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

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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
The Netherlands **housing stock**

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

57% Share of Dutch owner-occupied sector of the total residential sector
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.
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.
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)
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.
Behavioural 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?
New institutional economics and transaction cost theory

- Transaction cost theory by (Coase, 1937)
  - Actual costs of using market are more than 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
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

One common measurement of TCs is the difference between the prices paid by the buyers and received by the sellers.
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).
Transaction **cost factors**

- **Transaction Costs (TCs)**
  - Location specificity
  - Physical asset specificity
  - Dedicated asset specificity
  - Human asset specificity
  - Increase transaction frequencies
  - Reduce uncertainties because of past experiences
  - Reliable expert and information
  - Learning process = fewer efforts of information collection and learning
  - External factors
    - Diffusion through social networks and other communication channels
    - Reduce uncertainties of lack of communications between different parties
    - Experiences of other people, social media, etc.

- **Decision**
  - Uncertainty on the expected benefits
  - Uncertainty due to opportunism

- **Executing**
  - Transaction Costs (TCs)

- **Experiencing**

- **Planning**

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

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

Shima Ebrahimzadeh Hagh, Queenie K. Qian, Frits M. Meijer, Henk J. Visscher

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

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

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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?
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
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.
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
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: Logistic regression

\[ \log \frac{P(\text{renovation})}{1 - P(\text{renovation})} = X_{\text{socio-demographic variables}} + X_{\text{drivers}} + X_{\text{barriers}} \]
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.
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**
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?
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
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
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
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
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
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
Thank You for
Joining this Lecture
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