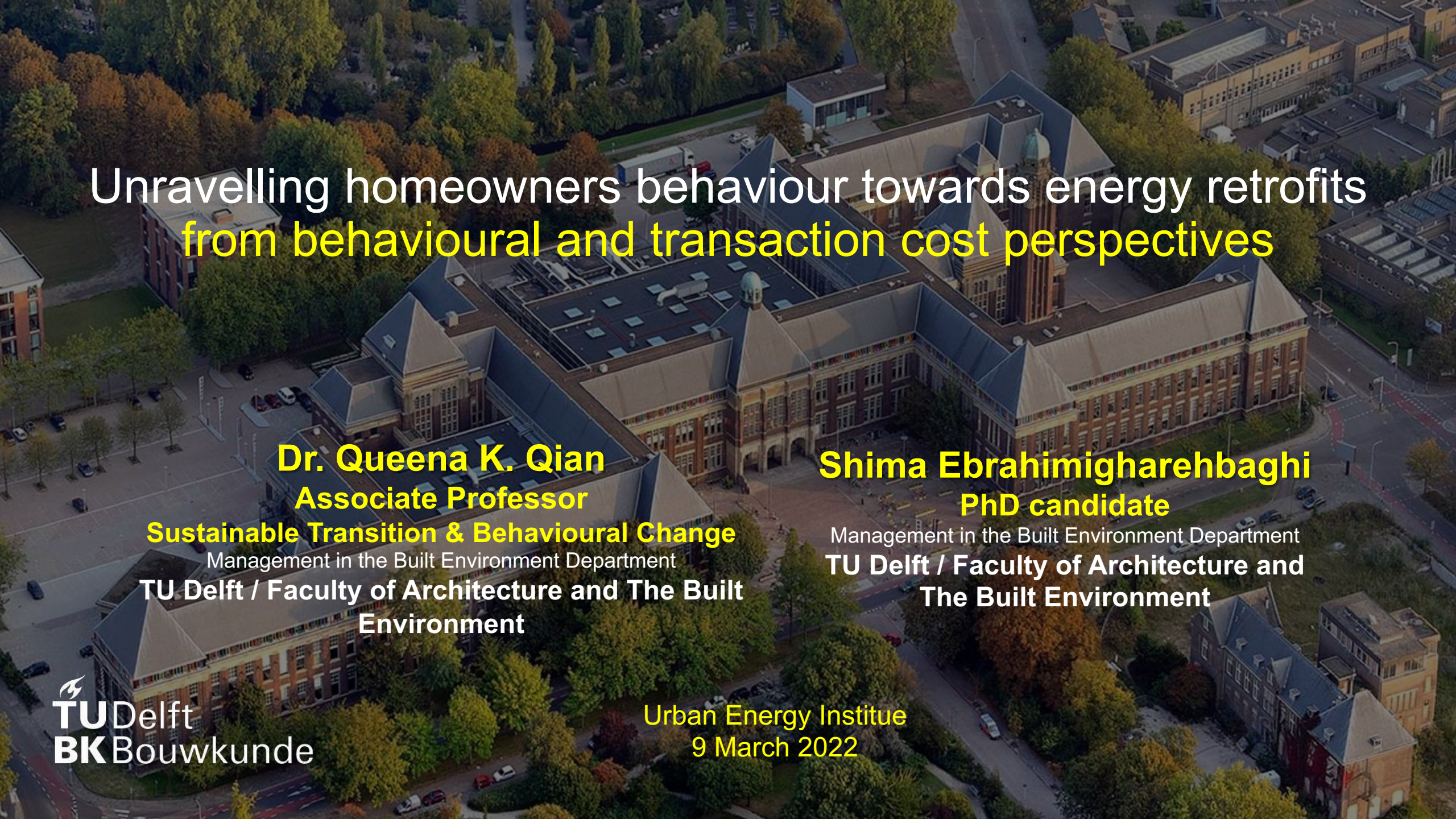

Unravelling homeowners behaviour towards energy retrofits from behavioural and transaction cost perspectives

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Urban Energy Institue
9 March 2022

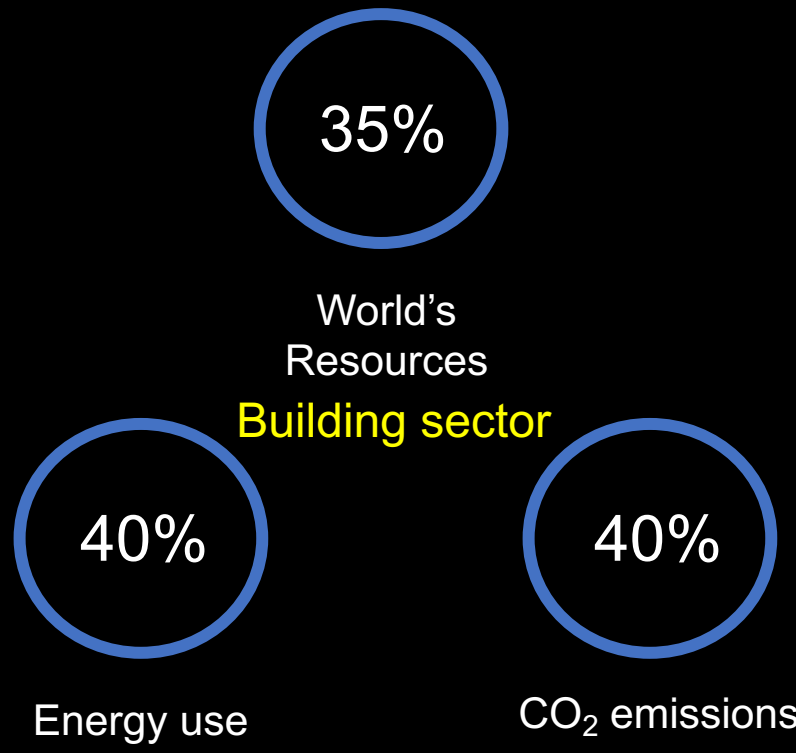
Energy efficiency targets at EU and national levels

European **Union**

- Actual renovation rate across EU: **0.5-1.5%**
- Target of renovation rate across EU: **2.5-3% by 2050**

The **Netherlands**

- Reducing **95%** GHGs emissions **by 2050**
- Removing natural gas from the heating system **by 2050**
- Renovating **200K** houses per year



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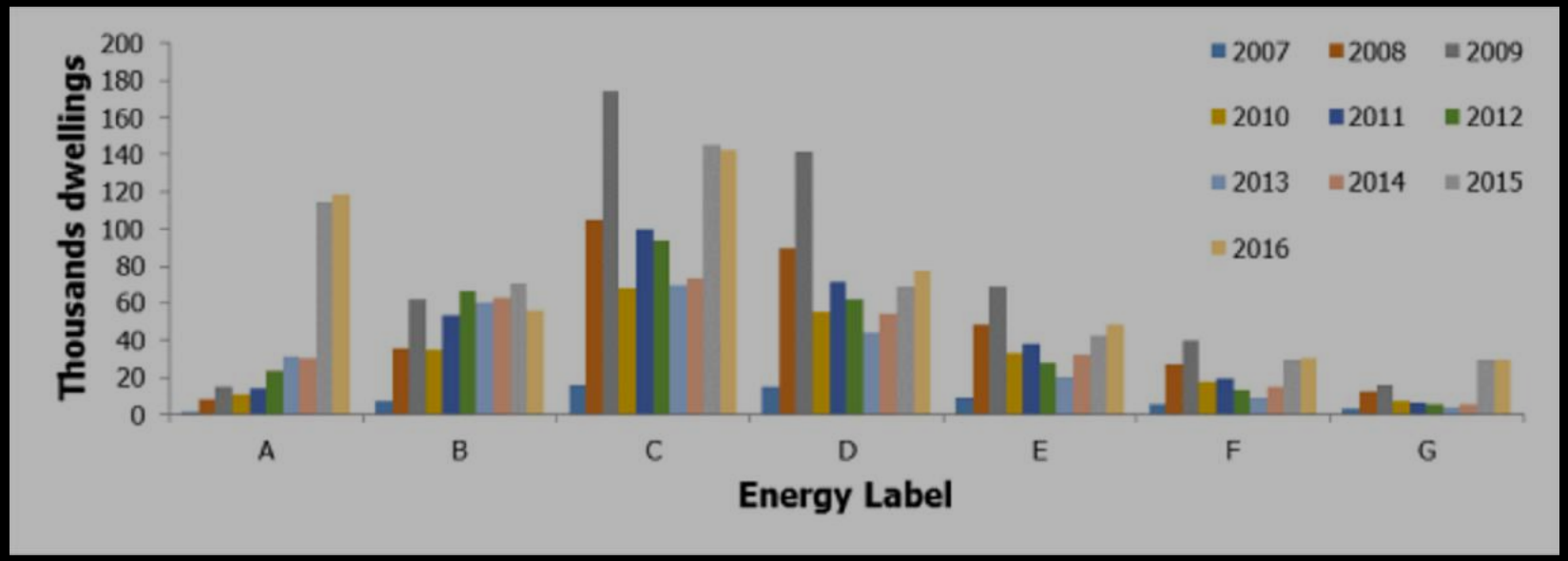
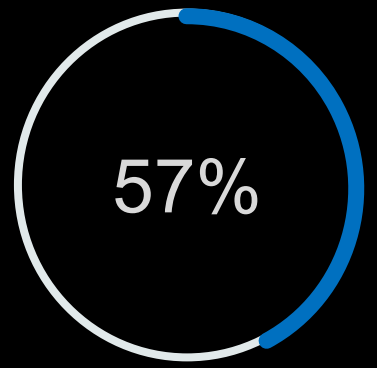
The Netherlands housing stock



Evolution of the energy label distribution of the Dutch housing stock from 2007 to 2016 (source: PBL 2017)



Share of Dutch owner-occupied sector

of the total residential sector

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The Dutch owner-occupied housing sector

- The energy retrofit rates is low in Dutch owner-occupied sector.
- Uncertainties exist in achieving ambitious energy efficiency targets defined at national levels.
- Dutch homeowners face issues such as finding resources including a financial support or a reliable contractor.
- Homeowners may decide not to perform energy efficiency renovations.

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What's the challenge now !

- Climate change facts: lower building energy consumption and increase energy renovation rate!
- 200.000 Dutch homes need to be renovated each year (Climate Agreement 2018) in order to achieve Energy transition goal 2050 in the Netherlands. – NOT happening!
- With the current technology available, the energy efficiency level in the building sector can be increased by 30%. – but adoption NOT!

The challenge is:

How to motivate the housing sector, market and occupants to participate in sustainable renovation !

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The knowledge gap

Influencing factors that can encourage or hinder homeowners' decision-making towards energy retrofits are not widely identified for homeowners and policy makers.

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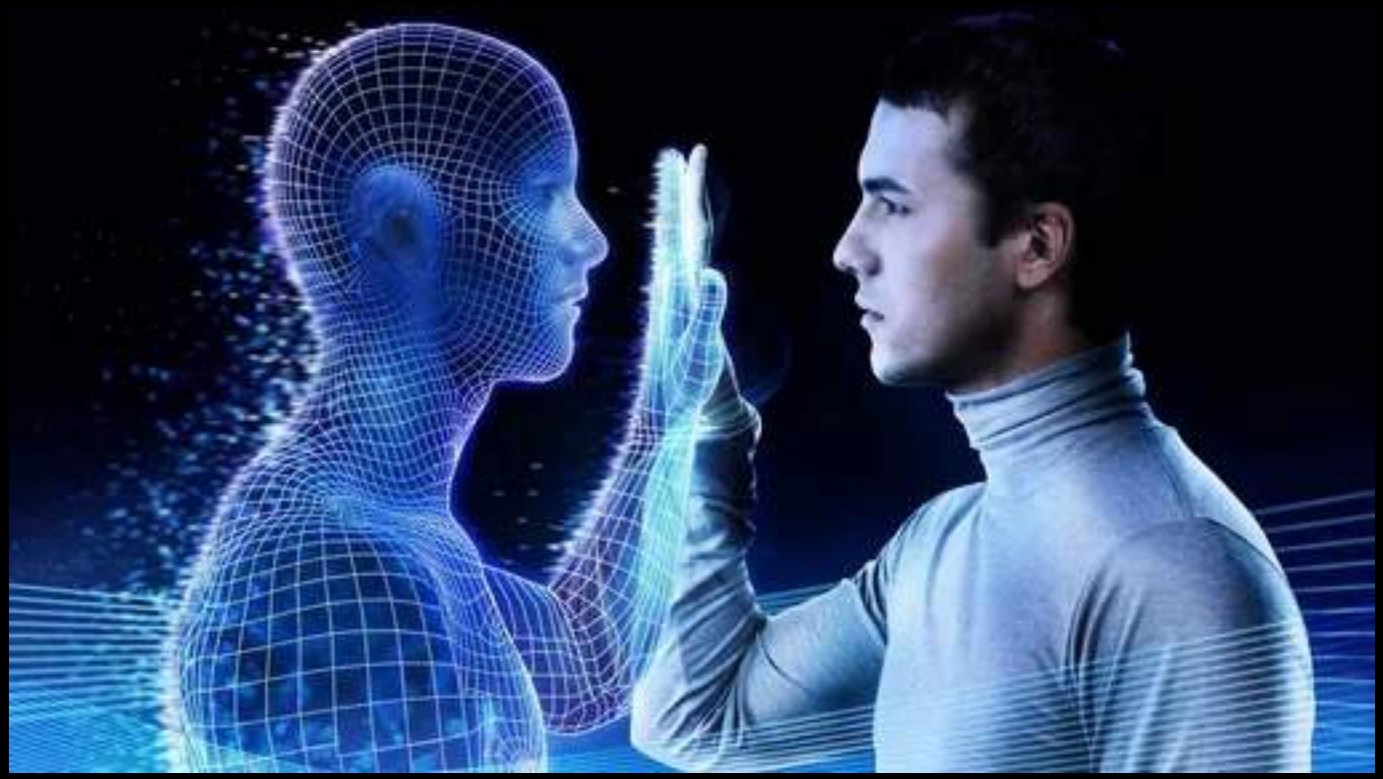
Internal and external processes of decision making



Behavioural economics:
Explaining internal process

New institutional economics:
Explaining external process

An analogy to sustainable building & energy renovation

Air shuttle to the outer space

- Air friction (barriers in the process: transaction costs) (e.g., the effort of searching for contractors, quality of information)
- Gravity (internal cognitive biases, perception and behavior)
  (e.g., status quo biases, loss aversion)
- Fuel & engine (incentive & nudges –intervention)

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Behavioral economics

- A more realistic understanding of human economic behaviour
- Emphasising the psychological and sociological foundations of economic analysis (Camerer,1999).
  - *biases and their effects on the decision-making processes*
  - *motivations and their effects on behaviour and decisions*
- Contribution to the theories, predictions, and policies

Behavioural aspects

- Behavioral aspects: mainly illustrate a range of personal and contextual factors influencing the homeowners' cognitive decision-making process.

Personal Factors:

- cognitive awareness,
- attitudes and beliefs,
- experience and skills.

Contextual Factors

- Homeowners' features,
- Socio-demographics,
- Property characteristics.

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Behaviourial aspects

Prior Conditions

Perceived needs/problems; Social norms of the systems; Innovativeness

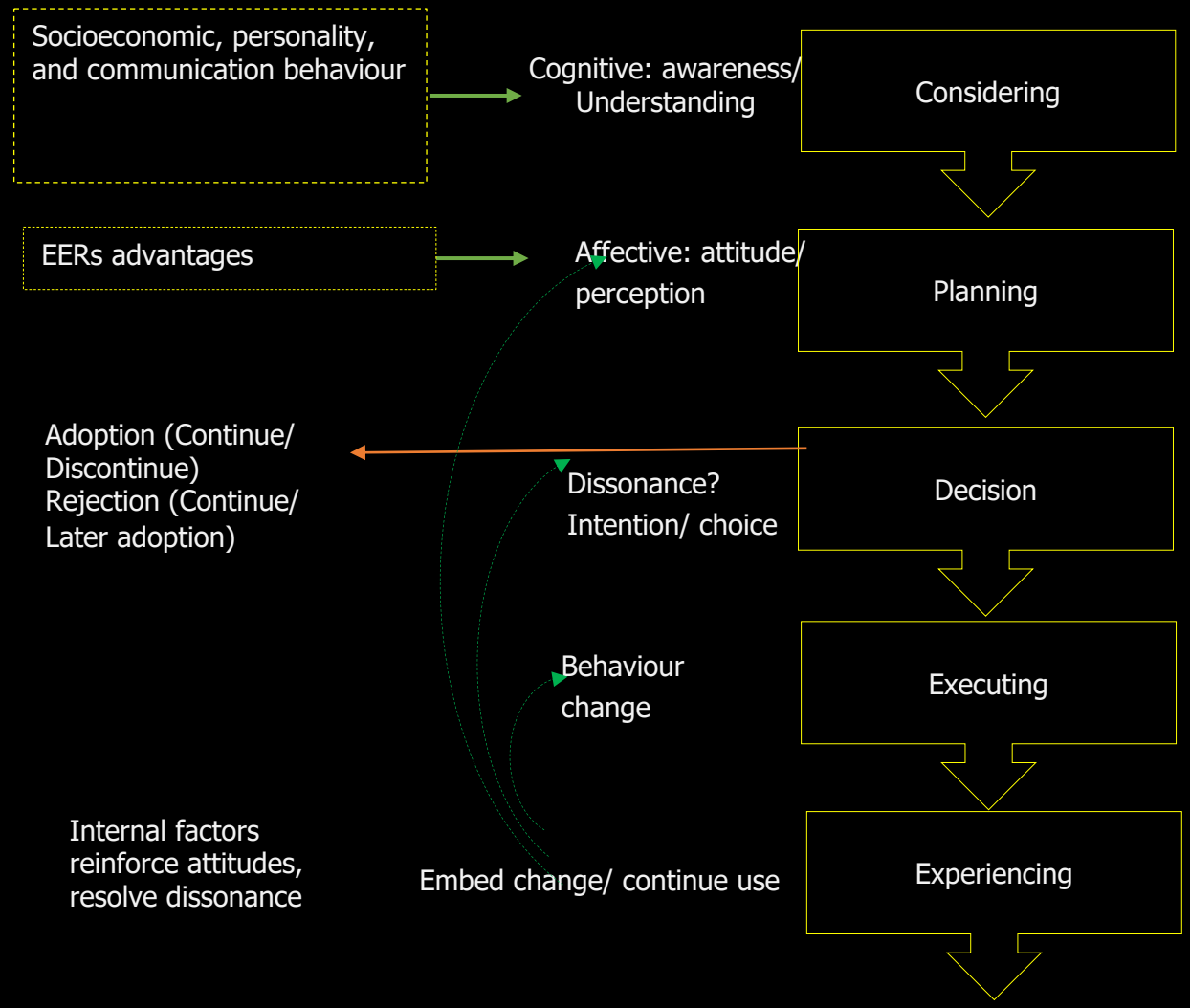
Which ESMs are available?
Which one is appropriate?
How much does it cost/benefit?

Which procedures should they take?
Who can help?
Are there examples?
Is permission required?

Who are reliable contractors?
Are there any subsidies/other benefits?

What can be done by homeowners?
How much hassle/mess
does it bring?

How much of the expectations are achieved?
What are other appropriate types of ESMs?



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New institutional economics and transaction cost theory

- Transaction cost theory by (Coase, 1937)
  - Actual costs of using market are more that the price of a good or service
  - A number of transaction costs to using the market including:
    - Search and information costs,
    - Bargaining costs, and
    - Policing and enforcement costs

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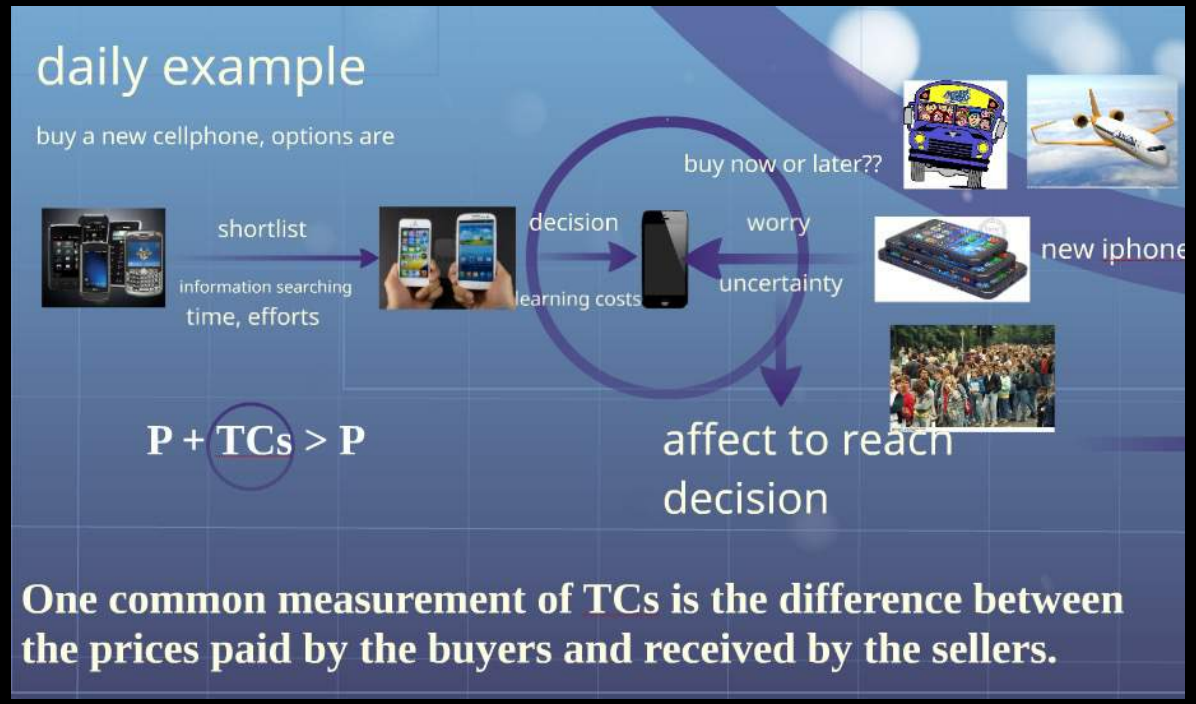
Application of TCs in the field of energy efficiency

- TCs for lighting and insulation, which were **10% and 30%** of the total investment costs for suppliers
- TCs account for **8–38% of the total costs for public authorities**
- Neglecting TCs in the evaluation (and preparation) of energy efficiency policies causes a sub-optimal allocation of resources
- TCs involved in changing a heating system as equal to **18 hours**, i.e., **13–28% of the predicted investment cost.**

Transaction costs and their affects on consumer decision

- Transaction cost means **any unavoidable indirect cost** in a transaction with an external party that negatively affects the consumers' decision.
- Different **forms:**
  - Time, effort, complexities in doing renovations, hassle factors, mess and nuisance, and uncertainties



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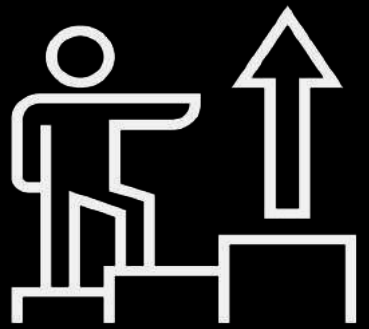
Transaction cost and its determinants

1) Degree of asset specificity refers to durable investments that are undertaken in support of particular transactions. These specific investments represent sunk costs that have a much lower value outside of these particular transactions (Williamson, 1985).
2) Uncertainties surrounding transactions refers to three aspects: economic uncertainty, market uncertainty and policy uncertainty
3) Frequencies refers to how often the buyers make purchases in the market (Williamson, 1985).

Asset specificity

Uncertainty



Experience

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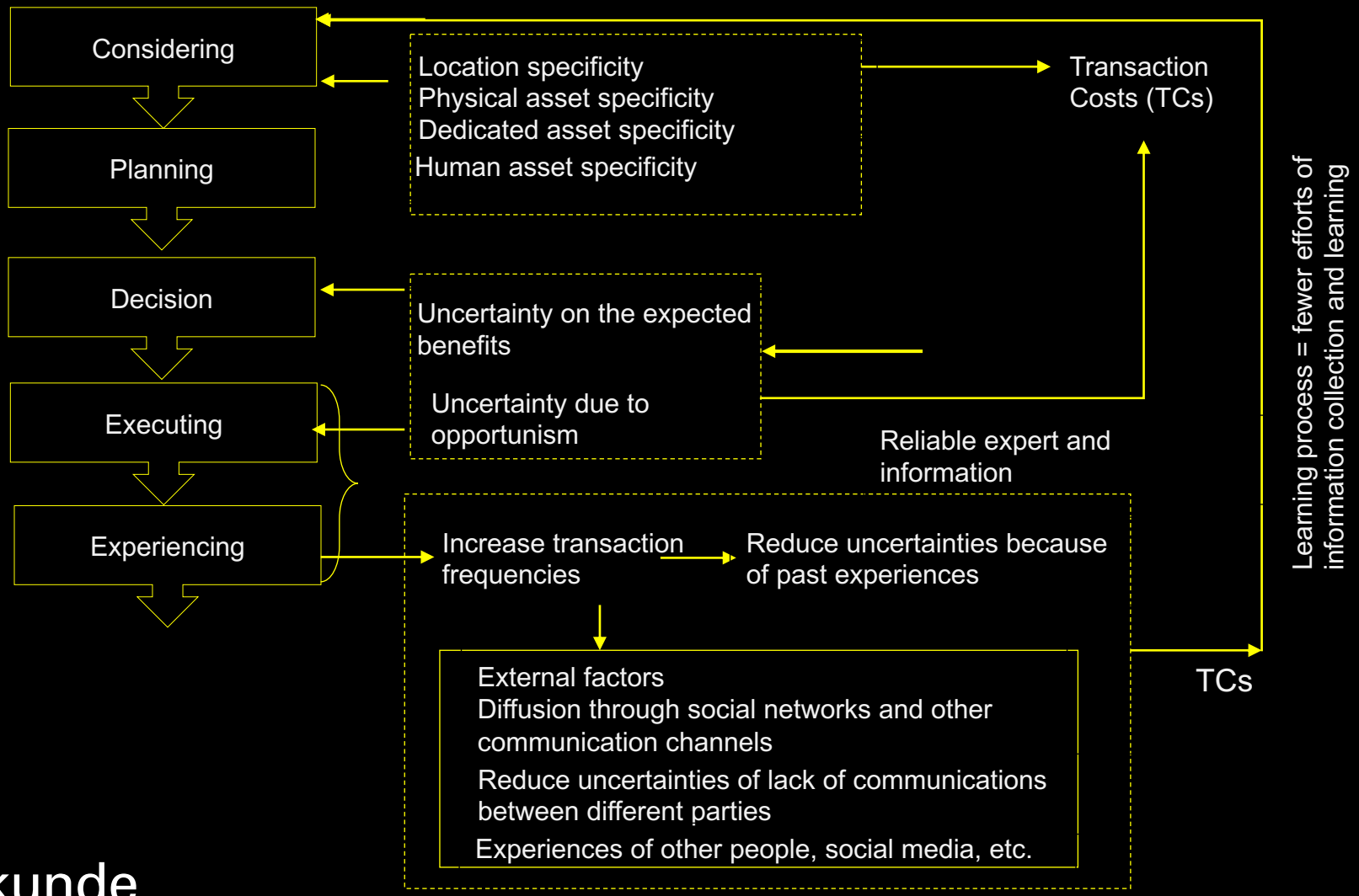
Transaction cost factors



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Objectives of IEBB program (Integrated Approaches for the Energy Transition in Existing Buildings)

- Developing affordable and user-friendly renovation concepts for residential buildings
- Innovative solutions for heat conversion and storage
- Digitization
- Industrialization concepts
- **Decision-making frameworks**
- Value chain integration and partnership models

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Project 5.2: Strategies for promoting energy efficiency renovations in the Dutch owner-occupied sector

- Diagnosing cognitive biases of homeowners during the renovation process
- Assessing hidden barriers (the “transaction costs”) for energy retrofits
- Provide homeowners with a hassle-free decision-making process for energy retrofits
- Partners: TU Delft, the city of the Hague, the city of Amsterdam, Enpuls (Buurkracht), MilieuCentraal

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Publications related to the investigation of homeowner decision-making process and renovation process

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Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Unravelling Dutch homeowners' behaviour towards energy efficiency renovations: What drives and hinders their decision-making?

Shima Ebrahimigharehbaghi*, Queena K. Qian, Frits M. Meijer, Henk J. Visscher

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ARTICLE INFO

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Transaction costs (TCs)
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ABSTRACT

The housing stock has a considerable share of 40% in energy consumption and 36% of CO_2 emissions in the EU. In accordance to energy efficiency and emissions targets set by EU, The Netherlands has aimed to renovate

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Identification of the behavioural factors in the decision-making processes of the energy efficiency renovations: Dutch homeowners

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ABSTRACT

Over half of all residential buildings in the Netherlands are owner-occupied. In this study, the influence of behavioural factors on individual decisions toward energy efficiency renovations (EERs) was investigated. This study focused on contextual (e.g. building characteristics), personal (e.g. awareness of energy consumption), and motivational factors (e.g. improving comfort). Logistic regression analyses were selected as the preferred method of analysis. The Netherlands's housing survey energy modules, which was conducted in 2018, was the basis of these analyses. 2878 homeowners were surveyed. Behavioural factors that influence the homeowners' decisions were investigated for four types of EERs: (1) double glazing, (2) insulation, (3) photovoltaic (PV) panel, and (4) sustainable heating. It was found that homeowners' preferences for double glazing were mainly influenced by the characteristics of the building and household and motivation to adopt EERs. Similarly, insulation and PV panels were to be mainly influenced by building characteristics. For sustainable heating, a combination

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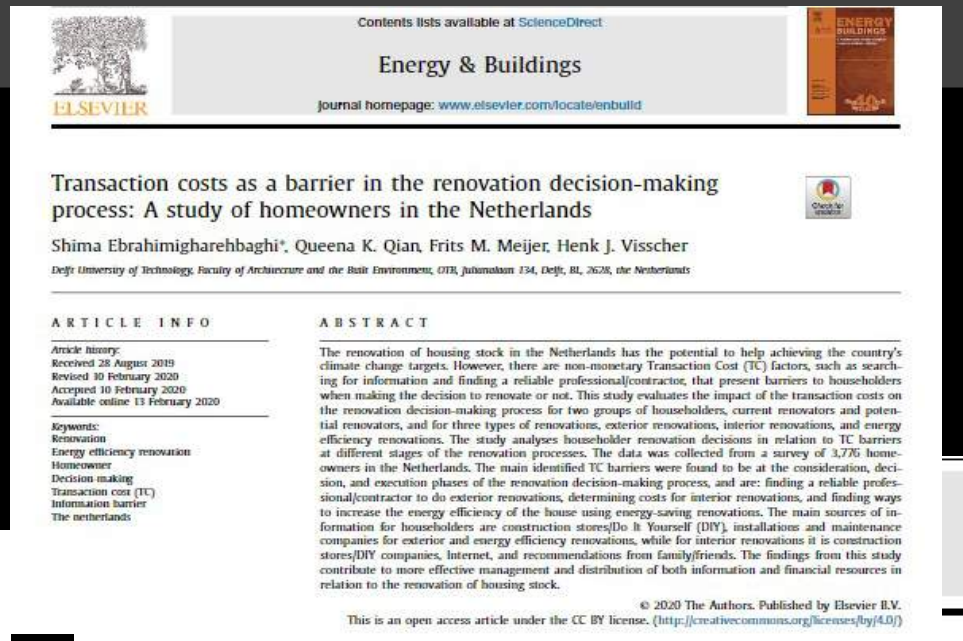
Energy efficiency; renovation; behaviour-influencing factor; residential sector; owner-occupied sector; the Netherlands



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Transaction costs as a barrier in the renovation decision-making process: A study of homeowners in the Netherlands

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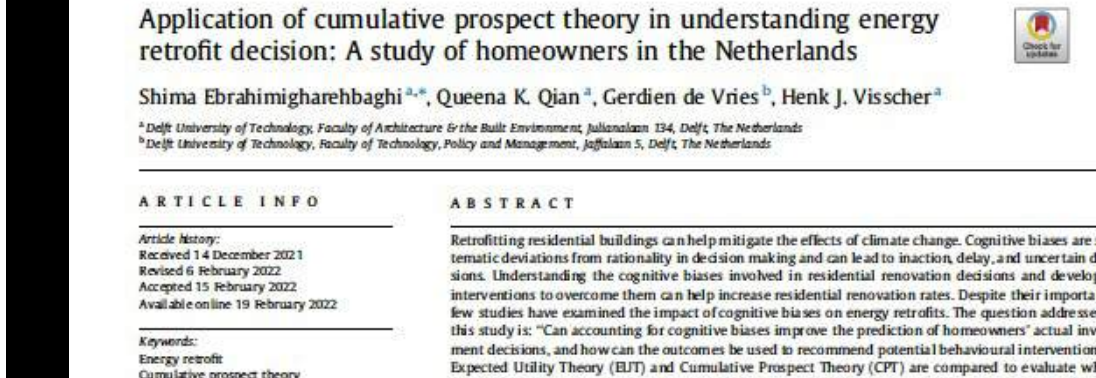
ABSTRACT

The renovation of housing stock in the Netherlands has the potential to help achieving the country's climate change targets. However, there are non-monetary Transaction Cost (TC) factors, such as searching for information and finding a reliable professional/contractor, that present barriers to householders when making the decision to renovate or not. This study evaluates the impact of the transaction costs on the renovation decision-making process for two groups of householders, current renovators and potential renovators, and for three types of renovations, exterior renovations, interior renovations, and energy efficiency renovations. The study analyses householder renovation decisions in relation to TC barriers at different stages of the renovation processes. The data was collected from a survey of 3,776 homeowners in the Netherlands. The main identified TC barriers were found to be at the consideration, decision, and execution phases of the renovation decision-making process, and are: finding a reliable professional/contractor to do exterior renovations, determining costs for interior renovations, and finding ways to increase the energy efficiency of the house using energy-saving renovations. The main sources of information for householders are construction stores/Do It Yourself (DIY), installations and maintenance companies for exterior and energy efficiency renovations, while for interior renovations it is construction stores/DIY companies, Internet, and recommendations from family/friends. The findings from this study contribute to more effective management and distribution of both information and financial resources in relation to the renovation of housing stock.



Application of cumulative prospect theory in understanding energy retrofit decision: A study of homeowners in the Netherlands

Shima Ebrahimigharehbaghi[a,*], Queena K. Qian[a], Gerdien de Vries[b], Henk J. Visscher[a]

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ABSTRACT

Retrofitting residential buildings can help mitigate the effects of climate change. Cognitive biases are systematic deviations from rationality in decision making and can lead to inaction, delay, and uncertain decisions. Understanding the cognitive biases involved in residential renovation decisions and developing interventions to overcome them can help increase residential renovation rates. Despite their importance, few studies have examined the impact of cognitive biases on energy retrofits. The question addressed in this study is: "Can accounting for cognitive biases improve the prediction of homeowners' actual investment decisions, and how can the outcomes be used to recommend potential behavioural interventions?". Expected Utility Theory (EUT) and Cumulative Prospect Theory (CPT) are compared to evaluate which

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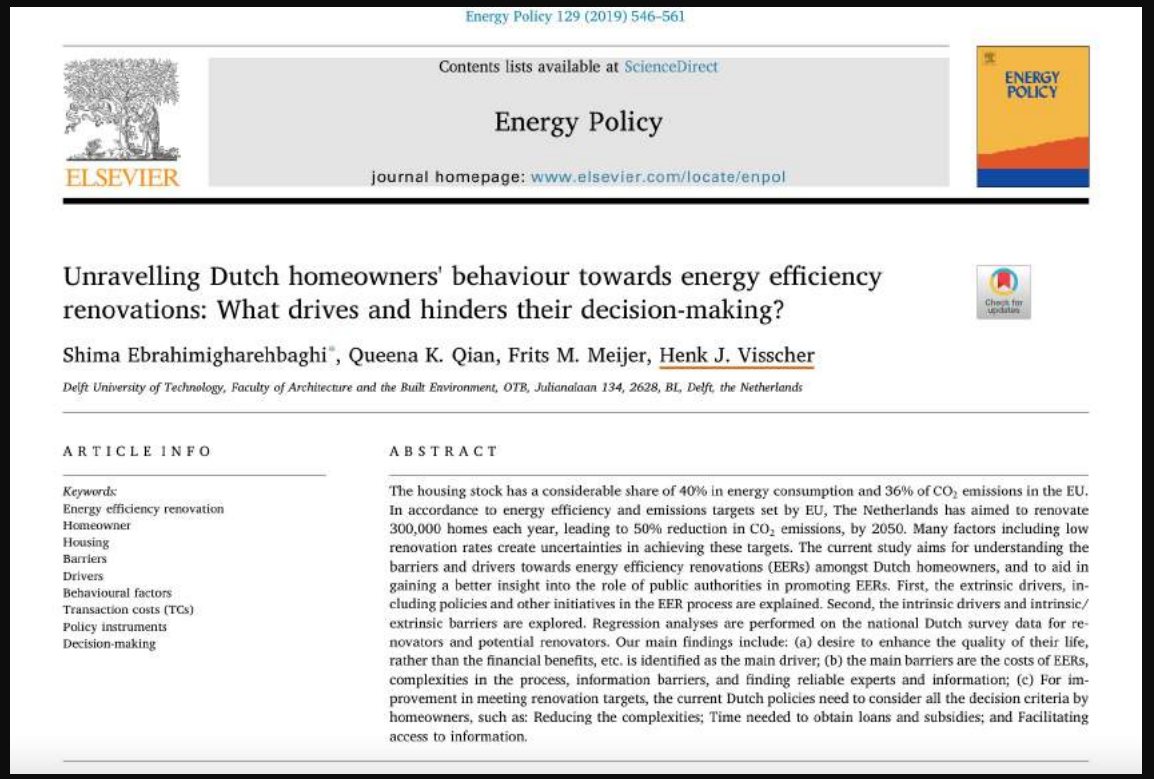
Unravelling Dutch homeowners' behaviour towards energy efficiency renovations

- Research questions
  - What are the main drivers and barriers to energy retrofits from the behavioural research and transaction cost perspectives?
  - Whether the current energy efficiency policies match the homeowners' needs?



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ABSTRACT

The housing stock has a considerable share of 40% in energy consumption and 36% of CO_2 emissions in the EU. In accordance to energy efficiency and emissions targets set by EU, The Netherlands has aimed to renovate 300,000 homes each year, leading to 50% reduction in CO_2 emissions, by 2050. Many factors including low renovation rates create uncertainties in achieving these targets. The current study aims for understanding the barriers and drivers towards energy efficiency renovations (EERs) amongst Dutch homeowners, and to aid in gaining a better insight into the role of public authorities in promoting EERs. First, the extrinsic drivers, including policies and other initiatives in the EER process are explained. Second, the intrinsic drivers and intrinsic/extrinsic barriers are explored. Regression analyses are performed on the national Dutch survey data for renovators and potential renovators. Our main findings include: (a) desire to enhance the quality of their life, rather than the financial benefits, etc. is identified as the main driver; (b) the main barriers are the costs of EERs, complexities in the process, information barriers, and finding reliable experts and information; (c) For improvement in meeting renovation targets, the current Dutch policies need to consider all the decision criteria by homeowners, such as: Reducing the complexities; Time needed to obtain loans and subsidies; and Facilitating access to information.

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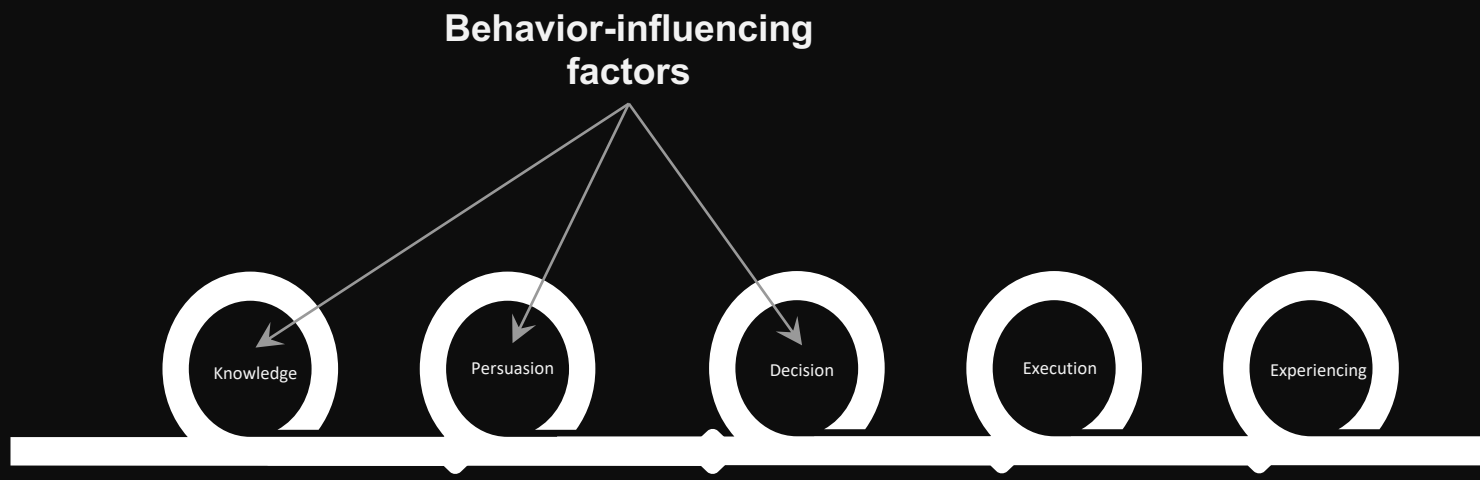
1) Developing the theoretical framework of BE on the energy retrofit decision making process

- Contextual factors
  - Homeowner characteristics: size, composition, and number of children
  - Socio-demographic variables: age, education, income, and employment
  - Property characteristics: construction period



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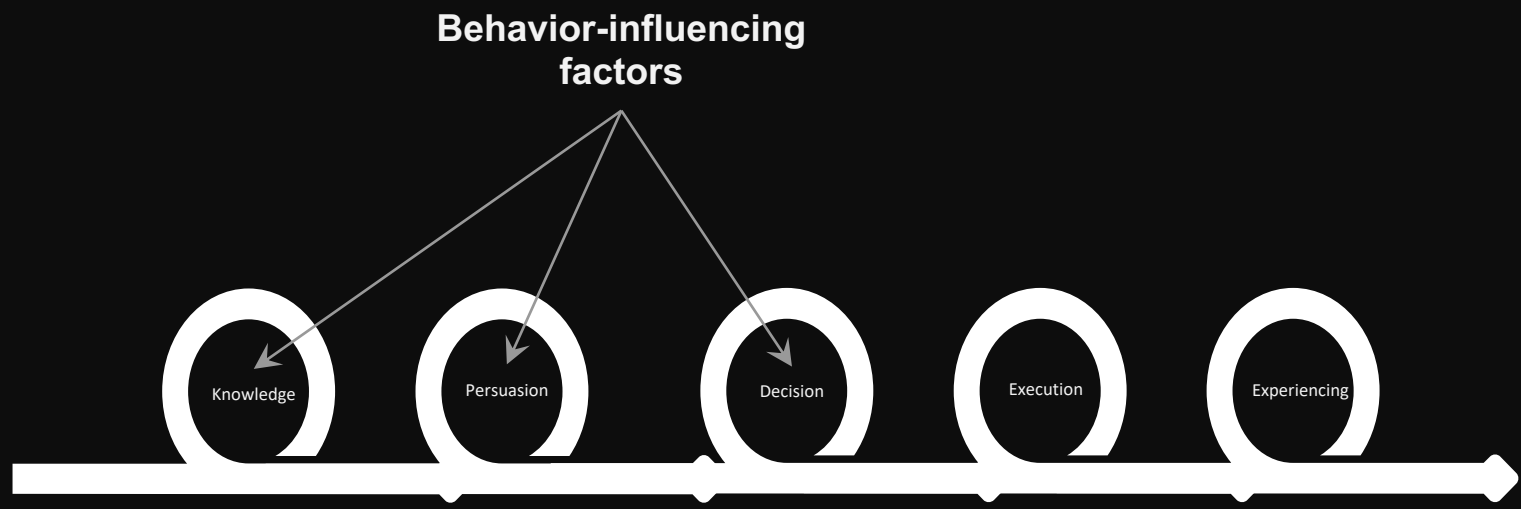
1) Developing the theoretical framework of BE on the energy retrofit decision making process

- **Personal factors**
  - Cognitive biases and awareness,
  - Attitudes and beliefs,
  - experience, and skills
- **Motivational factors**
  - Cost saving on energy bills
  - Repairing/replacing equipment
  - Enhancing the quality of life
  - Increasing the house value
  - Protecting environment
  - Other's experiences, following others



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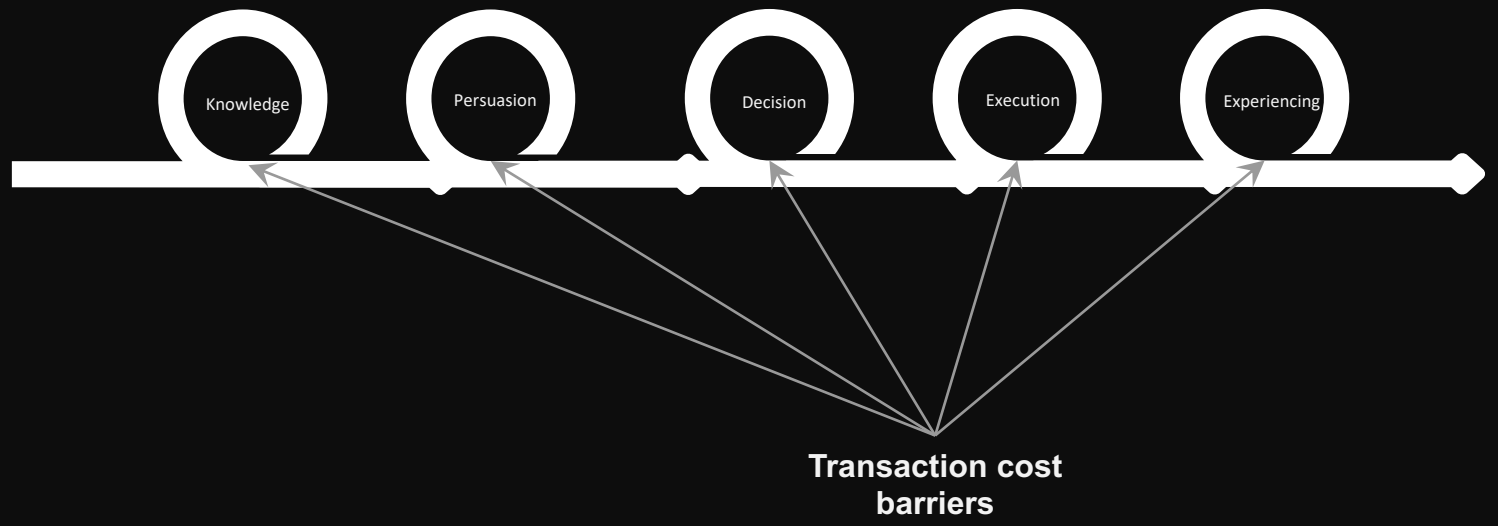
1) Developing the theoretical framework of TCs on the energy retrofit process

- Information
  - Time and efforts in finding info
- Credibility
  - Searching & finding reliable information and experts
- Self/support
  - Time/effort in finding support & help.



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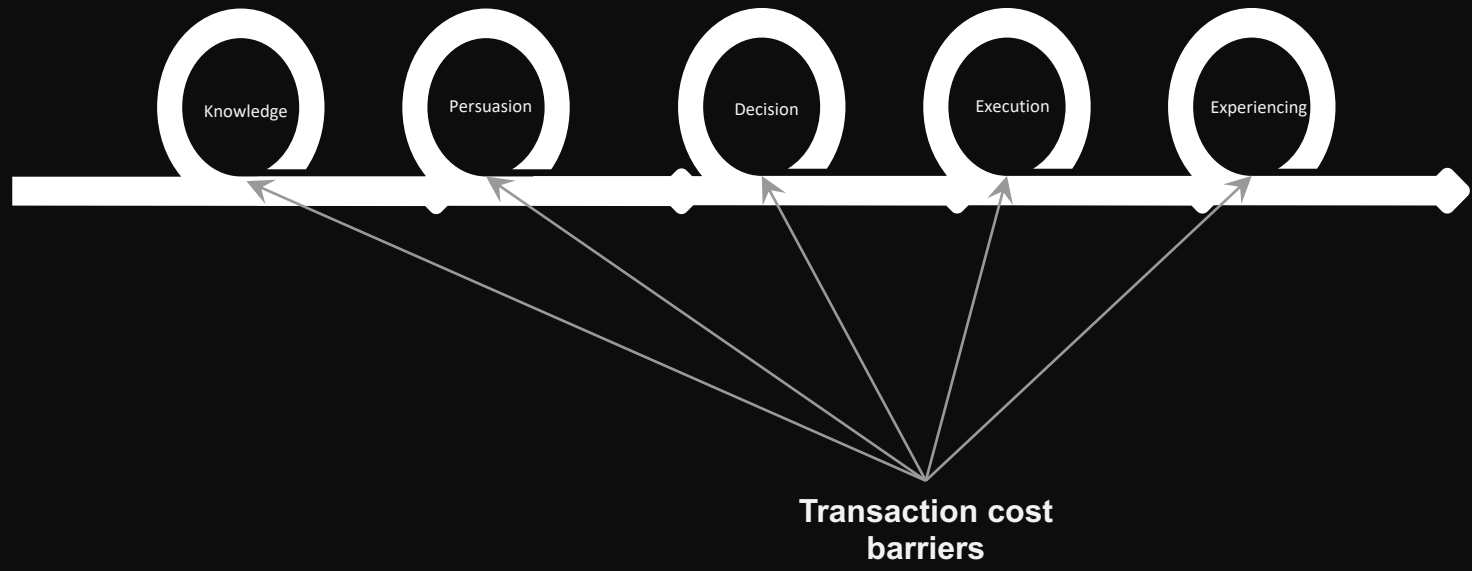
1) Developing the theoretical framework of TCs on the energy retrofit process

- Work/Process (W)
  - Disruption in the ordinary life and anticipated hassle fact
  - Perceiving energy retrofit as not essential
  - Complexities in acquiring the knowledge & skills
  - Dissatisfaction of the past experience
  - Time/effort apply for loans/subsidies, doing the work



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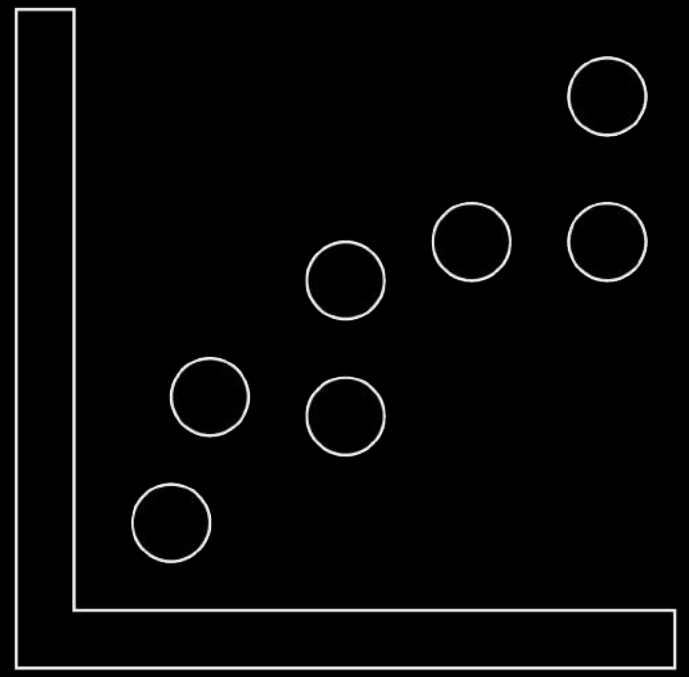
2) Methodology

- **Dataset**
  - Netherlands national housing survey 2012 (Woon – Woon Onderzoek Nederland)
  - Conducted among the owner-occupied, social housing and private rental sectors, 2784 homeowners
  - Renovators and potential renovators

- **Method of analysis:** ***L****ogistic regression*

$$Log\frac{P\ (renovation)}{1-P(renovation)} = X_{Socio\_demographic\ variables} + X_{Drivers} + X_{Barriers}$$



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3) Conclusions - the main identified motivations during the DM processes

- For homeowners, **quality of life (comfort level)** is amongst the top drivers, followed by general maintenance of the house, and saving money.
- Choosing “Increasing comfort” were 2.4 times more likely to renovate compared to those who did not choose this specific driver.

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3) Conclusions - the main identified barriers during the renovation processes

- Limited/no subsidies and the costs of energy retrofits
- **Complexity** in applying for loans/subsidies
- Time and effort in applying loans/subsidies
- The **unequal distribution** of the subsidies and grants among householders
- The **time and effort** spent in finding information,
- The reliability **of information and experts**

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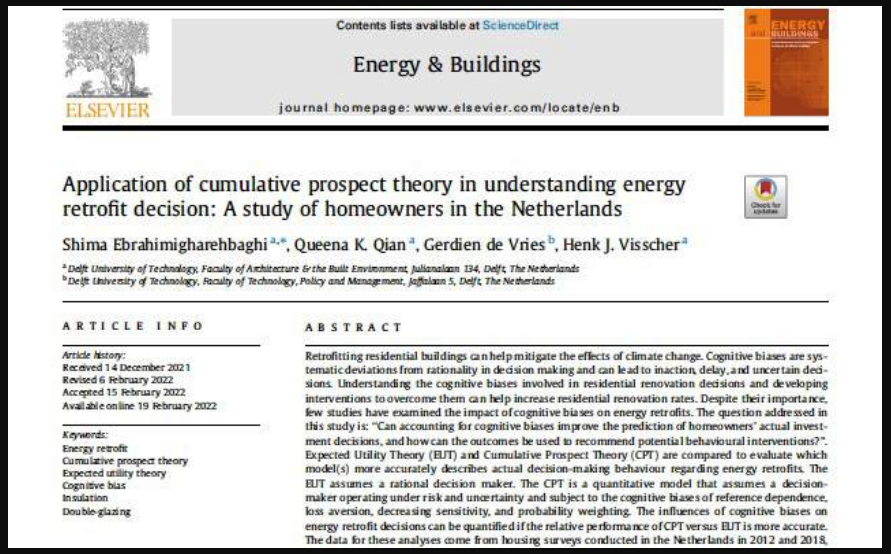
Application of cumulative prospect theory (CPT)

in understanding energy retrofit decision

- **Research questions:**
  - Whether CPT describes the actual decision-making behaviour more accurate compared to expected utility theory (EUT) in the context of energy efficiency investments?
  - How can the results of CPT be used to recommend potential behavioural interventions for promoting the energy efficiency renovations in the Dutch owner-occupied sector?



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Expected utility theory
Cognitive bias
Insulation
Double-glazing

ABSTRACT

Retrofitting residential buildings can help mitigate the effects of climate change. Cognitive biases are systematic deviations from rationality in decision making and can lead to inaction, delay, and uncertain decisions. Understanding the cognitive biases involved in residential renovation decisions and developing interventions to overcome them can help increase residential renovation rates. Despite their importance, few studies have examined the impact of cognitive biases on energy retrofits. The question addressed in this study is: "Can accounting for cognitive biases improve the prediction of homeowners' actual investment decisions, and how can the outcomes be used to recommend potential behavioural interventions?". Expected Utility Theory (EUT) and Cumulative Prospect Theory (CPT) are compared to evaluate which model(s) more accurately describes actual decision-making behaviour regarding energy retrofits. The EUT assumes a rational decision maker. The CPT is a quantitative model that assumes a decision-maker operating under risk and uncertainty and subject to the cognitive biases of reference dependence, loss aversion, decreasing sensitivity, and probability weighting. The influences of cognitive biases on energy retrofit decisions can be quantified if the relative performance of CPT versus EUT is more accurate. The data for these analyses come from housing surveys conducted in the Netherlands in 2012 and 2018,

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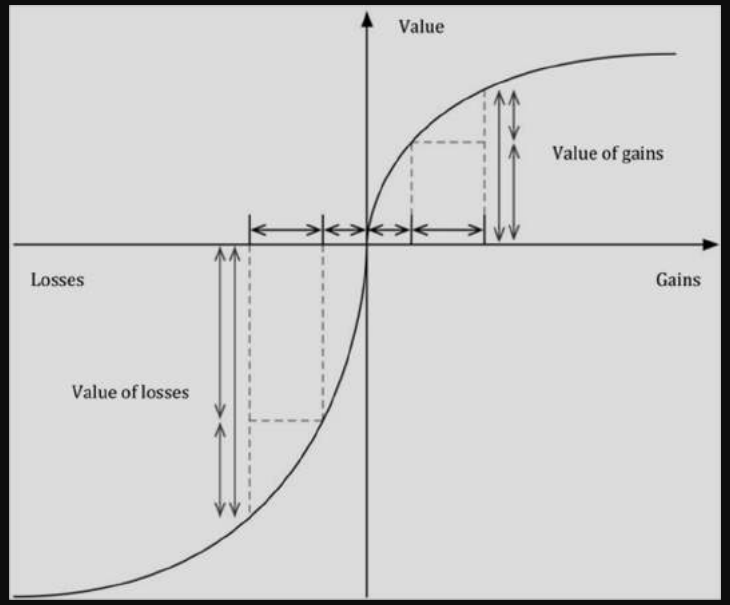
1) The theoretical framework:

cumulative prospect theory

- Loss aversion: people dislike more the same quantity of losses than the same quantity of gains
- Reference dependence:
  - The tendency to like things to stay relatively the same
  - The definition of the reference point and usually is the current value/expectation
- Risk averse/risk seeking behaviors



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2) Methodology

- **Dataset**
  - Netherlands national housing survey **energy modules 2012 and 2018**
  - Conducted among the owner-occupied, social housing and private rental sectors
  - 2784 and 2787 **homeowners**

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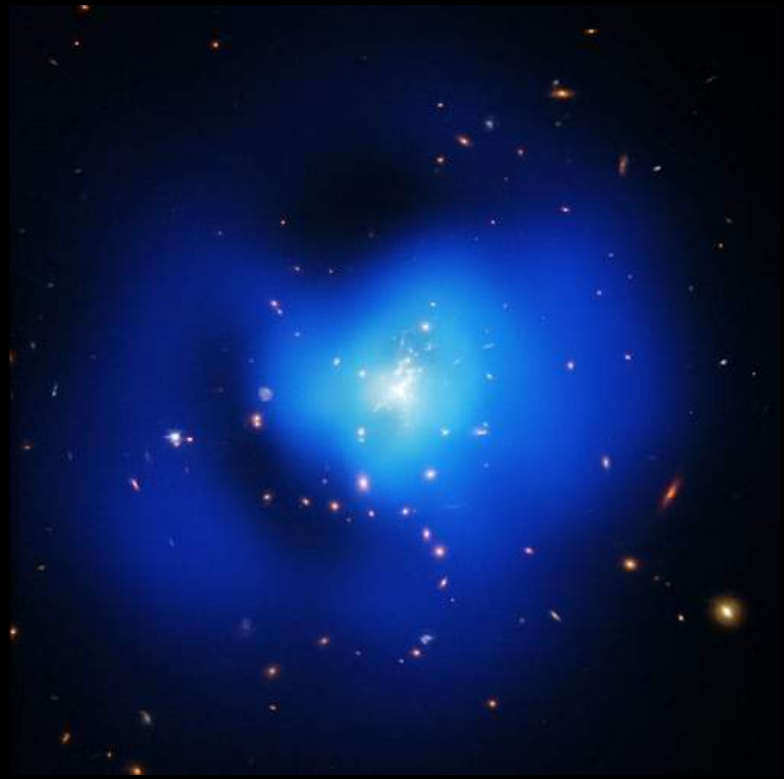
2) Methodology

- Cluster analysis based on the household and building characteristics
- Calculation of the main components of EUT and CPT models
  - Net present values of energy efficiency investments
  - Predicting the energy prices using “Geometric Brownian Motion”
  - Probability of each NPV
    - A Kernel density estimator (KDE)
- Estimation of the EUT and CPT parameters using the genetic algorithm



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3) Conclusions – CPT in understanding energy retrofit decision

- **EUT** overestimated the actual decisions of approximately **50% of homeowners**
- **CPT** predicted the decisions of **86% of individual homeowners accurately**
- **More accurate** prediction of homeowners' energy retrofit decisions by considering the cognitive biases
- The group of households that normally **avoid losses** invest more to prevent the further impact of losses

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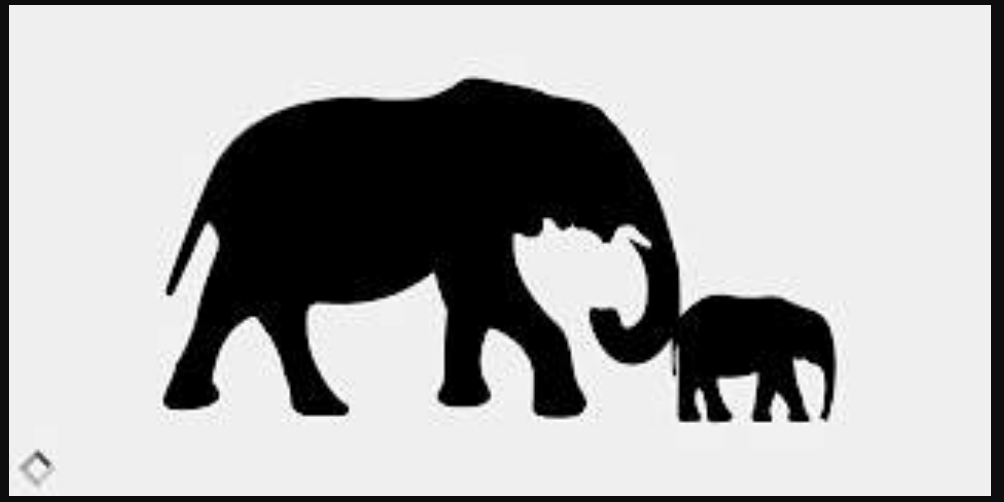
3) Conclusions – insights for behavioural interventions

- Illustrate the impact of installing energy retrofits in terms of reducing losses/costs for risk- and loss-averse individuals
- The front runner in the market needs to be identified and take the lead in adopting energy efficient technologies



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Final remarks and recommendation for future research

- More than 180 cognitive biases have been identified. Future research on the main CBs, such as social influence, is necessary.
- Dynamic of collective decision making vs. individual decision making
- Conducting experimental studies for testing the affects of other CBs
- Experiments on nudges which facilitate a behaviour
- Examining the impact of energy efficiency policy instruments

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Thank You for

Joining this Lecture

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