Natural Disasters, Property Insurance, and Housing Markets

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Abstract

We study how local climate risk affects house prices and location choices through insurance and migration channels in spatial equilibrium. We develop a dynamic spatial housing model in which households choose location, tenure, and property insurance coverage in the presence of heterogeneous climate risk across regions. Insurance decisions and spatial mobility interact to determine equilibrium house prices and population distributions across regions. The model generates realistic patterns of insurance demand, including underinsurance and strong heterogeneity across wealth, age, and regional risk exposure. Counterfactual increases in local climate risk induce selective migration out of exposed regions, leading to lower house prices in equilibrium as higher insurance costs are capitalized into asset values. Our results underscore the importance of jointly modeling climate risk, property insurance, and spatial sorting when evaluating the housing market impacts of climate change.

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1 Introduction

Natural disasters have become an increasingly important component in shaping 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. Beyond realized destruction that affect local housing stocks *ex post*, climate risk potentially affects housing markets *ex ante* by altering local amenities, expected housing quality, expected costs and homeownership tenure. Climate risk can also give rise to migrations and pricing differentials across geographies that generate spillovers impacting the *entire* housing market including beyond affected areas. As a result, climate risk can have significant influence on housing prices even in periods and in areas without realized climate shocks.

How does local climate risk affect housing prices and household location choices on the entire housing market? Housing is typically the largest asset on household balance sheets and a key form of collateral in the economy. Climate risk, an inherently spatial phenomenon that exhibist substational regional heterogeneity, can be partially insured against with property insurance. Altogether, housing prices and population distributions reflect the aggregation of household location, tenure, and insurance decisions. We demonstrate that understanding these joint decisions is central to assessing how climate risk is capitalized into house prices and how households adapt over space.

While some components of climate risk are correlated at the national or continental levels, exposure is largely determined locally. As a result, differences in climate risk translate into differences in housing markets across geographic regions. When households are mobile, these differences generate spatial reallocation in addition to purely local price changes. Changes in the composition of local homeowners alters the marginal buyer, which feeds back into equilibrium housing prices. Therefore, understanding how climate risk affects housing markets requires an equilibrium model in which prices and population distributions adjust jointly across space.

In this paper, we develop such a dynamic spatial equilibrium housing model. Households choose location, tenure, and property insurance coverage in the presence of heterogeneous local climate risk. In the United States, property insurance is effectively mandatory for most homeowners through mortgage underwriting standards, making insurance costs a large and recurring component of total housing costs. Households respond to differences in climate risk through a number of channels: adjusting insurance coverage, changing tenure between owner and tenure, and relocating across regions. These responses interact in equilibrium, jointly determining regional house prices and the spatial allocation of households. A non-spatial framework would miss these feedback effects and fail to fully characterize the impact of climate risk on housing markets.

We contribute a structural spatial model to a growing literature documenting how cli-

mate risk affects insurance coverage choices, migration patters, and house prices. These reduced-form estimates are an important step in documenting the impact of climate risk on housing markets, but reflect the combined effects of risk exposure, insurance costs, and endogenous household sorting. Our structural framework allows us to disentangle these channels and assess how local shocks propagate across housing markets in general equilibrium. Existing models that abstract from spatial mobility or insurance decisions cannot capture how household responses reshape housing demand across regions. Our framework fills this gap by jointly modeling climate risk, insurance contracts supplied by both private and public firms, and endogenous spatial sorting in equilibrium.

The model generates realistic property insurance demand across households and regions. When presented with a menu of insurance premiums and coverage, demand is highly non-linear in household liquidity, age, and background climate risk. Underinsurance is prevalent at both tails of the wealth distribution. Liquidity constrained households cannot afford insurance and are exposed directly to climate risk, while wealthier households can partially self-insure and avoid directly buying full coverage. Increased climate risk weakens this pattern by reducing sensitivity of insurance demand to household liquidity and increasing average insurance coverage.

We use the model to study how an increase in local climate risk affects housing markets and spatial allocation. In our first counterfactual experiment, we calibrate the model to reflect key facts about Florida, a high-risk region, and the rest of the United States. We study the implications of a 10% increase in the likelihood of natural disaster shocks in Florida. This directly increases the cost of property insurance, which induces selective migration: lower income households can no longer afford housing in Florida, forcing them to move out of the state. This reduces the population in Florida while increasing homeownership and average wealth among remaining residents. Among these remaining high-wealth owners, elevated climate risk increases both insurance costs and insurance coverage, which lowers housing prices as higher expected costs are capitalized into asset values. These results illustrate how insurance, prices, and migration jointly shape the equilibrium response to climate risk.

1.1 Related Literature

This paper studies how natural disaster risk and property insurance interact to shape modern housing markets. We study how natural disaster risk, which is mostly local, affects aggregate housing markets when property insurance is available and, in turn, how property insurance itself affects the spatial location of households, hence local housing markets, in the presence of climate risk. We contribute to three main strands of the literature.

Natural Disasters and Housing Markets First, our work complements the growing literature on natural disasters and housing markets, which is mostly empirical. There is increasing evidence that natural disaster risk affects financial markets in general and housing markets in particular (see, e.g., the surveys by Giglio *et al.* (2021b), who document how climate risk is priced across asset classes and emphasize the role of expectations), and that it has become a first-order consideration for investors and policymakers (Stroebel & Wurgler, 2021).

Existing work using cross-sectional variation across exposed areas to identify the effects of climate risk suggests that exposure varies strongly with geography as well as with housing stock and household types. For example, Bernstein *et al.* (2019) estimate price discounts for sea-level-rise exposure in coastal housing markets in a local and partial-equilibrium empirical design. Baldauf *et al.* (2020) show that climate risk is capitalized into house prices only where beliefs about climate change are stronger (including systematic heterogeneity in beliefs) and Bakkensen & Lint (2022) estimate a dynamic housing-market framework in which heterogeneous flood-risk beliefs generate sorting and can rationalize mixed evidence on flood-risk capitalization. This directly motivates our equilibrium approach to joint price and location adjustments. Keys & Mulder (2020) document dynamic changes in both housing outcomes and mortgage lending in response to sea-level-rise exposure, which closely relates to our analysis of mortgages and the market-wide consequences of local risk through reallocation. The estimated effects depend on households' preferences for housing services, expectations about future climate risk, and beliefs that differ across demographic and political groups. Financial resources play a key role: income and wealth affect both the ability to insure and to absorb losses, while credit constraints and mortgage contract terms shape households' responses to risk and realized shocks.

Most of these studies identify local average treatment effects by comparing more- and less-exposed areas. We contribute by considering the spillovers across housing markets that arise when households relocate in response to climate risk and endogenous house price adjustments. Existing empirical work also studies different types of climate risk but cannot compare their economic effects on the housing market as a whole. While hurricanes, wildfires, and severe storms act primarily as housing-capital depreciation shocks, extreme heat and sea level rise risk mostly operate through productivity and amenities (Bilal & Rossi-Hansberg, 2025). Our setting allows us to disentangle the effects of *ex ante* climate risk from those of realized climate shocks, including how insurance premia and coverage choices mediate the mapping from risk into housing demand and prices.

Macroeconomic Models with Climate Risk Second, our paper adds spatial heterogeneity and detailed property insurance markets to the recent literature on macroeconomic and asset pricing models of climate risk.

Spatial heterogeneity is a first-order feature of the data since climate risk exposure is mostly local. Giglio *et al.* (2021a) develop a benchmark asset-pricing framework for housing valuation with climate risk and carefully model the stochastic process for climate damages, but they study a single location and abstract from housing as both a consumption and an investment good. Compared to Van der Straten (2025), who studies climate change and adaptation in a macro-finance model with housing, we add property insurance and explicitly model mobility across housing markets as key adjustment margins for heterogeneous households in response to climate change. Our novel setting bridges an important gap in the literature on macro-finance models of climate risk: the lack of an equilibrium housing/asset-pricing model with heterogeneous locations and different exposures that can generate aggregate spillovers from local shocks through migration, insurance costs, and endogenous sorting.

We carefully model public and private property insurance suppliers who offer a menu of coverage and premium options to homeowners. Sastry *et al.* (2025b) study how insurer fragility and climate-related losses interact with mortgage markets and show that insurance market disruptions can transmit to mortgages. We build a structural equilibrium model in which the kink between insurance and mortgage choices arise endogenously through location, tenure, and coverage decisions. Relatedly, Ge *et al.* (2026) estimate the effect of rising homeowners-insurance premiums on mortgage and credit outcomes and show that rising premia spur relocation, which is a migration channel captured in our model. Keys & Mulder (2025) show in large-scale escrow-based premium data that the repricing of catastrophic risk increases premium pass-through and reduced home values in high-exposure areas, which our model also captures in equilibrium. Similarly, Wylie *et al.* (2025) report that insurers can pass disaster costs to policyholders not only through premiums but also through non-price contract dimensions (e.g., claim rejections), including spillovers to unaffected areas.

Gropper & Kuhnen (2025) study how wealth affects insurance choices in the context of life insurance (coverage and deductibles) and document that wealthier households purchase more coverage, which we use to discipline the heterogeneity in coverage and the extent to which insurance can attenuate or amplify housing market responses to risk. For property insurance and its pricing of climate risk, we build on the analysis of rate regulation and cross-subsidies in Oh *et al.* (forthcoming) to motivate our treatment of insurance pricing as shaped by both risk and institutional features rather than actuarially fair pricing alone. Our treatment of insurance pricing builds on the capital-frictions framework of Koijen & Yogo (2015) and Koijen & Yogo (2016), who show that insurance premia include a capital wedge arising from regulatory and financial frictions. We extend this logic to property insurance markets, where capital requirements are tied to catastrophe tail risk and reinsurance costs, generating nonlinear pricing in coverage. Relatedly, Sastry *et al.* (2025a) document an "insurance protection gap," and demand elasticities using microdata on homeowners insurance, which we seek to explain in a model in which

insurance interacts with mobility and housing prices in equilibrium. Finally, Eastman *et al.* (2024) estimate the effect of homeowner insurance price increases on housing prices using regulatory variation in Florida, which offers an empirical benchmark for the magnitude of the insurance-price capitalization channel we quantify in a structural model.

In terms of modeling, our work most closely relates to Bilal & Rossi-Hansberg (2025), who analyze how various U.S. regions respond to anticipated climate change in a high-dimensional spatial quantitative model. While they focus on the macroeconomic consequences of climate risk, we analyze its implications for housing and mortgages—households' largest assets and liabilities—in the presence of property insurance. We add to this literature by calibrating a structural model with housing, property insurance, and spatial sorting. Our equilibrium model with endogenous location and insurance choices, and price adjustments, allows us to quantify the respective importance of the various channels documented in isolation in the data—out-migration following risk reassessments or disasters, premium growth (including from reinsurance repricing), insurer exit/market distress and contract non-price adjustments, and changes in mortgage outcomes and constraints—and to trace how these channels interact once households reallocate across regions and marginal buyers change endogenously.

Three ingredients in our model are key to accurately capturing the spatial equilibrium consequences of climate risk. First, the model features heterogeneous local exposure to climate shocks across geographic areas, with climate risk following a state-of-the-art specification used in quantitative macroeconomic models (Bilal & Rossi-Hansberg, 2025). We solve the model at an annual frequency to capture migration, insurance adjustment, and housing market dynamics, which substantially increases the dimensionality of the state space. To address this challenge, we introduce a new recursive formulation of the discrete choice problem governing household location and tenure decisions.

Second, we introduce Epstein–Zin preferences that allow for a separation between risk aversion and intertemporal substitution, and capture households' preference for early resolution of uncertainty. This feature is essential to match how natural disaster risk is priced into housing markets even in the absence of realized shocks.

Third, we introduce a nested CES aggregator between non-durable consumption and housing services within households' Epstein–Zin preferences. This structure captures the trade-offs households face between consumption and housing quality in the presence of climate risk, especially when households can insure housing services at the cost of higher premia and reduced non-durable consumption. Together, these ingredients allow us to provide a unified quantitative framework that links climate risk, property insurance, household sorting, and housing prices in a spatial general equilibrium setting.

Models of Spatial Housing and Mortgage Markets Finally, our work contributes to the literature on spatial housing and mortgage market models by analyzing how regional heterogeneity shapes aggregate responses to shocks. Beraja *et al.* (2019) study how

regional heterogeneity in the distribution of borrowers' home equity shapes the entire economy's response to monetary policy shocks. Hurst *et al.* (2016) show that mortgage-market institutions can generate large redistribution across U.S. regions and result in substantial cross-subsidization across housing and mortgage markets. Guren *et al.* (2020) show that cross- regional estimates mix partial-equilibrium responses with local general-equilibrium effects in response to area-specific shocks, and propose a method to recover partial-equilibrium effects in various settings. Our spatial macro-finance model complements their work by allowing us to separate the effects of local from those of aggregate shocks. Mabille (2023) uses a related model with regional heterogeneity but without climate risk and insurance and shows that an aggregate shock, in that case to credit conditions, can generate heterogeneous local housing responses even when local shocks are identical, underscoring the importance of decomposing the various types of shocks. Fonseca *et al.* (2025) extend this setting into a spatial housing ladder model to study the dynamic impact of mortgage lock-in, but they also abstract from climate risk and property insurance, which are two major features of modern housing markets.

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, insurance companies, and finally housing supply. We then define the recursive competitive equilibrium that jointly determines household allocations, insurance outcomes, and house prices in each region.

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, $\Xi_{\ell R}$.

2.1.1 Climate Risk

Natural disaster shocks are i.i.d. over time and space. In region ℓ, each homeowner has likelihood p_ℓ that they will be hit with a climate disaster shock which destroys $\chi_{i,\ell} \equiv \lambda_i \chi_\ell$ of their effective housing stock. The climate disaster shock consists of a regional component, χ_ℓ, multiplied by a household-specific exposure, λ_i, which captures heterogeneity in household behavior with respect to climate risk mitigation. For example, within a region exposed to wildfire risk, households may vary with their propensity to trim tree branches and lessen their exposure to the risk.

2.1.1.1 Climate Risk and Insurance

The household-specific exposure factor, λ_i, may be public or private information, which will be important for adverse selection in insurance pricing. Additionally, when λ_i is endogenously chosen by the household, insurers must also consider the impacts of moral hazard. In the benchmark version of the model, $\lambda_i = 1$ for all households is publicly observable and exogenous, and thus insurance markets are efficient.

2.2 Households

Households 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/tenure. In other words, these are unconditional value functions which depend generically on household wealth, income, and age, but not on their current location/tenure. C

In what follows, we assume there are $N_\ell = 2$ locations, denoted by the household's current location, ℓ, and the other location, ℓ'.

2.2.1 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 section, these three value functions will be used to build up the rest of the household's decision tree.

2.2.1.1 Inactive Homeowner: Living in Location

A homeowner living in location ℓ has state variables cash-on-hand X, mortgage balance M, effective housing quality ω, and the persistent component z of the (log) income process. Letting $S = \{X, M, \omega, z\}$, an inactive homeowner $\tilde{O}$ in region ℓ chooses consumption and property insurance to maximize the value function:

$$V_t^{\ell\tilde{O}}(S) = \max_{c_t^{\ell\tilde{O}}(S), \phi'^{\ell\tilde{O}}(S)} u(c_t^{\ell\tilde{O}}(S), \omega h_\ell, \Xi_{\ell O}) + \beta E V_{t+1}^{\ell O}(X', M', \omega', z'),$$

subject to the budget constraint:

$$c_t^{\ell\tilde{O}}(S) + p_\ell(\phi'^{\ell\tilde{O}}(S)) p_{h,\ell} \omega h_\ell + (1 - \lambda + r_M) M + \frac{s}{1+r} = X.$$

The total insurance expenditure, $p_\ell(\phi'^{\ell\tilde{O}}(S)) p_{h,\ell} \omega h_\ell$, is the product of the per-unit price $p_\ell(\phi)$, which depends on the chosen coverage level, and the effective home value $p_{h,\ell}\omega h_\ell$. The continuation value function, V_{t+1}^ℓ, will be defined below. Re-arranging the budget constraint implies that saving is equal to the income from cash-on-hand minus expenditures:

$$s = (1+r)(X - c_t^{\ell\tilde{O}}(S) - p_\ell(\phi'^{\ell\tilde{O}}(S)) p_{h,\ell} \omega h_\ell - (1 - \lambda + r_M) M).$$

Future cash-on-hand combines saving with exogenous income:

$$X' = Y' + s = Y' + (1+r)(X - c_t^{\ell\tilde{O}}(S) - p_\ell(\phi'^{\ell\tilde{O}}(S))p_{h,\ell}\omega h_\ell - (1-\lambda+r_M)M),$$

where Y' is a combination of deterministic and stochastic components of income, including z'. Mortgage balances decrease by the principal payment:

$$M' = M - (1-\lambda)M = \lambda M.$$

Finally, the effective housing quality evolves according to the endogenous insurance choice and the exogenous climate shock:

$$\omega' = [1 - (1 - \phi_t'^{\ell\tilde{O}}(S))\chi_\ell']\omega.$$

2.2.1.2 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 it's current location or homeownership status (e.g., 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.

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 $\theta_{LTV}^{\cdot,\ell O}$ is chosen subject to an exogenous LTV limit $\bar{\theta}_{LTV}$ and a payment-to-income ratio $\bar{\theta}_{PTI}$, measured as:

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

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

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

For a given LTV, the required mortgage is $\theta_{LTV,t}^{\cdot,\ell O}p_{h,\ell}h_\ell$, and the required downpayment is $(1-\theta_{LTV}^{\cdot,\ell O})p_{h,\ell}h_\ell$, Further, 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 defined as:

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

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

$$V_t^{\cdot,\ell O}(X,z) = \max_{\theta_{LTV,t}^{\cdot,\ell O}(X,z)} V_t^{\ell\tilde{O}}(\tilde{X}^{\cdot,\ell O}, \tilde{M}^{\cdot,\ell O}, 1, z),$$

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

2.2.1.3 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 to maximize the value function

$$V_t^{\ell\tilde{R}}(X,z) = \max_{c_t^{\ell\tilde{R}}(X,z), h_t^{\ell\tilde{R}}(X,z)} u(c_t^{\ell\tilde{R}}(X,z), h_t^{\ell\tilde{R}}(X,z)\cdot h_\ell, \Xi_{\ell R}) + \beta E V_{t+1}^{\ell R}(X',z'),$$

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

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

The location-specific rental rate, $p_{r,\ell}$, is the user cost of capital:

$$p_{r,\ell} = (r + \omega_{r,\ell} p_\ell(1) + \phi^{R,\ell}) p_{h,\ell},$$

where $\omega_{r,\ell}$ is the pass-through from landlords to tenants on the full coverage insurance price, $p_\ell(1)$, and $\phi^{R,\ell}$ is an additional rent premium. Future cash-on-hand combines future income and net savings after the household's choices for consumption and rental housing:

$$X' = Y' + (1+r)(X - c_t^{\ell\tilde{R}}(X,z) - p_{r,\ell} h_t^{\ell\tilde{R}}(X,z)).$$

2.3 Spatial and Tenure Decisions

We now turn to the household's joint discrete decision 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 sells its home and faces two options in each location: buy a new home or rent. So with N_ℓ locations, the homeowner has $2N_\ell + 1$ 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. Let $L = \{\ell_1, \ell_2, \ldots, \ell_{N_\ell}\}$ denote the set of all locations, including the current location $\ell \in L$. 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 $\ell' \in L$, 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 or become a renter:

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

In both cases, the household sells its current home in ℓ for $p_{h,\ell}\omega$, 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:

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

2.3.1.1 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.

2.3.1.2 Owner in New Home

The homeowner in location ℓ considers purchasing a new home in ℓ'.[1] Moving entails a utility cost $\Psi(\ell O, \ell' O)$ and a financial cost $\psi(\ell O, \ell' O)$.

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:

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

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:

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

[1] This general formulation allows for the case where $\ell' = \ell$, i.e., the homeowner moves to a different house in the same location.

Altogether, cash-on-hand is initial cash holdings plus proceeds from the current home sale, less outlays for the new home sale and moving costs.

2.3.1.3 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:

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

2.4 Renter

Consider instead a household entering the period as a renter. A renter will have 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 N_ℓ 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 $\ell' \in L$, 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.

2.4.1 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 real 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:

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

2.4.2 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:

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

2.5 Insurance Companies

2.5.1 Private Insurance Company

A representative national insurance company supplies insurance contracts in each location. The per-unit price of insurance in location ℓ for a household choosing coverage ϕ is:

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

where $p_{A,\ell} = E[\chi_\ell]$ is the actuarially fair value of insurance (the expected loss per unit of home value), $\mu \geq 0$ defines a constant markup, and $\kappa(\phi)$ is a coverage-dependent capital charge:

$$\kappa(\phi) = c \cdot \phi^\eta,$$

with $c > 0$ and $\eta > 1$. The formulation nests actuarially fair pricing ($c = 0$, $\mu = 0$) as a special case.

This reduced-form specification is motivated by the framework developed in Koijen & Yogo (2015) and Koijen & Yogo (2016), in which insurance premia 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 actuarily fair price.

Primary insurers typically transfer catastrophe 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 η, 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 $\eta > 1$ 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.

2.5.2 Public Insurance Company

Each location also contains a single insurer-of-last resort that offers a minimum level of required property coverage, $\underline{\phi}_\ell$, for $\underline{p}_\ell < p_{A,\ell}$. This insurer is financed through a lump sum tax charged to all homeowners in the location.

2.6 Housing Supply

In each region, the supply of owner-occupied housing is measured in square feet and depreciates at a constant rate δ_ℓ. Total supply in the current period also includes new construction funded by exogenous, perfectly competitive developers:

$$H^\ell_{S,t} = (1-\delta)H^\ell_{S,t-1} + I^\ell_{S,t}. \tag{1}$$

We assume that new housing construction in ℓ is supplied according to a reduced-form function of the house price, which captures developers' incentives to build:

$$I^\ell_{S,t} = \overline{I}^\ell_S \times p^{\rho_\ell}_{h,\ell}, \tag{2}$$

where $\overline{I}^h_S$ is a vertical supply curve shifter and ρ_h is the price elasticity of housing supply, which both differ between combinations of housing statuses and location h. The lower $\overline{I}^h_S$, the higher the house price required to construct a given level of housing. The lower ρ_h, the larger the price change required to induce a given change in construction. The supply function can be micro founded using the optimization problem of perfectly competitive developers.

2.7 Equilibrium

A dynamic spatial recursive competitive equilibrium describes how the economy in steady state responds to unanticipated local shocks. Given exogenous time paths for unanticipated local climate shocks $\{\chi^\ell_t\}$, an equilibrium consists of the following sequences for locations $\ell \in L$:

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

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

(iii) policy functions describing non-durable consumption, rental housing services, and homeowner insurance $\{c^{h,h'}_t, h^{h,h'}_t, \theta^{h,h'}_{LTV,t}, \phi^{'h,h'}_t\}$ for each possible household transition $h, h' \in \{O, R\} \times L$ between owner-occupied or rental housing, O or R, in location ℓ.

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

such that households optimize given prices, insurance companies optimize given prices (Section 2.7.1 below), the law of motion for the distribution of households is consistent with their individual choices market and prices, and house prices and rents are such that housing markets clear (Section 2.7.2 below).

2.7.1 Insurance Companies

Let $\Omega_t^{\ell h}$ denotes the set of households with combination of housing status $h \in \{O, R\}$ and location $\ell \in L$ 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.

2.7.1.1 Private Insurance Companies

Define $\Omega_t^{\ell h,\phi} \subseteq \Omega_t^{\ell h}$ as subset of households who are insured by the private insurance company. Since all renters have full insurance, $\Omega_t^{\ell R,\phi} = \Omega_t^{\ell R}$, while homeowners may instead be part of the subset of households who are insured by the public insurer, and thus be part of the subset $\Omega_t^{\ell h,\underline{\phi}} \subseteq \Omega_t^{\ell h}$. As above, $\mathcal{M}_t^{\ell h,\phi}$ and $\mathcal{M}_t^{\ell h,\underline{\phi}}$ are the mass of households in each set.

In each location, the private insurer receives revenues from contracts purchased in the current period and makes insurance payments for contracts purchased in the previous period:

$$\pi_\ell = p_\ell \left(\mathcal{M}_{t+1}^{\ell R} + \int_{\Omega_{t+1}^{\ell O,\phi}} \phi_i' \omega_i di \right) - \chi_\ell \left(\mathcal{M}_t^{\ell R} + \int_{\Omega_t^{\ell O,\phi}} \phi_i \omega_i di \right)$$

Total profit for the private insurer is the sum of profits across all locations:

$$\Pi = \sum_{\ell \in \mathcal{L}} \pi_\ell.$$

In steady state, the distributions of households in $\Omega_t^{\ell h,\phi}$ and $\Omega_{t+1}^{\ell h,\phi}$ are the same, hence $\mathcal{M}_t^{\ell R} = \mathcal{M}_{t+1}^{\ell R}$ and the two integral terms in each π_ℓ above are the same. We can rewrite total profits as a linear combination of $p_\ell - \chi_\ell$ with positive weights,

$$\Pi = \sum_{\ell \in \mathcal{L}} (p_\ell - \chi_\ell) \underbrace{\left(\mathcal{M}^{\ell R} + \int_{\Omega^{\ell O,\phi}} \phi_i \omega_i di \right)}_{>0}$$

Therefore, when the insurer is perfectly competitive and makes zero profits in expectation, $E[\Pi] = 0$, all insurance prices across locations are actuarily fair: $p_\ell = E[\chi_\ell]\ \forall \ell$. This implies that in steady state, $E[\pi_\ell] = 0$ in each location.

2.7.1.2 Public Insurance Companies

The public insurer receives revenue from households who purchase insurance in the current period, and makes payouts to households in the current period based on the observed climate shock and outstanding insurance contracts purchased in the previous period. The public insurer charges a lump-sum tax (or distributes a lump-sum transfer), T, to all homeowners in each location to ensure that it earns zero profits in each location:

$$\underline{p}_\ell \underline{\phi}' \int_{\Omega_{t+1}^{\ell O,\underline{\phi}}} \omega_i di + T = \underline{\phi} \chi_\ell \int_{\Omega_t^{\ell O,\underline{\phi}}} \omega_i di.$$

2.7.2 Housing markets.

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

$$\int_{\Omega_t^{\ell O}} \omega_i h_\ell di = H_{S,t}^\ell, \tag{3}$$

where housing demand depends on the effective stock of housing and $H_{S,t}^\ell$ is the supply of housing in region ℓ. Rental units are perfectly elastically supplied at the rental price defined above as a function of house prices.

3 Calibration

3.1 Parameters

We organize the model parameters into three parts in Table 1. The first set of parameters are common to macroeconomic and asset pricing models with housing (Panel A). The last two sets of parameters are unique 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 γ = 2 and elasticity of intertemporal substitution of 0.5. These are standard values in the asset pricing literature. We set the preference for housing coefficient to 0.4 as in Favilukis *et al.* (2023). The income parameters are from Kaplan & Violante (2022). We set the maximum LTV and PTI limits at mortgage origination to be close to those used by Greenwald (2018). We set rental premiums to match average price-to-rent rations in the two regions. We give more details when we describe Table 2.

Climate risk and insurance. Climate risk is characterized by the annual probability of a climate shock and the conditional loss given a shock. Climate risk can take many forms, from severe storms, heatwaves, sea level rise or wildfires. In our baseline calibration we consider Florida as coastal state subject with high climate risk and rest of U.S. as a second region. We calibrate the probability of a climate shock in the high risk region to be 8%, following Bilal & Rossi-Hansberg (2025) estimates of probability of a 1-in-50 year storm following a 1 degree increase in temperature relative to 1920. We calibrate the rest of the U.S. to have a ten times lower probability of a 1-in-50 year storm which is their estimate for an inland county. We calibrate the conditional loss following a climate shock to be 17% of the house value, which we calibrate following Bilal & Rossi-Hansberg (2025) estimate of capital depreciation following a large storm.

We set insurance coverage choices to range between $\underline{\phi} = 30\%$ (severely underinsured) and $\bar{\phi} = 100\%$ (full coverage). The capital charge on insurance follows $\kappa(\phi) = c \cdot \phi^{\eta}$, with $c = 0.5944$, $\eta = 3$, and $\mu = 0$. This generates an effective markup that ranges from 1.02 at minimum coverage to 1.59 at full coverage. The convex loading ensures that per-unit insurance costs increase with coverage, generating realistic variation in insurance take-up across households with different wealth, income, and risk exposure. The insurance pass-through to rental units is full, meaning that rental units are always fully insured and landlords pass through insurance costs fully to tenants.

Regional heterogeneity. The last set of parameters captures geographic heterogeneity between low- and high- climate risk exposure areas. We let the amenity shifters to depend on households age and calibrate them to match an average share of population of 10% in the high climate risk area. We calibrate the homeownership utility shifters to match average homeownership rates over the life cycle in the U.S. . We calibrate the utility cost of moving to match the average migration rate between Florida and the rest of the U.S.. We expand on this in Table 2 below. Finally, the housing supply levels are calibrated to match average home prices in each region and the elasticities estimation follow Baum-Snow & Han (2024).

3.2 Baseline Results

Similar to the parameters, we report the model results into 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 unique 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, respec-

tively, and weighting each variable by population. Average house prices and rents are from Zillow Home Value Index and Zillow Rent Index respectively. Zillow reports these statistics at the MSA level, that 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, similar to the model value of $87.2 thousand. The model matches housing affordability reasonably well: the average house price–to–income ratio is 6.06 in the data versus 5.76 in the model, and the rent–to–income ratio is 0.25 in the data compared with 0.24 in the model.

The model implies substantial heterogeneity in climate-shock losses across regions. Conditional losses from a climate shock are modest in low-exposure areas (-3.9%) but much larger in high-exposure areas (-24.3%). Average insurance coverage in the data is 70% (Sastry *et al.*, 2025a), while the model generates a slightly lower average coverage rate of 59%.

The average annual moving rate between areas is 2.2% in the data and 2.0% in the model. Population shares are concentrated in low-exposure areas ("rest of the U.S.", with 93% in the data and 90% percent in the model, leaving 7% percent and 10% percent, respectively, 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 $1,742 in the model, and high-exposure rents of $1,917 in the data compared with $2,055 in the model.

Finally, Figure 1 plots income (Panel A) and wealth (Panel B) over the life-cycle. Wealth is total household net-worth, meaning that it include home equity. More importantly, Panel C plots average homeownership rate over the life-cycle both in the model and in the data.

4 Demand for Property Insurance

We start by studying the drivers of insurance demand in our model. Figure 2 plots the unconditional distribution of coverage endogenously demanded by homeowners in our model. The vast majority of households do not hold full insurance, which means that if

their house is hit by a natural disaster, the insurance company will not cover the full cost of rebuilding their homes. Insurance demand picks around 70% coverage and there is a significant mass of households severely underinsured. Our evidence is consistent with Sastry *et al.* (2025a) who document empirically and average coverage ratio of 70% as well as significant fraction of underinsured households.

Figure 3 and 4 illustrate how liquidity, age and background climate risk shape insurance demand. Insurance demand in the model is highly non-linear function of all the model state variables (liquidity, leverage, income, age, etc). To study the impact of key state variables on demand we use binscatter plot that allow us to partial out effects of key state variables. Panel A and B of figure 3 show insurance coverage demanded as a function of liquid wealth (cash-on-hand). This binscatter partials out age fixed effects, and controls for housing quality, permanent income and leverage. Two patterns are clear: first, insurance coverage is systematically higher in high-risk regions across most levels of liquidity, consistent with greater expected losses increasing the value of insurance. Second, the sensitivity of insurance demand to household liquidity depends sharply on regional risk exposure. In the low-risk region, insurance coverage declines monotonically with liquid resources: households with low cash-on-hand insure at substantially higher rates than wealthier households. In contrast, the relationship in the high-risk region is considerably flatter, with insurance coverage remaining high and relatively insensitive to cash-on-hand over most of the distribution. This suggests that background climate risk attenuates the role of liquidity in insurance decisions.

The bottom panels plot insurance coverage against age (again controlling for the remaining state variables). In both regions, insurance demand declines with age, but the gradient is markedly steeper in the low-risk region. Younger households insure at high rates regardless of location, while older households in low-risk areas sharply reduce coverage. In high-risk areas, insurance demand remains elevated well into older ages, consistent with persistent exposure to climate risk sustaining insurance demand over the life cycle.

Figure 4 zooms in on the left and right tails of liquid wealth distribution. The top (bottom) two panels show agents in the lowest (highest) decile of liquid wealth. Among low–liquid-wealth households, insurance coverage is pretty low. In our model buying insurance is a transfer of resources from today to the future. Poor households therefore do not insure. Further, insurance coverage is relatively flat in cash-on-hand within both regions, with similar take-up rates in low and high climate risk locations. This indicates that for liquidity-constrained households, marginal changes in cash-on-hand do not meaningfully alter insurance choices, even for very different levels of climate risk.

The bottom panels show insurance demand for the top decile of liquid wealth distribution. Just like poor households, wealth households demand insurance coverage below the averaqe demand. This households can self-insure and rebuild their home (in our model rebuilding or moving to a new house within a region are isomorphic). However,

unlike the poor households, among high–liquid-wealth households, stark regional differences emerge. In the low climate risk region, insurance coverage remains nearly constant across the cash-on-hand distribution. In the high-risk region, however, insurance demand declines sharply with liquid resources: wealthier households are substantially less likely to purchase insurance as cash-on-hand rises. This pattern suggests that in high-risk areas, wealthy households increasingly rely on self-insurance as their liquidity increases.

5 Climate Risk, House Prices, and Spatial Allocation

How does climate risk affect the demand for insurance and housing? We study how an increase in climate risk affects housing markets when households can insure and relocate endogenously. We conduct a counterfactual experiment in which we increase the probability of a climate disaster shock by 10 percent in the high-risk region, holding all other parameters fixed. Specifically, the likelihood of a climate shock in the high-risk region increases from 8.0% to 8.8%. We compute the new equilibrium and compare it to the baseline economy.

The increase in disaster probability mechanically raises the price of insurance in the high-risk region. As insurance markets are competitive in the benchmark environment, higher expected losses are fully passed through into higher insurance premia, and the 10% increase in climate risk implies a 10% increase in insurance premia. Households respond to the increased background risk by adjusting both their insurance coverage choices and their housing decisions.

Figure 5 illustrates how the distribution of insurance coverage changes across regions. In the high-risk region, the empirical CDF of insurance coverage shifts to the right. Despite the increased price, the region features higher average coverage and a compression of the lower tail. The mass of households purchasing low levels of coverage declines, implying higher background risk raises the marginal value of insurance for most homeowners. In contrast, the distribution of insurance coverage in the low-risk region remains essentially unchanged, reflecting the fact that neither risk nor prices are directly affected there.

Table 3 reports the steady-state effects of the counterfactual on housing markets and household sorting. In the new steady-state, despite the fact that households face endogenously higher insurance coverage in the high-risk region, house prices in that region decline roughly 2% relative to the benchmark, falling from $407 thousand to $399 thousand. This price response reflects the capitalization of higher expected climate losses into housing values, even in the presence of insurance. While insurance mitigates realized losses *ex post*, it does not fully eliminate the increase in expected housing costs, as higher insurance premia must be paid every period for insured households, or higher damages *ex post* for underinsured households.

Overall, the increase in climate risk and insurance costs drives migration of households, primarily renters, out of the high-risk region. This occurs in equilibrium despite the decrease in house prices. The population share of the high-risk region decreases by approximately 10%, from 9.9% to 8.8%. At the same time, homeownership in the high-risk region rises by almost 14%, rising sharply from 66.4% to 75.6% percent.

This increase reflects selective sorting: households that remain in the high-risk region after the increase in climate risk are disproportionately those with higher wealth and stronger incentives to insure or self-insure. They benefit from lower house prices due to the capitalization of insurance premia and can afford the higher user costs. Consistent with this interpretation, average net worth in the high-risk region increases substantially, from $323 thousand to $349 thousand. In contrast, changes in the low-risk region are modest, with house prices essentially unchanged and only small shifts in population and tenure. This is expected, since this region that we interpret as "Rest of the U.S." is large enough that migration has little effects on equilibrium prices, tenure, and insurance demand.

6 Conclusion

To be completed.

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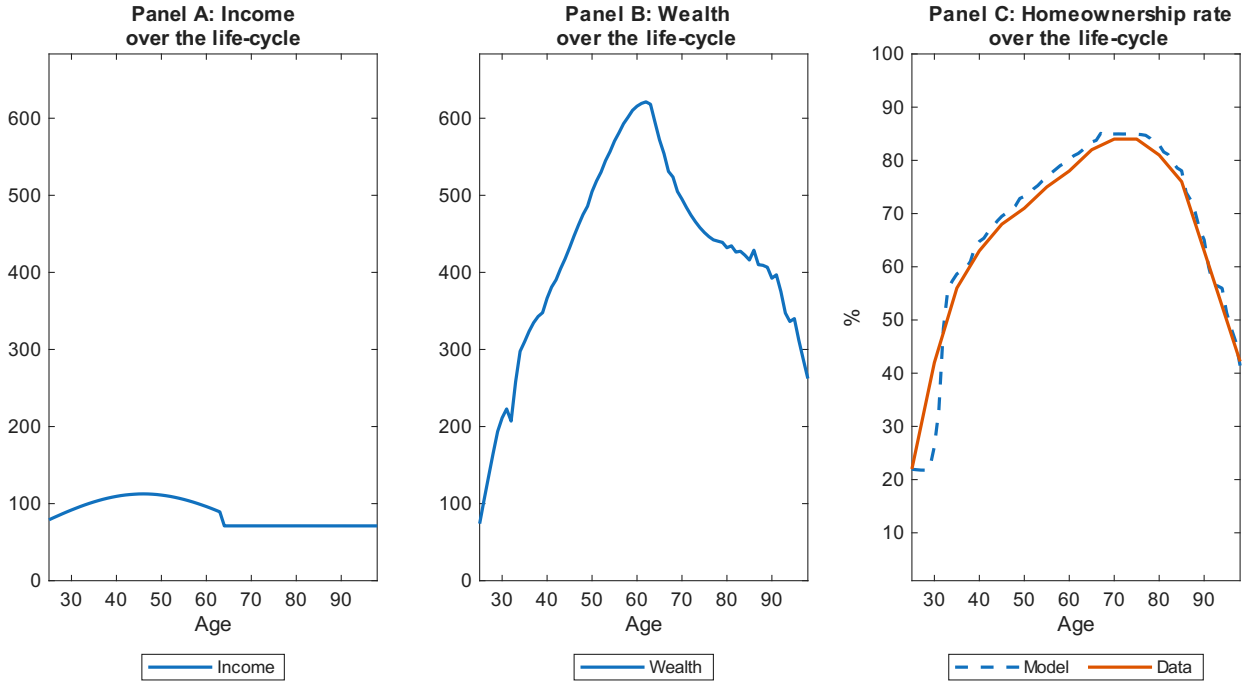
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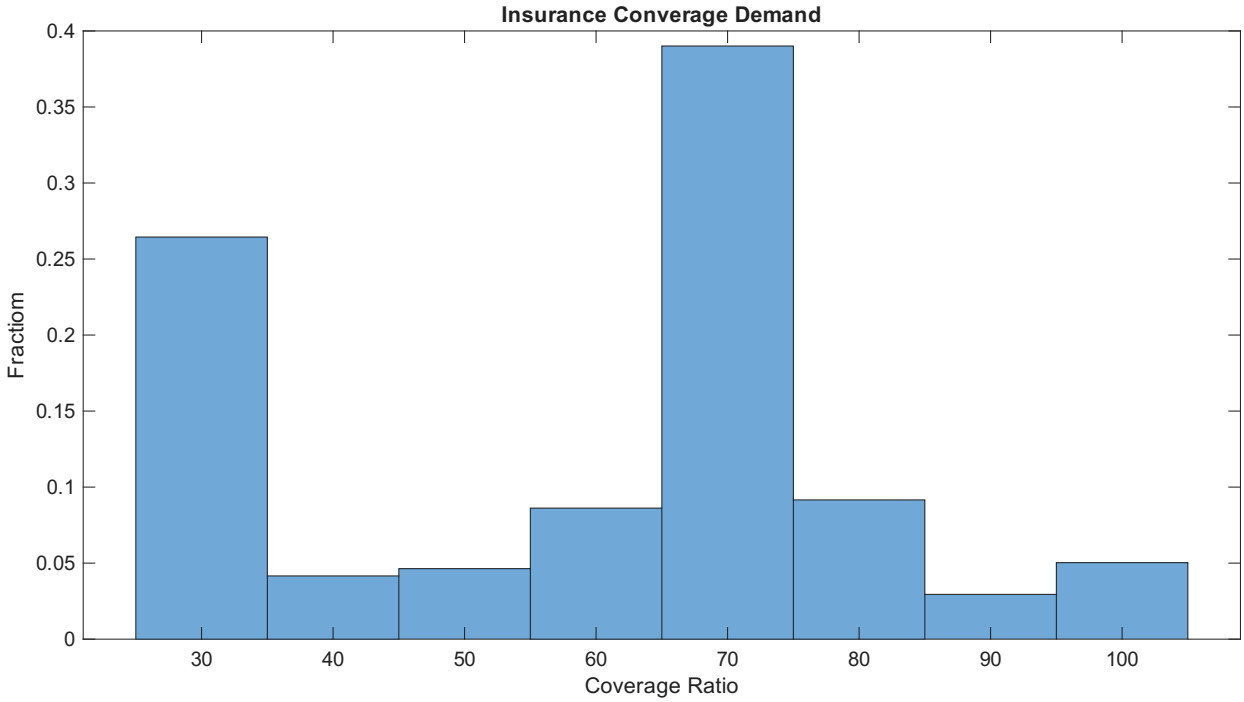
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Figure 1: Life-cycle profiles of income, wealth, and homeownership



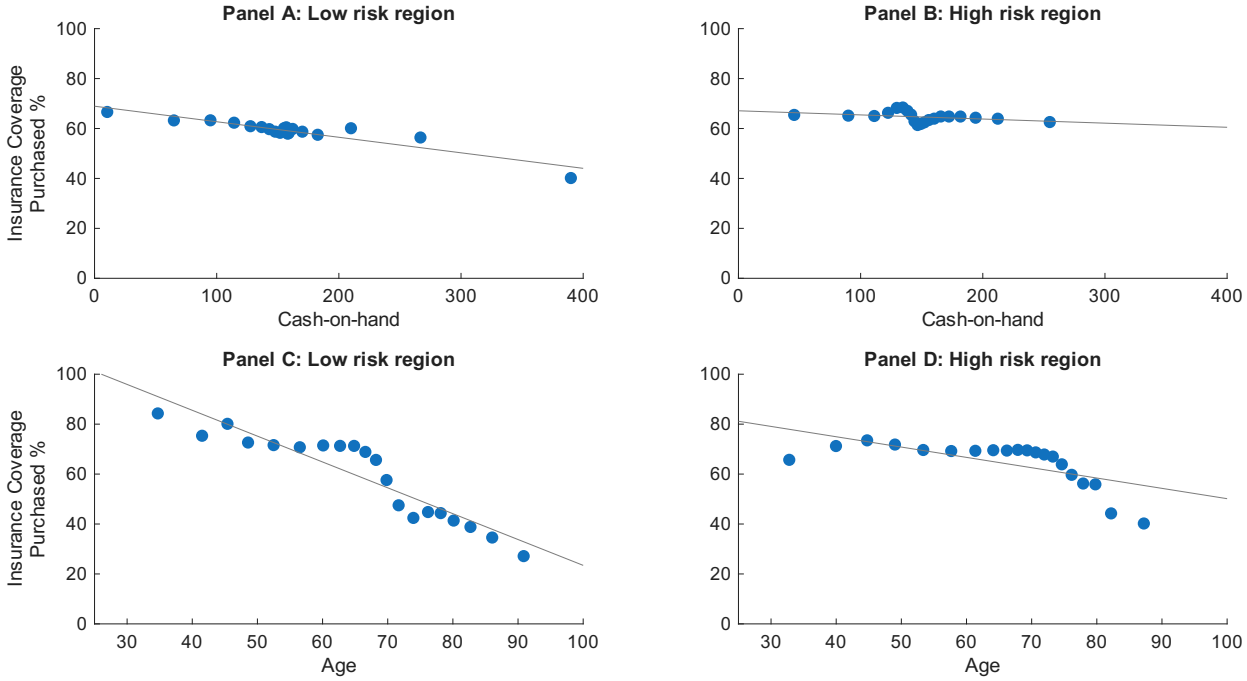
Notes: This figures plots average income over the life-cycle (Panel A), average wealth over the life-cycle (Panel B) and homeownership rate over the life-cycle (Panel C).

Figure 2: Insurance coverage demand



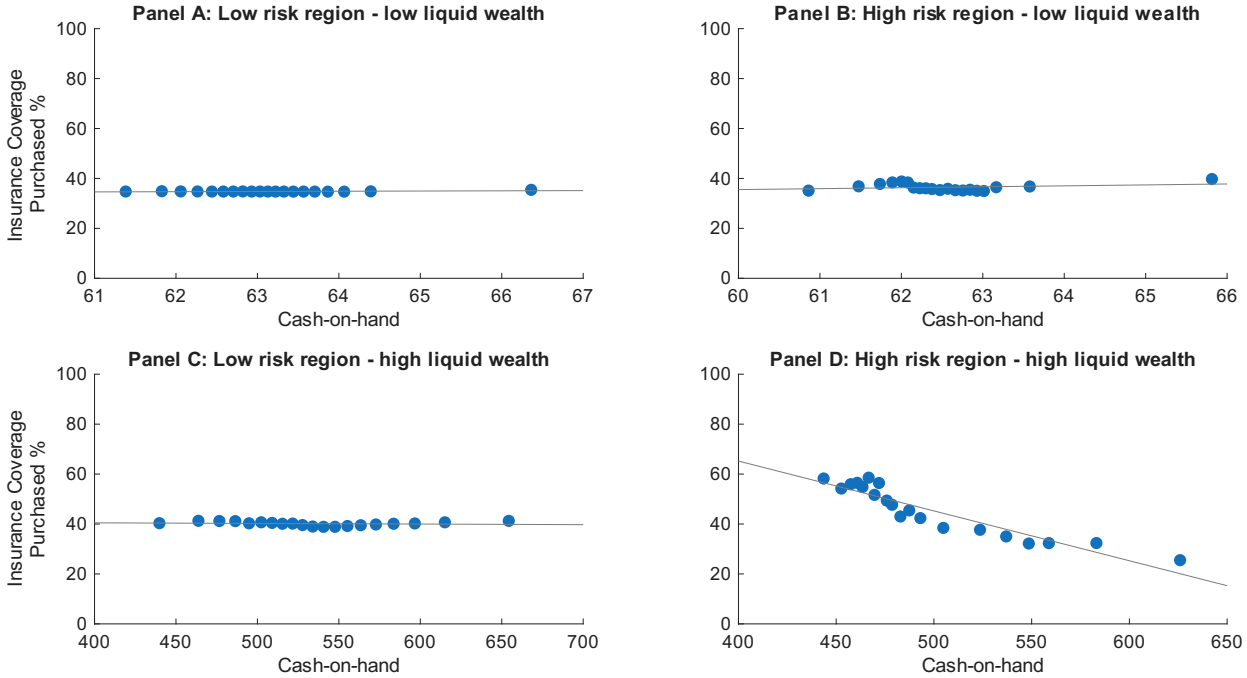
Notes: The figure shows the distribution of endogenous insurance coverage demand in the model.

Figure 3: Insurance demand by liquid wealth and age



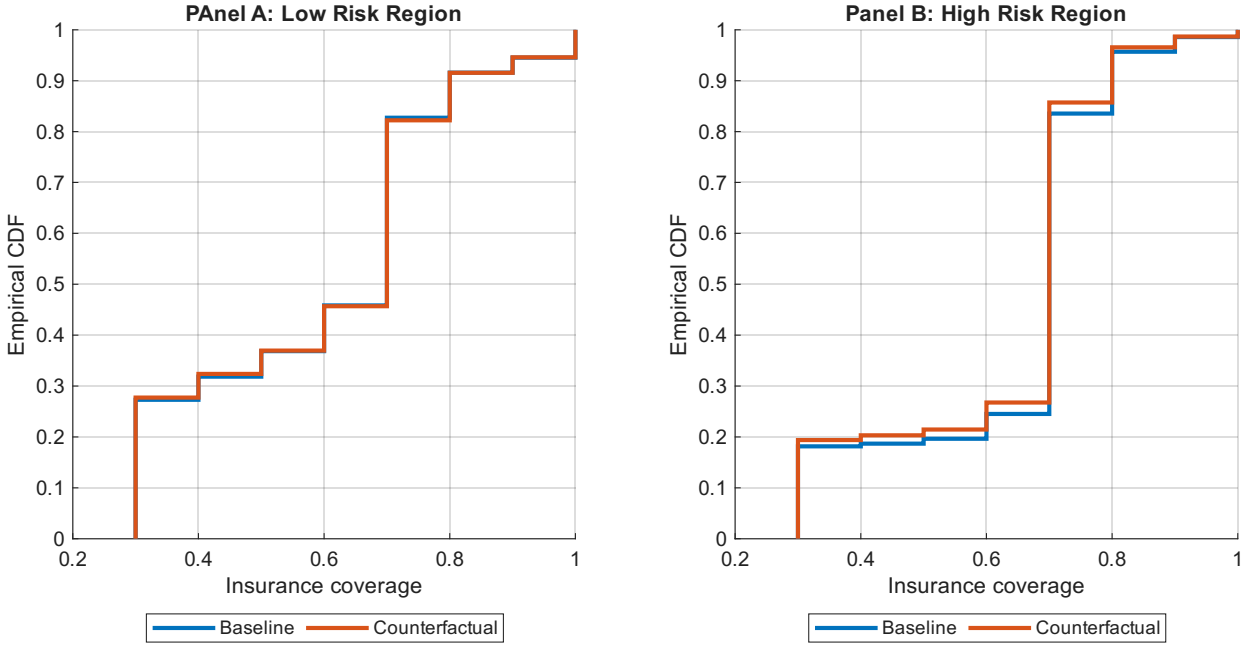
Notes: This figure plots binscatter relationships between insurance coverage and cash-on-hand (top panels) and age (bottom panels) for homeowners, separately for the low climate risk and high climate risk regions. Each point represents the mean of insurance coverage within bins of the x-axis variable. All specifications control for housing quality, permanent income, and leverage. The top panels include age fixed effects and the bottom panels control for cash-on-hand.

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 deciles, separately by climate risk region.

Figure 5: Empirical CDF of insurance coverage demand



Notes: This figure plots the empirical cumulative distribution functions (CDFs) of insurance coverage for homeowners by region. Panel A plots the CDF for the low-climate-risk region and Panel B for the high-climate-risk region. The solid blue line shows the CDF of the baseline model, while the solid orange line shows the CDF of the counterfactual experiment where the probability of a climate shock increases 10% in the high-climate-risk region. Differences between the curves reflect shifts in the distribution of insurance coverage induced by the counterfactual world.

Table 1: External parameters

Parameter	Description	Value	Source/Target
A. Preferences, Income, Mortgages, Housing			
β	Discount factor	0.95	standard
γ	Risk aversion	2	standard
ψ	Elasticity of intertemporal substitution	0.5	standard
α	Preference for housing	0.4	
ϵ	Elasticity of substitution consumption/housing	-0.5	Elasticity of substitution consumption/housing of 2/3
	Autocorelation permanent income	0.953	Kaplan & Violante (2022)
	Std. dev. permanent income	0.0422	Kaplan & Violante (2022)
	Std. idiosyncratic income	0.0494	Kaplan & Violante (2022)
r	Risk-free interest rate	0.02	Average t-bill rate (FRED)
r_M	Mortgage rate	0.05	Average mortgage rate (FRED)
$\overline{\theta}_{LTV}$	LTV limit	0.95	
$\overline{\theta}_{PTI}$	PTI limit	0.4	
ϕ^R	Rental premium	[0.021; 0.019]	Avg price-to-rent ratio
f_b	Proportional transaction cost buying	0.01	
F_b	Fixed transaction cost buying	1.5	
f_s	Proportional transaction cost selling	0.05	
F_S	Fixed transaction cost of selling	3	
B. Climate risk and insurance			
p_χ	Climate shock probability	[0.008; 0.08]	Bilal & Rossi-Hansberg (2025)
χ	Climate shock conditional loss	[0.017; 0.17]	Bilal & Rossi-Hansberg (2025)
ϕ_1	Private insurance coverage menu	{0.3, 0.4, 0.5, . . . , 1.0 }	
c	Cost of capital allocation	0.5944	Average U.S. premium Sastry *et al.* (2025a)
η	Loading curvature	3	
μ	Constant markup	0	
$\underline{\phi}_1$	Public insurance coverage	0.3	
$\underline{p}_1$	Public insurance price	see text	
ω_r	Insurance pass-through rental unit	1	
C. Geographic heterogeneity			
	Amenity shifter low/high-exposure area	see text	Pop share of each location
	Homeownership value shifter low/high-exposure area	see text	Homeownership rate
	Moving costs between areas (in utils)	0.0178	Avg migration Fl and U.S.
$\bar{I}_L$	Housing supply level low-exposure area	0.62	Avg house price low-exposure area
$\bar{I}_H$	Housing supply level high-exposure area	13.57	Avg house price high-exposure area
ρ_L	Housing supply elasticity low-exposure area	1.8134	Elasticity Baum-Snow & Han (2024)
ρ_H	Housing supply elasticity high-exposure area	0.99568	Elasticity Baum-Snow & Han (2024)

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	87.15
Avg wealth/avg income		1.02
Avg house price/avg income	6.06	5.76
Avg rent/avg income	0.25	0.24
B. Climate risk and insurance		
Conditional loss from climate shock in low-exposure area		-3.9
Conditional loss from climate shock in high-exposure area		-24.29
Avg property insurance premium		
Avg property insurance coverage	0.70	0.59
C. Geographic heterogeneity		
Avg moving rate between areas (%)	2.20	1.97
Population share in low-exposure area (%)	93	90.07
Population share in high-exposure area (%)	7	9.93
Avg house price low-exposure area	512	512
Avg house monthly rent low-exposure area	1,740	1.742
Avg house price high-exposure area	407	407
Avg house monthly rent high-exposure area	1,917	2.055
Avg income low-exposure area	83.6	87.16
Avg income high-exposure area	75.6	87.08

Notes: Moments are in annual terms.

Table 3: Steady-state comparison across regions

	Benchmark		Increased climate risk	
	Low Risk Region	High Risk Region	Low Risk Region	High Risk Region
Population share (%)	90.1	9.9	91.2	8.8
House Prices (thousands)	512.0	407.0	511.8	399.4
Homeownership rate (%)	67.5	66.4	66.7	75.6
Average net worth (thousands)	426.7	323.3	422.0	349.3

Notes: This table reports key statistics in the benchmark and counterfactual increased climate risk scenarios.