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FLOODED HOUSE OR UNDERWATER MORTGAGE? The Implications of Climate Change and Adaptation on Housing, Income and Wealth

EUROPEAN CENTRAL BANK

EUROSYSTEM

Flooded House or Underwater Mortgage? The Implications of Climate Change on Housing, Income and Wealth.

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Motivation

Significance of climate change adaptation is becoming increasingly evident as:

1. Mitigation efforts remain inadequate;
2. Climatic impacts are intensifying globally.

This paper: How do climate change and adaptation affect household wealth?

We know that climate *regulation* tends to hurt wealth, especially of poorer HHs (Känzig (2023)). But climate *change* = risk + shock realization!

→ Empirical evidence on sea level rise, floods, hurricanes, wildfires (Giglio, Kelly, and Stroebel (2021)), but little theory guidance.

Households and Firms

Households live for two periods, and get utility from housing *(L)* and a consumption good *(c)*:

$$U_i = c_{i,t+1} + v(L_{i,t}) \qquad v' > 0, v'' < 0$$

Firms operate for one period, and produce the consumption good:

$$Y_t = A\left[\eta\left(H_t^{\alpha} h_t^{(1-\alpha)}\right)^{\rho} + (1-\eta)\left(K_t^{\alpha} l_t^{(1-\alpha)}\right)^{\rho}\right]^{\frac{1}{\rho}}$$

using high-skilled labour *(h)*, complementary to intangible capital (*H*, created using effort), and low-skilled labour *(l)*, complementary to physical capital (*K*, created upon investment).

Climate Risk

An extreme weather event occurs in each period, and the probability that a given household or firm is hit by the event is denoted $\gamma \in (0,1)$. Losses are idiosyncratic:

- $\xi_{t+1}^{i} \in (0,1)$: Losses suffered by household *i* in period t, as a fraction of housing capital *(L)*.
- $\xi_{t+1}^{f} \in (0,1)$: Losses suffered by firm *f* in period t, as a fraction of *physical* capital *(K)*.

→ Expected losses conditional on being hit denoted by $\mu_L, \mu_K \in (0,1)$ respectively.

Climate damages reduce housing supply:

$$\bar{L}_{t+1} = \int_0^1 (1-\xi_{i,t})\, di \cdot \bar{L}_t \overset{\text{LLN}}{=} (1-\mu\gamma_{t+1}) \cdot \bar{L}_t$$

Physical capital losses reduce output:

$$\tilde{Y}_t = A\mathcal{F}(H_t, h_t, \tilde{K}_t, l_t), \qquad \mathcal{F}'_{\gamma}(H_t, h_t, \tilde{K}_t, l_t) \leq 0$$

Equilibrium

- Climate change *increases* house prices:

$$p_t = \frac{(1-\mu\gamma_{t+1})\, p_{t+1} + v'(\bar{L}_t)}{(1+r_{t+1})}$$

  and hence mortgage credit demand.
- Climate change *raises* the costs of borrowing:

$$(1+r_t) = A^{\rho}\alpha(1-\eta) \cdot \frac{\tilde{Y}_t^{1-\rho}}{((1-\mu\gamma_t)K_t)^{1-\alpha\rho}} \cdot l_t^{(1-\alpha)\rho}$$

  and hence reduces corporate debt.
- Climate risk *reduces* share prices:

$$e_t = \frac{d_{t+1}}{(1+r_{t+1})}$$

- Climate change *increases* the wage gap.

$$\frac{q_t}{w_t} = \frac{\eta}{1-\eta} \cdot \left(\frac{H_t}{(1-\mu\gamma_t)K_t}\right)^{\alpha\rho} \cdot \left(\frac{(1-\phi)\tilde{l}}{\phi\tilde{h}}\right)^{1-(1-\alpha)\rho}$$

Climate Change Adaptation

Households invest in adaptation to reduce vulnerability to climatic impacts. Denote by $x_{i,t} \in (0,1)$ the choice of adaptation by household *i* in period *t*, which reflects the fraction of idiosyncratic losses *prevented*. Adaptation shifts the distribution of idiosyncratic losses to the left:

$$\mathbb{E}(\xi_{i,t+1}) = (1-x_{i,t})\mu\gamma_{t+1}$$

and thus reduces the reduces the rate at which the supply of houses falls.
However, adaptation is increasing costly:

$$\psi_{i,t} = \tfrac{1}{2} L_{i,t} x_{i,t}^2.$$

Optimal Choice of Adaptation

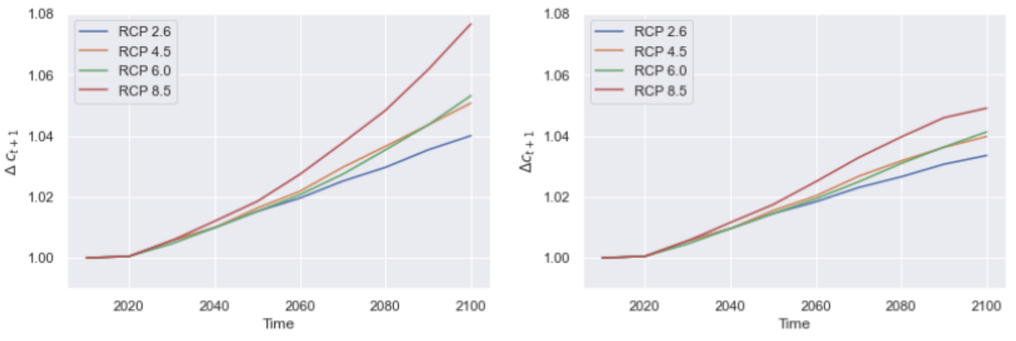
The unconstrained private choice of adaptation is

$$x_{i,t} = \frac{\mu\gamma_{t+1} \cdot p_{t+1}}{(1+r_{t+1})}$$

which is *efficient* as long as:

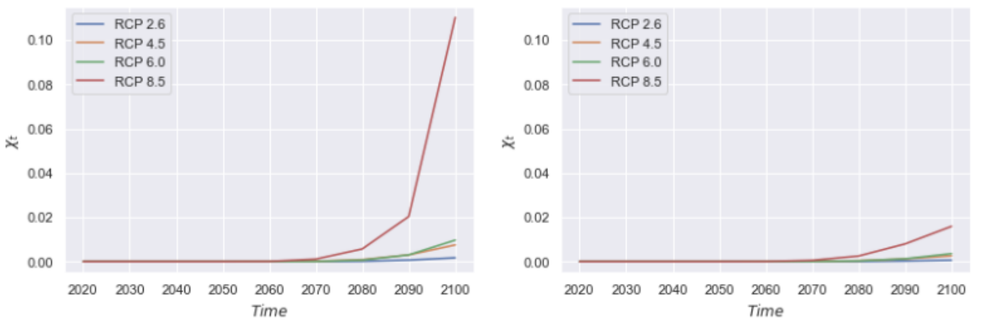
i) Climate risk is *accurately priced* in the market.
ii) Welfare of future generations is evaluated using the *market* discount rate.

Consumption Inequality



Consumption inequality without (L) and with (R) adaptation.

Mortgage Default Rates



Mortgage default rates without (L) and with (R) adaptation.

Financial Constraints

Rational creditors limit mortgage debt $(-S)$ to the expected liquidation value of the collateral. Adaptation is non-contractible, so investors form expectations on the private choice of borrowers:

$$-(1+\hat{r}_{t+1})S_{i,t} \leq (1-(1-\mathbb{E}(\bar{x}_{l,t}))\mu\gamma_{t+1})\, p_{t+1} L_{i,t}$$

The constrained private choice of adaptation is

$$x_{l,t} = \frac{\mu\gamma_{t+1} p_{t+1}}{(1+r_{t+1})(1+\lambda_t)}$$

with $\lambda \geq 0$ the shadow value of the constraint.

i. Low-income households protect a smaller *fraction* of their housing capital, and remain *more exposed* to climatic impact.
ii. The *"adaptation" gap widens* over time!

Policy Implications

A *Pareto improvement* is attainable if constrained households *rent* rather than buy:

- Constrained households better off by renting (no constraint).
- Unconstrained households equally well off in expectation.
- Economy as a whole better off as landlords have the (financial) incentive to adapt optimally.