Household Climate Finance: Theory and Survey Data on Safe and Risky Green Assets

Shifrah Aron-Dine
Stanford

Johannes Beutel
Deutsche Bundesbank

Monika Piazzesi
Stanford & NBER

Martin Schneider
Stanford & NBER

Eltville, May 2023

Disclaimer: The views expressed in this presentation are those of the authors and do not necessarily reflect the Deutsche Bundesbank, or the Eurosystem.

Motivation

- Can financial markets accelerate the transition to a green economy?

- Answer depends on
  - convenience yields, i.e. nonpecuniary benefits from holding green assets
  - hedging demand for green assets, i.e. their use as insurance against climate risks
  - expectations about financial returns on green assets?

Motivation

- Can financial markets accelerate the transition to a green economy?
- Answer depends on
  - convenience yields, i.e. nonpecuniary benefits from holding green assets
  - hedging demand for green assets, i.e. their use as insurance against climate risks
  - expectations about financial returns on green assets?
- This paper provides new micro evidence & quantitative asset pricing model with het agents
  - measure taste of households and their expectations about financial returns for green assets
  - actual green asset holdings, other asset holdings, characteristics like age, income, and wealth from representative survey of German households
  - counterfactuals to understand whether and how sustainable investing matters

Findings

- Green investments are popular but currently mostly risky
  - 34% of households have some green account, mostly green equity: overall 8% of total assets

Findings

- Green investments are popular but currently mostly risky
  - 34% of households have some green account, mostly green equity: overall 8% of total assets
- Important heterogeneity in green taste: does not always increase demand for green
  - heterogeneity present throughout wealth distribution, correlates with political party
  - convenience yields and hedging demands for green equity range from positive to negative

Findings

- Green investments are popular but currently mostly risky
  - 34% of households have some green account, mostly green equity: overall 8% of total assets
- Important heterogeneity in green taste: does not always increase demand for green
  - heterogeneity present throughout wealth distribution, correlates with political party
  - convenience yields and hedging demands for green equity range from positive to negative
- Current relevance of sustainable investing
  - distribution of tastes: on net, lowers prices of green firms
  - attention to green stocks ($=$ taste $+$ beliefs) increases prices of green firms, greenium $+82$bp

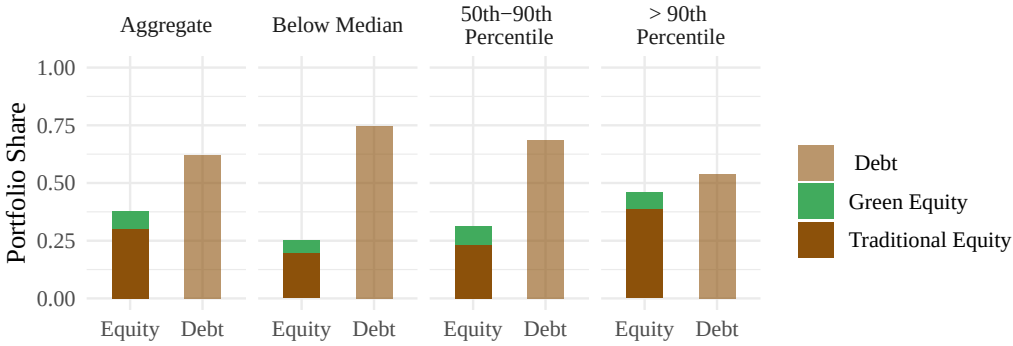
Findings

- Green investments are popular but currently mostly risky
  - 34% of households have some green account, mostly green equity: overall 8% of total assets
- Important heterogeneity in green taste: does not always increase demand for green
  - heterogeneity present throughout wealth distribution, correlates with political party
  - convenience yields and hedging demands for green equity range from positive to negative
- Current relevance of sustainable investing
  - distribution of tastes: on net, lowers prices of green firms
  - attention to green stocks (= taste + beliefs) increases prices of green firms, greenium +82bp
- Bright future
  - strong taste for green deposits, would also increase green equity investment, substantial overall boost
  - RCT information treatment: greater awareness dramatically increases green investment

Survey Data

- Deutsche Bundesbank Household Survey on Consumer Expectations
  - online survey of households since 2019
  - rich demographic information and detailed wealth and income data
- New Questions (November 2021 and May 2022 Waves)
  - detailed information about current green asset holdings
  - taste for a risk-free green asset
  - beliefs about expected returns and relative risk of green equity funds
- Data Quality
  - validate aggregate asset participation rates and portfolio shares with ECB's HFCS
  - validate reported party vote with official 2021 Bundestag election results

Aggregate portfolio of German households and portfolio by networth



- Green assets = 8% of aggregate portfolio, mostly equity
- Green share of equity 20%, less than 4% of debt (bonds + bank deposits + pensions)
- Green share broadly similar throughout wealth distribution

Measuring taste for safe green assets

- We show respondents first the following information:

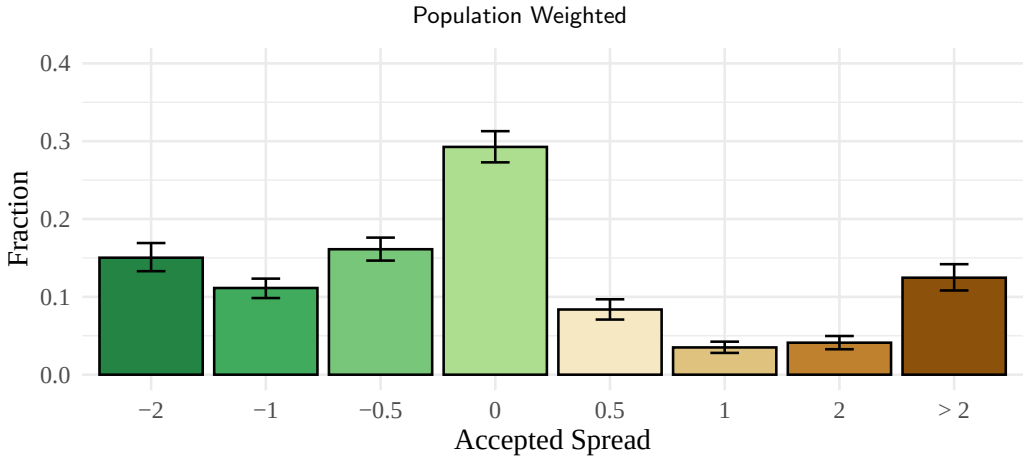
> *Some banks offer "green savings accounts" that guarantee that your deposits are used to fund green investments. Imagine your bank offered both traditional savings accounts and green savings accounts.*

- Then we present them with a sequence of interest-rate spreads on a green bank account:

> *In which cases would you choose the traditional account or the green account?*
> *The interest rate on the green savings account is:*
>
> *(a) 2% lower per year*
> *(b) 1% lower per year*
> *(c) 0.5% lower per year*
> *(d) the same*
> *(e) 0.5% higher per year*
> *(f) 1% higher per year*
> *(g) 2% higher per year*

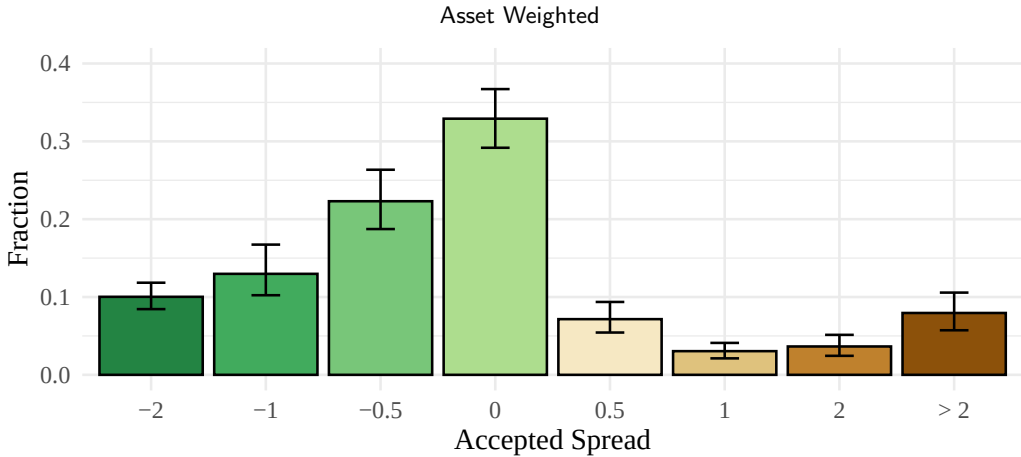
- Close to 90% of respondents answered completely and consistently
- Classify people by convenience yield = smallest spread on green bank account they accept

Distribution of taste for safe green asset



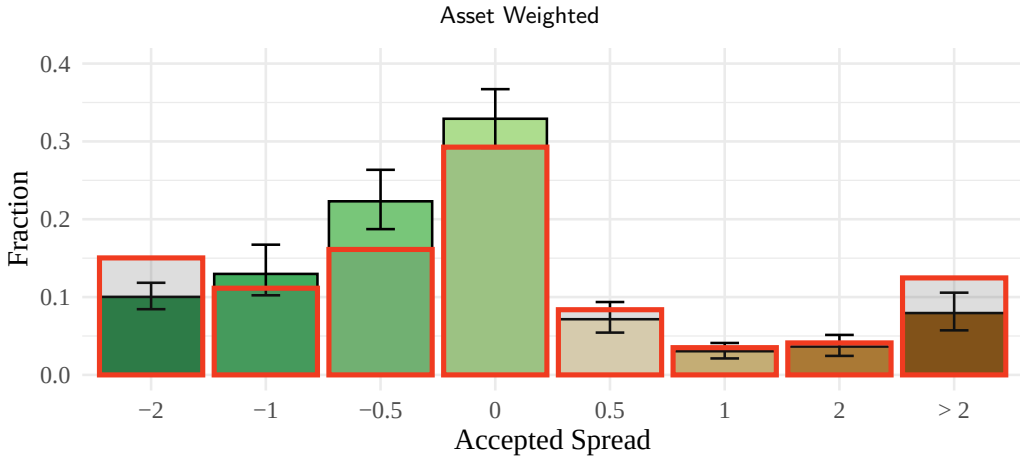
- Spreads on green safe asset range from negative to positive
- Large spreads compared to the cross section of interest rates on deposits offered by banks

Substantial wealth behind these preferences



- Wealthier people have somewhat less extreme preferences, still large heterogeneity

Substantial wealth behind these preferences



- Wealthier people have somewhat less extreme preferences, still large heterogeneity
- Correlates with other measures of green taste: vote Green, #1 concern is climate change, young, women, more education, live in West Germany

Measuring expectations about a risky green asset

- We first show respondents the following information:

> *Equity funds consist of multiple shares that are managed by a professional fund manager. In contrast to traditional equity funds, green funds invest more heavily in enterprises that operate in a comparatively climate-friendly manner.*

- Then we ask respondents to provide:
  1. expected returns over next 12 months of traditional & green equity fund
     (numeric value in percent)
  2. risk of a traditional equity fund relative to a green equity fund
     (scale: significantly lower, somewhat lower, roughly the same, somewhat higher, significantly higher)

Measuring expectations about a risky green asset

- We first show respondents the following information:

> *Equity funds consist of multiple shares that are managed by a professional fund manager. In contrast to traditional equity funds, green funds invest more heavily in enterprises that operate in a comparatively climate-friendly manner.*

- Then we ask respondents to provide:
  1. expected returns over next 12 months of traditional & green equity fund (numeric value in percent)
  2. risk of a traditional equity fund relative to a green equity fund (scale: significantly lower, somewhat lower, roughly the same, somewhat higher, significantly higher)
- Households who completely answered these questions are more likely to own equity
  - wealth-weighted expected excess returns: on green = 7.0, on traditional = 7.9
  - wealth-weighted greenium is 0.9pp, population-weighted greenium is roughly 0

Measuring taste for a risky green asset

- Finally we ask respondents to consider the following hypothetical investment decision:

> *Imagine you have saved part of your earnings and wish to invest this money in an equity fund starting today. Would you rather invest in a traditional equity fund or a sustainable equity fund?*

Measuring taste for a risky green asset

- Finally we ask respondents to consider the following hypothetical investment decision:

> *Imagine you have saved part of your earnings and wish to invest this money in an equity fund starting today. Would you rather invest in a traditional equity fund or a sustainable equity fund?*

- 18% of households choose equity funds they think are dominated in mean-variance sense

Measuring taste for a risky green asset

- Finally we ask respondents to consider the following hypothetical investment decision:

> *Imagine you have saved part of your earnings and wish to invest this money in an equity fund starting today. Would you rather invest in a traditional equity fund or a sustainable equity fund?*

- 18% of households choose equity funds they think are dominated in mean-variance sense
- More households choose dominated equity funds when they believe the funds have higher risk
  - believe funds have roughly the same risk, 24% choose green with lower expected returns
  - believe green equity funds have higher risk, 42% choose green with same or lower expected returns

Measuring taste for a risky green asset

- Finally we ask respondents to consider the following hypothetical investment decision:

> *Imagine you have saved part of your earnings and wish to invest this money in an equity fund starting today. Would you rather invest in a traditional equity fund or a sustainable equity fund?*

- 18% of households choose equity funds they think are dominated in mean-variance sense
- More households choose dominated equity funds when they believe the funds have higher risk
  - believe funds have roughly the same risk, 24% choose green with lower expected returns
  - believe green equity funds have higher risk, 42% choose green with same or lower expected returns
- Suggests extra motive for green investments that scales with risk, e.g. hedging climate risk
  - positive hedging demand for green funds, hedges faster climate transition
  - negative hedging demand for green funds, traditional funds hedge political backlash

Quantitative asset pricing model with heterogeneous agents

- Household i has financial wealth w_0^i, chooses consumption and portfolio allocation

$$\max_{c_0, e_t, e_g, b_t, b_g} \log c_0 + \beta^i \log\left(E\left[{w_1}^{1-\gamma^i}\right]^{\frac{1}{1-\gamma^i}}\right)$$

$$\text{s.t. } c_0 + e_t + e_g + b_t + b_g = w_0^i$$

$$\text{effective wealth} = w_1 = H^i\left(R^t e_t + \theta^i R^g e_g + R_f^t b_t + \theta^i R_f^g b_g\right)$$

$$e_t, e_g, b_t, b_g \geq 0$$

- Taste for different assets appears in two ways:
  1. parameter θ^i captures convenience yield, i.e. non-pecuniary benefits/costs of holding green
  2. factor H^i captures hedging demand, $\log H^i = \eta_0^i + \eta_g^i\left(\log R^t - \log R^g\right)$

     when green equity funds do well (e.g., faster climate transition)
     - positive η_g^i means low effective wealth
     - negative η_g^i means high effective wealth

Mapping survey responses to model parameters

- Observe for each household:
  - expected returns, riskfree rate
  - convenience yield θ^i from hypothetical green bank account question
  - portfolio weights ω_g^i and ω_t^i, overall financial wealth w_0^i
- Estimate 4 remaining household-specific parameters
  - risk sensitivity = variance of returns times risk aversion (3 parameters), hedging demand parameter η_g^i
  - use 2 observed portfolio weights, inequality constraints from risk ranking and hypothetical asset choice
  - shrink towards historical values: no difference in return distributions, high correlation

$\rightarrow$ joint distribution of wealth, portfolio weights, beliefs, and preference parameters

Aggregate portfolio demand

- Wealth-weighted average portfolio weights

$$\underbrace{\begin{pmatrix} 0.31 \\ 0.08 \end{pmatrix}}_{\overline{\omega}} = \underbrace{\begin{pmatrix} 0.30 \\ 0.09 \end{pmatrix}}_{\text{myopic demand}} + \underbrace{\begin{pmatrix} -0.01 \\ 0.00 \end{pmatrix}}_{\text{convenience yield } \theta^i} + \underbrace{\begin{pmatrix} 0.02 \\ -0.01 \end{pmatrix}}_{\text{hedging demand } \eta_g^i}$$

- Taste for green has small aggregate effects, masks very large effects at individual level
  - households with positive convenience yields account for 40% of aggregate green equity demand
  - households with positive hedging demands account for 50% of aggregate green equity holdings
  - offset in aggregate by negative convenience yields, negative hedging demands

Counterfactuals

- So far: model of household sector asset demand
- Two ways to quantify response to change in environment
  - e.g. shutting down all taste for green assets

1. Recompute aggregate household asset demand at fixed prices
   - corresponds to equilibrium with perfectly elastic asset supply
   - e.g. how much more/less green equity could firms have sold if no adjustment cost to green capital
2. Find hypothetical market clearing prices at fixed supply
   - temporary equilibrium: take as given expectations about future payoffs
   - find price s.t. households willing to hold all equity shares
   - e.g. how much more/less would firms have gotten for marginal new share if no green taste

What did the rise of sustainable investing do?

- Shutting down green taste (convenience yield & hedging demand)
  - standard theory: expect lower price of green equity in counterfactual, higher expected return
  - here: heterogeneous households, partly offsetting effects from investor composition

What did the rise of sustainable investing do?

- Shutting down green taste (convenience yield & hedging demand)
  - standard theory: expect lower price of green equity in counterfactual, higher expected return
  - here: heterogeneous households, partly offsetting effects from investor composition

1. Recompute aggregate household asset demand at fixed prices
   - green equity investments increase by 27%, traditional fall by 6%, overall more risk taking!
   - hedgers (cautious and pessimistic) leave green equity markets, optimists bid up price

What did the rise of sustainable investing do?

- Shutting down green taste (convenience yield & hedging demand)
  - standard theory: expect lower price of green equity in counterfactual, higher expected return
  - here: heterogeneous households, partly offsetting effects from investor composition

1. Recompute aggregate household asset demand at fixed prices
   - green equity investments increase by 27%, traditional fall by 6%, overall more risk taking!
   - hedgers (cautious and pessimistic) leave green equity markets, optimists bid up price
2. Find counterfactual market clearing prices at fixed supply
   - price of green stocks increases by 70bp, price of traditional stocks unchanged
   - in counterfactual, greenium rises by 70bp, lowers green firms' cost of capital

$\Rightarrow$ Taste holds back green investing

What did the rise of sustainable investing do?

- In addition to taste, perception of market changed
  - households now pay attention to emission scores, distinguish stocks along new dimensions
  - now form beliefs about imperfectly correlated green & traditional stocks

What did the rise of sustainable investing do?

- In addition to taste, perception of market changed
  - households now pay attention to emission scores, distinguish stocks along new dimensions
  - now form beliefs about imperfectly correlated green & traditional stocks
- What if households didn't distinguish green vs traditional stocks?
  - baseline equilibrium with beliefs about "two trees" (green/traditional), taste for green
  - compute counterfactual equilibrium with "one tree", treated as traditional by all, no taste

  $\Rightarrow$ value of stock market declines by 80bp

What did the rise of sustainable investing do?

- In addition to taste, perception of market changed
  - households now pay attention to emission scores, distinguish stocks along new dimensions
  - now form beliefs about imperfectly correlated green & traditional stocks
- What if households didn't distinguish green vs traditional stocks?
  - baseline equilibrium with beliefs about "two trees" (green/traditional), taste for green
  - compute counterfactual equilibrium with "one tree", treated as traditional by all, no taste

  $\Rightarrow$ value of stock market declines by 80bp
- What is the counterfactual value of green stocks?
  - estimate payoff share of green stocks = wealth-weighted expected payoffs today
  - value of green stocks = payoff share $\times$ price of one tree
  - value of green stocks falls by 1.48pp, traditional by 66bp

$\Rightarrow$ Sustainable investing opened up a greenium of 82bp

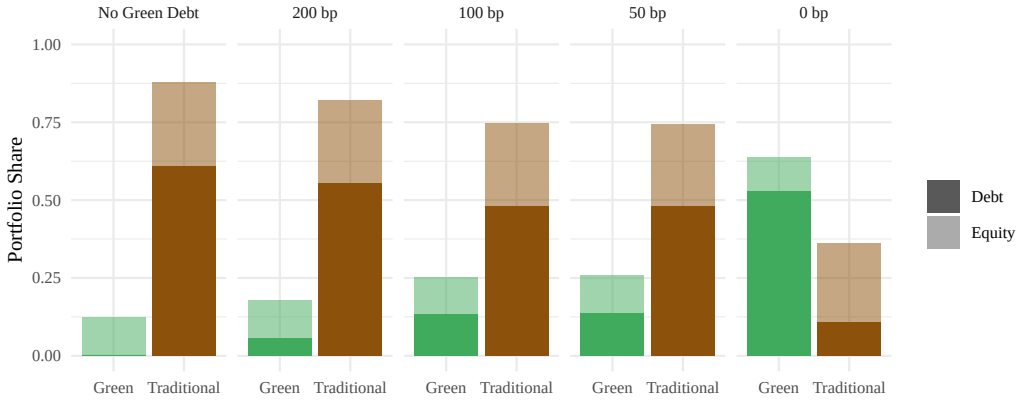
Introduction of a green fixed income market

- There are now two risk-free assets with potentially different returns
- For a given interest rate on green debt r_g^f,

  households with large enough convenience yield choose green: $\log \theta \geq r_t^f - r_g^f$
- Convenience yield lowers expected excess returns on risky assets

$\rightarrow$ counterfactual: vary interest rate on green debt, recompute aggregate portfolio weights

Introduction of a green fixed income market → large portfolio effects



More information about green assets $\rightarrow$ increase green equity holdings

- A subset of individuals were shown the following information:

> *Sustainable equity funds can contribute to climate protection by encouraging enterprises around the world to operate in a more climate-friendly manner.*

- Households who saw this information:
  - believe expected returns on green equity are 3pp higher on average
  - entirely driven by households who self report "very high" concern for climate change (7pp higher)

More information about green assets → increase green equity holdings

- A subset of individuals were shown the following information:

> *Sustainable equity funds can contribute to climate protection by encouraging enterprises around the world to operate in a more climate-friendly manner.*

- Households who saw this information:
  - believe expected returns on green equity are 3pp higher on average
  - entirely driven by households who self report "very high" concern for climate change (7pp higher)
- Suppose everyone who is very concerned about climate change received this information treatment

→ Counterfactual

  - 7pp higher expected return for risky asset holders who have high concern for climate
  - aggregate portfolio weights: share of green equity *doubles*
  - more information on green investing likely to have powerful effects

Findings

- Green investments are popular but currently mostly risky
  - 34% of households have some green account, mostly green equity: overall 8% of total assets

Findings

- Green investments are popular but currently mostly risky
  - 34% of households have some green account, mostly green equity: overall 8% of total assets
- Important heterogeneity in green taste: does not always increase demand for green
  - heterogeneity present throughout wealth distribution, correlates with political party
  - convenience yields and hedging demands for green equity range from positive to negative

Findings

- Green investments are popular but currently mostly risky
  - 34% of households have some green account, mostly green equity: overall 8% of total assets
- Important heterogeneity in green taste: does not always increase demand for green
  - heterogeneity present throughout wealth distribution, correlates with political party
  - convenience yields and hedging demands for green equity range from positive to negative
- Current relevance of sustainable investing
  - distribution of tastes: on net, lowers prices of green firms
  - attention to green stocks ($=$ taste $+$ beliefs) increases prices of green firms, greenium $+82$bp

Findings

- Green investments are popular but currently mostly risky
  - 34% of households have some green account, mostly green equity: overall 8% of total assets
- Important heterogeneity in green taste: does not always increase demand for green
  - heterogeneity present throughout wealth distribution, correlates with political party
  - convenience yields and hedging demands for green equity range from positive to negative
- Current relevance of sustainable investing
  - distribution of tastes: on net, lowers prices of green firms
  - attention to green stocks (= taste + beliefs) increases prices of green firms, greenium +82bp
- Bright future
  - strong taste for green deposits, would also increase green equity investment, substantial overall boost
  - RCT information treatment: greater awareness dramatically increases green investment