Knock, knock! Who's there? A Latent Class Typology of Household Photovoltaic Investors

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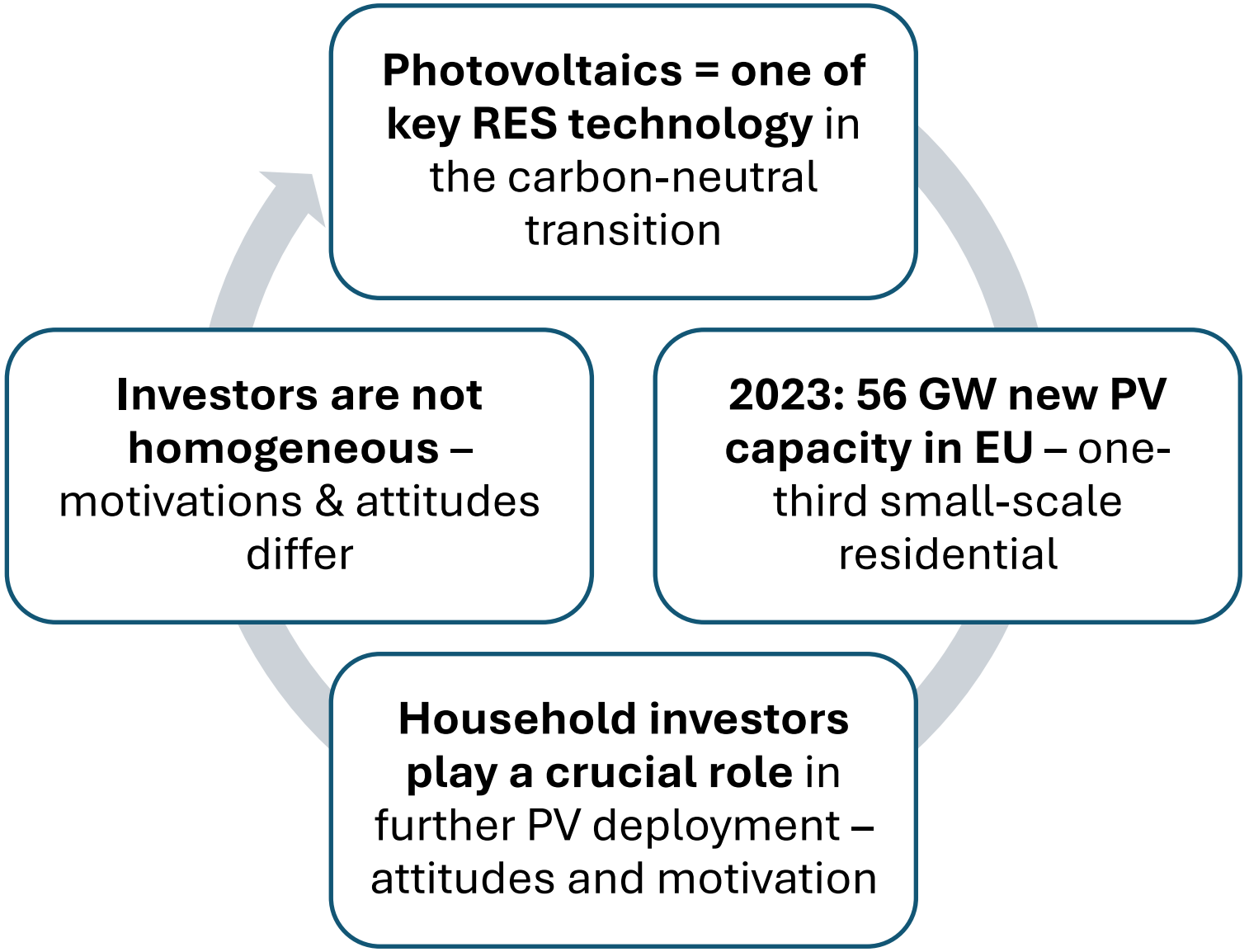
Context


Photovoltaics = one of key RES technology in the carbon-neutral transition
2023: 56 GW new PV capacity in EU – one-third small-scale residential
Household investors play a crucial role in further PV deployment – attitudes and motivation
Investors are not homogeneous – motivations & attitudes differ

Theoretical framework

Start with **Value-Belief-Norm (VBN) theory and Theory of Planned Behavior (TPB),** literature review and interviews

Four core factors - **Economic – Environmental – Technical – Surroundings**

Decision-making process influenced by **attitudes** & **socio-demographics**

Research Questions:

- What are the motivational groups of residential PV investors?
- What are their distinguishing characteristics & attitudinal differences?

Data

2,565 households (Czechia, 2022 survey)

Questionnaire: 4 factors of motivation, attitudes, technical characteristics of the instalation, sociodemographics

Latent Class Analysis (poLCA in R) – 40 models tested, 3 pre-selected (fit criteria, interpretability)

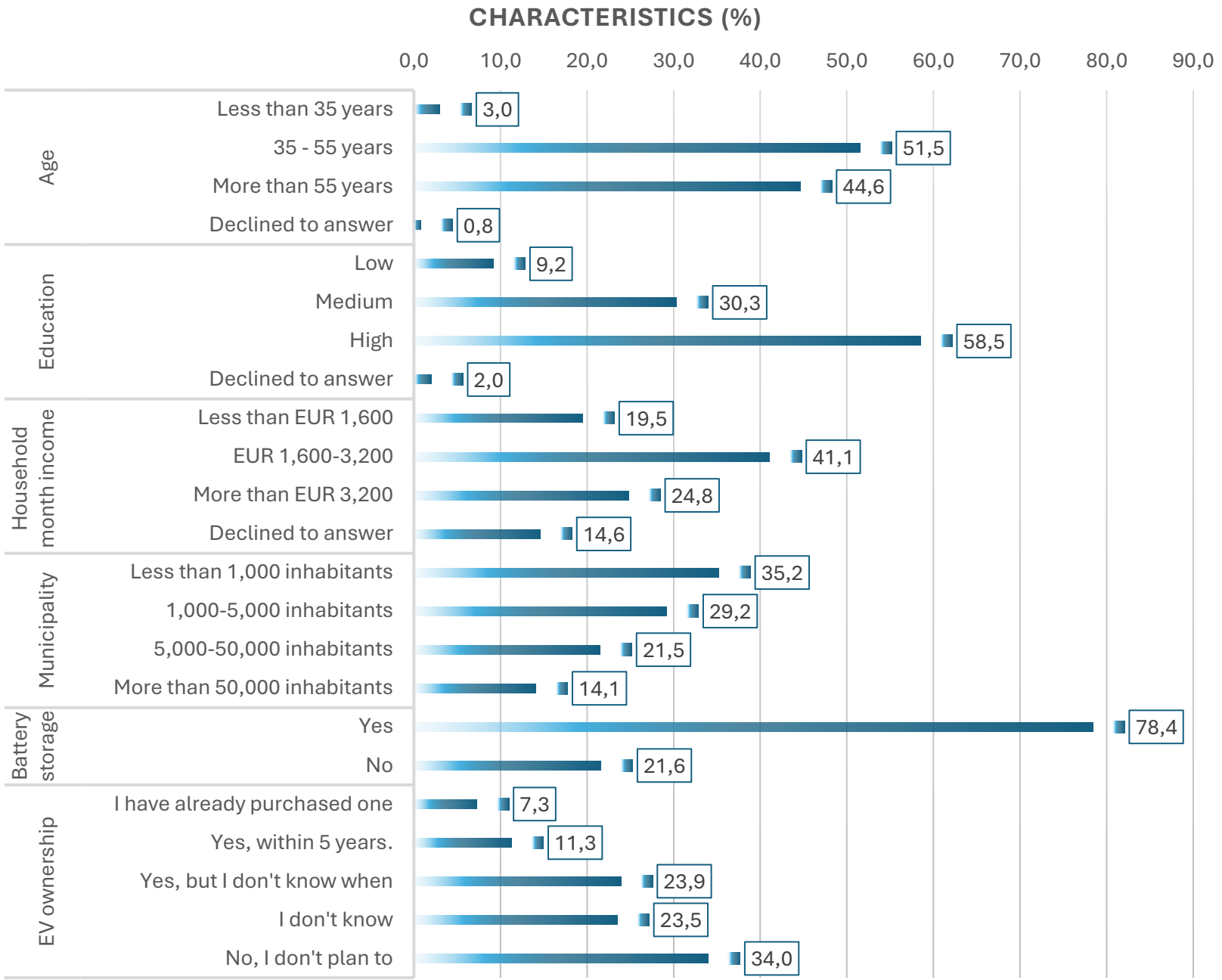
Final solution: **6 investor classes**

Methodological challenges addressed:

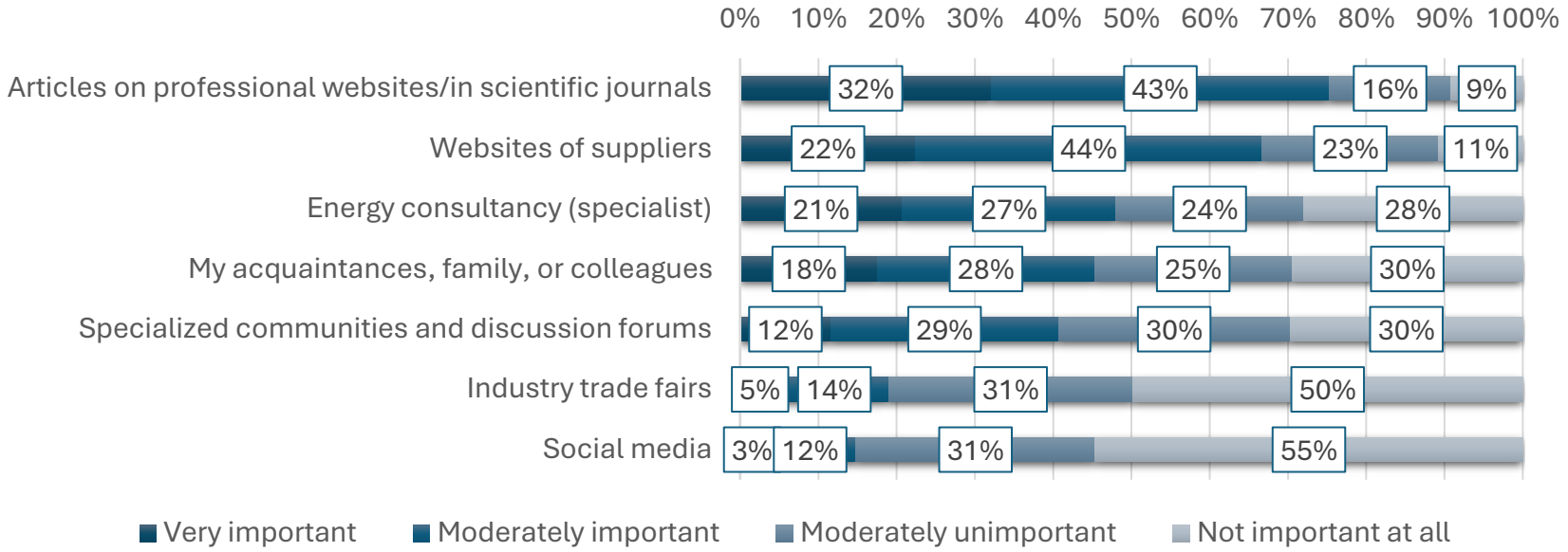
Response bias

“Yes-to-all” effect → normalized values

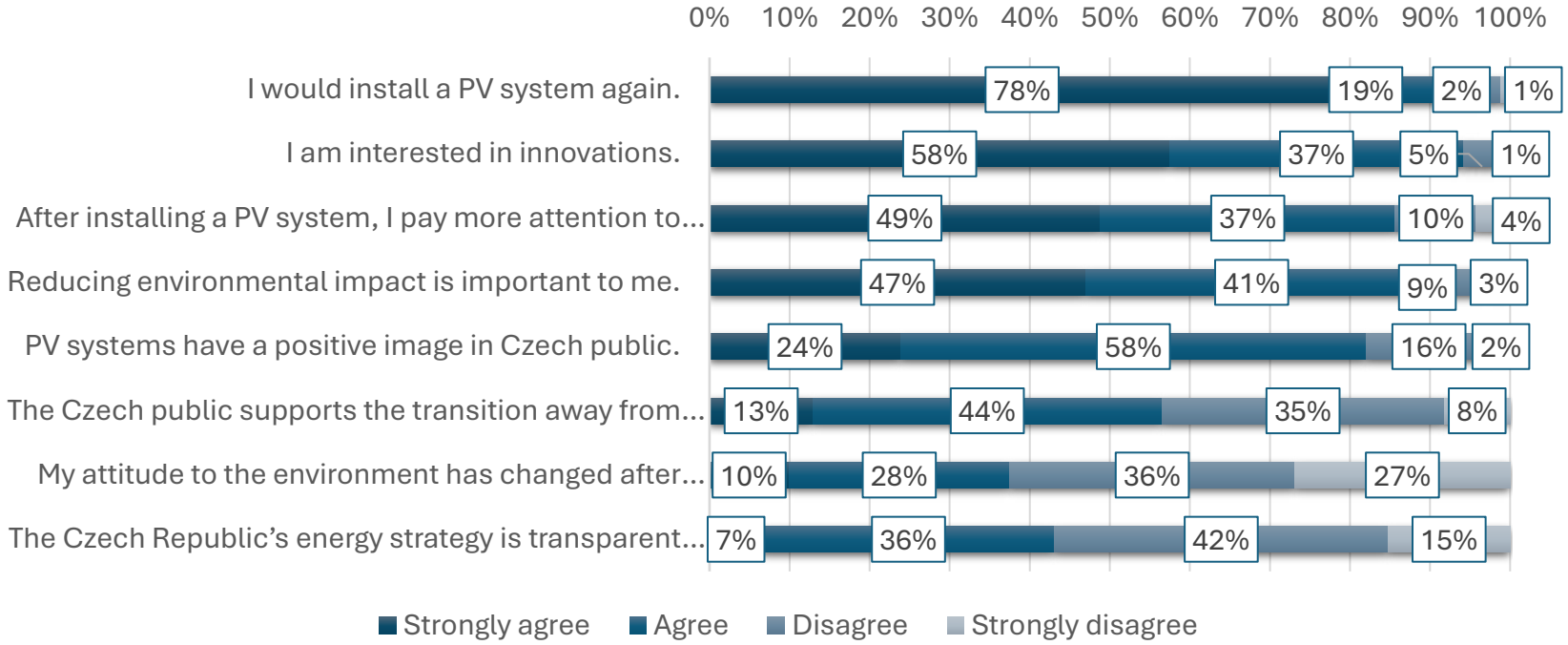
Sample


CHARACTERISTICS (%)
0,0
10,0
20,0
30,0
40,0
50,0
60,0
70,0
80,0
90,0
Age
Less than 35 years
3,0
35 - 55 years
51,5
More than 55 years
44,6
Declined to answer
0,8
Education
Low
9,2
Medium
30,3
High
58,5
Declined to answer
2,0
Household month income
Less than EUR 1,600
19,5
EUR 1,600-3,200
41,1
More than EUR 3,200
24,8
Declined to answer
14,6
Municipality
Less than 1,000 inhabitants
35,2
1,000-5,000 inhabitants
29,2
5,000-50,000 inhabitants
21,5
More than 50,000 inhabitants
14,1
Battery storage
Yes
78,4
No
21,6
EV ownership
I have already purchased one
7,3
Yes, within 5 years.
11,3
Yes, but I don't know when
23,9
I don't know
23,5
No, I don't plan to
34,0

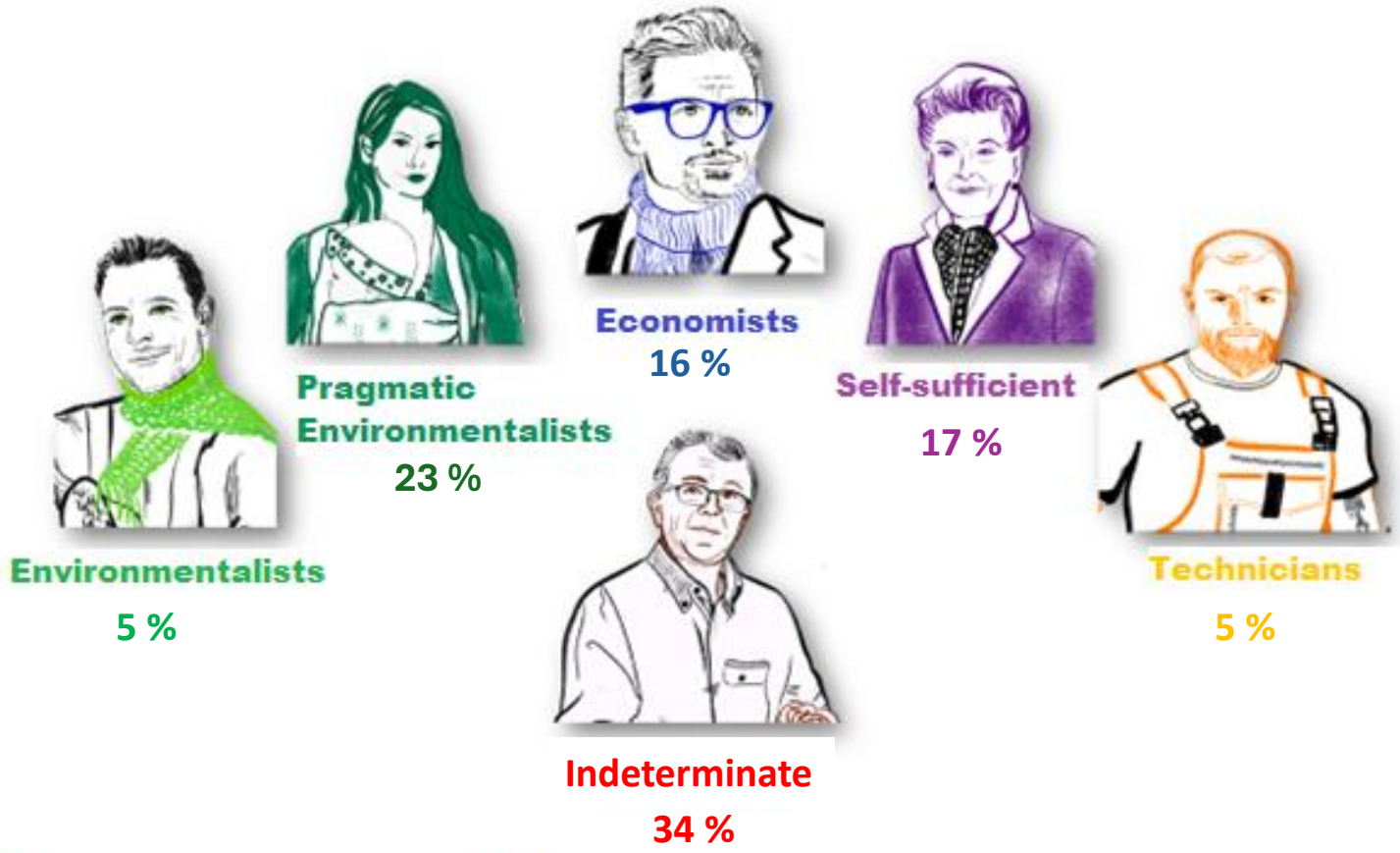
Sources of information

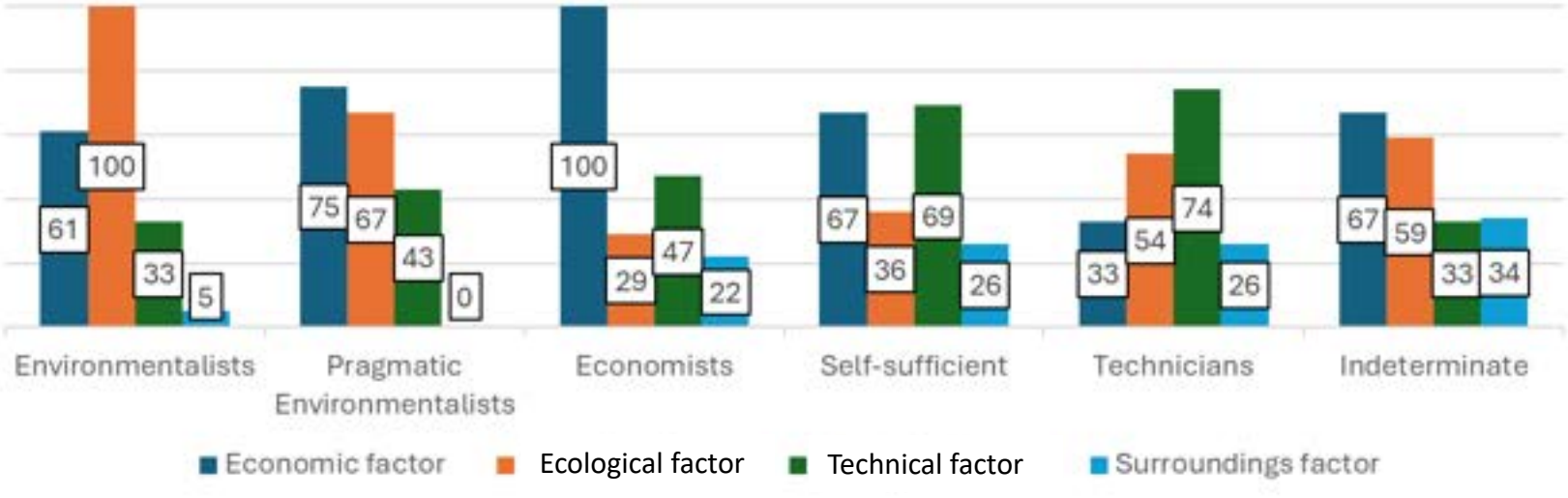


Attitudes



Six classes of investors

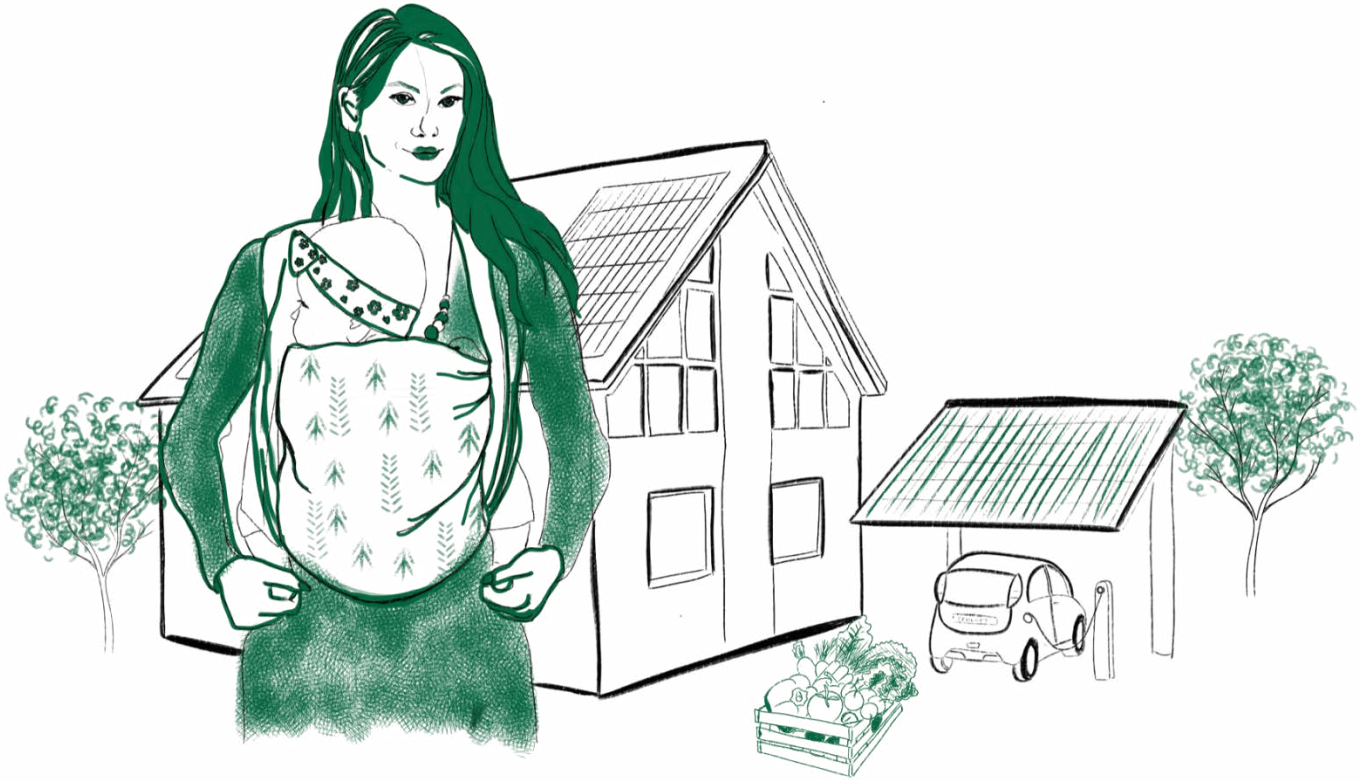




Environmentalists (5 %)

- Main motive: **ecology** (100% see as very important)
- Younger (<45), higher education & income, big cities (>50k)
- Strong interest in innovation, **often own/plan EVs**
- 98% would reinvest in PV
- Rely on **online sources** for information
- Stable, deeply rooted environmental attitudes

Pragmatic Environmentalists (23 %)

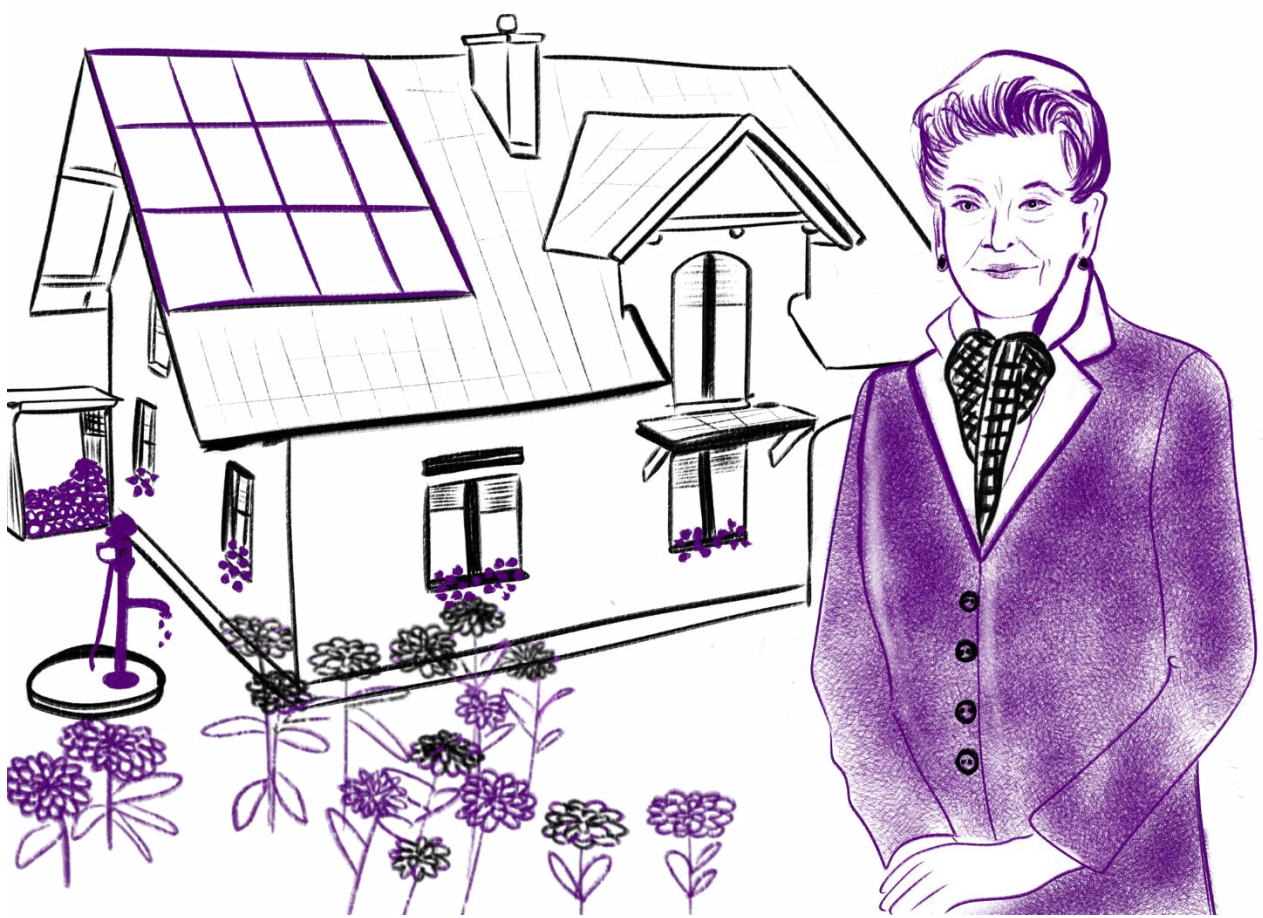


- Balanced motive: **ecology + economics**
- Younger (under 45), low education less common
- High trust in **public support for RES** (65%)
- Strong interest in innovation
- Prefer **professional literature & forums**
- Likely to reinvest, but less than Environmentalists

Economists (16 %)

- Motive: **financial benefit only**
- Mid-income, mid-sized cities
- Skeptical of politics & public support for RES
- Least EV ownership & plans, fewest batteries
- Information: mainly **expert online sources**
- Hold the **most fixed and strong opinions**

Self-sufficient (17 %)



- Motive: **independence from the grid** (economics + technical + surroundings)
- Aged 56–65, higher incomes
- Strong **preference for batteries**
- EV only if it “pays off”
- Skeptical of politics, do not rely on sources
- Less likely to reinvest compared to others

Technicians (5 %)

- Motive: **technical aspects**, least focus on economics
- Higher incomes, more men, smaller towns
- High **battery adoption**
- EVs more often considered for future
- Skeptical of policies & public support for RES
- 8% would not install again their PV (highest share)

Indeterminate (34 %)

- **Mixed motives**, economics slightly dominant
- Oldest group (65+), mid & lower incomes
- Often without batteries, PV part of renovation projects
- Strongest **trust in state policy** (55%)
- Most likely to change attitudes after installation (53%)
- Believe in **positive PV image** (90%)

Summary

- Behavior of investors depend on motivations, attitudes and sociodemographic
- Motivation drivers grouped into four key factors: Economic, Ecological, Technical, Surroundings
- Six classes identified, for most classes, one (or two) factors dominate motivation
- Non-economic motives (ecological, technical, independence) play a major role for majority of investors – only 16 % of respondents declare only financial motives
- Socio-economic variation mainly by age and income, less by education or settlement size
- Overall satisfaction is very high: 97% would invest in PV again

Limitations and Following research

Limitations

- Sample only includes **current PV adopters**, not non-adopters or those unable to invest (e.g., tenants in apartment buildings)
- February 2022
- LCA method: assumptions of independence between classes + challenges of interpretation
- Results depend strongly on **data preprocessing** and normalization strategies

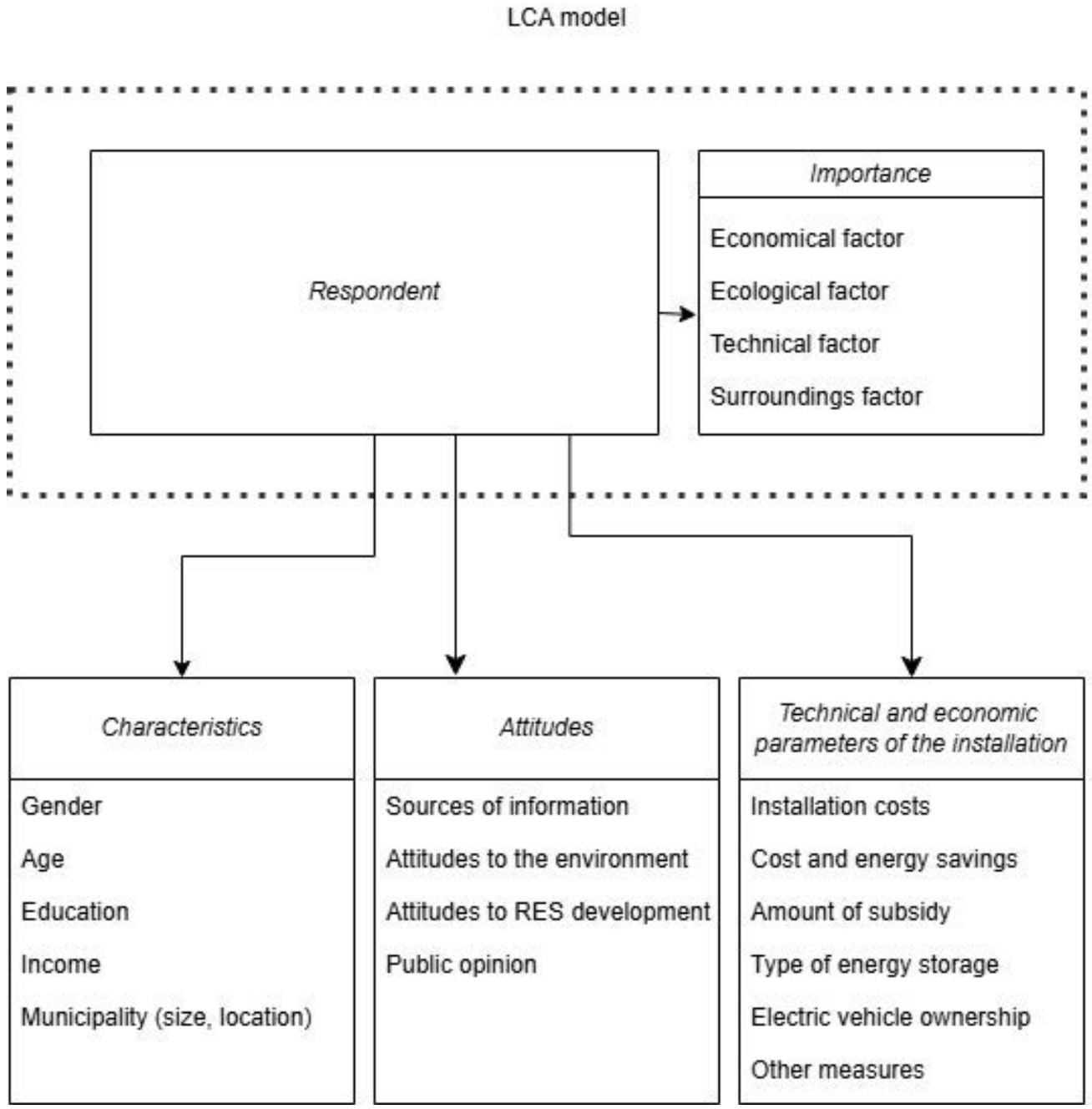
Future Research

- Explore **non-adopters** and their motivations, barriers, and perceptions
- Apply LCA to other **low-carbon technologies** (heat pumps, EVs, building renovation)
- Study **energy communities and collective models** in energy transition
- Further refine methods to address **response bias (“yes-people”)** and improve interpretability
- Assess how **tailored policy narratives** can increase acceptance and effectiveness

Q&A

Thank you for your attention!

Model


LCA model
Respondent
Importance
Economical factor
Ecological factor
Technical factor
Surroundings factor
Characteristics
Gender
Age
Education
Income
Municipality (size, location)
Attitudes
Sources of information
Attitudes to the environment
Attitudes to RES development
Public opinion
Technical and economic parameters of the installation
Installation costs
Cost and energy savings
Amount of subsidy
Type of energy storage
Electric vehicle ownership
Other measures

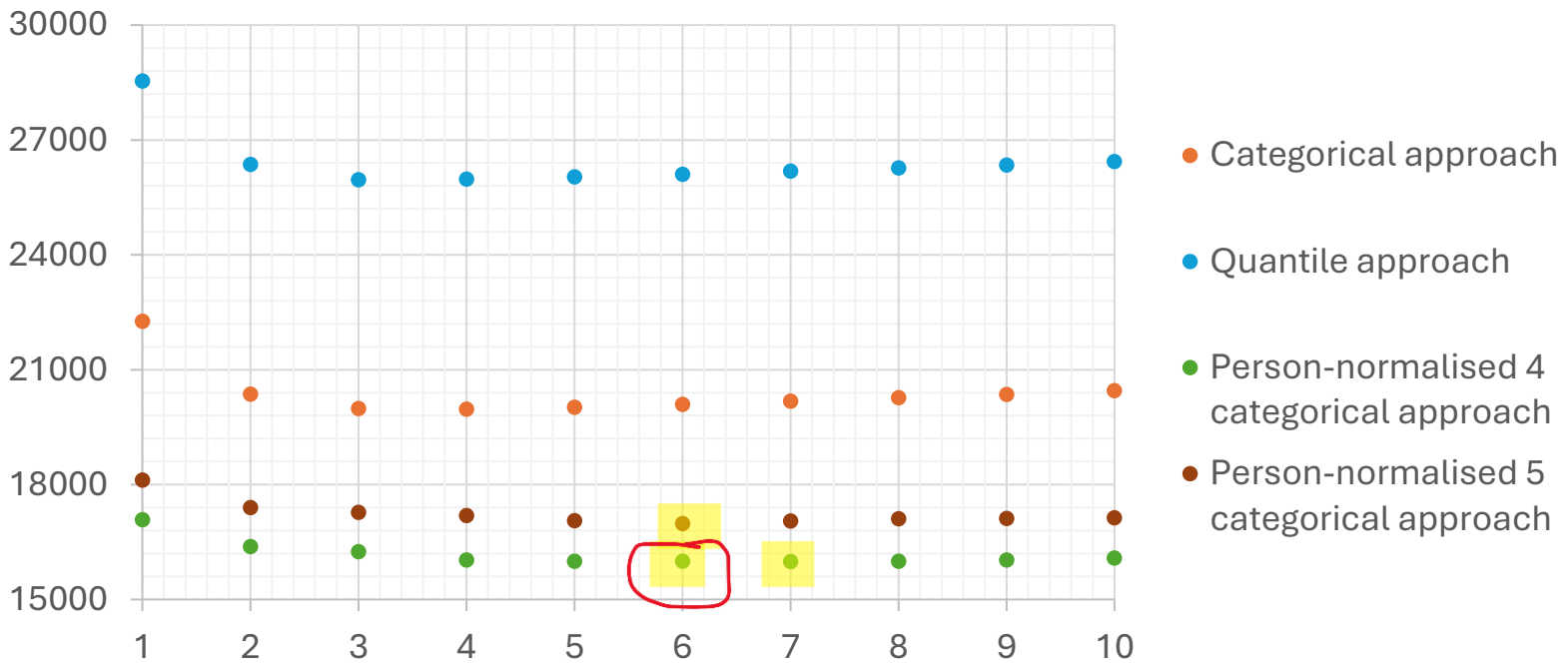
Data preparation

Discrete requirements of R

Yes-person bias

- Categorical approach: Continuous factor importance values were categorized into four discrete levels, where category 1 represented the range [0, 0.25), category 2 represented [0.25, 0.5), and so on.
- Quantile approach: Data were divided into four quantiles, where each category represents a quartile of respondents. Category 1 included values up to the first quartile, category 2 up to the second quartile, and so on.
- Person-normalised 4 categorical approach and (4) Person-normalised 5 categorical approach: To minimize response bias, values of factors scores were standardized by subtracting the mean value of each respondent. The standardized data were then categorized into four (Person-normalised 4 categorical approach) and five (Person-normalised 5 categorical approach) levels of the same range, respectively.

BIC criteriea



Entropy