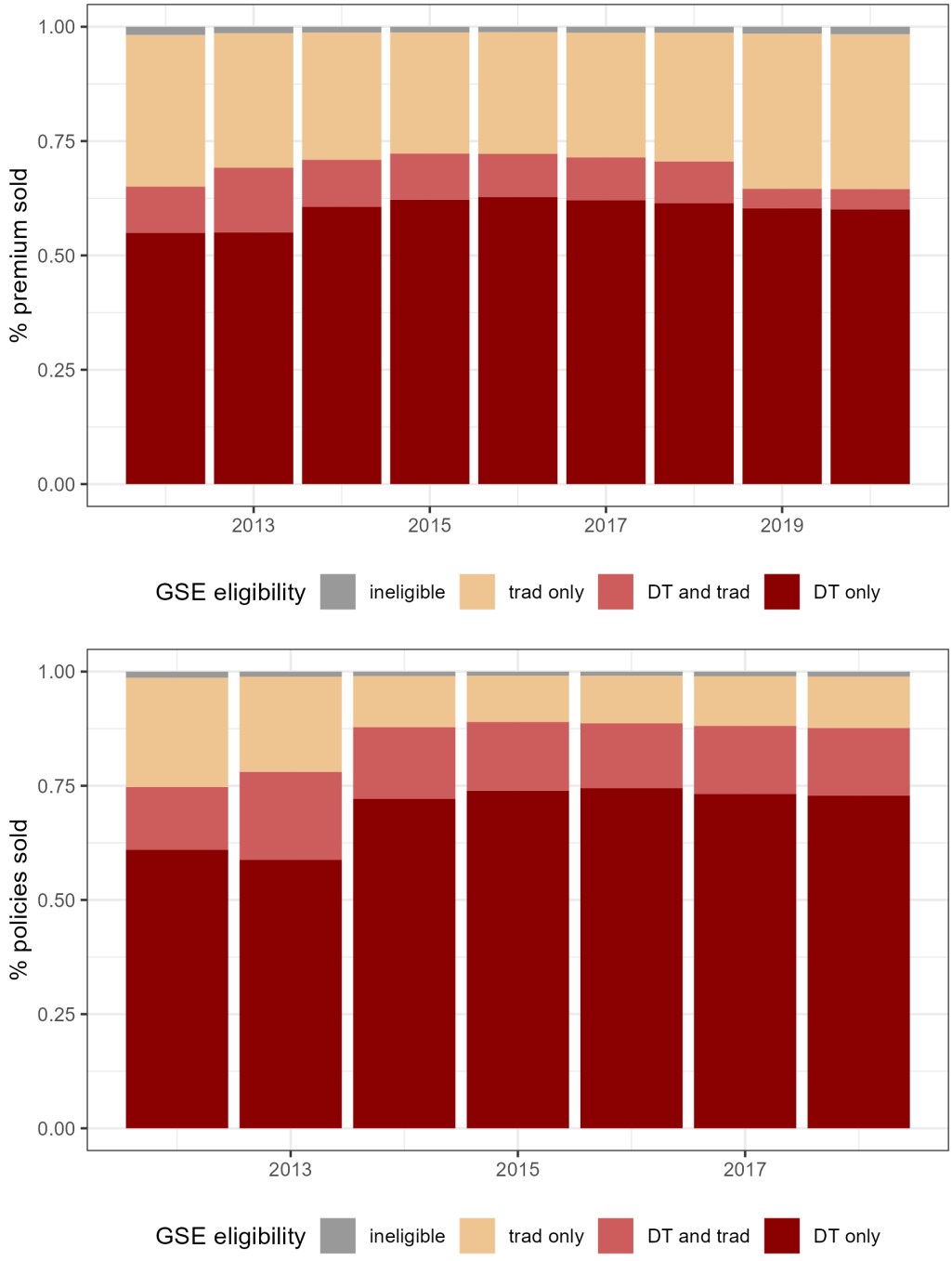
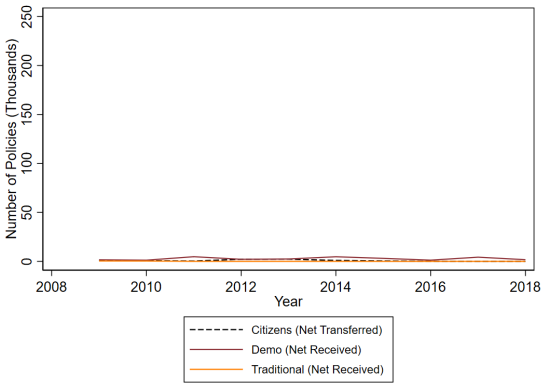


Figure A.4: Citizens' Depopulation and Climate Risk

The figure shows how Citizens' depopulation across counties varied by FEMA's climate risk categorization. Panel A shows counties classified as low risk, which are categories 1 and 2. Panel B shows counties classified as high risk, which are categories 3, 4, 5.

(a) FEMA Low Risk Counties



(b) FEMA High Risk Counties

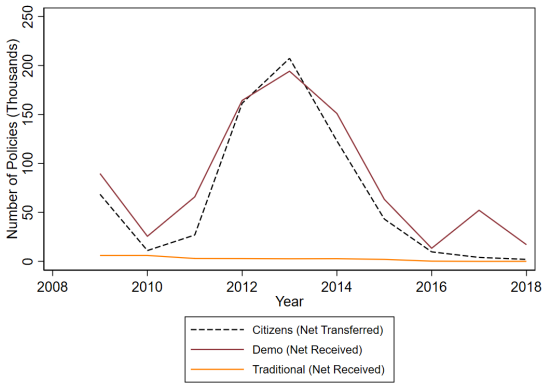


Table A.1: AM Best Rating Replication Model

We estimate the relationship between AM Best rating and various insurers characteristics, as shown in Equation 1. Note: * p < 0.10, ** p < 0.05, *** p < 0.01.

	Average AM Best rating$_i$
Log(Assets)	-4.937^{***}
	(1.265)
No. states selling HO	-0.023
	(0.014)
% premium from HO	0.023^{***}
	(0.008)
% of assets in the group	0.014^{**}
	(0.007)
Log(Assets)^2	0.159^{***}
	(0.048)
Leverage ratio^2	8.856^{***}
	(1.324)
Constant	37.181^{***}
	(8.087)
Observations	78
Adjusted R^2	0.593

B. Variable Definitions

1. *Assets* are total net assets of the operating company.
2. *Leverage ratio* is defined as total liabilities divided by total net assets.
3. *RBC ratio* is the ratio of available capital to required capital.
4. *Loss ratio* is the ratio of incurred losses to total written premiums.
5. *Coverage per policy* is the ratio of total coverage sold to total policies written;
6. *No. states selling HO* is the number of states in which an insurer has written positive premia.
7. *% premium from HO* is the fraction of total premiums arising from the homeowners' line of business.
8. *% of assets in the group* is the share of operating companies' assets in the overall group assets.
9. *No. firms in the group* is total number of operating companies belonging to the insurer's group.
10. *Stock company* is an indicator variable =1 for stock companies and =0 for mutual and other types.
11. *% assets in equities* is the total carrying value (book value) of equities divided by total carrying value of bonds and equities.
12. *% bonds in corporates* is the total carrying value in corporate bonds divided by total carrying value of all types of bonds.
13. *% bonds in NAIC 1, 2, 3+* are the total carrying value in NAIC 1 (2) (3+) bonds divided by total carrying value of bonds, where NAIC 1 are bonds rated AAA, AA, A, and treasuries, NAIC 2 are bonds rated BBB, and NAIC 3+ are bonds rated below BBB.
14. *Wtd avg maturity bonds* is the remaining maturity of bonds (weighted by carrying values).
15. *% premiums reinsured* is the fraction of premiums ceded to third-parties.
16. *Share of partners rated above A* is the fraction of reinsurance partners having an AMBEST rating of A or better.

17. *Fraction of premiums ceded to largest partner* is the premium ceded to the largest reinsurance partner divided by total premiums.

18. *Share of FHCF* are the share ceded to Florida Hurricane Catastrophe Fund (FHCF).

19. *Likelihood of exam in a year (%)* For all Florida domiciled insurers that sold HO insurance, we compute the average likelihood for an exam in a given year (number of exams per years the firm operated over a given period).

20. *% of insurers ever restated* is the percentage of insurers who received at least one exam that forced restatement out of all insurers who sold HO insurance in Florida and were regulated by the Florida office of insurance regulation.

21. *% exams with restatements*: Percent of financial exams which resulted in restatement among the financial exams of all Florida domiciled insurers.

22. *Share of complaints (%)*: We estimate for each year the total share of complaints coming from each insurer type, and then estimate the mean of this share for each insurer type across the years. Data comes from FLOIR annual reports, 2009 to 2018.

23. *Likelihood of any complaints in a year (%)*: We estimate for each insurer the average likelihood for at least one complaint ina given year (i.e. the percentage of years there was at least one complaint against the insurer). Then we compute the average likelihood for each insurer type.