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

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Motivation

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

- Models of ESG (environmental, social and governance) investing
  - investor taste for green assets (nonpecuniary benefit)
  - lowers premia on green assets, stimulates green firm investment

- This paper
  - evidence on beliefs, taste and portfolio choice: representative survey of German households
  - interpret using quantitative portfolio choice model
Message

- Asset-specific taste important, but doesn’t always increase demand for green assets
  - green deposit accounts: some people would pay to have them, others to avoid them
  - green investment funds: exposure to climate makes some people hold them, others avoid them

- Heterogeneity in green tastes reflects political differences (a lot) and age (somewhat) present throughout wealth distribution

- Heterogeneity in beliefs: expected returns and risk tolerance both matter and interact
  - optimism (high expected returns) on green goes together with low perceived risk
  - optimistic investors have less taste for risk, lowers their impact on risk premia

- Future financial innovation likely to boost green asset markets
  - safe investors hold very little green so far, but would like to!
  - optimism of risky investors also suggests gradual take-up
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Outline

- Stylized facts on taste and expectations
- Quantitative portfolio choice model
- Implications for asset pricing
- Implications for investment
Stylized facts on taste and expectations
Data

- Deutsche Bundesbank Household Survey on Consumer Expectations
  - online survey of households since 2019
  - rich demographic information and detailed wealth and income data
  - used as the main data source for inflation and real estate expectations

- New Questions (November 2021 and May 2022 Waves)
  - taste for a risk free green asset
  - expectations about relative risk and return on a green investment account
  - detailed information about current green asset holdings

- Data Quality
  - validate reported party vote with official 2021 Bundestag election results
  - validate aggregate asset participation rates and portfolio shares with ECB’s HFCS
Measuring taste for safe green assets

- Respondents are first shown 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 presented with a sequence of 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

- Classify people by minimum spread they accept
Distribution of taste for safe green asset

Close to 90% of respondents answered completely and consistently

Large compared to spread on deposits across banks
Substantial wealth behind these preferences

- Wealthier people have less extreme preferences → less extreme distribution
- “green” - 45%, “anti-green” - 22%, “neutral” - 33% of aggregate assets
Substantial wealth behind these preferences

- Wealthier people have less extreme preferences $\rightarrow$ less extreme distribution
- “green” - 45%, “anti-green” - 22%, “neutral” - 33% of aggregate assets
Correlates with other measures of green preferences

Parties ranked by advocacy for climate mitigating policy

Looks like most people understood the question
• Huge potential future demand - under 30 hold < 5% of assets
• Major differences in taste by gender, education, former East Germany

  however demographics, income, wealth, etc explain little of variation
Unmet demand for a risk-free green asset

• Despite our finding that many people have a high willingness to pay for a green bank account
  - only 5% of people report having a green bank account
  - while 37% report having a green investment account

• Most green assets available to individuals appear to be risky
  - breakdown of current green holdings - 66% equity, 4% bonds, 30% pensions
  - practitioners note supply constraints in ESG oriented fixed income assets

• There is strong demand for a risk-free green asset, but little supply yet
Measuring beliefs and taste for risky assets

• Respondents are first shown the following information:

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

• Then we ask respondents to provide the following:

1. The expected returns over the next 12 months of a traditional and green investment fund (numeric value)

2. The risk of a traditional investment fund relative to a green investment fund (scale significantly lower - significantly higher)

3. Which they would choose to invest in today

• People who completely answered these questions are more likely to have securities
Risk return tradeoff

Expected excess returns on strategy that buys green, shorts traditional fund: \( E[R_g] - E[R_t] \)

Wealth weighted excess returns reasonable: \( E[R_t] - E[R_f] = 5.7 \), \( E[R_g] - E[R_f] = 5.3 \)
Risk return tradeoff

Expected excess returns on strategy that buys green, shorts traditional fund: $E[R^g] - E[R^t]$

Wealth weighted excess returns reasonable: $E[R^t] - E[R^f] = 5.7$, $E[R^g] - E[R^f] = 5.3$
Expectations alone cannot rationalize decisions

- 64% of people choose the green investment fund in the hypothetical choice question
- Do people simply choose the asset with higher expected excess returns?

![Bar chart showing choices between Green and Traditional investment accounts](chart.png)

- Candidate explanation: same non-pecuniary taste benefit from deposit account
  - picture remains largely unchanged
  - implies taste for risk free and risky assets is not driven by a single parameter
- Candidate explanation: relative risk perception
Expectations and relative risk cannot rationalize decisions

- Now split people by relative risk perception of their choice

<table>
<thead>
<tr>
<th></th>
<th>Choice: Green investment account</th>
<th>Choice: Traditional investment account</th>
</tr>
</thead>
<tbody>
<tr>
<td>higher</td>
<td><img src="chart1" alt="Bar chart" /></td>
<td><img src="chart2" alt="Bar chart" /></td>
</tr>
<tr>
<td>similar</td>
<td><img src="chart3" alt="Bar chart" /></td>
<td><img src="chart4" alt="Bar chart" /></td>
</tr>
<tr>
<td>lower</td>
<td><img src="chart5" alt="Bar chart" /></td>
<td><img src="chart6" alt="Bar chart" /></td>
</tr>
</tbody>
</table>

- More households choose asset with lower expected return when they believe it is also riskier
- Suggests another motive for investment beyond returns that scales with risk, e.g. hedging exposure
Actual green holdings and hypothetical choice are broadly consistent

- People who have a green account may not necessarily choose green, could only want some green
- More surprising are people who say they would put all in green, but do not have any (13%)
- Interpret this as a constraint
  - expressing demand for, but do not yet hold these products
  - similar to constraints for the risk-free green asset
Quantitative portfolio choice model
Preferences

- Household $i$ has financial wealth $W$, chooses consumption and portfolio allocation.
- Risky returns on traditional investment fund $R^t$ and green investment fund $R^g$ are jointly lognormal

$$
\max_{c, \bar{c}, s_t, s_g, b} \log c + \beta \log \left( E \left[ (\bar{c}X)^{1-\gamma} \right] \right) ^{\frac{1}{1-\gamma}} \\
\text{s.t. } c + s_t + s_g + b = W \\
\bar{c} = R^t s_t + \theta R^g s_g + R^f b \\
s_t, s_g, b \geq 0
$$

- Taste for different assets appears in two ways:
  1. parameter $\theta$ captures direct non-pecuniary benefits/costs of holding green
  2. green or traditional asset may provide insurance against the state $X$ tomorrow
Portfolio choice

• Use Campbell-Viceira approximation

• Household $i$ has expected excess returns and covariance matrix

$$\mu = \log \theta + E[r^s] + \frac{1}{2} \text{diag}(\text{var}(r^s)) - r^f$$

$$\Sigma = \text{var}(r^s) = \begin{pmatrix} \sigma_t^2 & \sigma_t \sigma_g \rho \\ \sigma_t \sigma_g \rho & \sigma_g^2 \end{pmatrix}$$

• Optimal portfolio allocation given by

$$\omega = \begin{pmatrix} \omega_t \\ \omega_g \end{pmatrix} = \frac{1}{\gamma} \Sigma^{-1} \mu + \begin{pmatrix} h_t \\ h_g \end{pmatrix}$$

myopic demand hedging demand

• Hedging demand defined as

$$h = \frac{1 - \gamma}{\gamma} \Sigma^{-1} \text{cov}(r^s, x)$$

• Assume symmetric hedging demand $h_t + h_g = 0$ → relative shifter of portfolio weights
Mapping survey responses to model

• In November wave, we observe for each household:
  ■ expected excess returns $\mu_g$ and $\mu_t$
  ■ relative risk ranking $\sigma_g/\sigma_t$
  ■ hypothetical choice ranks $\omega_g = 1$ or $\omega_t = 1$
  ■ total wealth $W$, including pension funds
  ■ share of risky assets $\omega_g + \omega_t$

• In May wave, we observe green portfolio weights $\omega_g$ and household characteristics

• Common parameters across individuals
  ■ correlation of returns on the green and traditional assets $\rho$
  ■ discretized risk ranking: $\sigma_g/\sigma_t \in \{1/\lambda, 1, \lambda\}$

• Identify $\gamma(\sigma_t)^2$, $h_g$ for every household plus $\rho = 0.9$ and $\lambda = 3$ to match distribution of shares
Implications for asset pricing
Aggregate portfolio demand and asset prices

Two ways to understand aggregate portfolio weights

1. Decompose quantity (portfolio shares)

\[
\bar{\omega} = \sum_i \frac{W_i}{\bar{W}} \left( (\gamma_i \Sigma^i)^{-1} \mu^i + h^i \right)
\]

→ contributions of beliefs on myopic demand, hedging demand

2. Decompose price (risk premia)

- denote wealth-weighted averages by bars; \( \bar{\gamma} \Sigma = \) wealth-weighted harmonic mean of \( \gamma_i \Sigma^i \)

- subjective risk premium (all moments from wealth weighted x-sectional distribution)

\[
\bar{\mu} = \frac{\bar{\gamma} \Sigma \bar{\omega}}{\bar{\gamma} \Sigma} \quad \text{compensation for market risk}
\]

\[
- \frac{\bar{\gamma} \Sigma \bar{h}}{\bar{\gamma} \Sigma} \quad \text{compensation for exposure to } x
\]

\[
- \frac{\bar{\gamma} \Sigma \text{cov} \left( \left( \gamma^i \Sigma^i \right)^{-1}, \mu^i \right)}{\bar{\gamma} \Sigma} \quad \text{correction for heterogeneity}
\]
Decomposing risk premia

\[
\bar{\mu} = \gamma \Sigma \bar{\omega} - \gamma \Sigma \bar{h} - \gamma \Sigma \text{cov} \left( (\gamma^i \Sigma^i)^{-1}, \mu^i \right)
\]

- compensation for market risk
- compensation for exposure to \(x\)
- correction for heterogeneity

• Use wealth-weighted moments from cross sectional distribution to quantify:

\[
\begin{pmatrix}
5.7 \\
5.3
\end{pmatrix} = \begin{pmatrix}
1.5 \\
1.6
\end{pmatrix} + \begin{pmatrix}
0.3 \\
1.0
\end{pmatrix} + \begin{pmatrix}
3.9 \\
2.7
\end{pmatrix}
\]

• All three forces present
  - compensation for market risk at avg belief similar: green only 18% of market, but much more risky
  - hedging \textit{increases} premia, especially for green: worry about exposure makes green expensive
  - interaction of risk tolerance & mean belief is key: pushes up premia, but less so for green
Implications for investment
Investment counterfactuals

- Aggregate portfolio shares given by:

\[
\bar{\omega} = \sum_i \frac{W^i}{W} \left( (\gamma^i \Sigma^i)^{-1} \mu^i + h^i \right)
\]

- Experiments:
  - shut down non-pecuniary taste, \( \theta = 1 \)
  - myopic demand only, \( h_g = 0 \)
  - remove belief heterogeneity, give everyone wealth weighted beliefs/risk tolerance
  - make everyone a young green party voter

- Economy with linear production in capital
  - households invest directly in capital
  - green and traditional capital are perfect substitutes
  - Change in fundamentals \( \rightarrow \) aggregate portfolio \( \rightarrow \) capital stocks
Investment counterfactuals

- How much do different forms of taste matter?
- How important is heterogeneity?
• How much do different forms of taste matter? Hedging dominates.
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How important is heterogeneity? Joint distribution of wealth and expectations/taste is key.
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Conclusion

• Heterogenous asset-specific taste important
  ■ green deposit accounts: some people would pay to have them, others to avoid them
  ■ green investment funds: exposure to climate makes some people hold them, others avoid them

• Heterogeneity in beliefs: expected returns and risk tolerance both matter and interact
  ■ optimism (high expected returns) on green goes together with low perceived risk
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• Future financial innovation - particularity for fixed income securities - likely to boost green share