Natural Disasters, Property Insurance, and Housing Markets

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Abstract

We study how local climate risk affects nationwide housing markets. We develop a dynamic spatial housing model with migration and property insurance channels, in which heterogeneous households choose location, housing tenure, and insurance coverage across regions differently exposed to climate shocks. The model generates realistic under-insurance and coverage heterogeneity across wealth, age, and regions, which interact with migration to determine climate risk exposure in the population. Our counterfactual experiments show, first, that housing prices endogenously reflect local risk and insurance costs where housing supply is imperfectly elastic. Therefore, the geographic distribution of households changes only slightly due to climate risk, suggesting that adaptation through migration has positive but limited benefits in equilibrium. Second, we evaluate popular insurance pricing policies designed to address the resulting rise in insurance costs and the protection gap. A subsidy to insurers that lowers the cost of high coverage and is financed by local homeowners meaningfully reduces climate risk exposure in the population. Alternative policies either increase exposure or generate large wealth transfers across regions.

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1 Introduction

Natural disasters have become increasingly important in shaping local housing markets, both through the physical destruction of housing capital and changes in expected housing costs. In the United States, natural disasters have caused $2.9 trillion in damages from 1980 to 2024, with more than half of that total coming since 2015, and most of it being concentrated in areas with wildfires, storms, and sea level rise.[1] Beyond realized destruction that impacts local housing stocks ex post, natural disaster risk also potentially affects housing markets ex ante by altering the expected quality, services, and costs of housing. Numerous households have sought to adapt to such risks by migrating away from exposed areas (Boustan *et al.*, 2012; Nakamura *et al.*, 2022) and purchasing coverage from increasingly constrained insurance companies (Keys & Mulder, 2020; Sastry & Sen, forthcoming; Sastry *et al.*, forthcoming), with ambiguous net effects across housing markets and on the total population exposure to climate risk.[2]

This paper studies how local climate risk affects nationwide housing markets in the United States, and how these effects are shaped by households' adaptation through migration and property insurance across regions. There is increasing empirical evidence that climate risk affects local areas (see, e.g., Giglio *et al.*, 2021b; Wylie *et al.*, 2025, for surveys). However, its long-run equilibrium impact on the entire housing market beyond local estimates and affected areas remains an open question. On the one hand, adaptation potentially attenuates the net effect of climate risk on households' balance sheets through multiple channels, which have been documented in isolation in the data. Households can move to areas less exposed to climate risk, rent and avoid owning exposed units, default on exposed mortgages, and physically maintain their homes. Furthermore, the fact that they can buy property insurance makes the net effect of climate risk depend more on the sustainable profits of insurance companies than on their own balance sheets. On the other hand, the benefits of these channels may be limited by equilibrium adjustments on housing and property insurance markets. With imperfectly elastic housing supply and were households to migrate en masse, an endogenous increase in house prices and rents in less exposed regions can eventually lower incentives to migrate away from exposed regions. At the same time, if many households remain exposed, higher insurance costs may become unaffordable and lead them to reduce coverage.

[1] Sources: https://www.ncei.noaa.gov/access/billions/time-series/US/cost and https://www.ncei.noaa.gov/access/billions/mapping.

[2] See, e.g., "As Insurers Around the U.S. Bleed Cash From Climate Shocks, Homeowners Lose," *New York Times*, May 2024.

We develop a dynamic spatial equilibrium model of the cross section of U.S. housing markets with heterogeneous households and climate risk that realistically incorporates these channels. This setting is, to the best of our knowledge, the first spatial equilibrium housing and mortgage model that accounts for variation in exposure to climate risk between regions in the data, which models with a single location abstract from. Local differences in climate risk, income, amenities, and housing supply endogenously translate into differences between local house prices and rents. We focus on two central adaptation channels that have previously not been quantified. First, climate risk can give rise to migrations across geographies that generate spillovers impacting the entire housing market including beyond exposed areas. Second, households can cover part of their local exposure to climate risk with property insurance. As a result, population distributions, property insurance coverage, and house prices and rents are jointly determined across regions in equilibrium. Their joint adjustments are central to understanding the long-run equilibrium effects of climate risk on the population.

In the model, overlapping generations of heterogeneous risk-averse households with a lifecycle make housing decisions that are embedded in a dynamic consumption and saving problem with borrowing constraints on renters and home buyers. Households differ in age, income, wealth, housing tenure and quality. Housing quality determines the value of housing services received by households. It incorporates the effects of standard housing depreciation and climate shocks, maintenance expenses capturing housing unit repairs and upgrades, and insurance coverage over time. Every period, households receive idiosyncratic income shocks, routine property damage, and climate disaster shocks, and they optimally choose their location, tenure, long-term mortgage and default decisions, and property insurance coverage in the presence of heterogeneous local climate risk. As in the data, two types of insurance companies offer contracts that differ in coverage, price, and claim rejection rate. A private insurance company can operate across regions, while a public insurer captures a state-funded insurer of last resort that operates independently in each area. This richness is paramount to understanding the aggregate and distributional effects of climate risk and policies designed to address the insurance protection gap.

Our setting accounts for adaptation through migration and property insurance, as well as spillovers across local housing markets that arise when housing prices endogenously adjust in response to climate shocks and other sources of risk. Our equilibrium approach complements and nuances empirical work based on local treatment effects that are identified from cross-sectional variation between housing markets and households with various

exposures to climate risk and insurance. Three features of the model are quantitatively important for understanding the equilibrium consequences of climate risk. First, a constant elasticity of substitution utility function between non-durable goods and housing services captures the consumption trade-off induced by climate risk: households can maintain a high housing quality if they pay higher insurance premiums, but then they must face lower non-durable consumption. Second, Epstein–Zin preferences imply a preference for the early resolution of uncertainty that deepens house price discounts in exposed areas and increases households' incentives to adapt. Third, we calibrate the overlapping generations model with a lifecycle of seventy-five years, a high (annual) frequency that captures the dynamics of migration, insurance adjustment, and housing markets in the data. To solve the resulting model, which is computationally challenging, we introduce a new recursive formulation of the discrete choice problem governing location and tenure decisions.

We calibrate the model to match aggregate and distributional housing and mortgage market moments, including local population shares, homeownership rates, income levels, and housing supply elasticities (Saiz, 2010; Baum-Snow & Han, 2024). We map the model to the large empirical literature focusing on Florida (e.g., Sastry, 2026; Sastry *et al.*, forthcoming; Bellon *et al.*, 2025), and split nationwide housing markets between a coastal region with high climate risk exposure and the rest of the U.S. with relatively less exposure. Climate risk can take many forms, including hurricanes, heatwaves, floods, or wildfires. We follow Bilal & Rossi-Hansberg (forthcoming) and calibrate the probability of a climate disaster in the high-risk region and the resulting conditional loss as a fraction of the house value based on the probability of a 1-in-50 year storm following a 1 degree increase in temperature relative to 1920, which is a relatively conservative assumption. Compared with property insurance data, the model endogenously generates realistic insurance demand across households and regions without targeting it. When households are presented with a menu of insurance premiums and coverage, demand is non-linear in liquidity, hump-shaped in age, and differs with climate risk. Under-insurance is most severe among liquidity-constrained households. As in the data, credit-constrained households cannot financially adapt to climate risk by purchasing sufficient coverage, and their homes end up being more exposed and worth less. In contrast, wealthier households can partially self-insure and avoid buying full coverage.

Our first set of experiments studies the net impact of climate risk across housing markets. We consider two experiments that both result in a 10% increase in insurance costs in

the high-risk region, with the increase coming from two different sources. In the first experiment, we study a 13% increase in the annual probability of climate shocks in Florida, which endogenously increases insurance costs, and compute the new steady state of the model. When climate risk increases, buying less coverage does not help households smooth their consumption of non-durable goods and housing. Higher premiums are reflected in higher payouts households expect to receive. In equilibrium, coverage is largely unchanged and the shock is capitalized into house prices (which fall by 2.6% in Florida and rise by 0.1% elsewhere) and rents (respectively +0.6% and 0.0%). Average net worth falls by 15% in Florida and rises by 1.4% elsewhere, but mostly because older homeowners from the rest of the U.S. move to Florida to buy cheaper homes, while younger households leave. By contrast, our second experiment increases the cost of supplying insurance itself, leaving climate risk unchanged, which can reflect higher reinsurance costs, higher capital requirements, or tighter regulation. Although insurance costs rise identically in both experiments, households adapt in different ways. When insurance becomes more expensive, with no change in the underlying risk, households optimally purchase less coverage, widening the protection gap. House prices capitalize this increase in insurance costs, but by half as much as in the first experiment (respectively -1.3% and +0.1%).

In both experiments, the geographic distribution of households changes only slightly: in equilibrium, Florida's population falls by about 1.3% in response to higher climate risk and by about 0.7% in response to higher insurance costs, suggesting that adaptation through migration has positive but limited benefits in equilibrium. The intuition is that, first, when housing is durable and new construction is imperfectly elastic (Glaeser & Gyourko, 2005), house prices and rents end up adjusting more than the local population including with migration. Second, it is costly for risk-averse households in utility terms to sacrifice consumption in order to move to a less exposed but more expensive region. With such costs decreasing in wealth under concave utility, the incentives to migrate away from exposed regions are smallest for poorer households who would benefit the most (because they cannot afford insurance in exposed regions) and largest for richer households who would benefit the least (because they can also self-insure).[3] The net effect is that few households relocate on net in equilibrium in response to climate risk. The marginal resident is indifferent between moving and staying, so the burden falls on current residents through a larger protection gap, lower house prices, or higher rents.

Second, we evaluate the equilibrium effects of three popular policies designed to re-

[3]This stands in contrast with urban economics models with linear utility (e.g., Rosen, 1979; Roback, 1982), in which households with different wealth are indifferent across locations.

duce the cost of insurance against climate disasters. We use the model to examine how households endogenously react to them, on whom their costs ultimately fall, and how price adjustments capitalize and potentially mute or amplify these effects.

Our first policy experiment studies insurance rate regulation in the high-risk region (e.g., Oh *et al.*, forthcoming). We cap the high-risk region's private insurance prices at 90% of their baseline schedule, and the private insurer recovers its lost margin through a compensating markup in the rest of the United States. This experiment is designed to capture policies that limit how much insurance companies can raise premium prices on individual policies in a single year, for instance Florida's Citizens Property Insurance Corporation "glide path."[4] We find that when house prices and rents are fixed, the subsidy generates a large movement toward the high-risk region: its population share rises by 25.8 pp. In general equilibrium, most of this direct incentive is capitalized into Florida house prices, which rise by 1.7%, and the population share rises by only 0.07 pp. Insurance coverage in Florida increases from 60.5 to 69.1%, and incumbent Florida homeowners gain the equivalent of 13.1% of their annual consumption. Overall, insurance subsidies create large spatial incentives, but house-price capitalization removes the migration response, and the policy becomes a cross-regional transfer to incumbent homeowners.

Our second policy experiment subsidizes the public insurer of last resort, pricing its minimum-coverage contract at 90% of its actuarially fair rate and financing the gap with a lump-sum tax on Florida homeowners. For instance, Florida Citizens can finance catastrophe deficits through assessments on a broad set of insurance policyholders, while Louisiana Citizens issued state-supported debt following hurricanes Katrina and Rita.[5] We find that when house prices and rents are fixed, the cheaper public option pulls households toward Florida and onto the public contract. In equilibrium, however, the migration response again disappears, and the policy mainly reshuffles households within the coverage menu: take-up of the public contract nearly doubles, from 16.6 to 31.6% of Florida homeowners, while average coverage falls by 3.8 pp to 56.8%. Florida house prices are essentially unchanged, and average net worth and consumption in the region fall by 3.2 and 1.8%. Subsidizing the public insurer delivers affordability but lowers protection: households pay less for insurance, but insure a smaller share of their exposure.

Finally, our third policy experiment introduces a public catastrophe reinsurer, mod-

[4] See, e.g., https://www.citizensfla.com/-/20251106-2026-rate-change.

[5] See, e.g., https://www.citizensfla.com/web/public/assessments and https://www.gao.gov/assets/a269756.html.

eled on the Florida Hurricane Catastrophe Fund,[6] that lowers the cost for insurers of holding capital against disaster losses and thereby makes high levels of coverage relatively cheaper. The subsidy is financed by a lump-sum tax on Florida homeowners that balances the fund's budget period by period. We find that when house prices and rents are fixed, and before the tax is collected, the policy generates large effects: Florida's population share rises by 6.9 pp and its homeownership rate by 1.5 pp. In equilibrium, the tax response eliminates the incentive to relocate, and house prices are essentially unchanged. What remains is the insurance response: average Florida coverage rises by 7.0 pp. Therefore, financing cheaper coverage with a tax on homeowners leaves Florida homeowners holding more private insurance and paying for it themselves: they lose the equivalent of 2.4% of their annual consumption, because the tax they pay exceeds the value of the cheaper insurance. Taken together, these three experiments underscore a key policy insight: the equilibrium effects of lowering insurance costs are capitalized into house prices or paid for through taxation, and trigger only minor sorting responses across space.

Related Literature. Our main contribution is to evaluate the total effect of *local* climate risk on *nationwide* housing markets and insurance pricing policies that are designed to address the resulting rise in insurance costs. Doing so requires accounting for households' adaptation to natural disasters through migration and for housing price adjustments across regions, which shape the spatial distribution of households and the housing stock's long-run exposure to climate risk. Our work contributes to three research areas.

First, we extend the empirical literature on the local effects of climate shocks on exposed areas, most of which focuses on the short-run impact of sea level rise and storms on house prices (e.g., Bernstein *et al.*, 2019; Baldauf *et al.*, 2020; Keys & Mulder, 2020; Bakkensen & Barrage, 2022). Our quantitative model highlights the long-run equilibrium effects of climate risk on housing including beyond affected areas and on insurance coverage, which have become a first-order concern for policymakers and insurers alike (Stroebel & Wurgler, 2021; Sastry & Sen, forthcoming). We complement the literature on physical property adaptation (e.g., Kahn & Kok, 2014; Kahn, 2014; Fried, 2022; Van der Straten, 2025; Bellon *et al.*, 2025) by modeling two channels that have been documented in the data but whose effects on housing markets have not yet been studied: adaptation to natural disasters through migration (Boustan *et al.*, 2012; Nakamura *et al.*, 2022) and the demand for property insurance (Sastry *et al.*, forthcoming; Ge *et al.*, 2026).

[6] See, e.g., https://fhcf.sbafla.com/media/nmmi1mip/2025-sba-catf-annual-report-final.pdf.

Second, we add to recent research on the interaction between property insurance and climate risk (e.g., Sastry & Sen, forthcoming; Abramson *et al.*, 2025).[7] Shocks to insurers' balance sheets due to under-capitalization or over-exposure transmit to households and prices through premiums. In spatial equilibrium, they potentially distort the population distribution across regions and hence total exposure to climate risk. As in recent data, our model captures the pass-through of climate risk into higher premiums that reduce home values (Keys & Mulder, 2025), as well as its effect on non-price features of insurance contracts such as claim rejections (Jotikasthira *et al.*, 2025; Kalda *et al.*, 2025). We contribute by introducing private and public property insurance companies in a quantitative model of housing and mortgage markets. We adapt the setting in Koijen & Yogo (2015) and Koijen & Yogo (2016) to property insurance markets, where capital requirements are tied to disaster tail risk and reinsurance costs, generating nonlinear pricing in coverage. To match the data, insurance costs depart from actuarially fair pricing and depend on both property risk and local institutional features (Oh *et al.*, forthcoming). We capture the intertemporal aspect of households' insurance choices as in Rampini & Viswanathan (2022), and show that property insurance coverage, hence ultimately exposure to climate risk, differs from other insurance settings (e.g., life insurance in Gropper & Kuhnen, 2025). Coverage is non-linear in wealth and hump-shaped in age, and it differs across regions with the size of the risk being insured.

Third, our work contributes to the literature on dynamic spatial equilibrium housing models, most of which focus on shocks to mortgage finance (Hurst *et al.*, 2016; Beraja *et al.*, 2019; Guren *et al.*, 2020; Favilukis *et al.*, 2023; Mabille, 2023; Greaney *et al.*, 2025). We introduce climate risk in this class of models and account for its heterogeneous effects across regions, which is a central feature of U.S. data (Bilal & Rossi-Hansberg, forthcoming) from which house price models with a single location and without migration generally abstract (Giglio *et al.*, 2021a; Fried, 2022; Van der Straten, 2025; Aron-Dine, 2025). Our work is complementary to Bilal & Rossi-Hansberg (2021) and Bilal & Rossi-Hansberg (forthcoming), who study worker mobility and firm capital investment. Instead, we analyze the consequences of climate risk for housing, households' largest asset, and property insurance, a growing and increasingly risky financial sector. Our analysis differs from previous work in that it requires solving a detailed quantitative model of housing and property insurance markets while abstracting from firms' decisions.

The remainder of the paper is organized as follows. Section 2 presents the model.

[7] By contrast, Gupta *et al.* (2026) study how firms insure their production against climate shocks in a two-period model with two regions.

Section 3 describes the calibration. Section 4 documents insurance demand patterns in the model and studies two sources of rising insurance costs. Section 5 evaluates three policies that lower the cost of insuring against climate risk: rate regulation, a subsidy to the public insurer of last resort, and a public catastrophe reinsurer. Section 6 concludes.

2 Model

This section presents a dynamic spatial housing model with climate risk and property insurance. We first describe locations and their risk exposure before detailing households' tenure and location choice problems, housing supply, and insurance companies. We then define the recursive competitive equilibrium that jointly determines household allocations, insurance outcomes, and house prices in each region. The economy is populated by overlapping generations of heterogeneous risk-averse households. Markets are incomplete, and house prices and rents are endogenous. Population size is stationary, and there is a continuum of measure 1 of households with a lifecycle from age $t = 1$ to $t = T$. Time τ is discrete.

2.1 Locations

There are N_ℓ locations in the model indexed by $\ell \in \{1, 2, ..., N_\ell\}$. Each location has amenities for owners, $\Xi_{\ell O}$, and amenities for renters, $\Xi_{\ell R}$.

Property Damage and Climate Risk. Each period, houses experience a stochastic total damage rate δ_ℓ consisting of baseline depreciation and a climate disaster shock:

$$\delta_\ell = \delta_b + \chi_\ell \cdot \mathbb{1}_{\chi,\ell}, \qquad \delta_b \sim \text{Beta}(\alpha_b, \beta_b) \text{ on } [0, \bar{\delta}_b].$$

The baseline component δ_b captures routine depreciation events such as minor weather damage, wear-and-tear, and other property risks unrelated to major climate disasters, and is i.i.d. across properties and time. We show in the calibration section and in appendix Figure A1 that the scaled Beta distribution captures empirical patterns of property damage fairly well.

We model climate disasters as Bernoulli events that strike with probability $p_{\chi,\ell}$ in location ℓ and cause a damage rate of χ_ℓ. Climate disaster shocks are i.i.d. over time and across properties, region-specific, and their probability and damage rate are common to

all properties in ℓ.

2.2 Households

Households live for T periods, each corresponding to one year. They make location and tenure decisions in each period. We define generic location-specific value functions that are used by both homeowners and renters in evaluating their options of whether to move or remain in their current location and tenure status. These unconditional value functions depend generically on household wealth, income, and age, but not on their current location/tenure. In what follows, we denote the household's current location as ℓ and a generic destination location, which may equal the current one, as ℓ'.

2.2.1 Preferences and Income

Households have Epstein-Zin preferences that separate risk aversion from the elasticity of intertemporal substitution and imply a preference for the early resolution of uncertainty:

$$V_t(S) = \left(u(c,h)^{1-\rho} + \Xi_{\ell j} + \beta \left(\mathbb{E}_t \left[V_{t+1}(S')^{1-\gamma} \right] \right)^{\frac{1-\rho}{1-\gamma}} \right)^{\frac{1}{1-\rho}},$$

where γ is the coefficient of relative risk aversion, $1/\rho$ is the elasticity of intertemporal substitution, β is the subjective discount factor, and S is the state space that we describe below. Instantaneous utility is a constant elasticity of substitution (CES) aggregator of consumption c and effective housing services h,

$$u(c,h) = \left((1-\alpha) c^{\epsilon} + \alpha h^{\epsilon} \right)^{1/\epsilon},$$

where α governs the preference for housing services and ϵ controls the elasticity of substitution between consumption and housing. The amenity shifter $\Xi_{\ell j}$ is specific to location ℓ and tenure $j \in \{O, R\}$, with O for owner and R for renter. The substitutability between consumption and housing is important for the insurance channel: when a climate shock lowers housing quality, households can partially smooth utility by substituting toward consumption. For compactness, we write the Epstein-Zin aggregator combining instantaneous utility and the continuation value as

$$V_t(S) = \mathbb{U}_t\big(u(c,h),\, V_{t+1}(S'); \Xi_{\ell j}\big),$$

and we use this notation in the value functions below.

Households receive stochastic income that varies over the lifecycle and is a combination of persistent and transitory components. Log income for household i of age t in location ℓ is:

$$\log Y_{i,t,\ell} = \alpha_\ell^{inc} + g(t) + z_{i,t} + \eta_{i,t},$$

where α_ℓ^{inc} is a location fixed effect, $g(t)$ is a deterministic age profile, $\eta_{i,t} \overset{iid}{\sim} \mathcal{N}(0, \sigma_\eta^2)$ is a transitory shock, and $z_{i,t}$ is a persistent stochastic component following an AR(1) process:

$$z_{i,t} = \rho_z z_{i,t-1} + \varepsilon_{i,t}, \quad \varepsilon_{i,t} \overset{iid}{\sim} \mathcal{N}(0, \sigma_\varepsilon^2).$$

Retired households receive a deterministic income that is a fraction of their pre-retirement earnings.

2.2.2 Generic Location-Specific Value Functions

Within each location, households can either be homeowners or renters. We define three location-specific value functions for households: the value from living in an owner-occupied home in the location, the value from purchasing a new home in the location, and the value from renting in the location. In the next subsection, these three value functions will be used to build up the rest of the household's decision tree.

Inactive Homeowner: Living in Location. For a homeowner living in location ℓ, the state variables consist of cash-on-hand X, mortgage balance M, effective housing quality ω, and the persistent component z of the (log) income process; we collect these as $S \equiv (X, M, \omega, z)$ for use in the spatial-decision subsections below. An inactive homeowner $\tilde{O}$ in region ℓ chooses consumption c and property insurance ϕ' to maximize the value function:

$$V_t^{\ell\tilde{O}}(X, M, \omega, z) = \max_{c_t^{\ell\tilde{O}}(\cdot), \phi'^{\ell\tilde{O}}(\cdot)} \mathbb{U}_t\Big(u\Big(c_t^{\ell\tilde{O}}(X, M, \omega, z), \tilde{h}\Big), V_{t+1}^{\ell O}(X', M', \omega', z'); \Xi_{\ell O}\Big),$$

subject to the budget constraint:

$$c_t^{\ell\tilde{O}}(X, M, \omega, z) + P^{\ell\tilde{O}}(X, M, \omega, z) + T_\ell + (1 - \lambda + r_M)M + \frac{s}{1+r} = X,$$

where T_ℓ is the uniform lump-sum tax that finances the public insurer, $P^{\ell\tilde{O}}(X, M, \omega, z)$ is the cost of insurance, r_M is the mortgage interest rate, and $1-\lambda$ is the amortization rate, so that λ is the share of the balance carried into the next period. Mortgage balances decrease by the principal payment, $M' = M - (1-\lambda)M = \lambda M$, and cash-on-hand evolves according to exogenous income and savings, $X' = Y' + s$.

Utility is derived from chosen consumption and effective housing quality, $\tilde{h} \equiv \omega h_\ell$, that depends on the previous period's insurance choice and the realization of damage shocks. As emphasized by Rampini & Viswanathan (2022), insurance is an intertemporal decision: premiums $P^{\ell\tilde{O}}$ are paid in the current period for insurance contracts $\phi'^{\ell\tilde{O}}$ that pay off in the next period.

Each period, the household selects from a menu of insurance contracts with posted coverage, price, and claim rejection rates. The total cost of insurance is the product of the per-unit price, the chosen coverage level, and the effective home value:

$$P^{\ell\tilde{O}}(X, M, \omega, z) \equiv p^*\left(\phi'^{\ell\tilde{O}}(X, M, \omega, z)\right) \phi'^{\ell\tilde{O}}(X, M, \omega, z)\, p_{h,\ell}\, \omega\, h_\ell,$$

where the per-unit price of insurance $p^*(\phi')$ depends on the coverage choice ϕ'. The household's uninsured loss rate is the fraction of home value lost after coverage and claim rejection,

$$L_\ell(\phi') \equiv \left(1 - (1 - \mathbb{1}'_{\theta_b})\,\phi'\right)\delta'_b + \left(1 - (1 - \mathbb{1}'_{\theta_d})\,\phi'\right)\chi_\ell\, \mathbb{1}'_{\chi,\ell}, \tag{1}$$

with separate rejection indicators $\mathbb{1}'_{\theta_b}$ and $\mathbb{1}'_{\theta_d}$ that equal one with probabilities $\theta_{b,\ell}$ on baseline-depreciation claims and $\theta_{d,\ell}$ on climate-disaster claims. Altogether, effective housing quality evolves according to uninsured losses and the current effective quality, $\omega' = \left(1 - L_\ell(\phi')\right)\omega$.

Active Homeowner: Purchase New Home. We next define a generic value function, $V^{\cdot,\ell O}$, for a household O that purchases a new home in location ℓ, regardless of its current location or homeownership status (currently a renter or currently a homeowner that will sell its existing home and purchase another, whether within or across locations). The only relevant state variables are the current cash-on-hand X and the persistent component z of its income process.[8]

The generic household's choice variable is the size of the mortgage used to finance the new home cost, $p_{h,\ell}h_\ell$. The new LTV is chosen subject to an exogenous LTV limit

[8]The current cash-on-hand includes the proceeds of a sale of a home (net of fees and mortgage prepayment), if applicable. This will become clear later when we define $X^{\ell O,\ell' O}$.

$\theta^{\cdot,\ell O}_{LTV} \leq \bar{\theta}_{LTV}$ and a payment-to-income ratio $\bar{\theta}_{PTI}$, measured as:

$$\frac{(1-\lambda+r_M)\theta^{\cdot,\ell O}_{LTV} p_{h,\ell} h_\ell}{\tilde{Y}} \leq \bar{\theta}_{PTI},$$

with $\tilde{Y} = \exp(\alpha^{inc}_\ell + g(t) + z)$. Combining the two constraints implies that the maximum loan size is bounded above by the tighter of the two constraints:

$$\theta^{\cdot,\ell O}_{LTV} \leq \min\left\{\bar{\theta}_{LTV}, \left(\frac{(1-\lambda+r_M)p_{h,\ell}h_\ell}{\tilde{Y}}\right)^{-1}\bar{\theta}_{PTI}\right\}.$$

For a given LTV, the required mortgage is $\theta^{\cdot,\ell O}_{LTV,t} p_{h,\ell} h_\ell$, and the required downpayment is $(1-\theta^{\cdot,\ell O}_{LTV}) p_{h,\ell} h_\ell$. In addition, the household pays variable and fixed buying fees, $f_{b,\ell}$ and $F_{b,\ell}$. In total, the household's available cash-on-hand net of these fees is defined as:

$$\tilde{X}^{\cdot,\ell O} = X - (1 - \theta^{\cdot,\ell O}_{LTV} + f_{b,\ell}) p_{h,\ell} h_\ell - F_{b,\ell}.$$

Altogether, the problem of purchasing a new home is equivalent to the problem of choosing an LTV and then remaining inactive in that home:

$$V^{\cdot,\ell O}_t(X,z) = \max_{\theta^{\cdot,\ell O}_{LTV,t}(X,z)} V^{\ell\tilde{O}}_t(\tilde{X}^{\cdot,\ell O}, \tilde{M}^{\cdot,\ell O}, 1, z),$$

with $\tilde{M}^{\cdot,\ell O} = \theta^{\cdot,\ell O}_{LTV,t}(X,z) p_{h,\ell} h_\ell$ and the effective housing quality for the new home is $\omega = 1$.

Renter: Living in Location. The renter $\tilde{R}$ living in location ℓ has state variables cash-on-hand X and the persistent component z of the income process. The renter chooses consumption and the rental size every period to maximize the value function

$$V^{\ell\tilde{R}}_t(X,z) = \max_{c^{\ell\tilde{R}}_t(X,z), h^{\ell\tilde{R}}_t(X,z)} \mathbb{U}_t\Big(u\Big(c^{\ell\tilde{R}}_t(X,z),\, h^{\ell\tilde{R}}_t(X,z)\cdot h_\ell\Big),\, V^{\ell R}_{t+1}(X',z');\Xi_{\ell R}\Big),$$

with $h^{\ell\tilde{R}}_t(X,z) \in [\underline{h}^R, \bar{h}^R]$ and subject to the budget constraint:

$$c^{\ell\tilde{R}}_t(X,z) + p_{r,\ell} h^{\ell\tilde{R}}_t(X,z) h_\ell + \frac{s}{1+r} = X.$$

The location-specific rental rate, $p_{r,\ell}$, is an equilibrium object determined by rental market clearing in Section 2.6.2, exactly as the owner-occupied price $p_{h,\ell}$ is. It is disciplined by the cost of supplying rental units, which we describe in Section 2.4. Future cash-on-hand combines future income and net savings after the household's choices for consumption and rental housing:

$$X' = Y' + s.$$

2.3 Spatial and Tenure Decisions

We now turn to the household's joint discrete choices of where to live and whether to own or rent. Using the location-specific values for ownership and renting from the last section, we model the decision of a homeowner and renter currently living in location ℓ.

2.3.1 Homeowner

Consider a household entering the period as a homeowner. This household faces a menu of choices regarding homeownership. First, it can choose to remain in the same home, meaning it is inactive in the housing market. Alternatively, it faces three options in each location: sell its home and buy a new home, sell its home and rent, or default on its mortgage and rent. So with N_ℓ locations, the homeowner has $3N_\ell + 1$ options to consider.

We first consider the several options faced by a homeowner O in location ℓ. First, the homeowner may remain inactive ($\tilde{O}$), opting to live in the same home in the same location. Second, the homeowner may move to a new home, either as a renter or homeowner, in any location, including its current location. Third, the homeowner may default on its mortgage and become a renter in any location. Let $\mathcal{L} = \{\ell_1, \ell_2, \ldots, \ell_{N_\ell}\}$ denote the set of all locations, including the current location $\ell \in \mathcal{L}$. The household's envelope value function is given by the maximum over all options:

$$V_t^{\ell O}(S) = \max\{V_t^{\ell \tilde{O}}(S), V_t^{\ell O,\ell_1}(S), V_t^{\ell O,\ell_2}(S), \ldots, V_t^{\ell O,\ell_{N_\ell}}(S)\}.$$

The first option is to be inactive in housing markets and remain in both the same location and house. The other options entail moving to a different home. Consider a location $\ell' \in \mathcal{L}$, which we refer to as another location but may be the same as the current location. The function $V_t^{\ell O,\ell'}$ denotes the value of moving from being a homeowner O in location ℓ to location ℓ'. Within location ℓ', the household further decides to purchase a home, sell its current home and become a renter, or default on its mortgage and become a renter:

$$V_t^{\ell O,\ell'}(S) = \max\{V_t^{\ell O,\ell' O}(S), V_t^{\ell O,\ell' R}(S), V_t^{\ell D,\ell'}(S)\}.$$

In the first two cases, the household sells its current home in ℓ for $p_{h,\ell}\,\omega\,h_\ell$, subject to fixed and proportional selling fees $F_{s,\ell}$ and $f_{s,\ell}$. Net of mortgage prepayment, total proceeds from the home sale are given by $(1 - f_{s,\ell})p_{h,\ell}\omega h_\ell - F_{s,\ell} - M$, where M is the current mortgage balance. We therefore define new cash-on-hand for the household leaving homeownership in location ℓ as:

$$\tilde{X}^{\ell O,\cdot} = X + (1 - f_{s,\ell})p_{h,\ell}\omega h_\ell - F_{s,\ell} - M.$$

Stay in Current Home. The first option $V_t^{\ell\tilde{O}}(S)$ defined above is the value of the homeowner living in the current location. This is the choice to be inactive in housing markets and remain in both the same home and location.

Owner in New Home. The homeowner in location ℓ considers purchasing a new home in ℓ'. There are two types of moving costs as in the data. Moving entails a utility cost $\Psi(\ell O, \ell' O)$ and a financial cost $\psi(\ell O, \ell' O)$. This allows for the case where $\ell' = \ell$, i.e., the homeowner moves to a different house in the same location.

Using the new definition of cash-on-hand with net home proceeds and the generic home purchase value function defined above, we can write the problem of a homeowner in location ℓ purchasing a new home in location ℓ' as:

$$V_t^{\ell O,\ell' O}(S) = V_t^{\cdot,\ell' O}(\tilde{X}^{\ell O,\cdot} - \psi(\ell O, \ell' O), z) - \Psi(\ell O, \ell' O).$$

To see this, recall that cash-on-hand in the generic purchase value function for location ℓ' is defined as:

$$\tilde{X}^{\cdot,\ell' O} = X - (1 - \theta_{LTV}^{\cdot,\ell' O} + f_{b,\ell'})p_{h,\ell'}h'_\ell - F_{b,\ell'}.$$

Then, using the cash-on-hand net of proceeds from a home sale in location ℓ and subtracting the financial cost of moving, we can define:

$$X^{\ell O,\ell' O} \equiv X + (1 - f_{s,\ell})p_{h,\ell}\omega h_\ell - F_{s,\ell} - M - (1 - \theta_{LTV}^{\cdot,\ell' O} + f_{b,\ell'})p_{h,\ell'}h'_\ell - F_{b,\ell'} - \psi(\ell O, \ell' O).$$

Altogether, cash-on-hand is initial cash holdings plus proceeds from the current home

sale, less outlays for the new home purchase and moving costs.

Become a Renter. When the homeowner in location ℓ considers becoming a renter in ℓ', moving entails a utility cost of $\Psi(\ell O, \ell' R)$ and a financial cost of $\psi(\ell O, \ell' R)$.

Using the value function of a renter living in location ℓ', the value from becoming a renter is given by:

$$V_t^{\ell O, \ell' R}(S) = V_t^{\ell' \tilde{R}}(\tilde{X}^{\ell O, \cdot} - \psi(\ell O, \ell' R), z) - \Psi(\ell O, \ell' R).$$

Default and Become a Renter. Finally, the homeowner in location ℓ may default on its mortgage and become a renter in location ℓ'. In the baseline economy, we assume mortgages are non-recourse: a defaulting household sheds all negative equity but forfeits any positive equity, so cash-on-hand after default is simply X.However, default entails a financial cost $\psi_D(\ell, \ell')$ and a utility cost $\Psi_D(\ell, \ell')$, capturing frictions such as credit impairment and legal costs, which are distinct from the moving costs incurred in a voluntary sale-and-move. Using the value function of a renter living in location ℓ', the value of defaulting is:

$$V_t^{\ell D, \ell'}(S) = V_t^{\ell' \tilde{R}}\big(X - \psi_D(\ell, \ell'),\ z\big) - \Psi_D(\ell, \ell').$$

Comparing the two paths into renting, default is only preferred over a regular sale when equity is sufficiently negative relative to default costs. Because equity scales with effective housing quality ω, uninsured climate damage directly erodes home equity, concentrating default among highly leveraged households after large damage shocks.

2.3.2 Renter

Consider instead a household entering the period as a renter. A renter has the option to remain a renter or to buy a home. These options are present in every location, including the current location, and thus the renter has $2N_\ell$ options to consider.

A renter in location ℓ considers moving to a new home in every location, including the one in which they currently rent:

$$V_t^{\ell R} = \max\{V_t^{\ell R, \ell_1}, V_t^{\ell R, \ell_2}, \ldots, V_t^{\ell R, \ell_{N_\ell}}\}.$$

Unlike the homeowner, there is no explicit option to remain inactive in the current home, as the renter can simply choose to rent the same or a different unit in the same location.

As above, consider a location $\ell' \in \mathcal{L}$, which we refer to as another location but may be the same as the current location. The function $V_t^{\ell R,\ell'}$ denotes the value of a renter moving from location ℓ to location ℓ'. Within location ℓ', the household further decides to purchase or rent a home:

$$V_t^{\ell R,\ell'}(S) = \max\{V_t^{\ell R,\ell' O}(S), V_t^{\ell R,\ell' R}(S)\}.$$

When $\ell = \ell'$, the renter considers remaining a renter in the same location or becoming a homeowner in the same location.

Homeownership. The renter in location ℓ considers purchasing a new home in ℓ'. Moving from renting in ℓ to owning a home in ℓ' incurs a utility cost of $\Psi(\ell R, \ell' O)$ and a financial cost of $\psi(\ell R, \ell' O)$. We can then use the generic purchase value function in ℓ' to write the renter's problem as:

$$V_t^{\ell R,\ell' O}(X, z) = V^{\cdot,\ell' O}(X - \psi(\ell R, \ell' O), z) - \Psi(\ell R, \ell' O).$$

Renting. When the renter in location ℓ considers renting in ℓ', moving entails a utility cost of $\Psi(\ell R, \ell' R)$ and a financial cost of $\psi(\ell R, \ell' R)$. Using the value function of a renter living in location ℓ', the value from a renter in ℓ renting in ℓ' is given by:

$$V_t^{\ell R,\ell' R}(X, z) = V_t^{\ell' \tilde{R}}(X - \psi(\ell R, \ell' R), z) - \Psi(\ell R, \ell' R).$$

2.4 Housing Supply

Owner-occupied housing. In each region, the aggregate stock of owner-occupied housing in effective square feet is $H_{S,t}^{\ell} = \int_{\Omega_t^{\ell O}} \omega_{i,t}\, h_\ell \, di$. Each unit's quality evolves as $\omega_i' = (1 - L_{\ell,i})\, \omega_i$, where $L_{\ell,i}$ is the household-specific uninsured loss rate defined in equation (1). New construction is supplied by perfectly competitive developers,

$$I_{S,t}^{\ell} = \bar{I}_S^{\ell} \times p_{h,\ell,t}^{\rho_\ell}, \tag{2}$$

where $\bar{I}_S^{\ell}$ is a vertical supply curve shifter and ρ_ℓ is the price elasticity of housing supply, which differ across locations. The aggregate stock in ℓ next period is the sum of the surviving stock and new construction:

$$H_{S,t+1}^{\ell} = H_{S,t}^{\ell} - h_\ell \int_{\Omega_t^{\ell O}} L_{\ell,i}\, \omega_{i,t}\, di + I_{S,t}^{\ell}. \tag{3}$$

The aggregate loss term $h_\ell \int L_{\ell,i}\, \omega_{i,t}\, di$ is endogenous: it depends on the cross-sectional distribution of coverage ϕ_i', the rejection probabilities of each household's chosen insurer ($\theta_{b,\ell}, \theta_{d,\ell}$ on the private menu, $\underline{\theta}_{b,\ell}, \underline{\theta}_{d,\ell}$ on the public contract), the realization of δ_b for each household, and the realization of the climate-disaster indicator. In steady state, expected aggregate uninsured losses equal new construction, $h_\ell\, \mathbb{E}\big[\int L_{\ell,i}\, \omega_i\, di\big] = I_S^\ell$, which we use to calibrate the supply shifter $\bar{I}_S^\ell$.

Rental housing. Rental units are supplied by competitive landlords who own the units and rent them out. We model rental supply symmetrically to owner-occupied supply: the stock of rental units in region ℓ is increasing in the rent it commands, with the same price elasticity as owner-occupied housing,

$$H_{S,t}^{R,\ell} = \frac{\bar{I}_R^\ell\; p_{r,\ell,t}^{\rho_\ell}}{\delta_h}, \tag{4}$$

where δ_h is the depreciation rate of the rental stock and $\bar{I}_R^\ell$ is a rental supply shifter. Higher rents make it profitable to convert or construct additional rental units, and supply is more elastic in the region where land is more readily developed.

We calibrate the shifter $\bar{I}_R^\ell$ so that the baseline rent equals the landlord's user cost of providing a unit,

$$c_{L,\ell} = \big(r + p_\ell(1) + \phi_\ell^R\big)\, p_{h,\ell}, \tag{5}$$

the zero-profit rent for a landlord who finances the unit at the risk-free rate, insures it at full coverage at price $p_\ell(1)$, and bears an additional per-unit cost ϕ_ℓ^R capturing management and depreciation costs specific to rental units. Equation (5) pins down the *level* of rents in the baseline steady state, which we calibrate to the average rent paid in each region (Section 3).

Away from the baseline, rents are determined by market clearing rather than by the landlord's cost. This differs from the common assumption that rental units are supplied perfectly elastically at the user cost, which imposes $p_{r,\ell} = c_{L,\ell}$ at all times and mechanically passes insurance costs into rents one-for-one. In our setup, insurance costs still reach renters, but through the demand side of the market: when insurance becomes more expensive, households substitute between owning and renting, and the resulting shift in rental demand moves the equilibrium rent. This matters for the experiments below, in which tenure choice is a central margin of adjustment.

2.5 Insurance Companies

We model two types of insurance companies, private and public, that offer insurance contracts with three elements: coverage, price per unit of coverage, and rejection rate. The private insurance company may operate in multiple regions, while the public insurer is a state-funded "insurer of last resort" operating independently in each region.

2.5.1 Private Insurance Company

A representative national insurance company supplies insurance contracts in each location. The insurer offers a menu of coverage options from which households can endogenously select under- or full-coverage. Across its entire portfolio, the insurer rejects a fraction of valid claims with probabilities $\theta_{b,\ell} \in [0,1]$ on baseline-depreciation claims and $\theta_{d,\ell} \in [0,1]$ on climate-disaster claims.

As a benchmark, the actuarially fair price $p_{A,\ell}$ equals the expected payout per unit of contracted coverage. The insurer pays $(1-\theta_{b,\ell})\delta_b$ on baseline-depreciation claims and $(1-\theta_{d,\ell})\chi_\ell \mathbb{1}_{\chi,\ell}$ on climate-disaster claims per unit of ϕ':

$$p_{A,\ell} = (1-\theta_{b,\ell})\,\mathbb{E}[\delta_b] + (1-\theta_{d,\ell})\,p_{\chi,\ell}\,\chi_\ell,$$

where $\mathbb{E}[\delta_b] = \bar{\delta}_b \cdot \alpha_b/(\alpha_b+\beta_b)$ is the expected baseline damage rate. For example, with every valid claim paid ($\theta_{b,\ell} = \theta_{d,\ell} = 0$), this reduces to $p_{A,\ell} = \mathbb{E}[\delta_b] + p_{\chi,\ell}\chi_\ell$. Pricing net of denial means that each insurer charges for what it expects to pay, so a contract that rejects more claims is cheaper per unit of stated coverage exactly because it delivers less protection. This is what makes the public contract described below inexpensive without being subsidized. Even regions with no climate disaster risk ($p_{\chi,\ell} = 0$) have positive insurance costs reflecting baseline property damage.

Building on the actuarially fair price, the per-unit price of insurance in location ℓ for a household choosing coverage ϕ is:

$$p_\ell(\phi) = \frac{1 + c\,\phi^\kappa}{1-\mu_\ell} \cdot p_{A,\ell},$$

where $\mu_\ell \geq 0$ is a markup and $c\,\phi^\kappa$ is a coverage-dependent capital charge, with $c > 0$ and $\kappa > 1$. The formulation nests actuarially fair pricing as a special case with $c = 0$ and $\mu_\ell = 0$.

This reduced-form specification is motivated by the framework developed in Koijen

& Yogo (2015) and Koijen & Yogo (2016), in which insurance premiums reflect actuarial losses, competitive structure, and a capital wedge arising from regulatory and financial frictions. Under NAIC risk-based capital (RBC) standards, insurers must hold capital reserves proportional to their underwritten exposure. The parameter c reflects the cost of regulatory capital that insurers must hold per unit of coverage-weighted exposure, including cost-of-capital spread, the opportunity costs of holding reserves, frictional costs such as taxes, and origination costs. These costs are passed through to policyholders as a loading above the actuarially fair price.

Primary insurers typically transfer natural disaster risk exposure through layered reinsurance structures ("reinsurance towers"), with higher layers priced at increasing rates (Froot, 2001). We capture this institutional feature in reduced form through the curvature parameter κ, which governs how capital and reinsurance costs scale with coverage. As insured limits rise, insurers must obtain additional protection in higher layers and hold more capital against tail exposure. Values $\kappa > 1$ allow marginal costs to rise with coverage, consistent with capital requirements, concentration penalties in regulatory and rating-agency models, and the pricing structure of layered reinsurance contracts.

In each location ℓ, the insurer's expected profit is:

$$\mathbb{E}[\pi_\ell] = p_{h,\ell} \Big[p_\ell(1)\, H^{R,\ell}_{S,t+1} + h_\ell \int_{\Omega^{\ell O,\phi}_{t+1}} p_\ell(\phi'_i)\, \phi'_i\, \omega_i\, di - p_{A,\ell} \big(H^{R,\ell}_{S,t} + h_\ell \int_{\Omega^{\ell O,\phi}_{t}} \phi_i\, \omega_i\, di \big) \Big].$$

Altogether, the insurer collects premiums on current-period contracts (from homeowners, and from landlords who insure their rental units at full coverage on the same terms) and pays the effectively covered portion of realized depreciation on previous-period contracts. With $\Omega^{\ell h}_t$ the set of owners or renters in location ℓ at time t, $\Omega^{\ell O,\phi}_t \subseteq \Omega^{\ell O}_t$ is the set of homeowners on the private insurer in location ℓ at t (i.e., those who do not choose the public contract $\underline{\phi}_\ell$ described below), and these homeowners choose how much insurance coverage to purchase.

2.5.2 Public Insurance Company

In each location ℓ, a single insurer of last resort offers a fixed minimum-coverage contract $\underline{\phi}_\ell$ with rejection rates $\underline{\theta}_{b,\ell}$ and $\underline{\theta}_{d,\ell}$. The per-unit price applies a markdown $\underline{\mu} \geq 0$ to the actuarially fair price, $\underline{p}_\ell = (1 - \underline{\mu})\, \underline{p}_{A,\ell}$, with $\underline{p}_{A,\ell} = (1 - \underline{\theta}_{b,\ell})\, \mathbb{E}[\delta_b] + (1 - \underline{\theta}_{d,\ell})\, p_{\chi,\ell}\, \chi_\ell$. The public insurer charges homeowners a lump-sum "hurricane tax" T_ℓ to ensure that its

expected budget balances in each period:

$$p_{h,\ell}\, h_\ell\, \underline{p}_\ell\, \underline{\phi}_\ell \int_{\Omega_{t+1}^{\ell O,\underline{\phi}}} \omega_i \, di + T_\ell\, \mathcal{M}_{t+1}^{\ell O} = p_{h,\ell}\, h_\ell\, \underline{p}_{A,\ell}\, \underline{\phi}_\ell \int_{\Omega_t^{\ell O,\underline{\phi}}} \omega_i \, di,$$

where $\Omega_t^{\ell O,\underline{\phi}}$ is the set of homeowners on the public contract. Note that because prices are net of claim denial, a fairly priced public contract collects exactly what it expects to pay: in the baseline calibration $\underline{\mu} = 0$ and $T_\ell = 0$. Pricing the contract below fair value therefore requires financing from the first dollar, which is the policy we study in Section 5.

2.6 Equilibrium

2.6.1 Definition

A *dynamic spatial recursive competitive equilibrium* describes the economy in steady state. Given the local climate risk parameters $\{p_{\chi,\ell}, \chi_\ell\}$, an equilibrium consists of the following sequences for all locations $\ell \in \mathcal{L}$, which are constant over time in steady state:

(i) prices for owner-occupied and rental housing $\{p_{h,\ell,\tau}, p_{r,\ell,\tau}\}$;

(ii) value functions for homeowners and renters $\{V_\tau^{\ell O}, V_\tau^{\ell R}\}$;

(iii) policy functions describing non-durable consumption, rental housing services, and homeowner insurance $\{c_\tau^{j,j'}, h_\tau^{j,j'}, \theta_{LTV,\tau}^{j,j'}, \phi_\tau^{'j,j'}\}$ for each possible household transition $j, j' \in \{O, R\} \times \mathcal{L}$ between owner-occupied or rental housing, O or R, in location ℓ, including the homeowner's discrete choice to default on its mortgage.

(iv) a law of motion for the cross-sectional distribution of households Γ_τ across locations, housing statuses, and individual states,

such that households optimize given prices, the law of motion for the distribution of households is consistent with their individual choices and market prices, and house prices and rents are such that both the owner-occupied and the rental housing market clear in every location.

2.6.2 Market Clearing

Let $\Omega_t^{\ell h}$ denote the set of households with combination of housing status $h \in \{O, R\}$ and location $\ell \in \mathcal{L}$ at date t, and let $\mathcal{M}_t^{\ell h} = \int_{\Omega_t^{\ell h}} di$ denote the mass of such households. In

spatial equilibrium, this set depends on the entire vector of house prices and rents in all possible housing combinations because of endogenous sorting.

Insurance markets. The private insurer supplies coverage at the price schedule $p_\ell(\phi)$ of Section 2.5, whose parameters are calibrated to observed premiums and coverage. The schedule prices coverage above its net-of-denial actuarial cost, so the insurer earns a positive expected margin that compensates it for the cost of holding capital against the risks it underwrites. We hold that margin fixed when we study rate regulation in Section 5. The public insurer's lump-sum tax T_ℓ is set by its expected budget constraint in each location.

Housing markets. Market clearing for owner-occupied housing in each of the N_ℓ locations is given by

$$\int_{\Omega_t^{\ell O}} \omega_i h_\ell \, di = H_{S,t}^{\ell}, \tag{6}$$

where $H_{S,t}^{\ell}$ is the supply of owner-occupied housing in region ℓ, and for rental housing, with supply given by equation (4), by

$$\int_{\Omega_t^{\ell R}} h_{i,t}^{\tilde{R}} \, h_\ell \, di = H_{S,t}^{R,\ell}. \tag{7}$$

Equilibrium is a vector of $2N_\ell$ prices, $\{p_{h,\ell}, p_{r,\ell}\}_{\ell \in \mathcal{L}}$, that clears these markets jointly: tenure choice links the two markets within a location, and migration links markets across locations, so a shock in one location moves the entire price vector.

3 Calibration

3.1 Parameters

We organize the model parameters into three parts in Table 1. The first set of parameters is common to macroeconomic and asset pricing models with housing (Panel A). The last two sets of parameters are specific to our housing market model with climate risk and insurance. They are related to climate risk and insurance (Panel B), and geographic heterogeneity (Panel C). A subset of the parameters are calibrated externally, while the remaining parameters are chosen to match empirical targets in the data, as indicated in the last column of the table. One model period corresponds to one year and targets are in annual terms.

Preferences, income, mortgages and housing. The utility function is Epstein-Zin with a subjective discount factor of 0.95, a coefficient of risk aversion $\gamma = 5$ and an elasticity of intertemporal substitution of 0.5. These are standard values in asset pricing, which imply that households have a preference for the early resolution of uncertainty. The income parameters are from Kaplan & Violante (2022).

We set the preference for housing coefficient to 0.4 as in Favilukis *et al.* (2023) and the maximum LTV and PTI limits at mortgage origination to those in Greenwald (2018). We set the rental cost premiums ϕ_ℓ^R so that the average monthly rent paid by renters matches the Zillow Observed Rent Index (ZORI) in each region. Through equation (5), these pin down the landlord user cost at which each region's rental market clears in the baseline, and hence the level of rents. We set the depreciation rate of the rental stock to $\delta_h = 0.015$, and calibrate the supply shifters in each market so that the baseline clears at the observed prices: $\bar{I}_S^\ell$ so that each region's owner-occupied market clears at its average house price in the data, and $\bar{I}_R^\ell$ so that its rental market clears at the average rent. We give more details when we describe Table 2.

Property damage, climate risk and insurance. We model two layers of property damage against which households can purchase insurance. Baseline property damage is drawn each period from a scaled Beta distribution on $[0, \bar{d}]$, with parameters estimated from the 2021 American Housing Survey (AHS) microdata to match the cross-sectional distribution of routine maintenance expenditures relative to self-reported home values (see Appendix Appendix 1 for details). The estimated parameters imply an expected baseline damage of approximately 0.36% of home value per year.

In addition, climate disaster risk is characterized by the annual probability of a climate shock and the conditional loss given a shock. Climate risk can take many forms, including severe storms, heatwaves, floods, or wildfires. We calibrate the probability of a climate disaster in the high-risk region to be 8%, following Bilal & Rossi-Hansberg (forthcoming) estimates of probability of a 1-in-50 year storm following a 1 degree increase in temperature relative to 1920. We calibrate the conditional loss following a climate disaster to be 17% of the house value, following Bilal & Rossi-Hansberg (forthcoming) estimate of capital depreciation following a large storm. In the baseline calibration, the rest of the U.S. has zero climate disaster probability ($p_{\chi,\ell} = 0$), but properties in this region still face baseline property damage risk.

We set insurance coverage choices to range from $\underline{\phi} = 30\%$ (severely underinsured) to $\bar{\phi} = 100\%$ (full coverage). We calibrate the insurance supply parameters to jointly match

the average U.S. insurance premium paid by homeowners and the empirical distribution of coverage demand. These two objects naturally depend on one another since average premiums are determined by the product of coverage demanded times the insurance cost of given coverage. We calibrate a convex price schedule with rising marginal costs, consistent with regulatory requirements around holding concentrated geographic risk in a given region. For the baseline calibration, we assume that landlords insure their units at full coverage and bear the entire premium, which pins down the level of rents through equation (5). Beyond the baseline calibration, insurance costs reach renters through rental demand and general equilibrium changes in house prices and rent.

Claim rejection rates. To maintain our focus on insurance related to climate disasters, we set the rejection rate for baseline damages to zero for both insurers in both regions. In the high-risk region, we set the public insurer's rejection rate for climate-disaster claims based on the Citizens Property Insurance Corporation's December 2024 statement reporting a 13.2% "true denial rate" (i.e., excluding below-deductible, withdrawn, duplicate, and administrative closures) across Hurricanes Debby, Helene, and Milton.

For the private insurer, we use the NAIC Market Conduct Annual Statement (MCAS) data and find that the homeowners closed-without-payment (CWP) rate in calm years is approximately 30% in Florida. However, the bulk of these closures are mechanical (claims below deductible, withdrawn claims, duplicate filings) rather than discretionary denials of valid claims. Assuming a 20% true-denial share, we set the private insurer's rejection rate for climate-disaster claims to 6%.

Regional heterogeneity. We split the U.S. housing market between Florida, as a coastal state with high exposure to climate risk, and the rest of the country with lower risk. As described in Table 2, the model's endogenous choices are disciplined by several sets of parameters to generate rich geographic heterogeneity between low- and high-exposure areas.

We calibrate age-dependent amenity shifters to target population share in Florida and the rest of the U.S., and the utility cost of moving to match the average migration rate between these two regions. We set homeowner-specific amenities to target average homeownership rates over the lifecycle. Finally, we set housing supply elasticities for Florida and the rest of the U.S. using estimates from Saiz (2010), and apply the same elasticity to the owner-occupied and rental markets in each region.

3.2 Baseline Results

Similar to the parameters, we report the model results in three parts in Table 2. The first part is common to other models and describes key housing moments (Panel A). The last two parts are specific to our housing market model with climate risk and insurance. They center on climate risk and insurance (Panel B), and geographic heterogeneity (Panel C).

The data moments for income, population shares, and homeownership rates are drawn from the American Community Survey (ACS). We construct a panel of U.S. metropolitan statistical areas (MSAs) at the MSA–year level and use the most recent year available, 2024. We then aggregate these measures for Florida and for the rest of the United States (excluding Florida) by grouping all Florida MSAs and all non-Florida MSAs, respectively, and weighting each variable by population. Average house prices and rents are from Zillow Home Value Index and the Zillow Observed Rent Index (ZORI), respectively. Zillow reports these statistics at the MSA level, which we merge with our ACS panel.

Migration data are also drawn from the American Community Survey and are directly available at the state level. To construct gross migration rates between the two regions, we compute a population-weighted average of migration flows from Florida to the rest of the United States and from the rest of the United States to Florida. Specifically, flows are weighted by the population of the destination region, so that migration into larger areas receives greater weight. This measure captures the relative attractiveness of each region and can be interpreted as an average in-migration rate weighted by destination population.

Table 2 reports a detailed comparison between data moments and their model counterparts across the three groups of targets (aggregate, climate risk and insurance and geographic heterogeneity). Average income in the data is \$82.7 thousand, nearly identical to the model value of \$82.5 thousand. The model matches housing affordability well: the average house price–to–income ratio is 6.06 in the data versus 6.12 in the model, and the rent–to–income ratio is 0.25 in both the data and the model. Average wealth relative to income is lower in the model than in the data, 5.56 versus 6.33, and mortgages are less leveraged at origination, with a 90th percentile LTV of 0.76 and PTI of 0.32 against 0.90 and 0.48 in the data.

Two moments discipline the insurance price schedule jointly: the average premium homeowners pay, and the distribution of coverage they choose. These are demanding to match at the same time, because the average premium is itself the product of the price schedule and the coverage households endogenously select, so any change in the sched-

ule moves both moments at once. The model does well on both, generating an average coverage rate of 63% against 70% in the data (Sastry *et al.*, 2025), and an average premium of $1,512 per year against $1,123. Furthermore, we generate a rich distribution of coverage in line with the data, which is important because the experiments below operate on the shape of insurance demand.

The average annual moving rate between areas is 2.2% in the data and 2.1% in the model. Population shares are concentrated in low-exposure areas ("rest of the U.S."), with 93% in both the data and the model, leaving 7% in high-exposure areas. The model closely matches housing prices by exposure: average house prices are $512 thousand in low-exposure areas and $407 thousand in high-exposure areas in both the data and the model. Rents are also similar, with low-exposure monthly rents of $1,740 per month in the data versus $1,727 in the model, and high-exposure rents of $1,917 in both the data and the model.

Finally, Figure 1 plots income (Panel A) and wealth (Panel B) over the lifecycle, where wealth is total household net worth including home equity, while Panel C plots average homeownership rate over the lifecycle both in the model and in the data.

4 Insurance Demand and Adaptation Channels

4.1 Demand for Property Insurance

We begin by examining the determinants of insurance demand in our model. Figure 2 plots the unconditional distribution of coverage endogenously chosen by homeowners. The vast majority of households do not hold full insurance, implying that a natural disaster would not be fully covered by their insurer. Insurance demand peaks around 70% coverage and a sizable mass of households are severely underinsured. To understand why some households hold nearly-full coverage while others are severely underinsured, Figures 3 and 4 illustrate how liquidity, age, and climate risk shape insurance demand.

Panels A and B of Figure 3 plot insurance coverage as a function of liquid wealth, where households in each region are sorted into twenty bins with the same number of households in each bin. The x-axis range is different in each panel due to endogenous wealth and sorting across regions, something that we expand on below. Two patterns emerge. First, coverage is increasing in liquid wealth, but in a non-linear fashion: liquidity-constrained households exhibit steeper demand responses than their wealthier counterparts, while unconstrained households continue to increase coverage but at a diminishing

rate. Second, coverage is lower in the high-risk region across most of the liquid wealth distribution, consistent with higher premiums reducing the value of insurance. The figure also reveals endogenous precautionary savings behavior: households in the high-risk region hold substantially higher liquid wealth on average than those in the low-risk region. These aggregate patterns, however, mask important heterogeneity at the tails of the cash-on-hand distribution, which we examine in the next figure.

Panels C and D plot insurance coverage against age. In both regions, coverage follows a hump-shaped profile over the lifecycle, rising from young to middle age before declining. This pattern mirrors the lifecycle trajectory of wealth accumulation: as net worth rises, households demand more insurance, but as they age further, demand declines. Intuitively, insurance serves partly as a savings vehicle, and older households with no bequest motive have limited incentive to insure. The lifecycle profiles also differ across regions, reflecting both the cost of insurance and the type of risk it covers. Coverage is lowest among young households in the high-risk region, about 9 percentage points below their counterparts in the low-risk region at ages 25–34: young households hold little liquid wealth, and the higher premiums in the high-risk region are the hardest for them to afford. Later in life, coverage declines more slowly in the high-risk region: between ages 65–74 and 75–84 it falls by about 14 percentage points in the low-risk region but by only about 5 in the high-risk region, so that at ages 75–84 Florida owners insure more than owners elsewhere (about 59% versus 55%). In the low-risk region, insurance covers only routine damage, which older and wealthier households can absorb out of their savings. In the high-risk region, it also covers large disaster losses, which are much harder to self-insure, so its value persists further into retirement.

Figure 4 examines the tails of the liquid wealth distribution. Panels A and B restrict to homeowners in the bottom quintile of cash-on-hand, while Panels C and D restrict to the top quintile. Among liquidity-constrained households, coverage is low, reflecting the fact that purchasing insurance constitutes a transfer of resources from the present to the future. Within this group, coverage rises steeply with liquid wealth in both regions, from about a third of the house value for the poorest owners to about 60% at the top of the quintile, and the average coverage of the two groups is nearly identical (53% and 54%): for constrained households, additional liquidity goes in large part into insurance.

Panels C and D show that coverage changes little at the top of the wealth distribution. In the low-risk region, coverage at the top of the wealth distribution is flat. Unconstrained households purchase around 68% coverage, since they can easily self-insure the protection

gap to full insurance, given that expected damages are low. On the contrary, in the high-risk region, coverage keeps rising slowly with liquid wealth, from about 64% to 69%: even the wealthiest owners with over a million dollars in liquid wealth value insurance against large disaster losses, which are hard to self-insure.

4.2 Adaptation Channels

Households can adapt to their insurance and climate environment along six potential margins: they can adjust how much coverage to buy, switch between the private menu and the public insurer of last resort, switch tenure between owning and renting, move across regions, accumulate precautionary savings, and, in the extreme, default on their mortgages. House prices and rents adjust in equilibrium as households exploit these margins.

To trace the economic mechanisms through which these channels operate, we study two experiments that generate the same increase in insurance premiums from two different sources. In the first experiment, we raise the annual probability of a climate disaster in Florida from 8.0 to about 9.0%, an increase sized so that Florida premiums rise by 10% at every coverage level. In this experiment, climate risk itself is repriced, which affects both households who buy insurance and those who do not. Households who buy insurance are affected through higher premiums and, if they do not purchase full coverage, through higher expected losses, while households who do not buy insurance are affected through higher expected losses alone. In the second experiment, we raise the cost of supplying insurance in the high-risk region, holding physical climate risk fixed, so that the prices of the private insurer's contracts and of the public contract in Florida all rise by 10%. This experiment captures a change in the conditions under which insurance is supplied (for example, higher reinsurance, capital, or distribution costs, or tighter regulatory requirements), with no change in expected losses. These two experiments reflect different possible explanations for the recent premium increases households have faced across the U.S., and the model allows us to trace which margins adjust under each.

Table 3 reports the results of both experiments. The first two columns give the partial equilibrium (PE) and general equilibrium (GE) effects of higher climate risk, and the last two the corresponding effects of the supply-cost shock. In the PE columns, we hold house prices and rents at their baseline values, so that households adjust only along the margins available to them at fixed prices. In the GE columns, we solve for the new equilibrium, in which house prices, rents, and location, tenure, and insurance choices adjust jointly. Comparing the two columns within each experiment shows which responses are

amplified and which are muted once house prices and rents adjust.

We start by considering the first two columns of Table 3, which show the PE and GE results of raising the annual probability of a climate disaster in Florida from 8.0 to about 9.0%. The increase is sized so that private insurance premiums in Florida again rise by 10% at every coverage level, the same premium increase as in the second experiment, but produced by higher physical risk.[9] In partial equilibrium, when house prices and rents do not adjust, the exit incentive is even larger than under the supply-cost shock (Florida's population share falls by 4.5 pp and its homeownership rate by 23.2 pp), because higher disaster risk raises expected losses on the uninsured share of every home in addition to raising premiums. For the same reason, however, the coverage response is almost three times smaller, at only 3.1 pp. When climate risk increases and insurers raise the cost of coverage, households that remain homeowners may optimally choose to insure less despite the higher risk. In this experiment, higher insurance payments are directly associated with higher expected payouts to households for whom climate risk materializes. Here, buying less coverage no longer helps households smooth their consumption of non-durable goods and housing services; it merely shifts the expected loss from the insurer's balance sheet onto the household's. Insurance coverage optimally decreases by little, and average insurance payments in Florida rise by only 3.4%, against a fall of 8% in the supply-cost experiment.

In general equilibrium, the higher risk is capitalized into house prices. Florida house prices fall by 2.6%, twice the decline in the supply-cost experiment, and Florida rents rise endogenously by 0.6% as the tenure mix shifts toward renting (homeownership declines by 0.7 pp). As in the supply-cost experiment, the adjustment of house prices and rents mutes net migration, leaving Florida's population share essentially unchanged. The lower house prices make it cheaper to buy a home in the high-risk region, partially offsetting the higher risk of the underlying asset. The demand for insurance coverage declines modestly, by 2.1 pp, and take-up of the public contract rises by 5.6 pp, driven by households whose budgets are squeezed by higher premiums. Average Florida net worth falls by 14.8% and average consumption by 8.7%, mostly because the composition of Florida's population changes. Older homeowners from the rest of the U.S. who have little liquid wealth move in: they sell their homes and buy cheaper ones in Florida, where house prices have fallen

[9] Premiums at every coverage level are proportional to the actuarially fair price, and in Florida the expected disaster payout $p_{\chi,\ell}\,\chi_\ell\,(1-\theta_{d,\ell})$ accounts for roughly three quarters of that price, the remainder reflecting expected baseline damages. Raising the disaster probability by 13%, from 8.0 to about 9.0%, therefore raises the actuarially fair price, and with it the entire premium schedule, by 10%.

by 2.6%, to free up home equity for consumption late in life, while younger households leave. These two flows nearly offset each other, so net migration is small: Florida's population falls by only 1.3%. The share of Florida residents aged 85 and over rises from 20 to 37%. For households who live in Florida in both equilibria, net worth and consumption fall by less than 1%. The same sorting raises average net worth in the rest of the U.S. by 1.4%, where house prices rise by only 0.1%.

We then consider an increase in insurance supply costs in the last two columns. The partial equilibrium effect is a flight from the high-risk region toward the low-risk region and a decrease in private insurance coverage purchased. Florida's population share falls by 3.2 pp as higher insurance costs lead households to move from Florida to the rest of the U.S. Homeownership in Florida also decreases by 9.7 pp, so households adjust through both tenure and migration. With house prices and rents at their baseline levels, the higher recurring cost of insuring a home in the high-risk region makes owning there strictly less attractive. Households who remain in the region as homeowners adjust mainly on the insurance margin. The shock raises the cost of insurance coverage without a change in the underlying risk, so every contract, private or public, is now further from being actuarially fair. The optimal response of households who own a home is therefore to buy less insurance. This reduction in coverage allows households to better smooth their consumption of non-durable goods and housing services, at the cost of greater exposure to losses should a climate shock occur. Average Florida coverage falls by 8.3 pp: take-up of the public minimum-coverage contract rises by 17 pp, and homeowners who remain with the private insurer reduce their coverage by 3.0 pp. Average insurance payments fall by 8% even though unit prices are 10% higher: households move down the coverage menu and onto the public contract.

The last column of the table shows the general equilibrium effects. The main difference from the partial equilibrium response is that migration is now muted. When house prices and rents were held fixed, Florida's population share fell by 3.2 pp. Once equilibrium forces change house prices and rents, population shares are essentially unchanged. House prices and rents absorb the incentive to relocate. As demand for housing in the high-risk region declines, house prices fall until the marginal resident is indifferent. In equilibrium, Florida house prices fall by 1.3%. This makes homeownership in Florida more attractive, so the homeownership rate falls by only 0.4 pp. In the new equilibrium, fewer Florida households own their home, and their demand for rental units pushes rents up until the marginal household is indifferent between owning and renting; rents rise by 0.4%.

Households that remain homeowners in the high-risk region optimally buy less coverage from private insurers. Average coverage falls by 8.4 pp: take-up of the public contract rises from 17 to 35% of Florida homeowners, and homeowners who remain with the private insurer reduce their coverage by 2.5 pp. Homeowners in the high-risk region thus end up with a larger protection gap, the distance between the coverage they hold and their exposure. The incidence falls on the region's inframarginal residents: on owners through lower house values and costlier insurance, and on renters through higher rents. Average Florida net worth falls by 9.9% and average consumption by 5.8%, but, as in the climate experiment, almost entirely because older homeowners move in to buy cheaper homes; for households who live in Florida in both equilibria, net worth falls by only 0.4%.

Ownership shifts toward the low-risk region while renting shifts toward the high-risk region. The number of homeowner households rises in the rest of the U.S., where the homeownership rate increases by 0.05 pp, and falls in Florida. House prices in the rest of the U.S. accordingly rise by 0.06%, and rents there fall by 0.05% as rental demand thins. Average net worth in the rest of the U.S. rises by 1.0%, again because of sorting: the region loses older homeowners with little wealth to Florida and keeps younger households who would otherwise have moved to Florida. For households who live in the rest of the U.S. in both equilibria, net worth is unchanged.

The two experiments illustrate that increases in insurance premiums can be reflected on very different margins depending on their cause: a supply-cost shock is reflected mainly in the *insurance* coverage purchased by households, widening the protection gap while house prices adjust only modestly; on the other hand an increase in climate risk is reflected mainly in the *house-price* margin, leaving coverage roughly intact while home values absorb the loss. In both cases, net spatial reallocation is close to zero in equilibrium because prices and rents move until the marginal resident is indifferent. As a result, mobility protects the marginal household, while incumbents bear the burden through lower home values, costlier insurance, and higher rents. Gross migration also falls slightly, by about 0.2 pp in both experiments against a baseline rate of 2.1%, because fewer households leave Florida: the region has fewer younger residents, and the older households who move in stay. Across both experiments the margins of adjustment have the same ranking: insurance coverage adjusts most, tenure second, and location least. This ordering is intuitive, since moving is the most costly of the three margins. These underlying economic mechanisms will guide the discussion of the policy interventions that we evaluate in the next section.

5 Property Insurance Pricing Policies

Section 4.2 shows that whether an increase in insurance costs is reflected in households' insurance coverage or in house prices critically depends on its source. In the data, policymakers in high-risk regions have responded to rising premiums with three main instruments. Mapped to the model, each of them corresponds to a price cut on a different component of the premium schedule of Section 2.5, which combines the actuarially fair price of coverage with a markup and a capital loading that rises in coverage. In our baseline model, households optimally stop short of full coverage, which matches the data in which no Florida homeowner purchases full coverage. We refer to this shortfall between the coverage households hold and their exposure as the protection gap, following Sastry *et al.* (2025).[10] We consider three possible policies that affect costs of insuring against climate risk: *rate regulation* through regulatory caps on insurance premiums, a *subsidy to the public insurer of last resort* that makes it cheaper for households to afford minimum coverage, and the introduction of a *public catastrophe reinsurer* that makes it less costly for insurers to supply large amounts of coverage.

Importantly, each policy is financed in equilibrium, so household decisions take into account both its costs and its benefits. Our first policy, the rate cap in the high-risk region, is financed by an increase in insurance markups in the low-risk region that restores the private insurer's baseline underwriting margin. The required markup is solved jointly with equilibrium prices. The public-insurer subsidy and the public reinsurer are financed by a lump-sum tax on every Florida homeowner that balances the government's budget period by period, also solved jointly with prices. The previous section suggests that migration responses to insurance-cost changes are small in general equilibrium, because house prices and rents adjust until the marginal resident is indifferent. To the extent that the same logic applies to the policy experiments (we verify below that it does), house price and rent movements become useful statistics for a policy's incidence. A price increase in equilibrium means the policy is largely a windfall to incumbent owners, while a policy that leaves prices unchanged is paid for by its own beneficiaries. We therefore ask two questions of each policy: whether it raises or lowers the coverage households hold, and on whom its cost ultimately falls.

Table 4 reports the general equilibrium effects of the three policies. Figures 5 through

[10] The size of the protection gap depends on the calibrated loading, which is disciplined by average premiums and the distribution of coverage (Section 3). The comparison of the three policies below does not: for any loading that rises in coverage, a proportional price cap leaves the relative price of higher coverage unchanged, whereas removing part of the loading lowers it.

7 compare partial and general equilibrium responses. As before, the PE response applies the policy's insurance prices while not allowing house prices and rents to adjust, and, in addition, before we adjust the financing margins of each policy (markups in the first policy and taxes on the other two). The GE response lets house prices, rents, and the financing of the policies adjust jointly with household choices. The gap between them measures how much of each policy is undone by equilibrium movements in house prices and rents, by its own funding, and by the endogenous responses of households.

5.1 Rate Regulation in the High-Risk Region

Our first policy is rate regulation that suppresses private insurance prices in the high-risk region. A regulator caps the private insurer's price schedule in Florida at 90% of its baseline level, capturing the cumulative effect of binding rate-increase caps. The public contract remains fairly priced. The private insurer, which operates nationally, recovers the margin it loses in the high-risk region, where it faces the cap, through a compensating markup on the low-risk region, which the model solves jointly with equilibrium prices; margin neutrality raises the markup on policies in the rest of the U.S. from 0.5% to 3.15%.

This experiment is, by construction, a cross-subsidy from the low-risk region to the high-risk region, and we trace its consequences through the lens of our model. Similar regulatory cross-subsidies exist elsewhere in housing markets, such as the cross-regional transfers generated by uniform mortgage pricing at the GSEs (Hurst *et al.*, 2016).

Table 4 and Figure 5 show the results. We start with the partial equilibrium case, in which we keep house prices and rents fixed at their baseline values and show the effects before the compensating markup is levied in the low-risk region. Therefore, capped premiums are a pure handout to the high-risk region, and the partial equilibrium response is very large. Florida's population share rises by 25.8 pp and its homeownership rate by 6.9 pp. Average Florida consumption falls by 6.3%: in partial equilibrium, when prices do not adjust, the households that enter Florida are less wealthy than incumbent Florida households. The magnitudes are partially driven by borrowing constraints and the forward-looking nature of households. At fixed house prices and rents, a recurring saving of a few hundred dollars per year moves a large mass of near-indifferent households toward the subsidized region. Equilibrium adjustment undoes nearly all of the migration and tenure response once the subsidy is capitalized into house prices. As households bid for Florida homes, which are now cheaper to insure, house prices rise by 1.7%, and the population share ends up higher by only 0.07 pp. The subsidy mainly benefits incumbent

Florida homeowners, mostly through cheaper insurance and partly through housing capital gains, rather than movers. Average Florida net worth rises by 7.5%.

In the high-risk region, average demand for insurance coverage rises substantially, from 60.5 to 69.1%. Panel (b) of Figure 5 shows that the entire distribution of coverage in the high-risk region shifts to the right. The mass of households purchasing higher coverage levels increases substantially, and the gap between coverage and exposure narrows as cheaper insurance leaves Florida homeowners better protected against climate risk.

Households in the rest of the U.S. carry the burden of financing this subsidy. The national insurer adjusts markups in this region to recover the losses in Florida. Households in the rest of the U.S. decrease their coverage by 1.6 pp and are more likely to take public insurance. Public insurance take-up increases by 4.1 pp, and average net worth falls by 0.8% and consumption by 0.7%. The beneficiaries are incumbent Florida homeowners, who see the value of their homes appreciate. Rate regulation, in the model, is in substance a cross-regional transfer from low-risk policyholders to high-risk incumbent homeowners. This transfer happens mostly through cheaper insurance, financed by policyholders in the rest of the U.S., and partly through higher house prices.

The contrast between partial and general equilibrium also shows how spatial sorting shapes who gains and who loses. At fixed prices, average net worth falls in both regions, by 8.3% in Florida and 4.6% in the rest of the U.S., mostly because of who moves: the households drawn to Florida are wealthier than the average resident of the rest of the U.S. but less wealthy than the average Floridian. Once house prices and rents adjust, the relocation is priced out and the policy becomes a house-price phenomenon (Figure 5): Florida net worth rises by 7.5% and the loss in the rest of the U.S. is muted to 0.8%. Capitalization raises net worth in the high-risk region, where incumbent owners collect the house-price windfall on top of cheaper insurance, and mutes the losses in the low-risk region, whose households face tighter budget constraints because of higher insurance premiums.

5.2 Subsidizing the Public Insurer of Last Resort

Our second policy subsidizes the public insurer of last resort: it prices its minimum-coverage contract below actuarially fair value, compared to fair value in the baseline. The government therefore subsidizes its own insurer and finances the gap with a lump-sum tax on households in the high-risk region. In particular, we set the public minimum-coverage contract at 90% of its actuarially fair rate ($\underline{\mu} = 0.10$), which in equilibrium requires a tax of \$57 per homeowner per year.

This corresponds to Citizens Property Insurance Corporation lowering its rates below cost. Recall that the public insurer in our model denies climate-disaster claims at more than twice the private rate (13.2 versus 6%) and offers only the minimum-coverage level. Because prices are net of claim denial, its premium is correspondingly lower. In the baseline, it disproportionately attracts both the poor and the old, who value the low-coverage option.

Figure 6 shows the outcome of such a policy. In partial equilibrium, making the minimum-coverage option more attractive induces households to move from the low-risk region to the high-risk region. Florida's population share rises by 1.7 pp and take-up of the public contract increases by 15.6 pp. At the same time, the Florida homeownership rate falls by 1.1 pp. Households buy less coverage overall as more of them take up the public contract. Average Florida consumption and net worth fall, by 4.7 and 8.2%, mostly because the households the cheaper contract draws to Florida are poorer than the average resident of either region.

In general equilibrium, once the government increases taxes to finance the insurer, the migration effects are muted: Florida's population share is unchanged. Still, the general equilibrium adjustment does not overturn the effect on coverage: take-up of the public contract nearly doubles, from 16.6 to 31.6% of Florida homeowners, and average coverage falls by 3.8 pp to 56.8% as households shift toward the cheaper, publicly offered contract. The policy redistributes within the high-risk region: the subsidy is financed by all Florida homeowners, while its benefit accrues to those who take up the discounted contract, who are disproportionately poor and old. The transfer runs from homeowners who remain on the private menu toward those who move onto the public one.

Also in equilibrium, Florida house prices are essentially unchanged (falling 0.06%): unlike the rate cap, the subsidy does not raise the value of owning a well-insured home (it subsidizes holding less insurance), so there is little for house prices to capitalize, and the tax and the shift toward lower coverage slightly reduce the value of owning. Overall, subsidizing public insurance has a contractionary effect in Florida: non-durable consumption decreases by 1.8% and net worth falls by 3.2%. There are limited spillover effects to the rest of the U.S. as a result of this policy.

5.3 A Public Catastrophe Reinsurer

Our final policy is public provision of catastrophe reinsurance. Florida has a state-administered mandatory reinsurance program called the Florida Hurricane Catastrophe Fund. The gov-

ernment sells reinsurance against disaster losses to the private insurer at below-market rates, which lowers the insurer's cost of supplying disaster coverage in the high-risk region.[11] In the model, this policy corresponds to extending the fund's coverage to all climate-related losses.

The introduction of such a subsidy lowers the part of Florida premiums that compensates the insurer for the cost of holding capital against disaster losses. We set the subsidy to offset 40% of that cost.[12] Because these costs are largest for high levels of coverage, the price cut is concentrated at the top of the coverage menu, and since the subsidy leaves the actuarially fair component of premiums untouched, insurance in Florida remains more expensive than in the rest of the U.S. in proportion to its higher expected losses, in contrast to the rate cap. The fund is financed by a lump-sum tax on every Florida homeowner ($224 per year in equilibrium) that balances its budget period by period.

This policy differs from the rate cap in how it changes insurance prices. The rate cap experiment scales down all coverage prices proportionally, leaving the price of additional coverage relative to existing coverage unchanged. The reinsurance subsidy instead makes high levels of insurance coverage relatively cheaper. This is the coverage that is most expensive for insurers to supply (high levels of disaster coverage, which private carriers reinsure at the steepest rates), so the experiment effectively lowers the relative price of the coverage households do not yet hold, pulling them toward insuring more of their exposure.

The last two columns of Table 4 and Figure 7 report the results. In partial equilibrium, when house prices and rents do not adjust and before the tax is collected, the subsidy draws households to the high-risk region: Florida's population share rises by 6.9 pp and its homeownership rate by 1.5 pp. As under the rate cap, average Florida net worth and consumption fall, by 9.4 and 6.4%, mostly because the newcomers are less wealthy than incumbent high-risk region households.

General equilibrium removes the migration response but preserves the insurance gains.

[11] The Florida Hurricane Catastrophe Fund can charge less than private reinsurers because it does not need to hold capital against its obligations before disasters occur: when a large hurricane exhausts its resources, it issues bonds that are repaid by assessments levied on Florida property-and-casualty policyholders after the event. A private reinsurer must instead raise capital in advance and compensate its investors for holding it, a cost that is passed into reinsurance prices (Froot, 2001). Since disaster losses are idiosyncratic across households in the model, we study how this substitution is priced and who bears its cost rather than the fund's capital adequacy against a correlated tail event.

[12] Florida law lets insurers select coverage of 45, 75, or 90 percent of their hurricane losses above a retention, at a premium that must be "actuarially indicated" and therefore carries no return on capital (Florida Legislature, 2025). Offsetting 40% of the loading corresponds to roughly the lowest of these selections, net of the fund's own costs.

Once the tax is collected and prices adjust, Florida's population share and house prices are essentially unchanged (house prices fall by 0.12%), so, unlike under the rate cap, there is no windfall to incumbent owners. The homeownership rate falls by only 0.04 pp and Florida rents fall by 0.04%, as the tenure mix barely changes. On the insurance margin, endogenous demand for coverage rises by 7.0 pp to 67.5%, and take-up of the public minimum contract falls by 3.0 pp to 13.6% as households move up the now-cheaper private menu; panel (b) of Figure 7 shows the coverage distribution in the high-risk region shifting to the right. Average premium payments rise by 12.2% ($539 per year), not because insurance became more expensive per unit, but because households buy more of it. Florida net worth rises by 2.4% and consumption by 2.1%, with essentially no change in the rest of the U.S.

Compared with the rate cap, which produced large house price movements, the introduction of a public reinsurer leaves house prices and rents largely unchanged. Public reinsurance lowers a cost that households can scale by choosing how much coverage to buy. The lump-sum tax that finances it, in contrast, is a cost of owning in Florida: it falls on every Florida homeowner, and no coverage choice reduces it. Costs that households can adjust are only weakly capitalized into house prices; costs of ownership are capitalized fully. The introduction of the public reinsurer decreases the cost of insurance, and for the marginal buyer this decrease is roughly offset by the new tax, leaving little for house prices to capitalize. In effect, the public reinsurer taxes homeowners to bring down the price of coverage. The arrangement resembles federal disaster programs such as FEMA's, except that the tax base is exclusively the high-risk region itself rather than the entire nation. The contrast between partial and general equilibrium makes the same point through sorting: at fixed prices, households relocate toward the subsidized region and average Florida net worth falls by 9.4% as the newcomers are less wealthy than incumbent Floridians; in general equilibrium, the lower insurance costs and the offsetting tax remove the incentive to relocate. Net worth in Florida increases by 2.4% (it falls by 0.2% in the rest of the U.S.). The policy is not a transfer across regions: it changes how the high-risk region pays for insuring its own risk, converting charges that scale with coverage into a fixed charge on ownership, and in equilibrium the high-risk region holds more insurance, paid for almost one-for-one by taxing its own homeowners.

The average protection gap narrows: the subsidy lowers the price of the highest coverage levels by about 10%, and Florida homeowners respond by insuring a larger share of their exposure, although most continue to insure well below their full exposure. Over-

all, a public reinsurer buys more insurance rather than higher house prices, and it is the only one of the three policies that does so without a cross-regional transfer or a degraded contract.

5.4 Climate Risk Exposure and Welfare

The three policies we described above have different implications for households' exposure to climate risk as well as different welfare implications. In this subsection we study the implications of the policies for climate risk exposure and welfare.

An increase in climate risk in aggregate, or in a given region, does not necessarily mean that households become more exposed. Indeed, households can take actions to avoid this risk, they can move to a less exposed area, purchase insurance, or change tenure. This is why it is important to have a model that allows us to quantify how much exposure to climate risk changes following a change in policy. We start with a very intuitive measure of climate risk exposure, in particular we ask, what is the dollar value of Florida housing that is exposed to climate risk? Or in other words, if a household in our model gets hit by a climate shock, what share of its housing is not insured? A very simple way of capturing this is:

$$E = \text{PopShare}_{FL} \times \text{Homeownership}_{FL} \times \text{HomeValue}_{FL} \times (1 - \text{Coverage}_{FL}), \quad (8)$$

where E is average exposure which equals the average population share of Florida, times the average homeownership rate, times the average home value, times one minus the average coverage purchased (net of claim denials). Notice that all of the policies we analyzed can endogenously change each term of equation (8), since households can move, change their tenure, their insurance coverage, and all of their choices in equilibrium change home values.

In the baseline, counting homeowners who hold an insurance policy, the population share of Florida is 7.22%, the average homeownership rate is 66.6%, the average home value can be normalized to 1, and one minus the average coverage in Florida is 43.5%. Thus the baseline exposure metric is: $7.22\% \times 66.6\% \times 100\% \times 43.5\% = 2.09\%$. What matters is how exposure changes with each policy. The change in climate risk exposure can be decomposed into its four terms: $\Delta \ln E = \Delta \ln \text{PopShare}_{FL} + \Delta \ln \text{Homeownership}_{FL} + \Delta \ln \text{HomeValue}_{FL} + \Delta \ln (1 - \text{Coverage}_{FL})$. Panel A of Table 5 shows this decomposition.

The first row of Panel A shows the change in exposure in the high-risk region if there

is a price-cap. If regulation imposes a cap on insurance prices in this region, the overall climate risk exposure of homeowners declines by 17.94 log points. This is mainly due to an increase in coverage purchased by households, which contributes 21.44 log points to the decrease in exposure. The endogenous migration, tenure choices and equilibrium changes in house prices counteract this effect. In particular, households are more likely to move to the high-risk region (location choices increase exposure by 1.08 log points), and higher house prices raise the value of the homes exposed to climate risk (1.86 log points). Still, overall, this policy has net benefits in reducing exposure of homeowners in Florida. The second policy, which makes the coverage offered by the public insurer cheaper, actually increases exposure by 8.41 log points versus the baseline. Subsidizing the lowest level of coverage makes households buy less coverage endogenously (8.56 log points), while location, tenure, and house prices barely change. Finally, the last row of Panel A shows the effect of creating a public reinsurer. This policy has similar effects on exposure as the rate regulation. In particular, under this policy, exposure to climate risk in the high risk region declines significantly. This policy is effective at reducing the cost of high coverage levels, so households insure more; the effects of location, tenure and house prices are negligible.

Of course, being more or less exposed to climate risk does not have a direct mapping to welfare. In particular, some policies that reduce coverage costs increase taxation in that region, affect insurance prices in the other region, and have general equilibrium effects that impact house prices and rents (and therefore option values of moving). To understand the welfare effects of the policies, we compute the cash transfer that would make a given agent, in its current state of the world, indifferent between the status quo and the counterfactual policy. Formally, let S_i be the state variable vector of agent i, we then compute:

$$V_t^{\text{baseline}}(X_i + \Delta w_i, S_i \setminus X_i) = V_t^{\text{counterfactual}}(S_i).$$

That is, we ask the question, how much of a wealth transfer Δw_i would we need to give agent i for it to "wake up" in the counterfactual world at its current tenure, leverage, age, etc. This is an equivalent variation: a positive number means that the household is better off in the counterfactual, a negative number means that the household is better off in the baseline. We normalize this cash transfer by the household consumption in period t, so our welfare metric is an equivalent variation as a proportion of the household consumption that period.

In Panel B of Table 5 we report the results. We use a Shapley decomposition (Shapley,

1953; Shorrocks, 2013; Audoly *et al.*, 2025), and decompose the welfare change into its key components: change in insurance prices, equilibrium changes in house prices and rents, and levy. Note that the levy component of welfare differs depending on the policy under analysis. For example, under the price cap policy, levy is an increase in insurance prices in the low-risk region, whereas in the other two policies, it is an increase in taxation for homeowners. In our welfare analysis we focus on the trade-offs between Florida owners, Florida renters, and the rest of the U.S. We stop short of reporting aggregate welfare, since our welfare metric does not include the risk-neutral landlords or insurance companies. Still, we are able to show among households, either renters or owners, who benefits and who does not benefit from the policies.

The first row of Panel B shows the welfare impact of an insurance price cap in Florida. Florida owners gain the equivalent of 13.1% of their annual consumption. The gains are mainly driven by the lower insurance costs and the increase in house prices (9.82 pp and 3.70 pp, respectively). The levy has a slight negative impact, since this is a second order effect for Florida homeowners. The option value of moving to the rest of the U.S. has decreased, since that region now has higher insurance costs. Florida renters are also better off with this change. Despite the fact that rents increase in equilibrium, as well as house prices (which make it harder for households in this region to get on the property ladder), the net effect is still positive since insurance is much cheaper, and so the option value of becoming a homeowner for high risk region renters increases in value and dominates. Households living in the rest of the U.S. have the largest welfare loss under this policy, 1.39% of consumption. The policy raises their insurance rates (levy) and their rents, and higher house prices in Florida make a future move to Florida more expensive. Overall, incumbents in the low climate risk region are particularly hurt by this policy. The next three rows of Panel B show the welfare effects of subsidizing the public insurer in the high-risk region. Florida homeowners lose 0.12% of annual consumption. Getting basic insurance coverage is cheaper for them, but they get taxed and the value of their homes decreases in equilibrium. These latter two effects combined dominate the fact that insurance is cheaper. Renters in Florida also lose with this policy, since rents increase in equilibrium, and despite the fact that homes are cheaper in Florida, and thus it is easier for renters to get on the property ladder, future homeowners get taxed to finance the policy, and most of the welfare loss for Florida renters comes from the levy. In the rest of the U.S., welfare is positive under this policy (0.19%). This is mainly driven by general equilibrium price changes, and not the policy itself, since the subsidy changes nothing directly in the rest

of the U.S. (insurance prices are unchanged and there is no direct taxation on rest of the U.S. households). However, the option of moving to Florida later, where the public contract is cheaper, increases welfare (0.14%), and that benefit slightly dominates the future Florida taxes (0.12%). The rest of the benefit comes mainly from lower rents in the rest of the U.S., which particularly benefits young households, who gain the most, since they have the longest horizon of renting and possible moves across tenure and space. Finally, the last policy we consider is the public catastrophe reinsurer. This policy lowers private insurance premiums, mostly at high levels of coverage. This has a positive welfare impact on Florida owners (3.36%), but every homeowner pays a tax, which decreases welfare by 5.51%, and overall homeowners are worse off (-2.44%): homeowners who buy low coverage subsidize those who buy high coverage, and the tax also pays for extra coverage that households value at less than its cost. For Florida renters, the option of buying cheaper coverage once they become homeowners has a positive welfare impact (1.58%), but the expected tax, which only matters if they become owners, roughly offsets the gain (-1.67%). Overall, they are better off (0.12%), since house prices decline in Florida, and thus it is easier to get on the property ladder. In the rest of the U.S., the effects are small (-0.24%) and mainly driven by the option value of moving to Florida: the cheaper insurance is worth 0.24%, but the tax levy more than offsets that at -0.45%.

The three policies show that lowering climate risk exposure comes at a welfare cost for some households. Rate regulation and the public reinsurer reduce exposure in Florida by similar amounts, about 18 and 17 log points, because households buy more coverage when it becomes cheaper. Subsidizing the public insurer does the opposite: it raises exposure by about 8 log points, as homeowners move down to the minimum contract. In all three policies, the endogenous change in coverage accounts for most of the change in climate risk exposure. The welfare impact on households depends on who finances each policy. Rate regulation is financed by policyholders in the rest of the U.S., so it is a transfer from that region to Florida. The public reinsurer is financed by Florida homeowners themselves: they buy more coverage, but the tax they pay exceeds the value of the cheaper insurance. The subsidy to the public insurer has small welfare effects, but it leaves Florida homeowners more exposed to climate risk.

6 Conclusion

We study how local climate risk affects nationwide housing markets, and hence households' balance sheets and risks, through the interaction of spatial mobility and property insurance. We develop a dynamic spatial equilibrium model in which households choose where to live, whether to own or rent, and how much property insurance to purchase in the presence of heterogeneous local disaster risk. By introducing insurance and migration channels, we show that local climate risk is transmitted not only through expected property losses, but also through insurance premiums, endogenous sorting, and changes in the composition of marginal buyers across regions.

Our calibration delivers realistic patterns of household insurance demand and regional housing outcomes. Without targeting it, the model generates substantial heterogeneity in coverage choices, including widespread under-insurance, which in turn determine how climate risk is capitalized into house prices. When climate risk rises, higher expected losses increase insurance costs, reduce the attractiveness of homeownership in exposed regions, and lower house prices as some households switch tenure or migrate away. At the same time, equilibrium responses in the model are shaped by selection: changes in insurance costs and disaster exposure alter the composition of households who remain in or enter risky locations.

Our main counterfactual experiments highlight that the housing market effects of climate risk depend critically on the property insurance context. Increases in local disaster probabilities or insurer costs generate lower house prices in exposed regions and change who lives there, with relatively modest net spatial reallocation. These findings suggest that adaptation to natural disasters through migration has positive but limited benefits when housing prices adjust, as they do when housing supply is imperfectly elastic.

Insurance rate regulation that compresses premiums in risky areas induces large cross-regional redistribution: Florida homeowners gain the equivalent of 13% of their annual consumption, paid for by policyholders in the rest of the U.S., while location choices and homeownership barely change once house prices adjust. In contrast, a subsidy to insurers that lowers the cost of high coverage and is financed by local homeowners meaningfully reduces climate risk exposure in the population. Taken together, our results underscore that property insurance is not a passive backdrop to housing markets and climate adaptation; it is a central mechanism through which climate risk is priced, shared, and propagated across regions.

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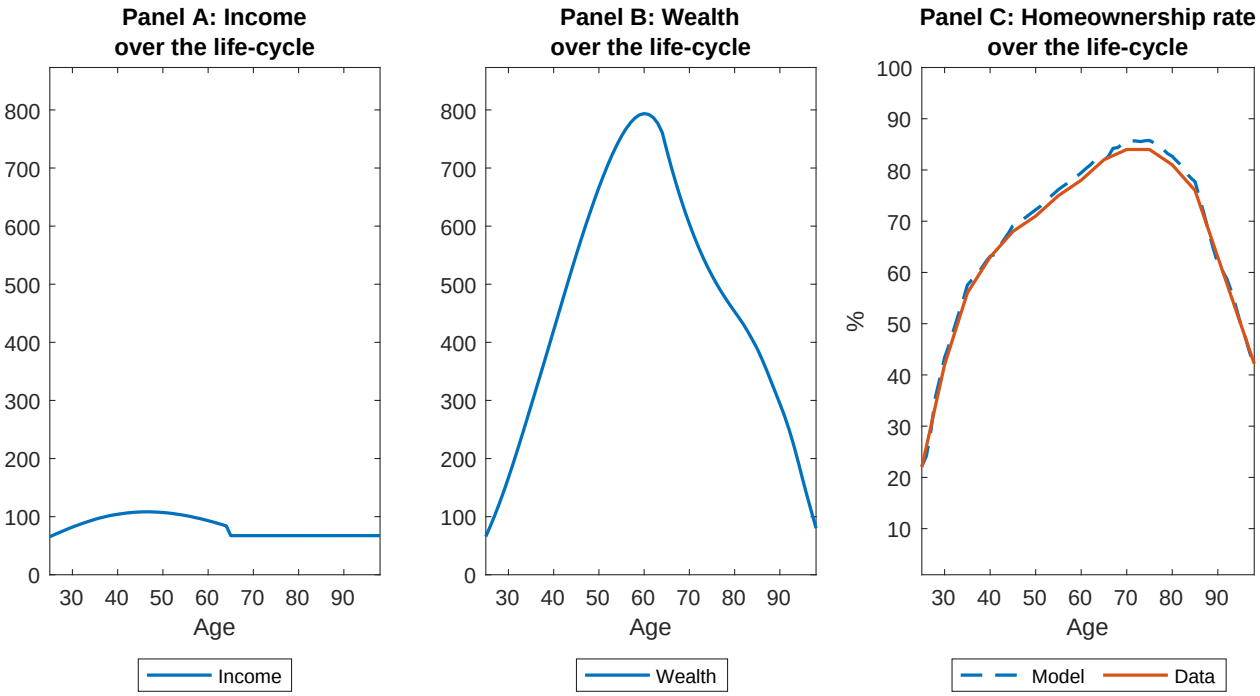
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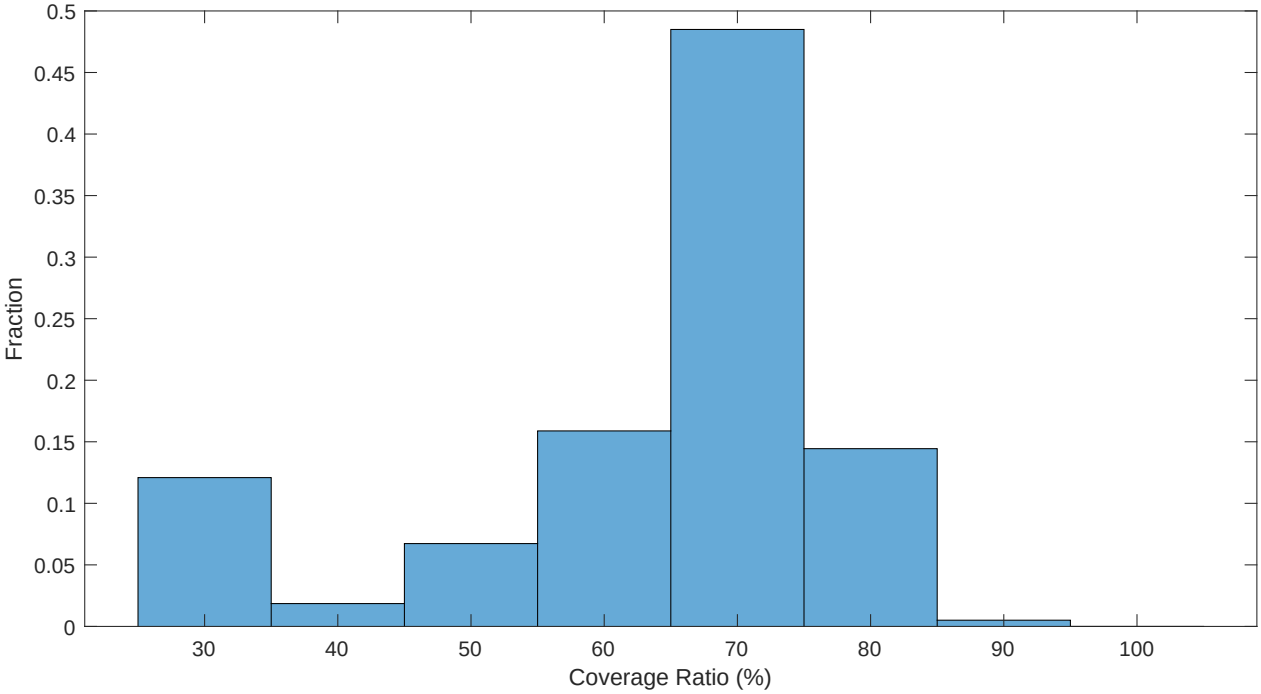
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Figure 1: Lifecycle profiles of income, wealth, and homeownership



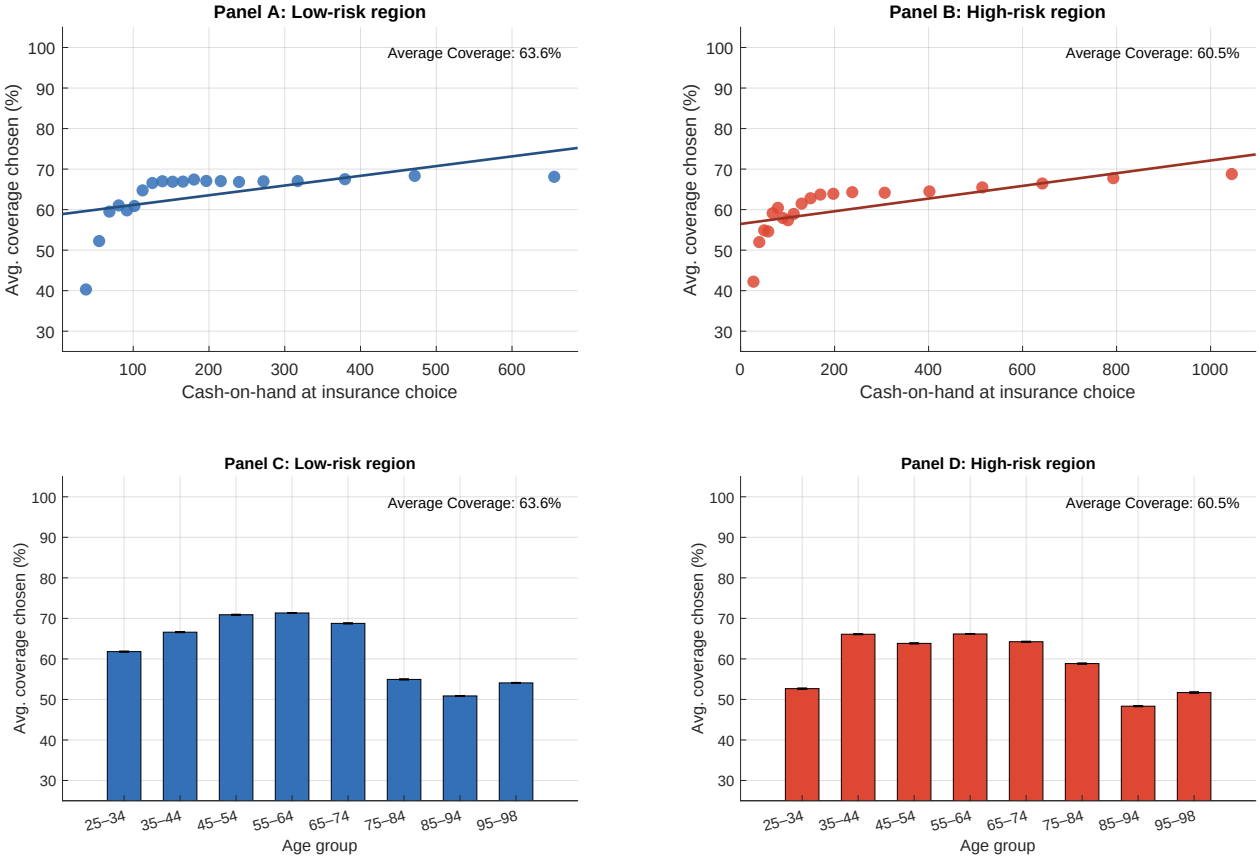
Notes: This figure plots average income (Panel A), average wealth (Panel B) and the homeownership rate (Panel C) over the lifecycle.

Figure 2: Insurance coverage demand



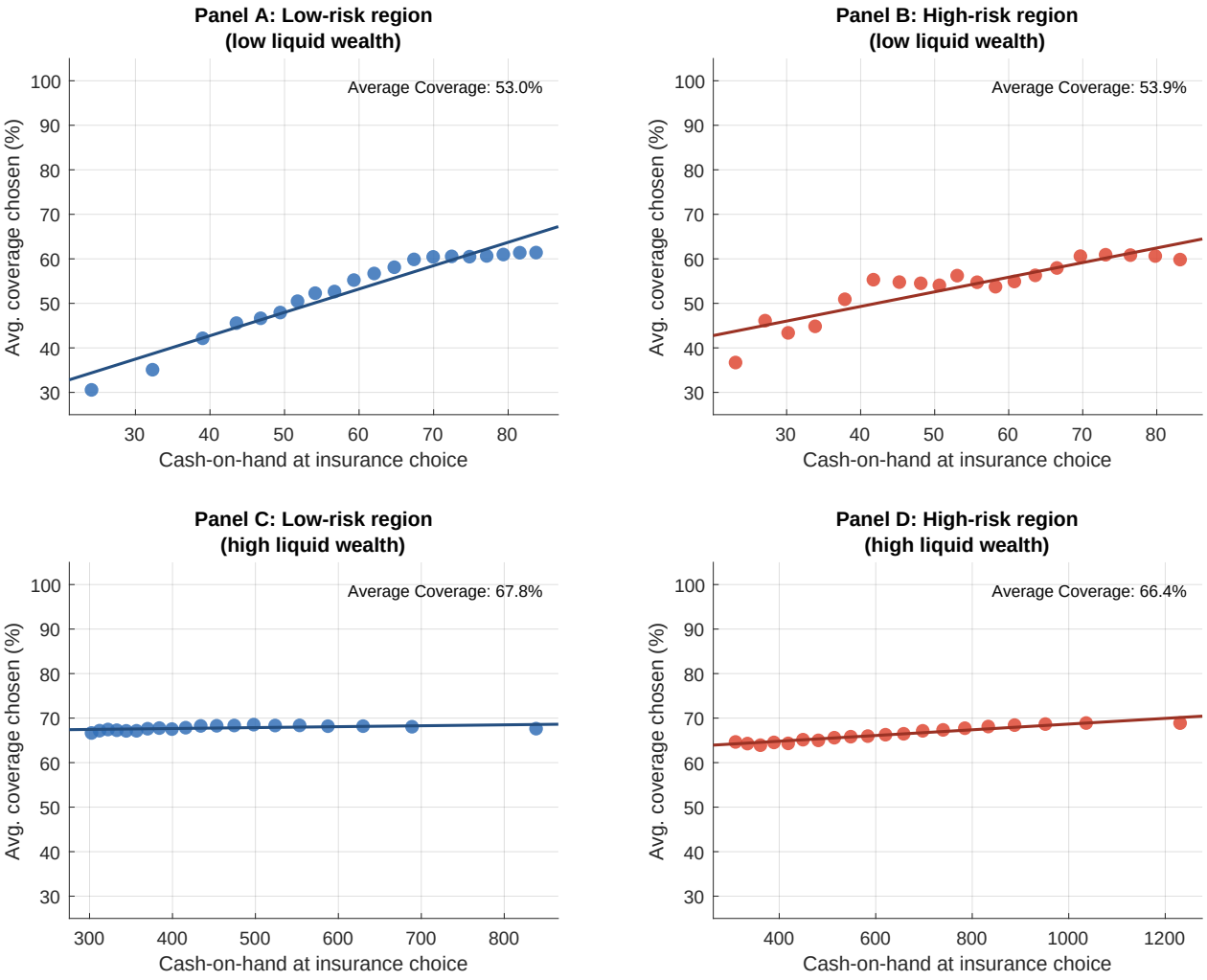
Notes: The figure shows the distribution of endogenous insurance coverage demand in the model.

Figure 3: Insurance demand by liquid wealth and age



Notes: This figure plots binscatter relationships between insurance coverage and cash-on-hand (top panels) and age (bottom panels) for homeowners, separately for the low- and high-risk regions. Each point represents the mean of insurance coverage within bins of the x-axis variable.

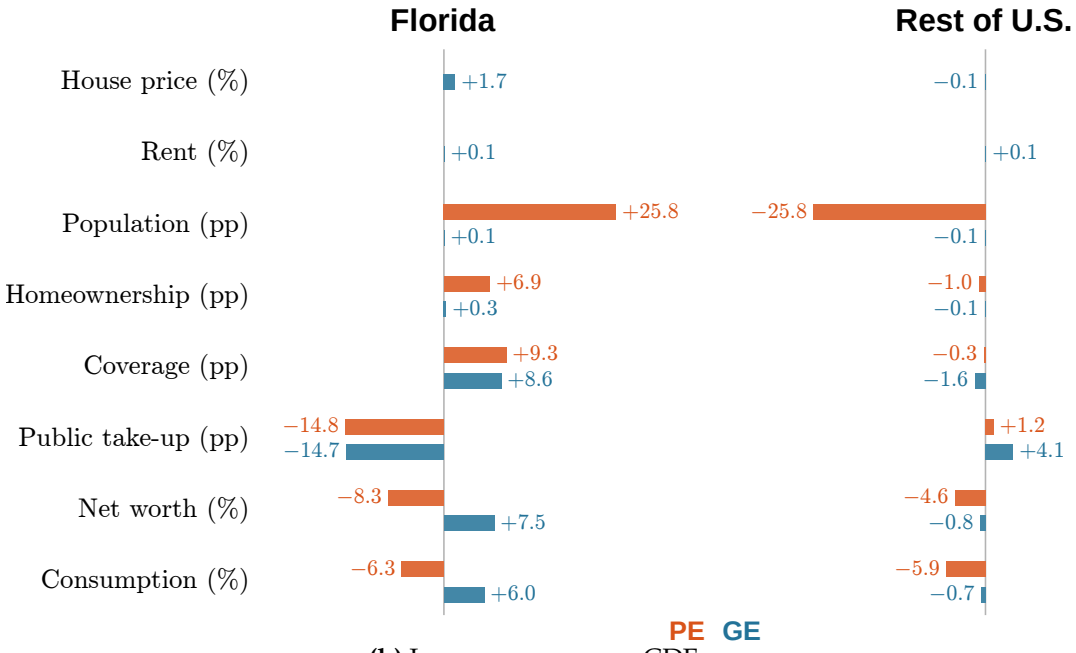
Figure 4: Insurance demand: extremes of liquid wealth distribution



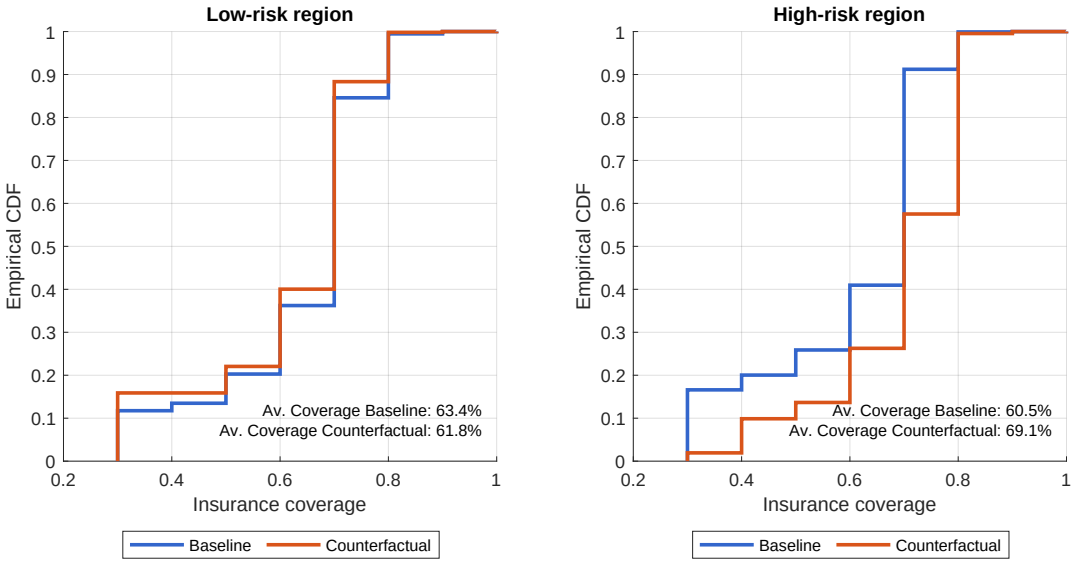
Notes: This figure plots binscatter relationships between insurance coverage and cash-on-hand for homeowners in the bottom and top liquid-wealth quintiles, separately for the low- and high-risk regions.

Figure 5: Rate regulation: PE versus GE effects and insurance coverage

(a) Partial- and general equilibrium changes relative to baseline



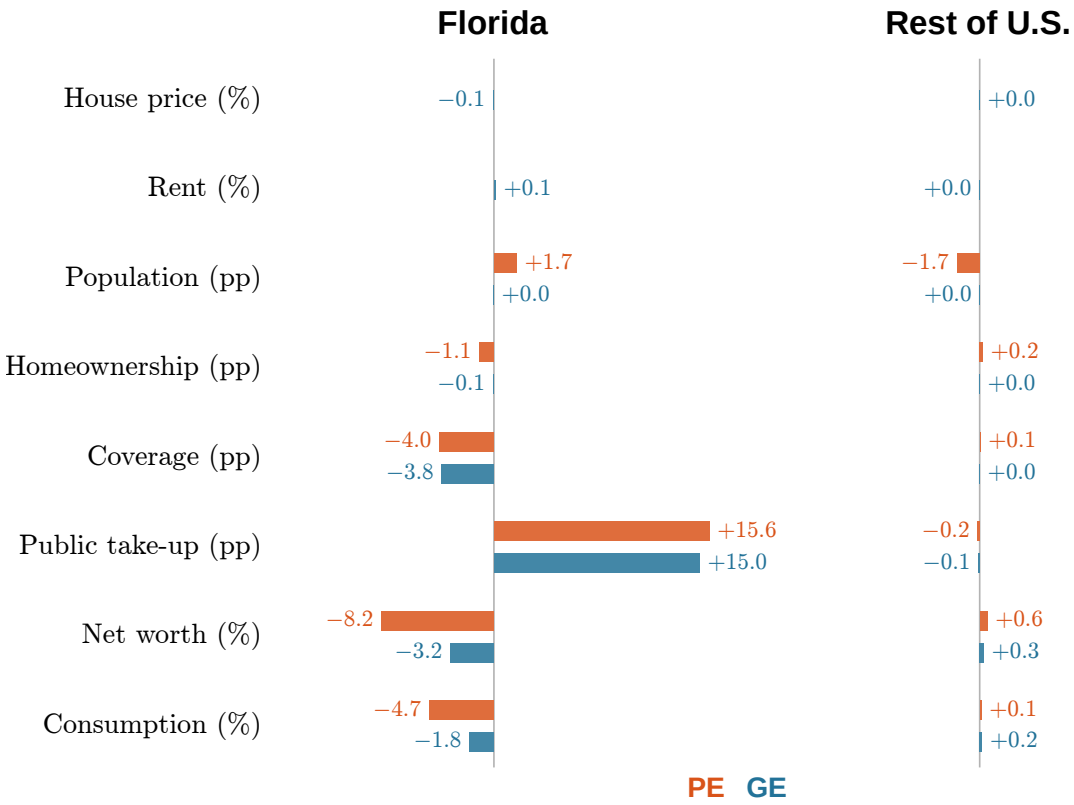
(b) Insurance coverage CDFs



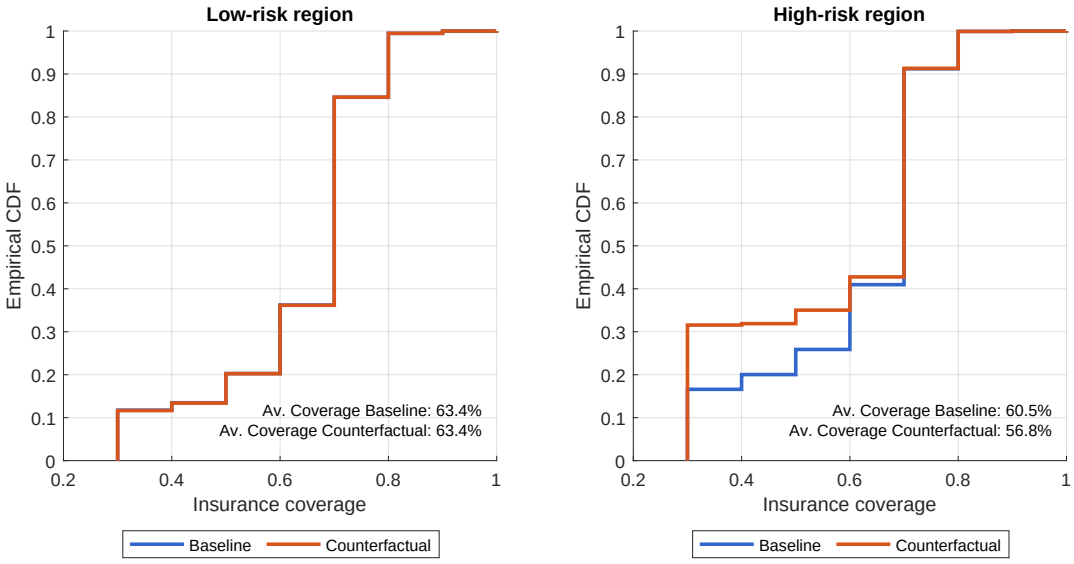
Notes: This figure shows the effects of a policy that caps the private insurance prices in the high-risk region at 90% of their baseline level. The private insurer charges a higher markup in the low-risk region to keep its margins unchanged. The top panel shows in orange the partial equilibrium effects and in blue the general equilibrium effects. Partial equilibrium holds house prices and rents at their baseline levels, and general equilibrium lets them adjust. The house-price and rent rows show only the general equilibrium response, since the partial equilibrium holds house prices and rents at their baseline values by construction. Panel (b) plots empirical CDFs of insurance coverage for homeowners by region. The solid blue line shows the baseline and the solid orange line shows the counterfactual.

Figure 6: Public insurer subsidy: PE versus GE effects and insurance coverage

(a) Partial- and general equilibrium changes relative to baseline

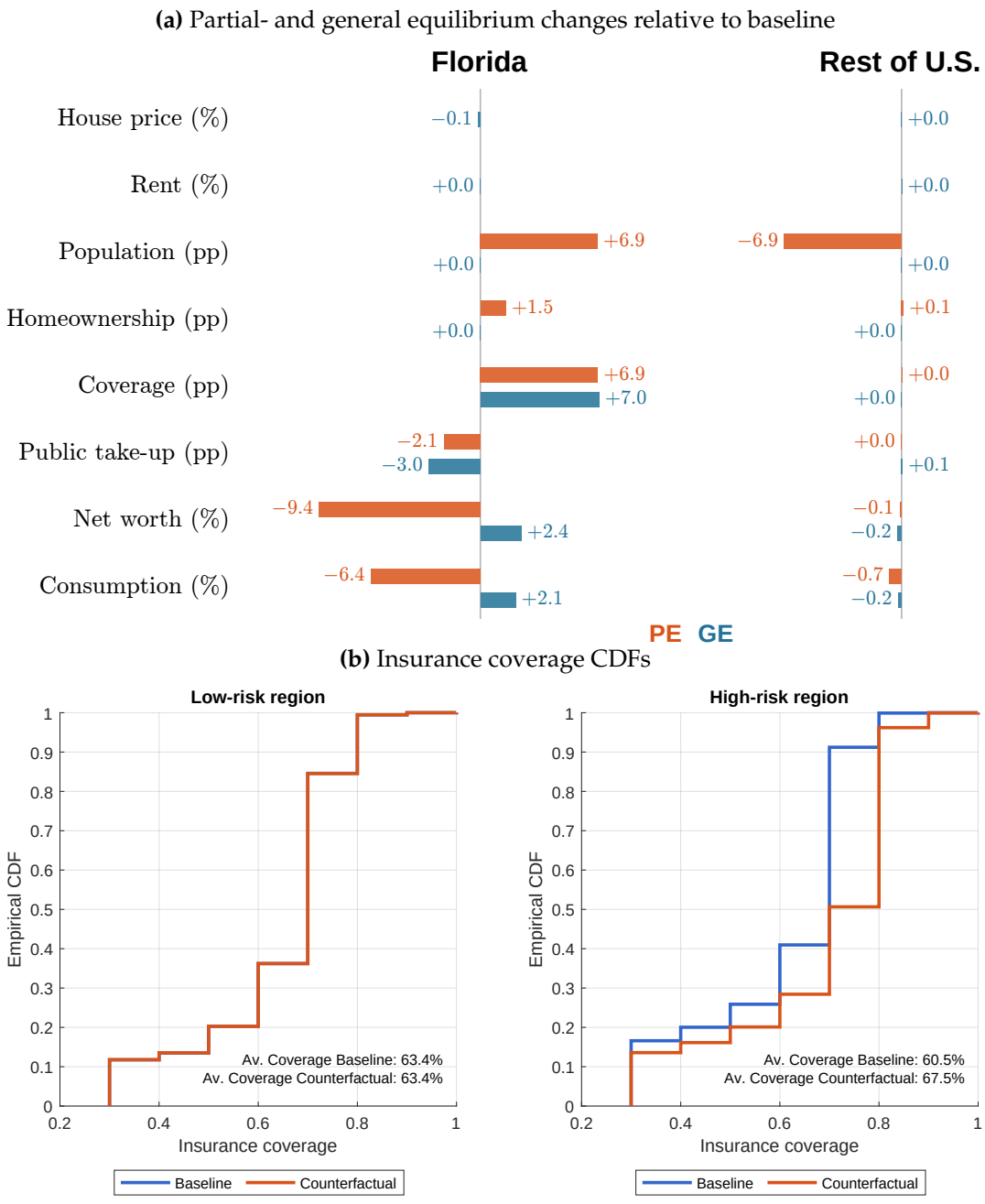


(b) Insurance coverage CDFs



Notes: This figure shows the effects of subsidizing the public insurance, pricing it below fair value. This subsidy is financed through a lump-sum tax that balances the government's budget period by period. The top panel shows in orange the partial equilibrium effects and in blue the general equilibrium effects. Partial equilibrium holds house prices and rents at their baseline levels, and general equilibrium lets them adjust. The house-price and rent rows show only the general equilibrium response, since the partial equilibrium holds house prices and rents at their baseline values by construction. Panel (b) plots empirical CDFs of insurance coverage for homeowners by region. The solid blue line shows the baseline and the solid orange line shows the counterfactual.

Figure 7: Public catastrophe reinsurer: PE versus GE effects and insurance coverage



Notes: This figure shows the effects of introducing a public reinsurer that lowers the cost for insurers of holding capital against disaster losses. The public reinsurer is financed through a lump-sum tax that balances its budget period by period. The top panel shows in orange the partial equilibrium effects and in blue the general equilibrium effects. Partial equilibrium holds house prices and rents at their baseline levels, and general equilibrium lets them adjust. The house-price and rent rows show only the general equilibrium response, since the partial equilibrium holds house prices and rents at their baseline values by construction. Panel (b) plots empirical CDFs of insurance coverage for homeowners by region. The solid blue line shows the baseline and the solid orange line shows the counterfactual.

Table 1: Model parameters

Parameter	Description	Value	Source/Target
A. Preferences, Income, Mortgages, Housing			
β	Discount factor	0.95	See text
γ	Risk aversion	5	See text
$1/\rho$	Elasticity of intertemporal substitution	0.5	See text
α	Preference for housing	0.4	Favilukis *et al.* (2023)
ϵ	Elasticity of substitution consumption/housing	-0.5	Elast. of subst. consumption-housing of 2/3
ρ_z	Autocorrelation, persistent income	0.953	Kaplan & Violante (2022)
σ_ε	Std. dev., persistent income shock	0.20543	Kaplan & Violante (2022)
σ_η	Std. dev., transitory income shock	0.22226	Kaplan & Violante (2022)
r	Risk-free interest rate	0.02	Average Treasury bill rate (FRED)
r_M	Mortgage rate	0.05	Average mortgage rate (FRED)
$\overline{\theta}_{LTV}$	LTV limit	0.85	Greenwald (2018)
$\overline{\theta}_{PTI}$	PTI limit	0.36	Greenwald (2018)
ψ_D, Ψ_D	Default costs (financial, utility)	0, 0	
ϕ^R	Rental premium (low / high region)	0.026 / 0.026	Avg monthly rent paid (Zillow ZORI)
δ_h	Depreciation rate of the rental stock	0.015	BEA via Mabille (2023)
f_b	Proportional transaction cost buying	0.01	Boar *et al.* (2022)
F_b	Fixed transaction cost buying	1.5	Boar *et al.* (2022)
f_s	Proportional transaction cost selling	0.05	Boar *et al.* (2022)
F_S	Fixed transaction cost of selling	3	Boar *et al.* (2022)
B. Climate risk and insurance			
p_χ	Climate shock probability (low / high region)	[0; 0.08]	Bilal & Rossi-Hansberg (forthcoming)
χ	Conditional loss from climate shock (low / high region)	[0; 0.17]	Bilal & Rossi-Hansberg (forthcoming)
$\bar{d}$	Upper bound of baseline damage distribution	0.05	AHS 2021
α_{base}	Beta shape parameter (baseline damage)	0.297	AHS 2021
β_{base}	Beta shape parameter (baseline damage)	3.851	AHS 2021
c	Capital charge cost	0.5	See text
κ	Capital charge curvature	4	See text
μ_ℓ	Insurer markup (low / high region)	[0.005; 0.005]	See text
ϕ	Insurance coverage menu	{30%, 40%, . . . , 90%, 100%}	See text
$\theta_{b,\ell}$	Private rejection rate, baseline (low / high region)	[0; 0]	No rejection of routine claims
$\underline{\theta}_{b,\ell}$	Public rejection rate, baseline (low / high region)	[0; 0]	No rejection of routine claims
$\theta_{d,\ell}$	Private rejection rate, climate disaster (low / high region)	[—; 0.060]	MCAS
$\underline{\theta}_{d,\ell}$	Public rejection rate, climate disaster (low / high region)	[—; 0.132]	Citizens CEO statement (Dec. 2024)
C. Geographic heterogeneity			
$\Xi_{\ell R}$	Amenity shifter low/high-exposure area	See text	Pop. share of each location
$\Xi_{\ell O}$	Homeownership value shifter low/high-exposure area	See text	Homeownership rate
Ψ	Moving costs between areas (in utils)	0.0113	Avg migration rate FL–U.S.
ρ_ℓ	Housing supply elasticity (low / high region)	1.81341 / 0.995683	Saiz (2010)

Notes: One model period corresponds to one year. Targets are in annual terms.

Table 2: Targeted moments

Variable	Data	Model
A. Aggregate		
Avg income	82.7	82.47
Avg wealth/avg income	6.33	5.56
Avg house price/avg income	6.06	6.12
Avg rent/avg income	0.25	0.25
P90 LTV	0.90	0.76
P90 PTI	0.48	0.32
B. Climate risk and insurance		
Avg property insurance premium ($ thousands)	1.123	1.512
Avg property insurance coverage	0.70	0.63
C. Geographic heterogeneity		
Avg moving rate between areas (%)	2.20	2.08
Population share in low-exposure area (%)	93	92.79
Population share in high-exposure area (%)	7	7.21
Avg house price low-exposure area ($ thousands)	512	512
Avg house monthly rent low-exposure area ($)	1,740	1,727
Avg house price high-exposure area ($ thousands)	407	407
Avg house monthly rent high-exposure area ($)	1,917	1,917

Notes: Moments are in annual terms.

Table 3: Channels of adaptation: increase in Florida climate risk and insurance premiums

		Higher climate risk		Higher insurance supply costs	
Variable / Region	Baseline	PE	GE	PE	GE
House price (% dev.)					
Rest of U.S.	\$512.00	—	0.10	—	0.06
Florida	\$407.00	—	-2.55	—	-1.27
Rent (% dev.)					
Rest of U.S.	\$1,727	—	-0.03	—	-0.05
Florida	\$1,917	—	0.63	—	0.43
Population share (pp dev.)					
Rest of U.S.	92.79%	4.53	0.10	3.24	0.05
Florida	7.21%	-4.53	-0.10	-3.24	-0.05
Homeownership rate (pp dev.)					
Rest of U.S.	67.69%	0.19	-0.18	0.09	0.05
Florida	66.72%	-23.15	-0.71	-9.69	-0.38
Insurance coverage (pp dev.)					
Rest of U.S.	63.42%	0.14	0.35	0.11	0.12
Florida	60.54%	-3.07	-2.14	-8.29	-8.43
Public insurance take-up (pp dev.)					
Rest of U.S.	11.74%	-0.06	-0.77	-0.06	-0.27
Florida	16.60%	5.45	5.63	17.18	18.64
Insurance payment (% dev.)					
Rest of U.S.	\$1.29	0.25	0.71	0.20	0.27
Florida	\$4.40	3.38	2.93	-8.11	-9.41
Net worth (% dev.)					
Rest of U.S.	\$451.75	0.88	1.38	0.55	1.01
Florida	\$544.54	11.86	-14.77	7.76	-9.85
Consumption (% dev.)					
Rest of U.S.	\$72.46	0.63	0.68	0.43	0.59
Florida	\$89.06	17.68	-8.65	9.04	-5.82
Migration rate (pp dev.)					
All	2.08%	2.02	-0.16	0.97	-0.15

Notes: This table reports the partial equilibrium (PE) and general equilibrium (GE) effects of two experiments. In the first experiment we increase climate risk (first two columns). In the second experiment we increase the cost of insurance (last two columns). Both experiments are sized so that private insurance premiums in Florida rise by 10% at every coverage level: "higher insurance supply costs" raises the private insurer's markup and the price of the public contract in Florida by the same 10%, holding physical risk fixed, and "higher climate risk" raises the annual disaster probability in Florida from 8.0 to about 9.0%. PE effects keep prices and rents fixed at their baseline values; GE solves for the new equilibrium in which house prices, rents, location, tenure, and insurance choices adjust jointly. House prices, net worth, consumption, and insurance payments are baseline levels in thousands of dollars (rents in dollars per month); deviations for these variables are in percent. Population shares, homeownership rates, insurance coverage, take-up of the public minimum-coverage contract, and the migration rate are baseline levels in percent; deviations are in percentage points. Insurance payment is the average premium paid by homeowners.

Table 4: Policy experiments: baseline levels and general-equilibrium effects

	Baseline		Rate regulation		Public insurer subsidy		Public reinsurer	
	US	FL	US	FL	US	FL	US	FL
House prices ($K; GE %)	512	407	-0.13%	+1.66%	+0.01%	-0.06%	+0.00%	-0.12%
Rents ($/month; GE %)	1,727	1,917	+0.10%	+0.06%	-0.03%	+0.14%	+0.02%	-0.04%
Population share (%; GE pp)	92.8	7.2	-0.07 pp	+0.07 pp	-0.00 pp	+0.00 pp	+0.01 pp	-0.01 pp
Homeownership rate (%; GE pp)	67.7	66.7	-0.09 pp	+0.31 pp	+0.02 pp	-0.06 pp	-0.01 pp	-0.04 pp
Insurance coverage (%; GE pp)	63.4	60.5	-1.62 pp	+8.58 pp	+0.02 pp	-3.79 pp	-0.00 pp	+6.96 pp
Public take-up (%; GE pp)	11.7	16.6	+4.14 pp	-14.67 pp	-0.09 pp	+14.96 pp	+0.05 pp	-3.02 pp
Insurance payment ($K; GE %)	1.29	4.40	-0.83%	+9.28%	+0.04%	-8.20%	-0.00%	+12.25%
Net worth ($K; GE %)	451.8	544.5	-0.84%	+7.53%	+0.30%	-3.16%	-0.24%	+2.39%
Consumption ($K; GE %)	72.5	89.1	-0.66%	+6.04%	+0.18%	-1.78%	-0.21%	+2.07%
Migration rate (%; GE pp)	2.08		-0.12 pp		-0.10 pp		+0.02 pp	

Notes: This table reports the general equilibrium (GE) effects of the three policy experiments. "Rate regulation" caps Florida private insurance prices below their baseline schedule; the private insurer charges a compensating markup on the rest of the U.S. that keeps its margin unchanged. "Public insurer subsidy" prices the public minimum-coverage contract below its actuarially fair rate; it is financed by a lump-sum tax on Florida homeowners that balances the government's budget period by period. "Public reinsurer" lowers the cost for insurers of holding capital against disaster losses embedded in Florida private premiums; it is financed by a lump-sum tax on Florida homeowners that balances its budget period by period. GE effects solve for the new equilibrium in which house prices, rents, the compensating markup, the lump-sum taxes, and household location, tenure, and insurance choices adjust jointly. House prices, insurance payments, net worth, and consumption are baseline levels in thousands of dollars (rents in dollars per month); deviations for these variables are in percent. Population shares, homeownership rates, insurance coverage, take-up of the public minimum-coverage contract, and the migration rate are baseline levels in percent; deviations are in percentage points. Insurance payment is the average premium paid by homeowners; public take-up is the share of homeowners on the public minimum-coverage contract.

Table 5: Climate risk exposure and welfare under the three policies

Panel A. Climate risk exposure (log points)					
	Total	Population share	Homeownership	Home value	$1 -$ Coverage
Rate regulation	-17.94	+1.08	+0.55	+1.86	-21.44
Public insurer subsidy	+8.41	+0.01	-0.10	-0.05	+8.56
Public reinsurer	-16.69	-0.16	-0.06	+0.03	-16.49
Panel B. Welfare, all ages (% of own annual consumption)					
	Total	Insurance	House prices	Rents	Levy
Rate Regulation in the High-Risk Region					
Florida owners	+13.08	+9.82	+3.70	-0.25	-0.19
Florida renters	+0.25	+3.69	-2.94	-0.38	-0.12
Rest of the U.S.	-1.39	+0.71	-1.04	-0.47	-0.58
Subsidizing the Public Insurer of Last Resort					
Florida owners	-0.12	+1.41	-0.14	+0.01	-1.41
Florida renters	-0.21	+0.25	+0.10	-0.12	-0.43
Rest of the U.S.	+0.19	+0.14	+0.05	+0.12	-0.12
A Public Catastrophe Reinsurer					
Florida owners	-2.44	+3.36	-0.26	-0.04	-5.51
Florida renters	+0.12	+1.58	+0.23	-0.01	-1.67
Rest of the U.S.	-0.24	+0.24	+0.07	-0.10	-0.45

Notes: Panel A reports the general equilibrium log change in climate risk exposure E of equation (8) and splits it into the log changes of its four terms: Florida's share of U.S. households, the Florida homeownership rate, the average value of a Florida owner-occupied home, and one minus the average effective coverage of Florida homeowners, the share of a climate loss that the insurer pays net of claim denials, $\phi(1-\theta_d)$. Because E is a product, the split is exact. Panel B reports the one-time wealth transfer Δw that makes a household at its baseline state indifferent between the baseline and the counterfactual economy, in percent of the household's own annual consumption and averaged within each group; positive values mean that the household is better off under the policy. Groups are defined by baseline location and tenure. The four channels sum to the total: each is the contribution of moving the insurance premium schedule, the two house prices, the two rents, or the levy that finances the policy from its baseline to its counterfactual value, averaged over every order in which these changes can be made (a Shapley decomposition). The levy is the compensating markup in the rest of the U.S. under rate regulation, and the lump-sum tax on Florida homeowners under the other two policies.

Appendix 1 Baseline Damage Calibration

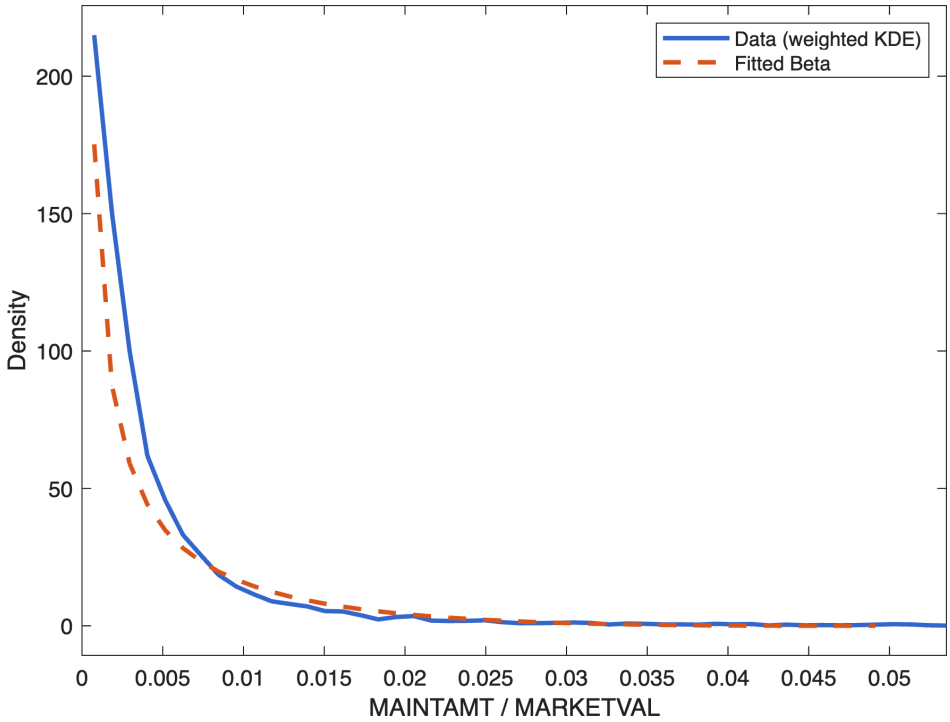
We calibrate the parameters of the baseline damage distribution using household-level microdata from the 2021 American Housing Survey (AHS), restricted to owner-occupied units. As a proxy for the annual flow of physical deterioration, we compute for each household i the ratio of self-reported annual routine maintenance expenditures (`MAINTAMT`) to self-reported market value of the housing unit (`MARKETVAL`), excluding land:

$$d_i = \frac{\texttt{MAINTAMT}_i}{\texttt{MARKETVAL}_i}.$$

The `MAINTAMT` variable covers spending on items such as painting, plumbing, roofing, and minor repairs. While this measure captures routine upkeep spending rather than physical depreciation per se, it provides a natural reduced-form proxy for baseline housing deterioration and should be interpreted as a lower bound on true annual damage rates.

We fit a scaled Beta distribution on $[0, \bar{d}]$ to the cross-sectional distribution of $\{d_i\}$ by maximum likelihood, trimming the sample at the 99th percentile to limit the influence of extreme outliers driven by major renovation projects misclassified as routine maintenance. Specifically, we maximize the log-likelihood of the observed d_i over the three parameters $(\bar{d}, \alpha_b, \beta_b)$, treating each observation as an independent draw from a Beta(α_b, β_b) rescaled to $[0, \bar{d}]$. The estimated parameters are $\bar{d} = 0.05$, $\alpha_b = 0.297$, and $\beta_b = 3.851$, implying an expected baseline damage of $\mathbb{E}[d_b] \approx 0.36\%$ of home value per year. Figure A1 plots the fitted density against a kernel density estimate of d_i and shows that the scaled Beta provides a good fit to the data.

Figure A1: Fitted scaled-Beta distribution for baseline damage



Notes: Weighted kernel density estimate of the damage proxy $d_i = \texttt{MAINTAMT}_i / \texttt{MARKETVAL}_i$ computed from the 2021 AHS (owner-occupied units), trimmed at the 99th percentile, together with the density of the fitted scaled-Beta distribution estimated by maximum likelihood.