Climate change beliefs and savings behavior: a macroeconomic perspective

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How does concern about an aggregate risk, such as climate change, affect the savings behavior of individuals? A rise in the probability of a low aggregate productivity state increases precautionary savings. Under incomplete markets, the short planning horizon of the poor may suppress their reaction, but conditional on saving, the magnitude of the consumption response decreases in wealth. This theoretical prediction is supported by empirical evidence from the UK Understanding Society survey, showing a significant and positive correlation between climate change concern and savings. The estimate further increases when restricting the sample to low income individuals. In a general equilibrium model featuring heterogeneous agents, incomplete markets and a non-stationary shift in the aggregate risk process, the 'climate concern' effect increases capital supply in the short run which mitigates the negative effects of climate change. Allowing for disagreement about the aggregate process exacerbates undersaving of unconcerned individuals due to downward pressure on the interest rate caused by the more concerned. This mechanims hurts mostly wealthy agents - those with low asset holdings instead benefit overall due to the positive effect of higher capital on wages.

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1 Introduction

Climate change is widely perceived as a major threat to human wealth and prosperity in this century due to a myriad of reasons, including more frequent extreme weather events, biodiversity loss and disruptions of the global economic system. While individuals cannot significantly mitigate the physical or macroeconomic impacts of global warming themselves, concern about aggregate shifts may still affect their behavior by changing intertemporal trade-offs. In particular, the extent to which an individual saves may be affected by beliefs over climate change. As aggregate savings determine capital in production, these individual decisions have important macroeconomic effecs on aggregate variables such as the interest rate and average wages. Macroeconomic mechanisms thus lead to a relevant role of beliefs about climate change when analyzing adjustments along the transition path to the economy of a warmed planet, even when direct climate impacts to the economy are assumed to be exogenous. Crucially, however, the exact economic impacts of climate change are both highly uncertain and subject to significant disagreement across the population.

This paper offers two novel findings that help understand the macroeconomic effects of climate beliefs, transmitted via savings. First, I establish both theoretically and empirically that concern about climate change affects individual savings. Second, I quantify how an increased level of capital under higher concern mitigates the decrease in output as climate damages increase. In particular, my analysis shows asymmetric gains along the wealth and income distribution: the relatively higher capital stock partly offsets the drop in wages from climate damages and thus increases labor earnings, but decreases asset returns. Finally, I analyze the aggregate, individual and distributional consequences of the empirically observed heterogeneity in climate concern. Capital is sensitive to the mean, but not the variance of concern. Less concerned agents become endogenously less wealthy, and it is precisely this group for which the general equilibrium effects of higher capital are beneficial.

The first part consists of a theoretical and empirical microeconomic analysis of individual savings under a change in beliefs over climate impacts on the economy. I analytically derive the relative consumption reponse to a shift in the stochastic aggregate productivity process in a general consumption-savings model featuring idiosyncratic risk and incomplete markets. The consumption response to an increase in the probability of a low productivity state is always non-positive and is further non-linearly related to the individual state in the presence of a borrowing limit. A key driver of this response is the difference between the marginal value of savings in the low rather than the high productivity state Higher wealth decreases the gap in welfare gain of additional savings between aggregate states, so that the response size decreases with wealth for savers. Agents who are constrained by the borrowing limit do not make any intertemporal decisions, so that they do not react at all to an shift in the process of future states. As they cross the threshold of wealth at which they start saving, their response is however more pronounced than for higher earning agents.

The theoretical prediction is confirmed by empirical evidence from the "UK Household Longitudinal Study". Exploiting heterogeneity in beliefs about the consequences of climate change, I can estimate the effect of stronger concern about climate change on savings decisions, controlling for a broad number of demographic indicators and previous exposure to extreme events, which may affect both beliefs and savings. To address any omitted variable bias due to heterogeneity in risk or time preferences, I run robustness checks controlling for individual fixed effects. The data shows a robust positive relationship both on the internal and on the external margin: Those who are most concerned about climate change are on average more likely to save. If they save, the amount is on average higher than for those less concerned. Running separate estimations for different income percentiles further shows that the relative effect is strongest for low income households.

The microeconomic evidence motivates a general equilibrium analysis to explore the aggregate effects of climate beliefs and disagreement therein. To do so, I build on a model with income heterogeneity, incomplete markets, and aggregate shocks in the spirit of Krusell and Smith (1998), to which I make two key adjustments to include climate change and disagreement: First, the aggregate process is assumed to be subject to a non-stationary increase in the probability of a low productivity state. The implicit time-dependence captures an important and distinctive feature of climate change, as impacts are projected to worsen over the coming century. Second, I allow agents to differ in their prior beliefs over the aggregate process, introducing an additional dimension of heterogeneity. The model thus takes seriously the empirically documented disagreement over climate impacts and evaluates its impact on the macroeconomy. Deviating from the standard approach in the climate-economic literature of an increasing level of damages and instead raising the probability of a low productivity state is an important feature of my model, as it allows heterogeneous beliefs that are consistent with observations. Note that this change to probabilities still decreases *mean* productivity. I allow agents to use Bayesian updating following realized aggregate states, so that beliefs converge to the truth in the long run.

The baseline case of homogenous beliefs shows the relevance of expectations for aggregate outcomes: In an economy populated only by agents who become instantly aware of the changing productivity process due to global warming, expected aggregate capital initially increases due to precautionary and consumption smoothing behavior, before then decreasing to a lower level in the long run, as mean productivity has permanently decreased. The buffer grows larger if the shift is anticipated ahead of time. If instead the population is completely unaware of the shift to productivity, capital decreases as aggregate shocks become more frequent, exacerbating the negative impacts of climate change.

Aggregate capital is thus sensitive to the population's average belief about climate change. Disagreement, modeled as a positive variance in prior beliefs over temperature impacts, has a negligible effect on aggregate outcomes. This additional heterogeneity does however matter for the distributional impacts along the climate transition path. General equilibrium effects lead to a further shortfall in asset holdings of unaware agents when they exist within the same economy as agents who know of the shift: since the latter save more due to climate concern, their presence pushes down the interest rate, which deincentivizes savings for all. Average wages however drop less, due to accumulated capital, increasing labor earnings for everyone. These general equilibrium effects are important determinants for the distributional incidence along the climate transition path: wealthy agents, whose income largely consists of asset returns, lose out from sharing the economy with more concerned agents. On the other hand, those with low asset holdings who rely mostly on labor income benefit from higher capital and are relatively better off in an economy with more accurate beliefs, even if they themselves are wrong.

In sum, this model uncovers the aggregate and distributional implications of inaccurate and dispersed beliefs over a non-stationary, aggregate shift, transmitted via the savings channel. It particularly emphasizes the social value of savings, which on aggregate mitigate the negative impacts along the climate transition by providing a capital buffer.

Related literature

Structure of the paper Section 2 begins with theoretical predictions on the savings choice under perturbed climate beliefs. Section 3 provides motivational evidence on the effect of climate beliefs on savings and explains the data, empirical strategy and empirical results. In section 4, the model is extended to a general equilibrium framework. The section further discusses the calibration and solution method. Model results are reported in section 5. Section 6 concludes.

2 Analytical Model

This section introduces a very general consumption-savings model in which consumers face both idiosyncratic and aggregate uncertainty. Abstracting from endogenity of future wages and returns, this set-up allows an analytical partial equilibrium characterization of the consumption response to changes in beliefs over the aggregate process which depends on a decision makers current idiosyncratic state.

2.1. The consumption-savings problem

Each period t, all individual agents, indexed by i, draw an idiosyncratic state ϕ_{it} from the finite set Φ. A state ϕ may represent skills or demographics and can also include death to allow for life-cycle effects. The process ϕ_{it} is allowed to be correlated over time. The aggregate economy is either in a high or low productivity state, which is indicated by the random variable $\zeta_t \in Z = \{\zeta^L, \zeta^H\}$ with $\zeta^L < \zeta^H$. In a given period, the probability of $\zeta_t = \zeta^L$ is given by p_t, and we assume that ζ_t and ϕ_{it} are independent for all $i,\ t$.

Aggregate shocks affect the productivity of a representative firm. Asset returns $R(\zeta) > 0$ and average wages $w(\zeta) > 0$ only depend on the current aggregate state. In particular, prices are unaffected by capital asset choices, a key assumption that is relaxed in section 4. Both returns and average wages are lower in the low state, but in the empirically relevant case of partial capital depreciation, the relative drop in wages is higher than for returns, i.e.

$$\frac{w(\zeta^L)}{w(\zeta^H)} < \frac{R(\zeta^L)}{R(\zeta^H)}.$$

While everyone is subject to the same rate of return, labor income varies by idiosyncratic type and is given by

$$y(\zeta, \phi) = w(\zeta) e(\phi)$$

where e is some function of the idiosyncratic state. I assume $e(\phi) \geq \underline{e} > 0$ for all ϕ, so that income is always above a minimal, positive threshold. An agent i chooses consumption to maximize expected utility over their life-time

$$\max_{c_{it}} \mathbb{E}\left[\sum_{t=0}^{\infty} \beta^t u(c_{it})\right].$$

Markets are incomplete. It is only possible to save a non-negative amount in assets, leading to the budget constraint

$$c_{it} + a_{it+1} = y(\zeta_t, \phi_{it}) + R(\zeta_t) a_{it} =: m_{it}, \quad a_{it+1} \geq 0,$$

where m_{it} denotes current cash-on-hand. I allow for heterogeneity in initial asset holdings a_{i0} and individual state ϕ_{i0}. I write $\theta_{it} = (\zeta_t, \phi_{it})$ for the overall state relevant for household i and $\theta^{it} = (\theta_{i0}, \ldots, \theta_{it})$ for the history of states up to time t.

The economic impacts of climate change are usually modeled as deterministic damages to productivity, see Nordhaus (2008), **?**. Here, I assume that concern about the economic impacts of climate change increases the (perceived) probability of the low productivity state, i.e. $dp_t > 0$ for at least one t. Importantly, as climate change is a non-stationary process, the effect on p may vary over time. This formulation allows for the case of a decision maker becoming aware of a change before it actually happens, capturing anticipatory effects.

2.2. Cosumption response

This section drops the index i and derives the relative response of initial consumption $d \ln c_0$ to an unanticipated change in probabilities dp_t for $t \geq 1$. As optimal consumption is always non-zero for standard utility functions, this will never be ill-defined. Focusing on consumption rather than savings has the advantage of facilitating comparisons with the literature, most importantly to the closely related work by Farhi et al. (2022). As initial income is fixed by the current state, the response of the savings share can be recovered as $da_1/m_0 = -dc_0/m_0 = -d \ln c_0 \cdot c_0/m_0$..

Let $MPS_t = da_{t+1}/dy_t = 1/R_t \cdot da_{t+1}/da_t$ be the marginal propensity to save out of income and $\varepsilon_t = -u(c_t)/(c_t u''(c_t))$ the elasticity of intertemporal substitution, both evaluated at the optimal choices $c_t,\ a_{t+1}$.

Proposition 1 To first order, the relative response of consumption c_0 to a perturbation in the sequence of probabilities dp_t for $t \geq 1$ is given by

$$\frac{dc_0}{c_0} = -MPS_0 \varepsilon_0 \sum_{t=0}^{\infty} \left(\sum_{\theta^t} \mathbb{P}^*(\theta^t) \left(\prod_{j=1}^{t} MPS_j(\theta^j) \right) \mathcal{D}_t(\theta^t) \right) dp_{t+1}. \tag{2.1}$$

Here,

$$\mathcal{D}_t(\theta^t) = \frac{\mathbb{E}[V'(a_{t+1}, \theta^{t+1}) | \zeta_{t+1} = \zeta^L,\ \theta^t] - \mathbb{E}[V'(a_{t+1}, \theta^{t+1}) | \zeta_{t+1} = \zeta^H,\ \theta^t]}{\mathbb{E}[V'(a_{t+1}, \theta^{t+1}) | \theta^t]}$$

is the difference between the expected marginal value of holding an extra unit of assets in the low versus high aggregate state relative to the unconditional expected marginal value, conditional on the previous idiosyncratic state, and

$$\mathbb{P}^*(\theta^t|\theta^{t-1}) = \mathbb{P}(\theta^t|\theta^{t-1})\frac{V'(a_t,\theta^t)}{\mathbb{E}[V'(a_t,\theta^t)]}, \quad \mathbb{P}^*(\theta^t|\theta^{t-1}) = \mathbb{P}^*(\theta^t|\theta^{t-1}\mathbb{P}^*(\theta^{t-1})$$

is the risk-adjusted probability of state θ^t. □

The result follows from an application of the implicit function theorem to the Euler equation. A detailed proof can be found in appendix A.1. This expression can now be used to disentangle the different channels driving the consumption response and to obtain predictions for heterogeneous reactions in the cross-section of households.

On the margin, the change in beliefs is only relevant for those agents who already make intertemporal decisions, which are those who already engage in savings and satisfy $MPS > 0$. The marginal propensity to save is a measure of how agents trade off between today and the future, with a high value indicating a relatively higher value of future consumption. As expectations over the future states vary, an agent with a high MPS will react stronger compared to one with a low MPS. In the extreme case of $MPS = 0$, the agent would prefer borrowing to consume more today and less in the future, but is constrained by the borrowing limit.

The elasticity of intertemporal substitution ε_0 mediates the consumption response: An agent who is more responsive to changes in relative prices reacts more to substitution effects. Crucially, however, due to the time separability of preferences, the IES coincides with the reciprocal of the coefficient for relative risk aversion. Thus, a change in $\varepsilon(c)$ also effects the marginal value of savings, another relevant statistic for the consumption response.

The key novel aspect of the decomposition is given by $\mathcal{D}_t(\theta^t)$, capturing the marginal value of savings. An increase in the probability of $\zeta_t = \zeta^L$ leads to a decrease of the same size in the probability of $\zeta_t = \zeta^H$. Thus, the direct effect on the expectation of the future marginal value of additional savings is given by dp_t times the difference between the expected marginal values of the low and high state. As the consumption response follows a change in probabilities from a previously optimal choice, what matters is not the marginal value of assets in the low state, but rather how much more an agent values assets in the low versus high state. If the marginal value is high in either case, then the marginal utility of consumption today is also high, as given by the Euler equation, so that the difference matters only relative to the unconditional marginal value of assets in the future. In general, $\mathcal{D}_t(\theta^t)$ could be negative. However, in the standard case of CRRA utility with an IES < 1 and a relatively larger drop in wages than returns, the marginal value of holding assets is higher in the low than in the high state, so that $\mathcal{D}_t(\theta^t)$ is positive. Note further that $\mathcal{D}_t(\theta^t)$ is bounded above, as everyone receives a positive income each period.

Perturbations in dp_t for $t > 1$ lead to a consumption response today only it also affects the choice in period $t-1$. Otherwise, the agent would just reallocate to an earlier period which is inconsistent an optimal decision under no perturbation. Thus, the response can be derived recursively, and future perturbations are weighed by the product over marginal propensities to save from now until then. In particular, a binding borrowing constraint in state θ^j implies $MPS(\theta^j) = 0$, so that any variation dp_{j+i} within that scenario is irrelevant for the consumption choice today.

Finally, for $t > 1$, the agent accounts for the uncertainty over their idiosyncratic state in $t-1$. Those states in which the marginal value of holding extra assets is higher matter relatively more for the consumption response. The contribution of a specific state can be expressed using the risk-adjusted measure of the physical probability, under which high marginal value states are weighted higher. This is analogous to the expression derived by Farhi et al. (2022).

It is now clear that a change in ε_0 leads to counteracting effects: A higher IES, which at first glance suggests a larger response, corresponds to a lower coefficient of relative risk aversion. In that case, the difference in marginal values of savings between bad and good outcomes is lower, so that both $\mathcal{D}_t(\theta^t)$ and the risk adjusted weights of bad states decrease. Quantitatively, the latter effect dominates, so that responses are higher for high coefficients of relative risk aversion.

2.2.1. Hand-to-mouth agents

In this model, the agent chooses whether to save at all or be hand-to-mouth. For those who do not save in period 0, the multiplier on the borrowing constraint is positive, so that the first order condition implies the inequality

$$u'(c_0^{\max}) > \beta \mathbb{E}[V_1'(0)].$$

Here, $c_0^{\max} = y_0 + R_0 a_0$ is the maximal amount they can consume by not saving at all. The inequality captures that they would prefer to consume more but are constrained by the borrowing limit $a \geq 0$. They will start saving following a perturbation dp_1 if and only if

$$\beta \left(\mathbb{E}[V_1'(0)|\zeta^L] - \mathbb{E}[V_1'(0)|\zeta^H] \right) dp_1 > u'(c_0^{\max}) - \beta \mathbb{E}[V_1'(0)]. \tag{2.2}$$

For an infinitesimal change dp_1, condition (2.2) can only be fulfilled for an infinitely large difference between expected marginal values of holding assets in the low versus high state. However, remember that this difference is bounded as agents receive positive income in each period. As $MPS_0 = 0$ for hand-to-mouth agents, equation (2.1) still holds.

In the data, climate concern is correlated with whether or not individuals save, not just the amount, see 3. For larger shifts in probabilities, as the ones introduced in section 4, the model also generates an effect on the extensive margin.

2.3. The role of the idiosyncratic state

The exposition in proposition 1 offers a framework to discuss the relevance of the idiosyncratic state and enables us to find predictions on how the consumption response differs in the cross section.

In many macroeconomic models, the intertemporal elasticity of substitution is assumed to be constant across the population. Variation in the marginal propensity to save on the other hand is a key driver of wealth accumulation in macroeconomic heterogeneous agent models. A standard consumption function is concave in current cash on hand, so that the marginal propensity to save increases in both income and wealth. The MPS is further affected by expectations over future earnings: Agents with low cash on hand in the first period would like smooth consumption by borrowing especially if they expect their income in the next period to be sufficiently high. When modeling income dynamics with a standard AR(1) process, those individuals with the lowest earnings today are the ones who expect a *relative* increase in their earnings, even under high persistence. In the empirically plausible case where low income furthermore correlates with low wealth, there is a bunching of low income agents with $MPS \approx 0$ close to the borrowing constraint.

Income and asset holdings are also sources of heterogeneity in $\mathcal{D}(\theta^t)$. For a given level of earnings, the difference drops as asset holdings a_0 rise, due to the convexity of marginal utility. Similarly, the difference is also higher for low earners if the income process is indepent over time. The monotonicity in labor earnings however no longer obtains in the empirically relevant case of a persistent, mean reverting income process. Whether the value $\mathcal{D}(\theta^t)$ is higher for low or high earners then also depends on the asset holdings. Those who currently have both low income and are also asset poor will be particularly bad off in the low aggregate state, so that $\mathcal{D}(\theta^t)$ remains higher for low compared to high income individuals who both hold low assets. As asset holdings increase and the difference $\mathcal{D}(\theta^t)$ drops, it however does so faster for low than for high earning agents. Due to mean reversion, high earners are more likely to have lower income in the future relative to today. In those cases, the difference in the marginal value of savings between the low and high state is higher. For high asset holdings, this channel dominates, leading to higher values of $\mathcal{D}(\theta^t)$ for high income individuals.

In summary, the multiple channels through which the idiosyncratic state affects the consumption response may counteract each other. The interaction between the marginal propensity to save and the difference in marginal values of savings is crucial: While poor, low income households are the ones who gain the most from having more savings in low productivity states of the world, they may not react at all due to their small marginal propensity to save. It is a quantitative question to see which effect dominates.

3 Motivating evidence

]The previous section suggests a positive effect of climate change concern on individual savings, Further, a non-linear connection between the idiosyncratic state and the response to a shift in the aggregate process in a stylized framework, motivating an empirical examination of the relationship between beliefs, savings and earnings. In particular, the stark differences of responses for savers and non-savers raises the question of whether there is an extensive margin effect of climate change beliefs on savings.

The goal of this section is thus to estimate an equation of the type

$$s_{it} = f(\iota_{it}, y_{it}, X_{it}; \varepsilon_{it}). \tag{3.1}$$

Here, s_{it} is a savings indicator, which may be binary or continous, ι_{it} is a measure of concern about climate change, y_{it} denotes personal income and X_{it} is a vector of controls.

3.1. Data and measurement

The data is taken from the UK Longitudinal Household Study *Understanding Society*, for Social and of Essex (2022). Individuals in participating households are interviewed once a year, either face-to-face or through a self-completion online survey, yielding an unbalanced panel. The study started with 40000 households in the first wave in 2009. There are now 14 waves available, with the last one collected in 2022-23. The data can be acquired via the UK Data Service after application.

Beliefs about climate change Questions about climate change beliefs were asked in waves 1 (2009-10), 4 (2012-13) and 10 (2018-19). Unfortunately, the mode of response was changed for some questions from wave 1 to 4. The main specification uses only data from waves 4 and 10. In particular, the analysis does not include waves of the survey that were conducted during the COVID pandemic. In the benchmark specification, the sample is made up of around 65000 observations across the two waves.

Savings data Questions related to savings are asked in all even waves of the survey. Respondents are asked *Do you save any amount of your income?*, to which they can answer 'yes' or 'no', and *About how much on average do you personally manage to save a month?*, which asks them to enter a non-negative GBP amount. These two questions allow us to analyze savings behavior both on the extensive and intensive margin. Savers are also asked if their savings are mainly planned to be long-term or short-term, neither, or both equally. This indication is used for an additional analysis.

Any responses with average monthly savings in excess of income are excluded, and the data is winsorized at the 99th percentile. I obtain relative savings s_{it} by dividing the amount reported by income.

Income data For my baseline analysis, I use the derived total net personal income variable as y_{it}, which is net of taxes on earnings and national insurance contributions but without any further deductions. All income is converted to a monthly basis. Responses with negative incomes are dropped - this only happends due to self-employment reported losses. Again, the data is winsorized at the 99th percentile. Income data is collected each wave.

Location The special access version of the UKHLS survey includes the current place of residence for each respondent in England and Wales down to Lower layer Super Output Areas (LSOAs) according to the Census 2021 data.

Controls Further variables from the survey that are included as controls in the vector X_{it} are level of education, ten-year age bracket, number of children and a year dummy.

Flood and geographical data The Environment Agency's Recorded Flood Outlines data collects dates and geographic informations of historic flooding from rivers, the sea, groundwater and surface water. The Open Geography portal offers boundary set files for all LSOAs.

3.1.1. Measurement

Measuring concern about climate change The questionnaire in waves 4 and 10 includes five questions which I use to measure concern about climate change impacts on the UK. Participants were asked to answer 'yes' or 'no' whether they believed in the statement *People in the UK will be affected by climate change in the next 30 (200) years* and to state the extent to which they agree or disagree with the statements *If things continue on their current course, we will soon experience a major environmental disaster*; *The so-called 'environmental crisis' facing humanity has been greatly exaggerated*; and *The effects of climate change are too far in the future to really worry me*. The scale offered five possible response: 'strongly (dis)agree', 'tend to (dis)agree' and 'neither agree nor disagree'.

To obtain an aggregate index on the belief about climate change, I first normalize all responses to numerical values within the unit interval so that a higher value correspond to higher concern. The resulting variables are positively correlated, though not very highly, see appendix B.2. These auxiliary indices are then aggregated into a single index. In the baseline, my measure will simply be the mean of all normalized responses. Robustness checks with alternative definitions show that the key results are not very sensitive to the exact weighting of variables.

Further questions ask about their belief over individual responsibility for climate change and their environmental habits. Similarly obtained indices based on those responses are included as controls in some robustness checks. All questions as well as the definition of the indices are reported in appendix B.

Measuring exposure There is some evidence that climate change beliefs may be affected by personal exposure, examined for example by Howe et al. (2019) and Rüttenauer (2024). It seems reasonable to expect that those individuals who are individually particularly exposed to climate change, for example due to their place of residence, would also save more to insure themselves.

This poses a challenge for my identification, as I want to examine savings as a response to the aggregate risks of climate change. Controlling for exposure would ensure that my results are not driven by individually highly exposed respondents.

I focus on exposure to floods, which are frequent environmental events in the UK, using the methodology of Rüttenauer (2024) to match historic floods to LSOAs. A respondent is flagged as exposed if their place of residence experienced a flood within the past 2 years which affected more than 3% of the are within a one mile radius of the population-weighted centroid of their respective LSOA. This measure has been shown to have a positive effect on climate change beliefs by Rüttenauer (2024).

3.1.2. Descriptive Statistics

Table 1 collects means and standard deviations of the belief index in each wave and overall. The autocorrelation of this index is $\rho = 0.5268$. Importantly, the index is not perfectly persistent, so that we can exploit the time variation of beliefs within one individual.

[add tables on savings and histogram of index]

	Overall	Wave 1	Wave 2
Mean	0.7181	0.6859	0.7570
SD	0.2162	0.2201	0.2048

Table 1: Descriptive statistics on the concern index

3.2. Empirical strategy

My baseline regression to estimate the relationship between climate change concern and savings is a simple linear specification for $\mathfrak{s}_{it}$ which may either be the probability of saving $\mathbb{P}(s_{it} > 0)$ or the savings share s_{it}:

$$\mathfrak{s}_{it} = \alpha\iota_{it} + \gamma\ln(y_{it}) + \beta X_{it} + \varepsilon_{it}.$$

The value of $\alpha(\mathfrak{s})$ can then be interpreted as the effect of being maximally concerned versus not at all on the probability of saving or the savings share, respectively. As the considered savings variables are restricted, I also specify non-linear models

$$\mathfrak{s}_{it} = G(\alpha\iota_{it} + \gamma\ln(y_{it}) + \beta X_{it} + \varepsilon_{it}).$$

which are solved by maximum likelihood estimation. G is taken to be the logistic function for the binary indicator and the maximum function $G(x) = \max\{x, 0\}$ for the savings share, i.e. a Tobit regression.

Individual fixed effects A key concern for my identification is the role of unobserved idiosyncratic characteristics relevant for both savings and climate beliefs, for example preferences. A particularly patient or risk averse individual would be expected to save more, and also to be more concerned about climate change. As there are two waves which include both savings and climate belief questions, I can control for individual fixed effects and examine within respondent variation. This isolates the effect of climate change concern from those of variables that are constant over the life-cycle, a common assumption for preferences. As the restriction leads to a significant loss in variation, I only control for the log of income when including individual fixed effects:

Distributional heterogeneity The analytical derivations in section 2 suggest a relationship between the savings response to climate change beliefs and the idiosyncratic state. I examine this channel in the data by running my baseline regression separately for each of the five quintiles.

3.3. Results

Tables 2 and 3 report the main results of the empirical estimation on the extensive and the intensive margin, respectively.

Both OLS and a Logit model estimate that the probability to save is 9.5 percentage points

	Probability to save $\mathbb{P}(s > 0)$				
	(1)	(2)	(3)	(4)	(5)
CC concern index ι	0.095***	0.094***	0.095***	0.044**	0.086***
	(0.010)	(0.010)	(0.010)	(0.020)	(0.015)
Wave FE	✓	✓	✓		✓
Income control	✓	✓	✓	✓	✓
Additional controls	✓	✓	✓		
Ind FE				✓	
Exposure control		✓	✓	✓	
Area FE					✓
Observations	64,847	64,847	64,847	44,111	44,094

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table 2: Marginal effect of ι on the probability to save. (1) and (2) are the baseline OLS specifications, where (2) controls for flood exposure. (3) reports the average marginal effect in a Logit model. (4) includes individual fixed effects. (5) includes area fixed effects.

higher for respondents with maximum versus those with no concern, and that this estimate is significant at the 1% level. Controlling for the flood-based exposure measure does not have a major effect; the coefficient is insignificant. As expected, including individual fixed effects makes a larger difference. Still, the probability to save is estimated to be 4.4 percentage point higher for those with high climate beliefs. Importantly, this specification also controls for the exposure measure. Under area fixed effects, the estimate of 8.6 percentage points is again closer to the unconditional OLS estimate.

Table 3 reports the estimated marginal effects of the belief index on the relative amount of savings. Again, the exposure flag plays only a small role. Both OLS specifications estimate an effect on the savings rate of 1.6 percentage points. Under a Tobit model, the average marginal effect is even estimated to be 5.1pp. Including individual fixed effects here makes the estimate insignificant. The specification with area fixed effects is at 1.2pp again close to the OLS estimate.

3.3.1. Distributional analysis

The estimated marginal effects from all separate regressions are reported in table 4. Restricting the sample to the lowest income quintile leads to strong effects: In this subsample, respondents with a maximum concern index are 10.7 percentage points more likely to save as estimated with the standard OLS specification. On the intensive margin, the OLS model esti-

	Savings share s_{it}				
	(1)	(2)	(3)	(4)	(5)
CC concern index ι	0.016^{***}	0.016^{***}	0.051^{***}	-0.002	0.012^{***}
	(0.003)	(0.003)	(0.006)	(0.005)	(0.004)
Wave FE	✓	✓	✓		✓
Income control	✓	✓	✓	✓	✓
Additional controls	✓	✓	✓		
Ind FE				✓	
Exposure control		✓	✓	✓	
Area FE					✓
Observations	60,645	60,645	60,645	41,192	41,175

$^{*}p$ <0.1; **p¡0.05; $^{***}p$ <0.01

Table 3: Marginal effect of ι on the share of savings relative to income. (1) and (2) are the baseline OLS specifications, where (2) controls for flood exposure. (3) reports the average marginal effect in a Tobit model. (4) includes individual fixed effects. (5) includes area fixed effects.

		Q1	Q2	Q3	Q4	Q5
$\mathbb{P}(s_{it} > 0)$	OLS	0.107	0.099	0.066	0.108	0.058
		(0.021)	(0.022)	(0.022)	(0.022)	(0.022)
	Logit	0.109	0.100	0.066	0.108	0.057
		(0.021)	(0.022)	(0.022)	(0.022)	(0.022)
s_{it}	OLS	0.031	0.013	0.014	0.015	0.006
		(0.008)	(0.005)	(0.005)	(0.005)	(0.006)
	Tobit	0.143	0.058	0.036	0.041	0.019
		(0.028)	(0.014)	(0.011)	(0.009)	(0.009)
Observations		13909	13908	13908	13907	13907

Table 4: Marginal effects estimates of concern index on savings variables for subsamples along the income distribution quintiles. Controlling for wave fixed effects, income, exposure, and additional controls.

mates a 3.1 percentage point increase of the savings rate, whereas the Tobit model estimates even 14.3 pp.

There is no clear downwards trend in the effect as income increases. The effects are similarly large in the fourth quintile. However, when restricting the analysis to the top income quintile, the values are significantly lower. The OLS estimate for the intensive margin becomes insignificant.

4 Model

I now turn to a general equilibrium extension of the analytical model from section 2 and impose parametric assumptions. The core of my model follows closely the set up in the seminal paper by Krusell and Smith (1998), with life cycle extensions following Krueger et al. (2016). I extend this framework by introducing a non-stationary shift in the aggregate process, over which agents may have heterogeneous beliefs.

4.1. Households

There is a continuum of consumers of measure 1, a share Ω_{Wt} of young workers and the remaining share $\Omega_{Ot} = 1 - \Omega_{Wt}$ of old age and retired. The young workers face a probability $1 - \theta$ of retiring in the next period, while retirees die with a probability of $1 - \nu$. All deceased are replaced by young working consumers.

Agents can save a non-negative amount $a_{it} \geq 0$ in physical capital which is rented out to firms and pays a return r_t based on the aggregate state of the economy. A fraction δ of the capital stock depreciates during production, so that the net return equals $r_t - \delta$. All assets from the deceased are redistributed to surviving retirees proportionally to their current asset holdings[1].

Each worker is endowed with one unit of time and labor efficiency units $e_{it} \in \mathcal{E}$ from a finite set $\mathcal{E}$ which they supply inelastically to the labor market in exchange for the wage w_t. Efficiency units are stochastic and follow a Markov chain, where the probability of moving from state e to e' is given by $M^E(e', e)$. I impose $\int e_{it} di = 1$ for all t, so that labor supply is exogenously fixed at $L_t = \Omega_{Wt}$. Workers pay social security contributions as a fraction τ^{SS} of their labor income. The budget constraint of each working consumer is thus given by

$$c_{it} + a_{it+1} = (1 - \tau^{SS}) w_t e_{it} + (1 + r_t - \delta) a_{it}. \tag{4.1}$$

Retirees receive transfers b_t^{SS} from social security, so that their budget constraint is

$$c_{it} + a_{i,t+1} = b_t^{SS} + (1 + r_t - \delta) a_{it} / \nu. \tag{4.2}$$

Newly born workers are initially endowed with zero assets and randomly draw a skill level from the current distribution of efficiency units. Let ϕ denote the demographic characteristic of a consumer, i.e. age and skill level, with

$$\phi \in \Phi = \{O, (W, e) | e \in \mathcal{E}\}.$$

Now, define M as the transition matrix of the demographic process, so that $M(\phi', \phi)$ is the probability of moving from state ϕ to ϕ'. We denote the cash on hand for any individual in state (ϕ, a) by $\mathcal{B}(\phi, a)$ and their current income by $\mathcal{I}(\phi, a)$.

A consumer's per-period utility is given by a CRRA utility function $u(c) = \frac{c^{1-\sigma} - 1}{1-\sigma}$ with parameter $\sigma > 1$. The objective of an individual is to maximize their net present utility

$$\max_{c_{it}} \mathbb{E}_{i0} \left[\sum_t^{\infty} \beta^t u(c_{it}) \right]$$

subject to their respective budget constraint $c_{it} + a_{i,t+1} = \mathcal{B}(\phi_{it}, a_{it})$ and the borrowing restriction $a_{it+1} \geq 0$. I write $\mathbb{E}_{i0}$ to emphasize the dependence on current individual expectations.

4.2. Firm

There is a representative firm producing according to a Cobb-Douglas production function using capital and labor as inputs

$$\mathcal{Y}_t = F(K_t, L_t; \zeta_t) = \zeta_t K_t^{\alpha} L_t^{1-\alpha}.$$

Here, α denotes the capital share and ζ_t is a stochastic aggregate shock. The firm demands capital and labor until

$$r_t = F_K(K_t, L_t; \zeta_t), \quad w_t = F_L(K_t, L_t; \zeta_t),$$

consistent with profit maximization.

[1] This can be interpreted as access to perfect annuity markets, see Krueger et al. (2016).

4.3. Aggregate shock process

All aggregate shocks are transmitted via the multiplicative shock to productivity ζ_t. There are two states of the economy, a high state ζ^H and a low state $\zeta^L < \zeta^H$. The low state may represent a variety of disruptions to the global economic system or physical damages and has a positive likelihood even without climate change.

The values ζ_t are drawn independently over time with a per-period probability of the low state $p_t > 0$, which is allowed to vary over time. Specifically, I assume that there is a non-stationary variable T_t and a parameter γ so that

$$p_t = p(T_t) = p^{1-\gamma T_t} \in [p, 1). \tag{4.3}$$

While path of the time-dependent variable T_t is assumed to be common knowledge, there may be disagreement about the parameter γ, determining the variation of p_t over time.

The variable T_t captures any relevant exogenous and deterministic aggregate trends over time. In the baseline model, only the increase in physical impacts from climate change matter. These are assumed to be fully identified by the current increase in global temperature, so that $T_t = \mathsf{T}_t$ is one-dimensional. However, climate change impacts on the economy may also include transitional effects, e.g. due to stranded assets in fossil fuel intensive sectors or innovations in carbon-neutral production. Different to the changes in the physical climate system, these impacts are unlikely to be permanent, and thus have to be accounted for separately. In an extension, I include a dummy variable indicating whether or not productivity is currently harmed by transition and allow $T_t = (\mathsf{T}_t, \mathcal{T}_t)^{tr}$ to be a vector in $\mathbb{R}_{\geq 0} \times \{0, 1\}$. The parameter $\gamma = (\gamma_1, \gamma_2)$ is then a row vector in $\mathbb{R}^2$, and the product in (4.3) is a scalar product. In both cases, rising temperature cannot decrease the probability of the low state, so that $\gamma,\ \gamma_1 \geq 0$.

For current global temperature $Temp_t$, we set $\mathsf{T}_t = \min\{0, Temp_t - \overline{Temp}\}$ to be the increase over some threshold $\overline{Temp}$, beyond which temperature impacts on the aggregate economy become significant. This formulation is consistent with an interpretation of a *damage tipping point*, which is a temperature level above which climate damages become relevant, see also Lontzek et al. (2024). From $t = 0$ onwards, the increase is governed by an AR(1) process

$$T_{t+1} = \mu_T + \nu(T_t - \mu_T) \tag{4.4}$$

where $\mu_T > 0$ is the long run temperature increase and ν is a persistence parameter. Requiring $p_t < 1$ for all t pins down the parametric restriction $\gamma\mu_T < 1$ and $\gamma_1\mu_T + \max\{0, \gamma_2\} < 1$, respectively.

The formulation here is slightly different to most integrated assessment models which assume deterministic changes to the level of productivity caused by climate change. Note that there is an implicit level effect, as a rise in p decreases the **expected** level of output. The stochastic formulation is a key feature of my model, as the uncertainty allows for disagreement over the aggregate process that is not immediately resolved when temperature increases. To ensure consistency, it is crucial to assume that all realized processes are possible under all distinct beliefs held within the population.

4.4. Consumer beliefs

Consumers are assumed to have perfect knowledge over the transition probabilities of demographics, i.e. the matrix M. Furthermore, the current aggregate states ζ_t and K_t as well as the deterministic process $\{T_s\}$ are known.

4.4.1. Beliefs over the aggregate shock

The parameter γ, while constant, is not observable by consumers. They only know that there are two possible values $\gamma \in \{0, \overline{\gamma}\}$. In particular, if T_t is two-dimensional, they believe that either both physical and transitional effects matter for productivity, or that there is no time variation in p_t. For a given period t, let $\overline{\pi}_{it}$ denote consumer i's prior belief that $\gamma = \overline{\gamma}$, i.e. $\overline{\pi}_{it} = \mathbb{P}_{it}(\gamma = \overline{\gamma})$. In every period, everyone observes the state ζ_t and may update their beliefs to obtain a posterior belief π_{it}. Note that the current prior is given by the posterior of the previous period $\overline{\pi}_{it} = \pi_{it-1}$. Updating occurs following Bayes' rule. For a given prior $\overline{\pi}$ and a current level of the variable T, let $\tilde{\pi}(\zeta, \overline{\pi}, T)$ denote the updated belief after ζ is observed and $F(\zeta|\pi, T)$ denote the subjective distribution of ζ. For periods $t \leq 0$, there is no informational value in the aggregate state, so that beliefs are perfectly persistent.

4.4.2. Beliefs over aggregate capital

To solve their intertemporal decision problem, households need to form expectations over future wages and returns which depend on the endogenously determined aggregate capital stock. To accurately forecast prices consistent with rational expectations, they would have to keep track of the entire cross-sectional distribution, leading to an infinitely dimensional state variable. As in the original Krusell and Smith (1998) model, I instead assume that households are boundedly rational and use a *perceived law of motion* (PLM) $\mathcal{H}$ to forecast next period's capital. Their forecast will always depend on the current aggregate shock, the time-trend and capital. It may also depend on their personal belief π, change over time or include stochasticity. I discuss the specifications explicitly in section 4.8 and write for now

$$K' \sim \mathcal{H}(K, \zeta, T; \mathcal{X})$$

where $\mathcal{X}$ summarizes any additional dependencies and $\sim$ should be read as $=$ in the case of no stochasticity.

4.5. Recursive formulation of the consumer problem

The idiosyncratic state consists of the demographic state ϕ, individual assets a and the current belief π. Let Ψ denote the distribution over these individual states, which is defined over the space $\mathbb{S} = \Phi \times \mathbb{R}_{\geq 0} \times [0, 1]$. Assume that the distribution over ϕ is in its stationary equilibrium, so that the labor force does not vary over time. As agents only use the mean of the asset distribution, i.e. aggregate capital, to forecast future prices, their problem can be formulated as depending on the aggregate states capital K, ζ and trend variable T. The subscript captures a possible dependence on $\mathcal{X}$.

$$V_{\mathcal{X}}(\phi, a, \pi, K, \zeta, T) = \max_{c,a'} u(c) + \beta \mathbb{E}\left(V_{\mathcal{X}'}(\phi', a', \pi', K', \zeta', T')\right) \tag{4.5}$$

$$\begin{aligned} s.t.\ \ & c + a' = \mathcal{B}(\phi, a, K, \zeta) \qquad (4.6)\\ & \phi' \sim M(\cdot, \phi),\ \zeta' \sim F(\cdot|\pi, T)\\ & \pi' = \tilde{\pi}(\zeta', \pi),\ T' = \mu_T + \nu(T - \mu_T)\\ & K' \sim \mathcal{H}(K, \zeta, T; \mathcal{X}),\ \mathcal{X}' = \mathcal{G}(\mathcal{X}) \end{aligned}$$

This pins down the choice function $a'_{\mathcal{X}} = a'_{\mathcal{X}}(\phi, a, \pi, K, \zeta, T)$. The expectation is taken over future individual and aggregate states, ϕ' and ζ'.

4.6. Equilibrium

I define the equilibrium of this economy in two steps. In each period, the economy is assumed to be in *temporary equilibrium*. This concept was proposed by [Hicks, Lindahl, Grandmont] and is commonly used in settings of bounded rationality in dynamic problems, see for example [FarhiWerning, Moll]. Beliefs over the future are taken as given, so that a Nash equilibrium is attained when all consumers optimize according to their current expectations. In the *dynamic equilibrium*, the economy is assumed to be in temporary equilibrium within a period, but the realized process may differ from agents' perceptions.

Definition 1 In a period t, taking as given a PLM $\mathcal{H}(K, \zeta, T; \mathcal{X})$ and current state variables ζ_t, Ψ_t and T_t, a *temporary equilibrium* is defined as wage w_t, interest rate r_t and a choice function of households $a' = a'(\phi, a, \pi, K, \zeta, T)$ so that:

(a) The choice function solves the individual household problem defined in (4.5), taking prices as given.

(b) The representative firm sets $r_t = F_K(K_t, L_t; \zeta_t)$, $w_t = F_L(K_t, L_t; \zeta_t)$, consistent with profit maximization.

(c) Capital and labor supply are given by the distribution Ψ_t:

$$L_t = \Omega_{Wt} = \int_{\{\phi=(W,\cdot)\}\times\mathbb{R}_{\geq 0}\times[0,1]} d\Psi_t, \qquad K_t = \int_{\Phi\times\{a\geq 0\}\times[0,1]} a d\Psi_t.$$

The markets for capital, labor and social benefits clear. ◇

Definition 2 For given processes $\{\{\zeta_t\}, \{T_t\}\}_{t\geq 0}$, PLM $\mathcal{H}(K, \zeta, T; \mathcal{X})$ and initial histogram Ψ_0, the *dynamic equilibrium* of the economy is given by a sequence $\{\Psi_t\}_{t\geq 0}$ so that:

(a) Each period, the economy is in temporary equilibrium.

(b) The distribution evolves consistently with the exogenous law of motion for demographics, Bayes' formula, and the endogenous choice function a':

$$\Psi_t(\phi', a', \pi') = \int_{a'(\phi,a,\pi,K_t,\zeta_t,T_t)=a'} \int_\phi \int_{\tilde{\pi}(\zeta_t,\pi)=\pi'} \Psi_{t-1}(\phi, a, \pi) M(\phi', \phi)$$

◇

Note that the initial perceived law of motion $\mathcal{H}$ is not assumed to be an equilibrium outcome, which constitutes a crucial deviation from rational expectations. However, the choices of $\mathcal{H}$ discussed in 4.8 all lead to close approximations of the realized process.

4.6.1. Characterizing the equilibrium

As demographics evolve exogenously, the distribution over ϕ will converge to its unique stationary equilibrium in all dynamic equilibria. We impose this distribution for all simulations. The stationary share of workers and retirees is given by

$$\Omega_W = \frac{1-\nu}{(1-\nu)+(1-\theta)}, \qquad \Omega_O = \frac{1-\theta}{(1-\nu)+(1-\theta)}.$$

Let Ω^E denote the stationary distribution implied by M^E.

In this case, labor is constant over time at $L_t = \Omega_W$. Both wages and interest rates are thus pinned down fully by capital and the aggregate shock ζ_t and given by

$$r_t = r(K_t, \zeta_t) = \alpha\zeta_t(\Omega_W/K_t)^{1-\alpha}, \qquad w_t = w(K_t, \zeta_t) = (1-\alpha)\zeta_t(K_t/\Omega_W)^{\alpha}. \tag{4.7}$$

Furthermore, social benefits depend only current wages and are given by

$$b_t^{SS} = \tau^{SS} w(K_t, \zeta_t)\Omega_W/\Omega_R.$$

The first order condition of consumers with respect to the asset choice, the Euler equation, is given by

$$u'(c_{it}) \geq \beta\mathbb{E}[(1+r_{t+1}-\delta)u'(c_{it+1})], \quad = \text{ if } a_{it+1} > 0.$$

Finally, the law of motion for beliefs is given by

$$\pi_{it} = \pi_{it-1}\mathcal{P}_{it}, \text{ where } \mathcal{P}_{it}^{-1} = \begin{cases} \pi_{it-1} + (1-\pi_{it-1})p^{\overline{\gamma}T_t} & \text{if } \zeta_t = \zeta^L \\ \pi_{it-1} + (1-\pi_{it-1})\frac{1-p}{1-p^{1-\overline{\gamma}T_t}} & \text{if } \zeta_t = \zeta^H. \end{cases} \tag{4.8}$$

The belief π increases in periods of the low state ζ^L and decreases for ζ^H.

In the case of $\zeta_t = \zeta^L$, the posterior π_{it} from a prior $\overline{\pi}_{it} = \pi_{it-1}$ is given by

$$\pi_{it}|(\zeta_t = \zeta^L) = \frac{p^{1-\overline{\gamma}T_t}\pi_{it-1}}{\pi_{it-1}p^{1-\overline{\gamma}T_t} + (1-\pi_{it-1})p} = \frac{\pi_{it-1}}{\pi_{it-1} + (1-\pi_{it-1})p^{\overline{\gamma}T_t}} > \pi_{it-1}.$$

In the case of $\zeta_t = \zeta^H$, updating is given by

$$\begin{aligned} \pi_{it}|(\zeta_t = \zeta^H) &= \frac{(1-p^{1-\overline{\gamma}T_t})\pi_{it-1}}{\pi_{it-1}(1-p^{1-\overline{\gamma}T_t}) + (1-\pi_{it-1})(1-p)} \\ &= \frac{\pi_{it}}{\pi_{it} + (1-\pi_{it})(1-p)/(1-p^{1-\overline{\gamma}T_t})} < \pi_{it}. \end{aligned}$$

4.7. Calibration

Each time period is one year.

Life-cycle parameters The logarithm of efficiency units follows an AR(1) process

$$\log(e_{i,t+1}) = \rho \log(e_{i,t}) + \varepsilon_t$$

where $\varepsilon_t \sim \mathcal{N}(0, \sigma_\varepsilon^2)$. I estimate this process with GLM using time fixed effects and winsorized income data at the 1st and 99th percentile on reported net labor earnings from the subset of employed, working age individuals in the UK Understanding Society survey. This yields a persistence parameter $\rho = 0.93$ and a standard deviation of $\sigma_\varepsilon^2 = 0.073$. These estimates, especially the variance, are rather higher than comparable studies. As responses from a general survey are expected to be more noisy than those in specific income dynamics studies, I assume for my baseline $\rho = 0.9$ and $\sigma_\varepsilon^2 = 0.03$, and run robustness checks assuming a higher variance. The standard deviation of the skill process can be derived by $\sigma_e^2 = \sigma_e^2/(1-\rho^2) = 0.157$. The process is discretized to a grid of $n_e = 7$ nodes using the Tauchen procedure.

The expected duration of working life and retirement is assumed to be 40 and 15 years, respectively, implying $1-\theta = 1/40$ and $1-\nu = 1/15$. The social security tax is assumed to be $\tau_{SS} = 15.3\%$, yielding a replacement rate of approximately 40%, consistent with the estimates used in Krueger et al. (2016).

Aggregate shock I assume $\zeta^H = 1$ and $\zeta^L = 0.93$ so that the economy produces 7% less output in the bad state. The probability p of a low state for $T_t = 0$ is 15%, so that currently, average output loss is equal to 1.5%, consistent with the estimates in Rising et al. (2022) for 2022. Long run temperature is assumed to be 0.9°C above current levels, so that $\mu_T = 0.9$. Most of this transistion is projected to happen by the end of this century, which I match with $\nu = 0.9$, corresponding to $T_{75} = 0.895$. The parameter $\overline{\gamma} = 0.7$ is chosen so that in the long-run, the probability approaches 0.5, corresponding to an average output loss of 3.5%, which Rising et al. (2022) estimate as the effect in 2050. The global temperature increase should here be interpreted as a sufficient statistic measuring the extent of climate change. In particular, the stylized framework may capture a wide range of impacts, for example flooding, agricultural losses and heatwaves, but also disruptions of the global economy.

Preferences and production Utility is given by a CRRA function with a risk aversion of $\sigma = 2$. The Cobb-Douglas parameter for production is set to $\alpha = 0.37$ and capital depreciates at a rate $\delta = 0.08$. The discount factor is assumed to be $\beta = 0.965$ to match a capital to output ratio of 2.7 in the Aiyagari version of the model without aggregate risk, see below.

Grid choices and initial values The asset grid is chosen to be large and spaced denser towards the borrowing constraint. I set $a_{\max} = 35$ and $n_a = 150$. In stochastic steady state distribution without climate change, 50% of the total mass of consumers is concentrated at the lower 35 nodes, and 98% within the lower 100 nodes.

The baseline level of capital, around which the grid is spanned, is given by the market clearing level of an Aiyagari version of the model without aggregate risk. The shock ζ is then constant at its expected mean given $\gamma = 0$, i.e. $\overline{\zeta} = 0.985$. In this version, aggregate variables do not change over time and are known to all agents. This leads to $K_0 = 3.4557$. I span an equidistant grid of $n_K = 15$ gridpoints on $[0.8K_0,\ 1.2K_0]$.

4.8. Computational method

This section discusses the algorithm used to find $\mathcal{H}$, as well as alternative approaches used for comparison and robustness. The methods used for solving the consumer problem and the dynamic equilibrium are more standard and can be found in appendix C.3.

4.8.1. Baseline PLM

In my baseline, $\mathcal{H}$ may depend on the idiosyncratic belief π as well as the aggregate states K, ζ and T. For an agent with belief $\pi \notin \{0,\ 1\}$, $\mathcal{H}$ is assumed to be a convex combination of the PLMs for the extreme beliefs

$$\mathcal{H}_\pi(K, \zeta, T) = (1-\pi)\mathcal{H}_0(K, \zeta) + \pi \mathcal{H}_1(K, \zeta, T).$$

This leaves us with the task to find suitable approximation for the extreme cases, $\pi \in \{0, 1\}$. Here, I follow closely the original work by Krusell and Smith (1998). First, I assume

$$\mathcal{H}_\pi(K, \zeta) = \exp(a_\pi + b_\pi \mathbb{1}_{\zeta=\zeta^L} + c_\pi \log(K) + d_\pi \mathbb{1}_{\zeta=\zeta^L} \log(K) + e_\pi T))$$

with the additional restriction $e_0 = 0$, so that an agent unconcerned about climate change does not expect temperature to have any effect on capital accumulation. The coefficients are found using a slightly modified version of the Krusell-Smith algorithm, in order to account for the non-stationarity. Fix some initial distribution Ψ_0. For $\pi \in \{0, 1\}$, do the following:

1. Make an initial guess for the coefficients of $\mathcal{H}_\pi$.

2. Solve the consumer problem.

3. Draw n_{sim} sequences of ζ from the distribution $F(\zeta|\pi, T)$ for T_{sim} periods and solve the dynamic equilibrium.

4. Update the coefficients of $\mathcal{H}_\pi$ by regressing $\log(K_{t+1})$ on lagged aggregate variables. Iterate until coefficients converge.

The regression for both cases has $R^2 > 1 - 10^{-4}$ and $MSE < 10^{-8}$. It takes about 35 minutes on a MacBook from 2020 to find coefficients for both PLMs with $n_{sim} = 1000$ and $T_{sim} = 200$ under the error bound 10^{-6}.

A standard implementation of the Krusell-Smith algorithm would discard the first few thousand periods of the simulation before running the regression. This is not feasible for the present model due to the non-stationarity introduced by temperature increase, making a sensible initial distribution Ψ_0 crucial. I choose the stationary distribution from the Aiyagari model and assume that all agents share the belief π starting from $t = 0$. As the simulation algorithm is only used for the extreme cases $\pi \in \{0, 1\}$, there is no learning; these agents are further assumed to be unaware of any agents with different beliefs in the economy when forecasting capital. For inner values of $\pi \in (0,1)$, however, agents can be interpreted as only assuming that their personal belief is the mean of the population, but being open to other beliefs in the economy. For a given PLM, I obtain the stochastic steady state without climate change as the long run distribution of the dynamic equilibrium for the process $\zeta_t = \overline{\zeta}$. To validate the converged coefficients, I run one final step of the algorithm starting with the resulting asset distribution.

While the choice for n_{sim} and T_{sim} yield a large number of observations overall, random draws may lead to large deviations of the ζ^L share across the number of draws from p_t within a time period. To ensure matching the share correctly, I use stratified samples within each period. This substantially decreases the variation across periods, while still accurately matching the spread in outcomes within a period.

4.8.2. Accounting for future learning

The future state ζ' does not have a direct effect on the law of motion, as capital accumulation is determined by current savings. However, the future state affects the belief π, so that there will be an indirect learning effect. As a robustness check, I consider the alternative specification $K' \sim \mathcal{H}_{\pi'}(K, \zeta, T)$. Future capital is stochastic as it depends on the belief π' which is affected by next period's aggregate state ζ'. The quantitative implications of this additional channel are small.

4.8.3. Adaptive PLM

The formulation above abstracts from any distributional effect on capital accumulation. As beliefs affect savings choices, the cross-sectional beliefs of the population matter for aggregate savings. Particularly in the non-stationary framework, more concerned agents grow richer over time, which pushes up their marginal propensity to save further. Thus, we might expect a persistent error between predicted and realized capital. In the static approach above, agents do not improve on $\mathcal{H}$ if their predictions about future capital were wrong before.

In an alternative specification, I allow for an adaptive PLM, meaning that households update the function $\mathcal{H}$ after observing outcomes from previous periods. This extension adresses the critique brought forward by Moll (2024): Instead of assuming that agents simulate the economy forward, they base their beliefs on observed variables. This point becomes more critical in a non-stationary framework, where we cannot interpret the simulation as an extrapolation from previous observations.

To introduce the adaptive algorithm, let $\{\zeta_t\}$ be some fixed draw of productivity shocks. Let $\mathcal{H}_0^{adp}(K, \zeta, T)$ be some initial guess for the perceived law of motion. In my implementation, I take this to be the static PLM of the type $\pi = 0$ and drop the explicit dependence on T, as temperature increase is fully pinned down by time. We assume the same fixed functional form as before and abstract from dependency on the belief π, as everyone observes and learns from the same aggregate states. Let Θ denote the set of coefficients, so that

$$\mathcal{H}_0^{adp}(K, \zeta) = \mathcal{F}(K, \zeta; \Theta_0).$$

Further, let Σ_0 denote the covariance matrix obtained from the initial regression. Fix some $s > 0$, which will be the interval over which agents do not change their PLM. They update at points $\{t_s^* = ts \mid t \geq 0\}$, so that $\mathcal{H}_{t_s^*}^{adp} = \mathcal{H}_{t_s^*+i}^{adp}$ for all $i = 0...s-1$.

At any t_s^* for $s > 0$, update the coefficients and use them to solve for new choice functions. The updated coefficients can be found recursively by combining the previous guess and the new data $\mathbf{Y}_s = (\log(K_{t+1}))_{t=t_s^*+i}$ and

$$\mathbf{X}_s = (1,\ \log(K_t),\ \mathbb{1}_{\zeta_t=\zeta^L},\ \mathbb{1}_{\zeta_t=\zeta^L} \cdot \log(K))_{t=t_s^*+i}.$$

Assume Θ_{s-1} is the best linear approximation given all previous data $(\mathbf{X}_{-s}, \mathbf{Y}_{-s})$ and $\Sigma_{s-1}$is the corresponding covariance matrix. The covariance matrix on the entire data set then fulfils

$$\Sigma_s = \mathbf{X}_s^\top \mathbf{X}_s + \mathbf{X}_{-s}^\top \mathbf{X}_{-s} = \mathbf{X}_s^\top \mathbf{X}_s + \Sigma_{s-1}.$$

Using the identity $\Theta_{s-1} = \Sigma_{s-1}^{-1} \left(\mathbf{X}_{-s}^\top \mathbf{Y}_{-s} \right)$ for the previous OLS estimator, the updated estimator on all data can now be expressed as

$$\begin{aligned}
\Theta_s &= \Sigma_s^{-1} \left[\mathbf{X}_{-s}^\top \mathbf{Y}_{-s} + \mathbf{X}_s^\top \mathbf{Y}_s \right] \\
&= \Sigma_s^{-1} \left[\left(\Sigma_s - \mathbf{X}_s^\top \mathbf{X}_s \right) \Theta_{s-1} + \mathbf{X}_s^\top \mathbf{Y}_s \right] \\
&= \Theta_{s-1} + \Sigma_s^{-1} \mathbf{X}_s^\top \left[\mathbf{Y}_s - \mathbf{X}_s \Theta_{s-1} \right].
\end{aligned}$$

In particular, it suffices to carry the estimate Θ_{s-1} and the 4×4 dimensional covariance matrix Σ_{s-1} for this updating procedure.

An underlying assumption of this updating procedure is that the coefficients have not structurally changed due to climate change. This is in contrast to the

5 Model results

5.1. Savings choices in general equilibrium

This section explores in detail the individual savings choices within the general equilibrium model, which drive capital accumulation in the aggregate. While section 2 provides important insights into the effect of a marginal change in beliefs on savings choices by uncovering the first-order drivers of the response, it becomes necessary to consider computational results from the globally solved model in order to examine responses under large shifts, which are more realistic in the case of climate change.

I denote by savers all agents who save part of their current income and thus choose $a' > (1-\delta)a$. This is a more restrictive characterization of saving than choosing to be asset unconstraint in the next period, i.e. $a' > 0$, and includes only those agents who do not rely on their savings for current consumption.

Under the baseline PLM, the asset choice $a'(\phi, a, \pi, K, \zeta, T)$ varies in the cross-section for a given aggregate state due to heterogeneity in the demographic state ϕ, asset holdings a and the belief π. As discussed in section 2, the difference in asset choices between otherwise

		$T = 0$		$T = \mu/2$		$T = \mu$	
		K_0^{SSS}	K_{CC}^{SSS}	K_0^{SSS}	K_{CC}^{SSS}	K_0^{SSS}	K_{CC}^{SSS}
Likelihood to save	ζ^L	0.804%	1.150%	3.028%	3.470%	6.434%	5.713%
	ζ^H	0.050%	0.049%	0.320%	0.310%	2.094%	2.242%
Savings share	ζ^L	0.263%	0.251%	0.526%	0.523%	0.981%	0.989%
	ζ^H	0.279%	0.262%	0.560%	0.545%	1.017%	1.006%
Savings share conditional	ζ^L	0.387%	0.364%	0.773%	0.758%	1.443%	1.434%
	ζ^H	0.366%	0.344%	0.734%	0.715%	1.333%	1.320%

Table 5: Average differences between agents with $\pi = 1$ and those with $\pi = 0$ in their likelihood to save and their savings share (relative to current income). The savings share in the final row is taken conditional on the agents saving under $\pi = 0$.

identical agents with different π depends on their current idiosyncratic state. Similarly, asset choices of course depend on the current aggregate state, as individuals smooth consumption in periods of low income, which depends not only on the shock ζ but also on current capital K.

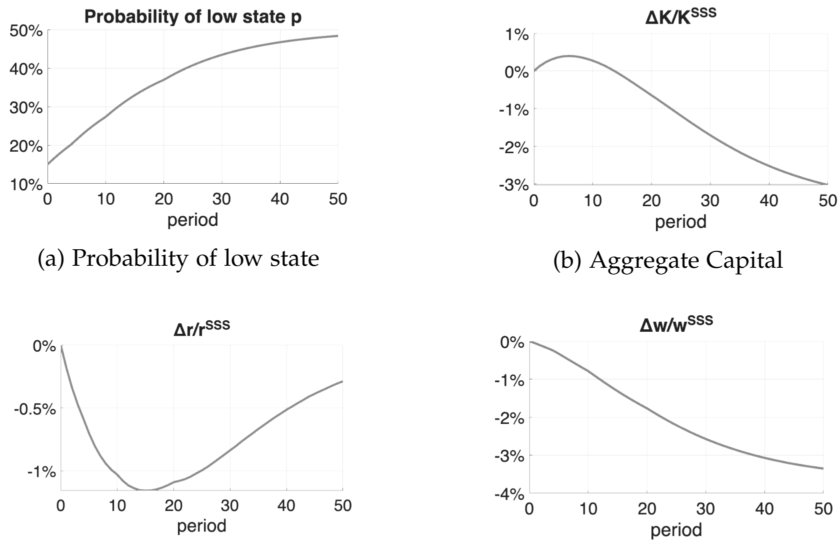
Table 5 illustrates the difference in savings choices between concerned and unconcerned agents in three key statistics: the likelihood to save and savings as a share of income, both on average and conditional on saving when unconcerned. To account for dependency on the aggregate state, I report these values for an individual moving from state $\pi = 0$ to $\pi = 1$[2] for the high and low productivity state, different levels of temperature and capital at its stochastic steady state value before and after the climate transition[3].

First, we notice that the increase in likelihood to save from being more concerned about climate change is substantially higher for the low than the high productivity state. All agents have an incentive to save in good times, so that they can use their savings in bad times in order to smooth consumption. Those who believe that the bad times only happen infrequently engage more in consumption smoothing and thus have a higher likelihood to stop saving in periods of low productivity. This shows the interplay between beliefs and periods of low productivity, especially as temperatures increase, which widens the discrepancy in beliefs about the near future. Variation between productivity states however matters little for differences in the savings share. [add relevance of temperature and capital]

[add table or figure on cross sectional variation]

[2]Comparing the edge cases of beliefs has the benefit that there is no learning effect of the current productivity state.

[3]Before the transition to high temperatures, aggregate capital falls below $K_C^{SSS}C$ in about 12% of simulations, and similarly, after the transition, aggregate capital is above K_0^{SSS} in roughly 10% of simulations. In particular, the consumption function is well-defined for all combinations presented in table 5. For both capital values, the underlying asset distribution is taken to be the one of the respective SSS.



(a) Probability of low state

(b) Aggregate Capital

(c) Rate of return

(d) Average wage

Figure 1: Dynamics of the probability p_t of the low state and of key aggregate variables under accurate beliefs. Panels (b)-(c) show deviations from the stochastic steady state value, averaged over 1000 simulations.

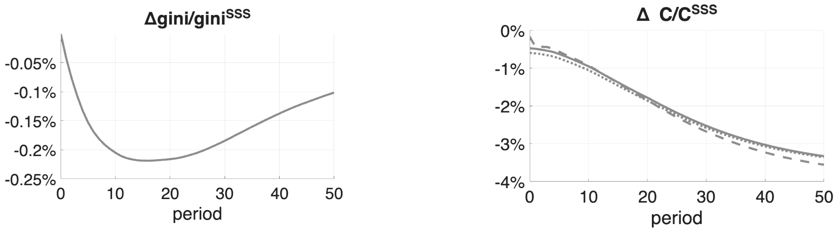
5.1.1. Disentangling beliefs over climate shocks and capital accumulation

As the PLM for capital depends on the current belief π, the variation above includes both the effect of differing expectations over productivity shocks and over future capital. To disentangle the effects, I also compute asset choices under two alternative laws of motion: first, everyone continues to assume the PLM from before the climate transition, and second, everyone has fully adaptive expectations over capital, thus acting as if future capital will be the same as today. In contrast to the responses derived in section 2, the comparison between agents with different climate beliefs under fully adaptive expectations about capital using globally solved individual choice function accounts not only for higher order effects, but also for the more large-scale shifts expected under climate change.

[add table]

5.2. Macroeconomic dynamics under accurate expectations

To illustrate the dynamics caused by the shift in temperature, we first focus on the case of homogenous and accurate beliefs. In period 0, everyone becomes aware of the increase in temperature and its effect on the likelihood of the low probability state. Figure 1 shows the time series of the probability p_t as well as the averages across 1000 draws of the dynamic equilibrium of key aggregate variables. Initially, the higher incentive to save caused by changed beliefs leads to a slight increase in capital, but after about 10 periods, the physical effect of the changed aggregate process dominates and average capital decreases to its new long run average. The rate of return drops initially, due to both the decreased average productivity and the increase in capital. As the capital stock diminishes, the rate of return picks up again. Average wages decrease as climate change progresses, with an initially muted effect due to the rise in capital.



(a) Gini coefficient

(b) Consumption

Figure 2: Distributional dynamics. The figures show deviations from the stochastic steady state value, averaged over 10000 simulations. In panel (b), the solid line is average consumption, the dashed line is average consumption within the first wealth quintile, and the dotted line is average consumption within the fifth wealth quintile.

Figure 2 illustrates the distributional consequences of the shift in temperature. As capital rises and the rate of return falls, wealth inequality as measured by the Gini coefficient slightly drops. In the long run, however, the reduction in productivity increases wealth inequality. Consumption within the first quintile of the wealth distribution is depicted as the dashed line in panel 2b. As this group includes the share of non-savers who do not react to the increase in p_t, consumption of this group initially decreases less than the average. The relative decrease in the long run however is lower.

6 Conclusion

This paper examines an increase in individual savings as a response to concern about climate change. Motivated by the predictions of a standard consumption-savings model, I first present empirical evidence on higher savings of individuals who are more concerned about climate change. A general equilibrium model shows how accurate beliefs increase welfare indirectly through their effect on savings as the economy moves along the climate transition path. The role of savings here is two-fold: The insurance value for the individual, to ensure consumption smoothing, and the value for the aggregate economy as a factor of production.

In particular, my work uncovers key macroeconomic consequences of individual conceptions about aggregate shifts. Importantly, the impacts are not evenly distributed along the wealth distribution: Poor households are the ones who suffer most from inaccurate average beliefs, as wages decrease due to undersaving. The wealthy, on the other hand, benefit from higher returns as capital becomes more scarce. Both the aggregate and distributional results emphasize the social value of savings, complementary to the private value which determines the individual responses. In particular, if a policy maker is more aware of an aggreggate shift than the public, they may choose to incentivize savings exogenously to mitigate utility losses along the transition path.

The partial equilibrium model shows that poor, low income agents are the ones whose marginal value of holding additional assets rises the most under climate change. Due to a low MPS, this does not necessarily translate into a large response. The full model shows however that the more relevant determinant of their welfare is not individual savings, but rather the increase in capital.

The general model can be applied to a broad range of questions surrounding uncertain aggregate shifts in heterogeneous agent models, including the rise of artifical intelligence or the fertility decline.

References

L. Bakkensen, T. Phan, and T.-N. Wong. Leveraging the disagreement on climate change: Theory and evidence. *Federal Reserve Bank of Richmond Working Papers*, 23:1–75, 1 2023. ISSN 2475563X. doi: 10.21144/wp23-01.

L. A. Bakkensen and L. Barrage. Going underwater? flood risk belief heterogeneity and coastal home price dynamics. *The Review of Financial Studies*, 35:3666–3709, 8 2022. ISSN 0893-9454. doi: 10.1093/rfs/hhab122. URL https://doi.org/10.1093/rfs/hhab122.

T. Broer, A. Kohlhas, K. Mitman, and K. Schlafmann. Expectation and wealth heterogeneity in the macroeconomy. *CEPR Discussion Paper*, 2022.

Y. Cai and T. S. Lontzek. The social cost of carbon with economic and climate risks. *Journal of Political Economy*, 127:2684–2734, 2019. doi: 10.1086/701890.

C. D. Carroll. The method of endogenous gridpoints for solving dynamic stochastic optimization problems. *Economics Letters*, 91:312–320, 2006. ISSN 0165-1765. doi: https://doi.org/10.1016/j.econlet.2005.09.013. URL https://www.sciencedirect.com/science/article/pii/S0165176505003368.

H. Chen, S. Joslin, and N.-K. Tran. Rare disasters and risk sharing with heterogeneous beliefs. *The Review of Financial Studies*, 25:2189–2224, 7 2012. ISSN 0893-9454. doi: 10.1093/rfs/hhs064. URL https://doi.org/10.1093/rfs/hhs064.

A. Dechezleprêtre, A. Fabre, T. Kruse, B. Planterose, A. S. Chico, and S. Stantcheva. Fighting climate change: International attitudes toward climate policies. *NBER working paper*, 2022. doi: https://doi.org/https://doi.org/10.1787/3406f29a-en.

E. Farhi, H. A. Olivi, and I. Werning. Price theory for incomplete markets *. Technical report, 2022.

J. Fernández-Villaverde, S. Hurtado, and G. Nuño. Financial frictions and the wealth distribution. *Econometrica*, 91:869–901, 2023. ISSN 0012-9682. doi: 10.3982/ecta18180.

I. for Social and E. R. U. of Essex. Understanding society: Waves 1-12, 2009-2021 and harmonised bhps: Waves 1-18, 1991-2009, 2022.

H. Hong, N. Wang, and J. Yang. Mitigating disaster risks in the age of climate change. *Econometrica*, 91:1763–1802, 2023. ISSN 0012-9682. doi: 10.3982/ecta20442.

P. D. Howe, J. R. Marlon, M. Mildenberger, and B. S. Shield. How will climate change shape climate opinion? *Environmental Research Letters*, 14:113001, 2019.

D. Krueger, K. Mitman, and F. Perri. *Chapter 11 - Macroeconomics and Household Heterogeneity*, volume 2, pages 843–921. Elsevier, 2016. doi: https://doi.org/10.1016/bs.hesmac.2016.04.003. URL https://www.sciencedirect.com/science/article/pii/S1574004816300039.

P. Krusell and A. A. J. Smith. Income and wealth heterogeneity in the macroeconomy. *Journal of Political Economy*, 106:867–896, 1998. ISSN 00223808, 1537534X. doi: 10.1086/250034. URL http://www.jstor.org/stable/10.1086/250034.

T. Lontzek, W. Pohl, K. Schmedders, M. Thalhammer, O. Wilms, A.-F. Allard, R. Bansal, N. Branger, E. Fama, K. Fabisik, C. Gao, L. P. Hansen, K. L. Judd, R. Koijen, S. Nagel, C. Pflueger, S. Pouget, E. Rossi-Hansberg, C. Schneider, and P. Whelan. Asset pricing with disagreement about climate risks *. Technical report, 2024.

B. Moll. The trouble with rational expectations in heterogeneous agent models: A challenge for macroeconomics. 2024.

W. Nordhaus. *A Question of Balance: Weighing the Options on Global Warming Policies*. Yale University Press, 2008. ISBN 9780300137484.

J. Rising, S. Dietz, M. Dumas, R. Khurana, J. Kikstra, T. Lenton, M. Linsenmeier, C. Smith, C. Taylor, and B. Ward. What will climate change cost the uk? risks, impacts and mitigation for the net-zero transition. Technical report, Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science., 2022.

T. Rüttenauer. More talk, no action? the link between exposure to extreme weather events, climate change belief and pro-environmental behaviour. *European Societies*, 26:1046–1070, 8 2024. ISSN 1461-6696. doi: 10.1080/14616696.2023.2277281. URL https://doi.org/10.1080/14616696.2023.2277281. doi: 10.1080/14616696.2023.2277281.

C. Severen, C. Costello, and O. Deschênes. A forward-looking ricardian approach: Do land markets capitalize climate change forecasts? *Journal of Environmental Economics and Management*, 89:235–254, 2018. ISSN 0095-0696. doi: https://doi.org/10.1016/j.jeem.2018.03.009.

A Analytical model

A.1. Analytical derivations

Proof (Proposition 1) We drop the index i in this appendix. Combining the Euler equation and the envelope theorem yields

$$u'(c_t) = \beta \mathbb{E}[V'(a_{t+1})].$$

A perturbation of the system by dp_s for any $s > t$ can be written as

$$\begin{aligned} u''(c_t)dc_t = \beta \Big\{ & \Big(\mathbb{E}[V'(a_{t+1})|\zeta^L] - \mathbb{E}[V'(a_{t+1})|\zeta^H] \Big) dp_{t+1} \\ & + \mathbb{E}[V'']da_{t+1} + \mathbb{E}\left[dV'|_{da_{t+1}=0} \right] \Big\}. \end{aligned} \tag{A.1}$$

We write

$$\mathcal{D}_t = \frac{\mathbb{E}[V'(a_{t+1})|\zeta^L] - \mathbb{E}[V'(a_{t+1})|\zeta^H]}{\mathbb{E}[V'(a_{t+1})]}$$

for the expected difference in marginal value between the low and high aggregate state, relative to the overall expected marginal value. As there is no income effect, $da_{t+1} = -dc_t$ holds. Exploiting the identity $MPCu''(c) = \beta MPS\mathbb{E}[V'']$ and using the elasticity of intertemporal substitution ε for convenience of notation leads to

$$\frac{dc_t}{c_t} = MPS_t\varepsilon_t \left\{ \mathcal{D}_t dp_{t+1} + \frac{\mathbb{E}[dV'|_{da_{t+1}=0}]}{\mathbb{E}[V']} \right\}.$$

The final term $\mathbb{E}[dV'|_{da_{t+1}=0}]$ may be different from zero only due to substitution in the future, caused by $dp_s > 0$ for $s > t+1$. An application of the envelope theorem shows

$$dV'|_{da_{t+1}=0} = R_{t+1}u''(c_{t+1})dc^S_{t+1}$$

where dc^S is the Slutsky compensated demand change. But this is precisely the response just derived for dc_t, which can be plugged in to obtain

$$R_{t+1}u''(c_{t+1})dc^S_{t+1} = R_{t+1}\frac{u'(c_{t+1})}{\varepsilon_{t+1}}\frac{dc^S_{t+1}}{dc_{t+1}} = V'_{t+1}MPS_{t+1}\left\{ \mathcal{D}_{t+1}dp_{t+2} + \frac{\mathbb{E}\left[dV'_{t+2}\right]}{\mathbb{E}[V'_{t+2}]} \right\}.$$

Solving the system forward gives the time 0 response in terms of fundamentals

$$\frac{dc_0}{c_0} = MPS_0\varepsilon_0 \sum_{t=0}^{\infty} \left(\sum_{\theta^t} \mathbb{P}^*(\theta^t) \left(\prod_{j=1}^{t} MPS(\theta^j) \right) \mathcal{D}_t(\theta^t) \right) dp_{t+1} \tag{A.2}$$

where

$$\mathbb{P}^*(\theta^t|\theta^{t-1}) = \mathbb{P}(\theta^t|\theta^{t-1})\frac{V'(a_t,\theta^t)}{\mathbb{E}[V'(a_t,\theta^t)]}$$

is the risk-adjusted weight on the state θ^t. □

To first order, the positive effect on asset holdings does not affect the marginal propensity to save. As a consequence, the response to dp_{t+1} does not depend on dp_t.

A.2. Numerical illustration

B Data

B.1. Survey questions

Tables 6 and 7 report all questions which are related to climate change concern.

Tables 8 - 12 report the precise questions and response modalities for the variables concerning environmental habits (table 8), beliefs and attitudes (tables 9 - 10) and savings (table 12).

Table **??** reports descriptive statistics on the responses on savings. From wave 4 to wave 10, both the share of respondents stating that they save and the average amount of savings per

Please select whether, on the whole, you personally believe or do not believe each of the following statements.

Response options are: yes (1), no (2)

Statement	Variable name
People in the UK will be affected by climate change in the next 30 years.	scopecl30
People in the UK will be affected by climate change in the next 200 years	scopecl200

Table 6: Beliefs about extent of climate change, asked in waves 4 and 10

Please select the extent to which you agree or disagree with the following statements.

Response options are: strongly agree (1), tend to agree (2), neither agree nor disagree (3), tend to disagree (4), strongly disagree (5)

Statement	Variable name
If things continue on their current course, we will soon experience a major environmental disaster.	meds
The so-called 'environmental crisis' facing humanity has been greatly exaggerated.	crex
The effects of climate change are too far in the future to really worry me.	nowo

Table 7: Beliefs concerning climate change, asked in waves 4 and 10

Now a few questions about the environment.

Could you tell me how often you personally do each of the following things.

Response options are: always (1), very often (2), quite often(3), not very often (4), never (5)

Habit	Variable name
Leave your TV on standby for the night	envhabit1
Switch off lights in rooms that aren't being used	envhabit2
Keep the tap running while you brush your teeth	envhabit3
Put more clothes on when you feel cold rather than putting the heating on or turning it up	envhabit4
Decide not to buy something because you feel it has too much packaging	envhabit5
Buy recycled paper products such as toilet paper or tissues	envhabit6
Take your own shopping bag when shopping	envhabit7
Use public transport (e.g. bus, train) rather than travel by car	envhabit8
Walk or cycle for short journeys less than 2 or 3 miles	envhabit9
Car share with others who need to make a similar journey	envhabit10
Take fewer flights when possible	envhabit11

Table 8: Questions about environmental habits in waves 4 and 10

Question	Variable name	Response options
Which of these best describes how you feel about your current lifestyle and the environment?	ftst	happy with what I do (1), like to do a bit more (2), like to do lots more (3)
Which of these would you say best describes your current lifestyle?	crlf	I don't really do anything (1), do one or two things (2), do quite a few things (3) that are environmentally-friendly, I'm environmentally friendly in most things (4), everything (5) I do
Do you agree or disagree that being green is an alternative lifestyle, it's not for the majority?	grn	agree strongly (1), agree (2), disagree (3), disagree strongly (4)

Table 9: Opinions about personal lifestyle in relation to the environment, asked in waves 4 and 10

Please select the extent to which you agree or disagree with the following statements. Response options are: strongly agree (1), tend to agree (2), neither agree nor disagree (3), tend to disagree (4), strongly disagree (5)

Statement	Variable name
My behavior and everyday lifestyle contribute to climate change.	bccc
I would be prepared to pay more for environmentally-friendly products.	pmep
Climate change is beyond control - it's too late to do anything about it.	tlat
Any changes I make to help the environment need to fit in with my lifestyle.	fitl
It's not worth me doing things to help the environment if others don't do the same.	noot
It's not worth the UK trying to combat climate change, because other countries will just cancel out what we do.	canc

Table 10: Beliefs concerning climate change, asked in waves 4 and 10

Statement	Response options
Do you save any amount of your income, for example by putting something away now and then in a bank, building society, or Post Office account, other than to meet regular bills? Please include share purchase schemes and ISA's.	Yes (1), No (2)
About how much on average do you personally manage to save a month?	numerical value

Table 11: Questions about savings, asked in even waves

Statement	Response options
Would you say your savings are mainly long term savings for the future or mainly short term savings for things you need now and for unexpected events?	Mainly long term (1), mainly short term (2), both equally (3), neither (4)

Table 12: Question about long term and short term savings

	fitl	noot	pmep
fitl	1		
noot	0.321	1	
pmep	0.140	0.218	1

Table 13: Correlations between indicator variables for ι^{resp}

month increased.

Table 12 reports the additional savings related question, asking about long term vs short term savings.

To evaluate the responses for the question on long-term vs short-term savings, I create dummies on what they indicated, with those that responded *Both equally* being put in both groups.

B.2. Construction of additional indices

A second index, ι^{resp}, aims to measure how much the participant believes that they have an individual responsibility and scope to mitigate climate change. In the baseline specification, this index is calculated based on the degree to which participants agree or disagree with the statements *It's not worth me doing things to help the environment if others don't do the same* (noot), *I would be prepared to pay more for environmentally-friendly products* (pmep) and *Any changes I make to help the environment need to fit in with my lifestyle* (fitl). Again, the indicators are realigned and normalized, and a higher value means a higher belief that individual action can mitigate climate change. Table 13 shows the correlations of the different indicators after being realigned and normalized.

The two indices are positively correlated with a correlation coefficent of

$$\rho_\iota = 0.463.$$

It is plausible that people are worried about the climate but do not consider themselves able to do anything about it, i.e. having a high value for ι^{conc} but a low value for ι^{resp}. It is more surprising to see that there are some people who report a high degree of assuming personal responsibility, but lower concern for the climate. These may be people who are concerned about the environment rather than the climate, or people who believe that the global climate is changing due to anthropogenic emissions, but without a large impact on themselves and the UK.

	Wave 4	Wave 10	Total
ι^{conc}	0.669	0.740	0.701
	(0.199)	(0.191)	(0.199)
ι^{resp}	0.507	0.557	0.530
	(0.173)	(0.173)	(0.175)
η^{hh}	0.539	0.572	0.554
	(0.168)	(0.154)	(0.163)
η^{transp}	0.226	0.263	0.243
	(0.182)	(0.204)	(0.193)

Table 14: Descriptive statistics for indices. Means with standard deviations in brackets

	ι^{conc}	ι^{resp}	η^{hh}	η^{transp}
ι^{conc}	1			
ι^{resp}	0.464	1		
η^{hh}	0.215	0.263	1	
η^{transp}	0.120	0.145	0.226	1

Table 15: Correlations between indicator variables for ι^{resp}

The questions about an individual's environmental habits can broadly be separated into two classes: One accounting for environmentally friendly behavior in the household, e.g. saving energy around the house and reducing packaging, and one describing habits concerning transportation, e.g. using car sharing platforms or avoiding flying when possible. The participants are asked how often they take certain actions and respond on a five step scale ranging from *Always* to *Never*. As for ι^{conc} and ι^{resp}, the indicators are normalized to lie between 0 and 1 and realigned such that higher numbers reflect enganging in an environmental habit more often. They are then aggregated into two indices representing the two classes, η^{hh} for habits in the household and η^{transp} for habits related to transportation.

Table 14 displays means and standard deviations for each of the indices. The means of all of the indices increased from wave 4 to wave 10, indicating that people became more aware about climate change, more conscious about their own contribution and also engaged in environmental habits more often. Table 15 shows the pairwise correlations of all four indices with each other. In particular, note that both habits indices are slightly more correlated with ι^{resp} than with ι^{conc}.

C Computational details

C.1. Solving the consumer problem

I solve for maximizing asset choice a' directly using the endogenous grid method suggested by Carroll (2006). This avoids solving maximization problem in each period, significantly simplifying computation. Assume for this section the consumer uses a given function $\mathcal{H}_\pi$ as PLM.

Guess some function V_a to be the value function's derivative with respect to a on the asset grid. For any agent in state (ϕ, π, K, ζ, T) who chooses the asset level $a' > 0$, the first order and envelope conditions together pin down the corresponding consumption choice

$$c = u_c^{-1}\left(\beta \mathbb{E} V_a(\phi', a', \pi', K', \zeta', T')\right).$$

The budget constraint can be rearranged to then find the current level of assets

$$a = \frac{c + a' - \mathcal{I}(\phi; K, \zeta, T)}{1 + r(K, \zeta) - \delta}.$$

This endogenously determines the grid A' for current assets. The envelope theorem then pins down V_a on A' which can be interpolated onto the initial grid A and used as an updated guess. I iterate until the convergence error is $< 10^{-6}$.

C.2. Solving the dynamic equilibrium

With given choice functions a', the definition of a dynamic equilibrium pins down all variables in the economy for a given sequence $\{\zeta_t\}$. In practice, however, the choice function is only defined on a discrete grid, thus requiring interpolation both within the cross-section and on the aggregate variables. For the former, I follow the endogenous gridpoint method for distributional dynamics suggested by Bayer et al. (2024) which generalizes the histogram method of Young (2006). To ensure shape preservation, in particular monotonicity, I use piecewise cubic Hermite interpolation instead of splines.

C.3. Initial distribution of beliefs

To initialize the cross section of beliefs π, I compare parametric and non-parametric approaches. An important choice in a setting with learning is whether or not to include people with $\pi \in \{0, 1\}$, as they have no uncertainty and do not learn.

For the non-parametrical approach, I use the mean over waves 4 and 10 of the empirically observed histogram from the UK Understanding Society Survey. With this choice, there is a share of .. with $\pi = 0$ and a share of .. with $\pi = 1$.

The standard continuous parametrization of a distribution over $[0, 1]$ is the Beta distribution, which is fully identified by the mean μ_Π and variance Σ_Π. With this parametrization, the atomic mass of agents with a specific belief will always be zero. In the baseline, I discretize using nodes within $(0, 1)$, so that all agents are somewhat uncertain. To allow for some flexibility when introducing extreme beliefs, I fix the shares s_0 and s_1 of agents with $\pi = 0$ and 1, respectively, and then fit a Beta distribution on $(0, 1)$. When fixing overall mean and variance, the parameters for the inner Beta distribution are pinned down by

$$\mu_{\Pi,B} = \frac{\mu_\Pi - s_1}{1 - s_0 - s_1}$$

and

$$\Sigma_{\Pi,B} = \frac{\Sigma_\Pi - s_1 + \mu_\Pi^2}{1 - s_0 - s_1} - \mu_{\Pi,B}^2.$$