

# 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

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  - 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

# 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*

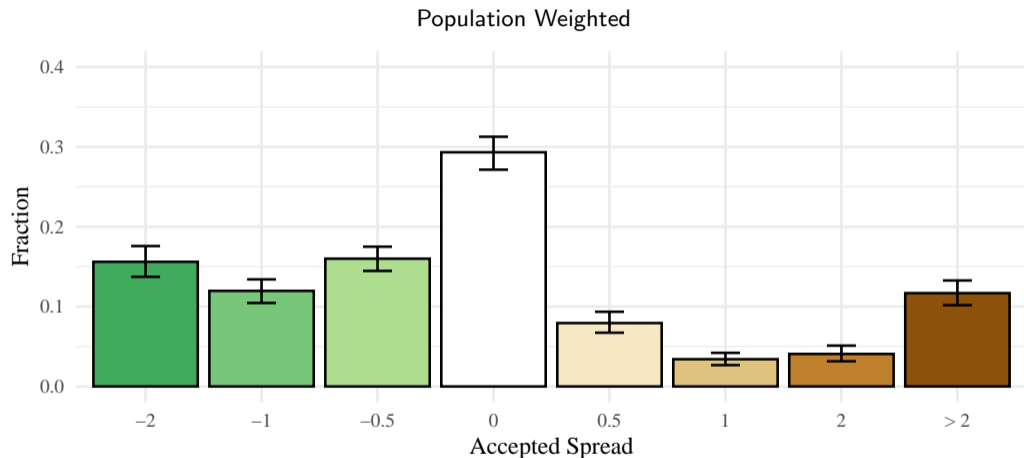
*(e) 0.5% higher per year*

*(f) 1% higher per year*

*(g) 2% higher per year*

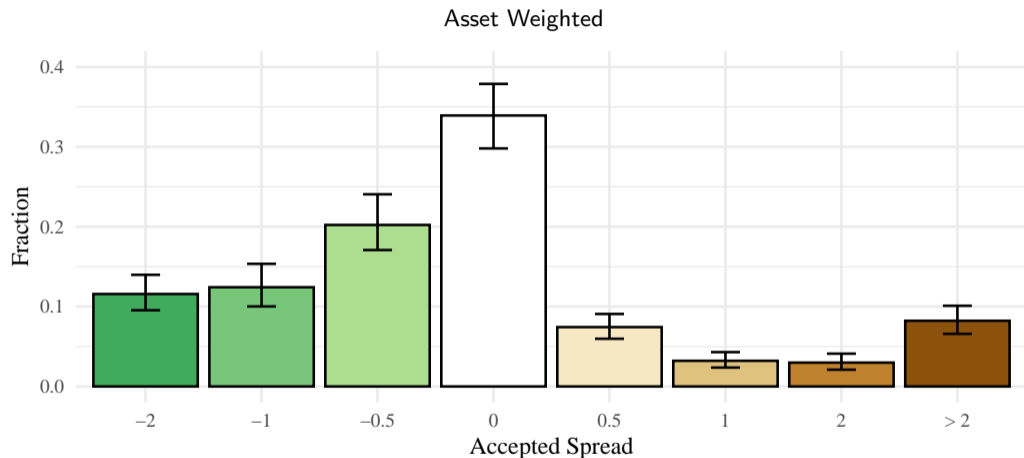
- Classify people by minimum spread they accept

# Distribution of taste for safe green asset



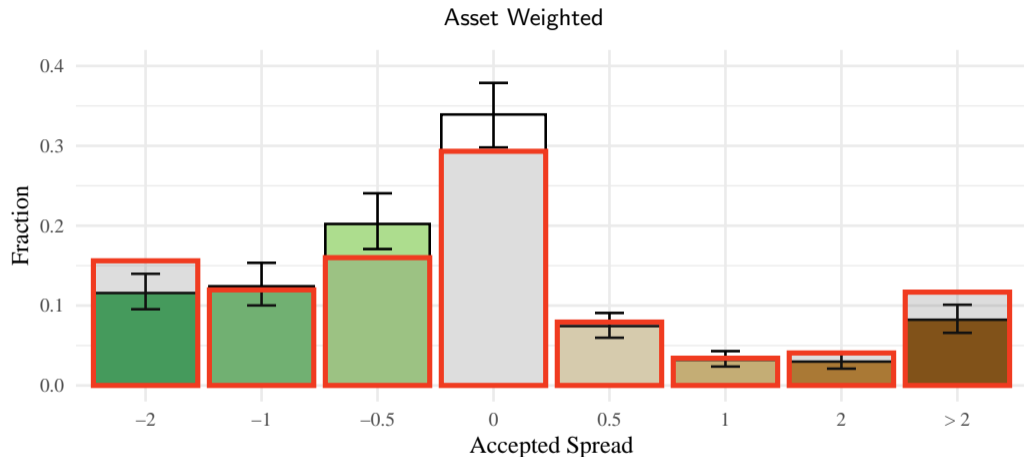
- Close to 90% of respondents answered completely and consistently
- Large compared to spread on deposits across banks

## Substantial wealth behind these preferences



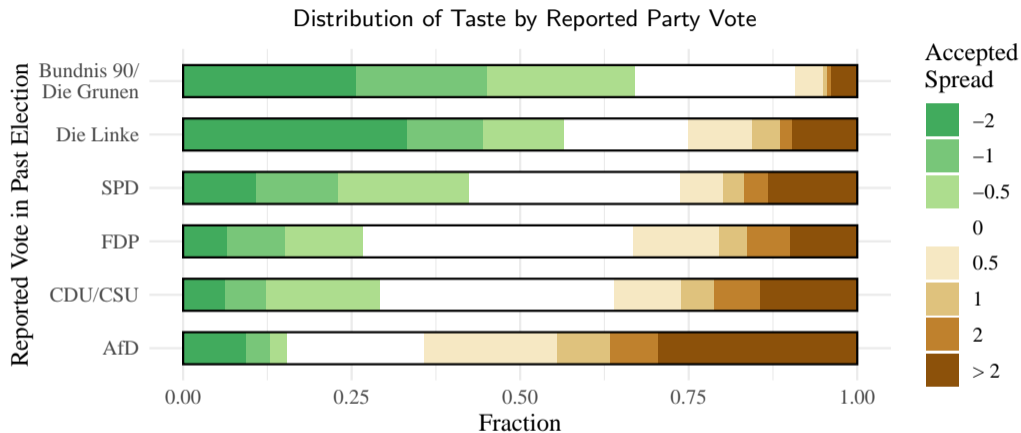
- Wealthier people have less extreme preferences → less extreme distribution
- “green” - 45%, “anti-green” - 22%, “neutral” - 33% of aggregate assets

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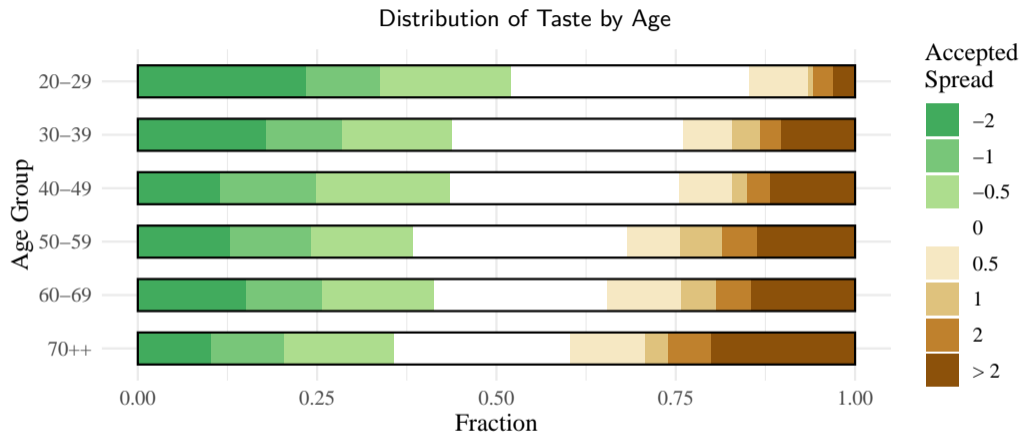
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## Correlates with other measures of green preferences



- Parties ranked by advocacy for climate mitigating policy
- Looks like most people understood the question

## Rich heterogeneity



- 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

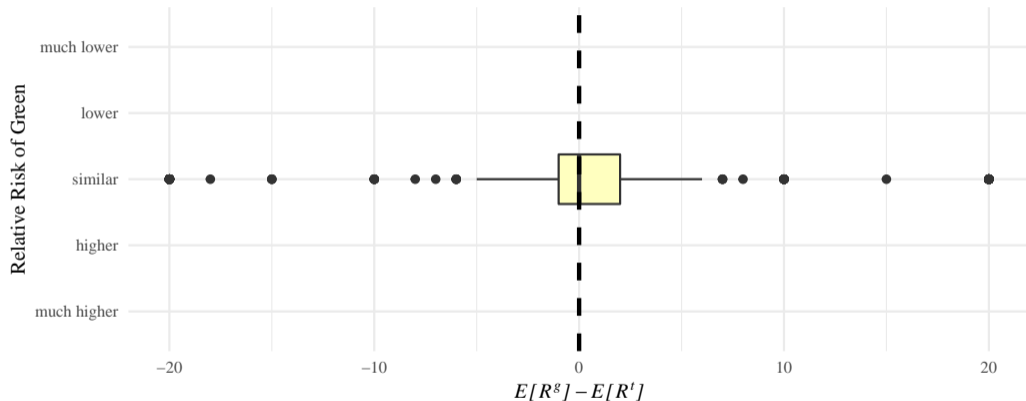
- Respondents are first shown the following information:

*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:  $E[R^g] - E[R^t]$

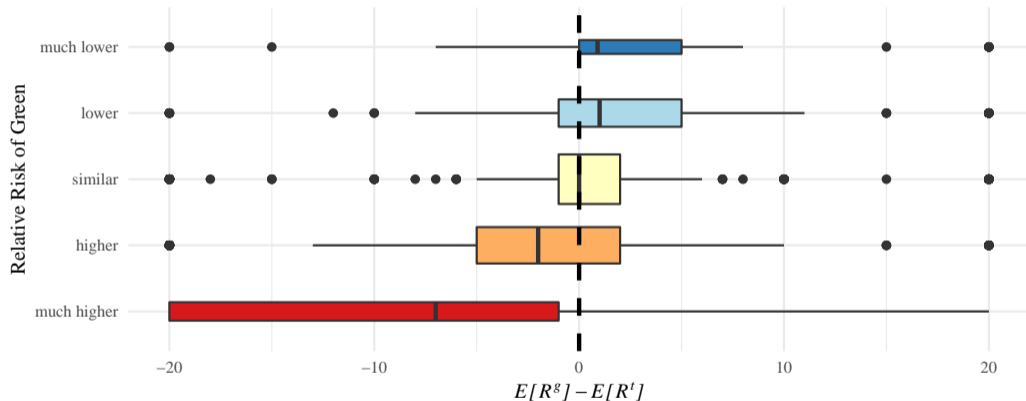


Note: winsorizing at +/- 20

Wealth weighted excess returns reasonable:  $E[R^t] - E[R^f] = 5.7$ ,  $E[R^g] - E[R^f] = 5.3$

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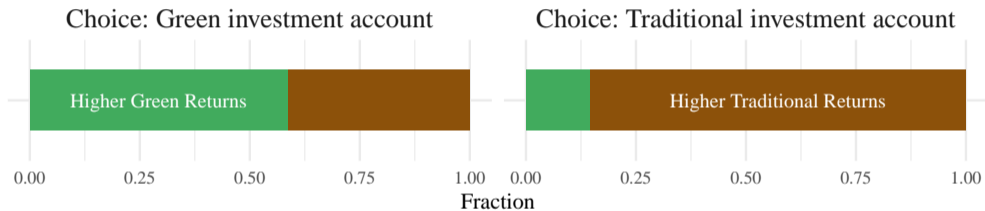


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## Expectations alone cannot rationalize decisions

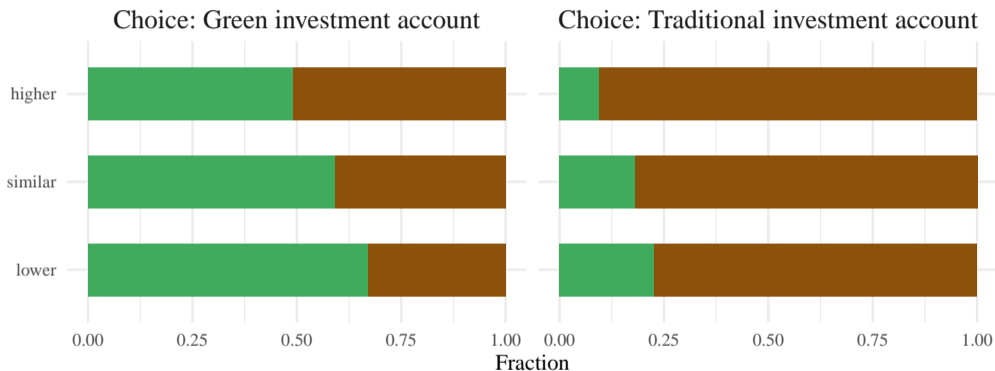
- 64% of people choose the green investment fund in the hypothetical choice question
- Do people simply choose the asset with higher expected excess returns?



- 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



- 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

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

- 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

$$\omega = \begin{pmatrix} \omega_t \\ \omega_g \end{pmatrix} = \underbrace{\frac{1}{\gamma} \Sigma^{-1} \mu}_{\text{myopic demand}} + \underbrace{\begin{pmatrix} h_t \\ h_g \end{pmatrix}}_{\text{hedging demand}}$$

- Hedging demand defined as

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

- Assume symmetric hedging demand  $h_t + h_g = 0 \rightarrow$  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:  $\sigma_g/\sigma_t \in \{\frac{1}{\lambda}, 1, \lambda\}$
- 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)

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

→ contributions of beliefs on myopic demand, hedging demand

## 2. Decompose price (risk premia)

- denote wealth-weighted averages by bars;  $\overline{\gamma \Sigma}$  = wealth-weighted harmonic mean of  $\gamma^i \Sigma^i$
- subjective risk premium (all moments from wealth weighted x-sectional distribution)

$$\bar{\mu} = \underbrace{\overline{\gamma \Sigma} \bar{\omega}}_{\text{compensation for market risk}} - \underbrace{\overline{\gamma \Sigma} \bar{h}}_{\text{compensation for exposure to } x} - \underbrace{\overline{\gamma \Sigma} \text{cov} \left( \left( \gamma^i \Sigma^i \right)^{-1}, \mu^i \right)}_{\text{correction for heterogeneity}}$$

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- 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 *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

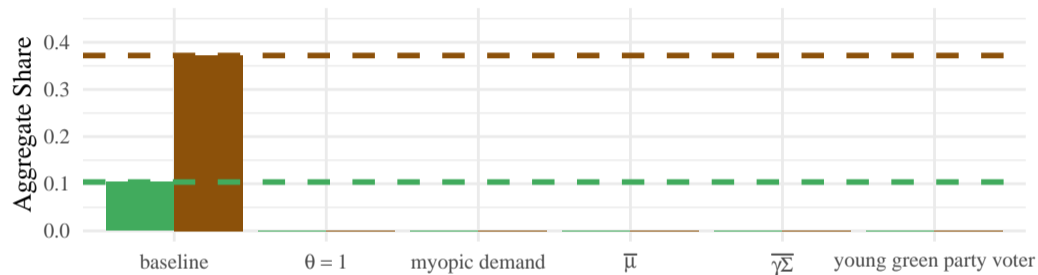
# Investment counterfactuals

- 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

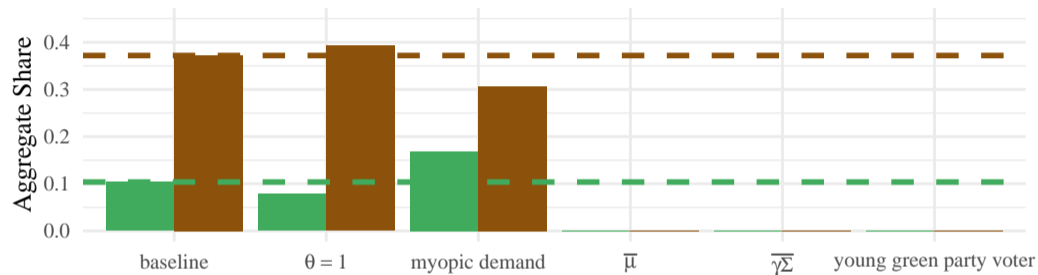
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- How important is heterogeneity?

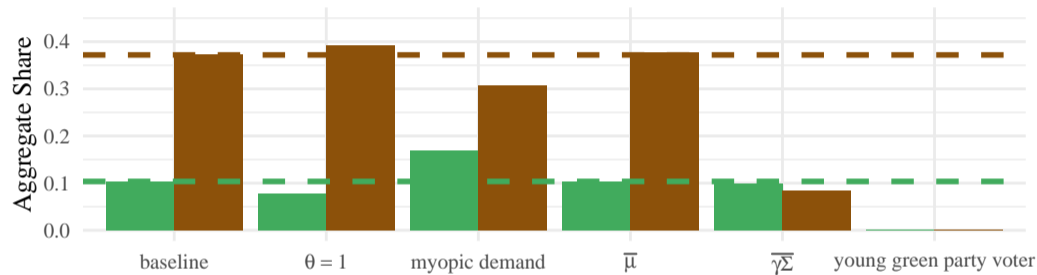


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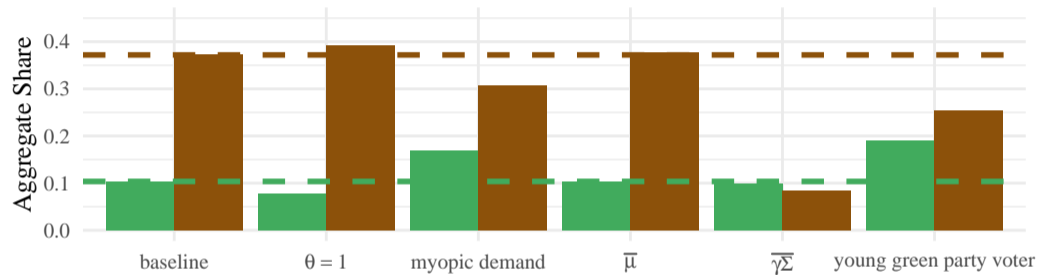
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# Conclusion

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- Future financial innovation - particularity for fixed income securities - likely to boost green share