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THE ROLE OF SOCIAL CAPITAL AND HOUSING-RELATED LIFESTYLE IN FOSTERING ENERGY-EFFICIENT RETROFITS IN SLOVENIA

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Motivation

- In 2018 household energy consumption accounted for roughly 26% of final energy consumption in the EU (Eurostat, 2020). Space heating has the largest share in residential energy consumption, accounting for 64% of energy consumed in EU households in the same year.

- In a household setting, undergoing retrofits to reduce energy consumption for heating/cooling is a way of improving the household's energy efficiency.

- JRC Technical report (2019) on achieving the cost-effective energy transformation of Europe's buildings highlights that almost 75% of EU building stock is energy inefficient according to current building standards, where only 0.4 -1.2% of the building stock in the EU is retrofitted each year, with slight differences among member states.

An overview of relevant literature

- Various studies (Fraunhofer Institute, 2019) have identified a large potential for cost-efficient household energy savings. However, this potential remains largely unrealized.

- A vast body of literature addresses the energy efficiency gap (Jaffe & Stavins, 1994; Allcott & Greenstone, 2012) and explores barriers (Alcott & Greenstone, 2012; Throne-Holst, Strandbakken & Stø, 2008) and drivers to energy efficiency (Sudhakara Reddy et al., 2014; Mills & Schleich, 2010)

- Several studies examine factors influencing energy-efficient retrofits (Achtnicht & Madlener, 2014; Banfi, Fillipini & Jakob, 2008; Wilson, Crane, & Chryssochoidis, 2015; Hrovatin & Zorić, 2018)

Contribution & research questions

- We extend the existing studies by considering the role of social capital (Cirman et al., 2013) and housing-related lifestyle (as operationalised in Thogersen, 2017) on energy-efficient retrofits.

- RQ1: What is the role of social capital in making decisions to undergo energy-efficient retrofits?
- RQ2: What is the role of housing-related lifestyle in fostering energy-efficient retrofits?

Data

- Primary data was collected from a household survey conducted in August 2020 as a part of the EU funded Care4Climate project.
- The sample included 3000 respondents from Slovenia, economic decision-makers in their household.
- The survey was conducted online, with the help of a market-research agency.
- Characteristics of respondents in the sample closely resemble the population with respect to the region, gender and age, with a slight over-representation of individuals with higher levels of education.

Method

- We employed the random utility theory and the method of revealed preference. According to it, a choice to perform an energy-efficient (EE) retrofit can be represented in the following way (Train, 2009):

$$U_{nj} = V_{nj} + \varepsilon_{nj}$$

U_{nj} - the individual's utility obtained from alternative j,

V_{nj} - the known component of utility, assumed to be linear in parameters and estimated through several variables (household and individual characteristics, dwelling and location characteristics, social capital, housing-related lifestyle, etc.)

ε_{nj} - the unknown component of utility

Method

- The probability that an individual *n* opts for an EE retrofit can be modelled through their utility, that is the individual will choose to perform an EE retrofit only if the choice increases their underlying utility.

$$\text{Prob ('individual opts for an energy-efficient retrofit')} = \text{Prob}\,(U_{ni} \geq U_{nj}) = \text{Prob}\,(V_{ni} + \varepsilon_{ni} \geq V_{nj} + \varepsilon_{nj})$$

- The dependent variable has a value of 1 in case that the respondent has performed an EE retrofit (window retrofit, façade retrofit, roof retrofit, heating system replacement, installation of a ventilation system with recuperation), and 0 otherwise.

- Different discrete choice methods were employed to estimate the specified model (Hoffman & Duncan, 1988; McFadden & Train, 2000; Train, 2009).

Dependent variable: overview

Was an energy-efficient retrofit performed?	Freq.	Percent
No	1319	51.95
Yes	1218	48.05

Type of EE retrofit	Freq.	Percent (of the number of respondents who performed EE retrofits)	Percent (of the total number of respondents)
Window replacement	824	67.65	32.48
Heating system replacement	718	58.95	28.31
Thermal insulation of the façade	652	53.53	25.70
Thermal insulation of the roof	449	36.86	17.70
Installation of a ventilation system with recuperation	75	6.16	2.95

Overview of explanatory variables (individual and household characteristics & dwelling and location characteristics)

	Mean	Std.Dev.	Min	Max
Individual and household characteristics				
Gender of respondent	.484	.5	0	1
Education level of respondents (1-elementary school or lower to 3 – University degree or higher)	2.472	.534	1	3
Age of respondents (in years)	46.989	13.445	18	86
Monthly income (five categories 1 – below minimum wage to 4 – above 2501 EUR and 5 – non reported)	3.127	1.172	1	5
Loan dummy	.557	.497	0	1
First owner dummy	.496	.5	0	1
Households with children (dummy)	.405	.491	0	1
Dwelling and location characteristics				
How old is the building (in years)	42.078	19.523	4	75
Type of housing (dummy for multi-dwelling housing)	.379	.485	0	1
Number of rooms	4.486	1.27	1	6
Capital city dummy	.292	.455	0	1
Region with the highest average temperature in Slovenia (dummy)	.048	.215	0	1
Noise level in the neighborhood (on a scale 1 – 4)	1.978	.693	1	4

Analysis: overview of explanatory variables (social capital and HRL)

Social capital				
Attachment to the neighbourhood (dummy)	.608	.488	0	1
Ease of agreement (dummy)	.504	.5	0	1
Respondent knows their neighbors (scale 1 – 3)	2.715	.477	1	3
Respondent finds the presence of a building manager is helpful (dummy)	.265	.441	0	1
No reserve fund (dummy)	.056	.23	0	1
Importance attached to free-of-charge public energy counseling in the local community (dummy)	.259	.438	0	1
Housing-related lifestyle				
A small amount of time spent at home (dummy)	.004	.066	0	1
Whether the respondent or their family members work from home (dummy)	.192	.394	0	1
PC1 - Privacy	0	1.683	-9.497	3
PC2 – DIY identity	0	1.615	-7.171	3.147
PC3 – Energy saving behaviour	0	1.537	-5.814	3.795
PC4 – Functionality and quality	0	1.461	-5.624	3.098
PC5 – Family life	0	1.379	-4.406	3.718
PC6 – Social life	0	1.343	-5.439	3.297
PC7 - Spaciousness	0	1.256	-5.244	3.747

Analysis: HRL variables operationalization

- The first step was to perform principal component analysis with Varimax rotation to help operationalize the variables related to housing-related lifestyle. We employed the Kaiser criterion which gave us 7 principal components.

	PC1 Privacy	PC2 DIY identity	PC3 Energy saving	PC4 Functionality and quality	PC5 Family life	PC6 Social life	PC7 Spaciousness
Explained variance (%)	10.2%	7.67%	7.58%	7.16%	6.56%	6.42%	5.45%
Cronbach's alpha	0.7717	0.6747	0.628	0.6535	0.6757	0.6244	0.6106

- The Kayser-Meyer-Olkin test for sampling adequacy (0.8667) and Bartlett's sphericity test show that the data is appropriate for this type of analysis. Cronbach's alphas show a satisfactory reliability of construction.

Analysis: logit model

	Coef.	St.Err.	t-value	p-value
Individual and household characteristics				
Gender	0.296***	0.097	3.04	0.002
Education	0.190**	0.090	2.12	0.034
Age of respondents	0.018***	0.004	4.67	0.000
Monthly income (base=below minimum wage)		.	.	.
Between 751 EUR and 1700 EUR	0.244	0.211	1.16	0.248
Between 1701 EUR and 2500 EUR	0.449**	0.218	2.06	0.040
2501 EUR and above	0.570**	0.227	2.52	0.012
Non-reported income	0.494**	0.228	2.16	0.031
Loan dummy	0.270***	0.094	2.88	0.004
First owner dummy	-0.279***	0.101	-2.75	0.006
Households with children (dummy)	-0.216**	0.102	-2.12	0.034
Dwelling and location characteristics				
How old is the building	0.024***	0.003	8.63	0.000
Type of housing (dummy for multi-dwelling housing)	0.096	0.178	0.54	0.589
Number of rooms	0.216***	0.047	4.59	0.000
Capital city dummy	-0.035	0.102	-0.35	0.728
Region with the highest average temperature in Slovenia (dummy)	-0.467**	0.215	-2.17	0.030
Noise level in the neighborhood (on a scale 1 – 4)	0.091	0.068	1.34	0.180

Analysis: logit model

Social capital				
Attachment to the neighbourhood (dummy)	-0.032	0.095	-0.34	0.738
Ease of agreement (dummy)	0.465***	0.097	4.80	0.000
Respondent knows their neighbors (scale 1 – 3)	-0.054	0.102	-0.53	0.595
Respondent finds the presence of a building manager is helpful (dummy)	0.470***	0.164	2.87	0.004
No reserve fund (dummy)	-0.420*	0.223	-1.88	0.060
Importance attached to free-of-charge public energy counseling in the local community (dummy)	-1.884***	0.117	-16.09	0.000
Housing-related lifestyle				
A small amount of time spent at home (dummy)	-1.229*	0.733	-1.68	0.094
The respondent or their family members work from home (dummy)	0.096	0.117	0.82	0.414
PC1 - Privacy	0.000	0.034	0.01	0.995
PC2 – DIY identity	0.068**	0.031	2.21	0.027
PC3 – Energy saving behaviour	0.061*	0.036	1.67	0.095
PC4 – Functionality and quality	-0.009	0.036	-0.24	0.811
PC5 – Family life	0.030	0.038	0.78	0.438
PC6 – Social life	0.022	0.040	0.55	0.579
PC7 - Spaciousness	-0.068*	0.040	-1.70	0.090
Constant	-3.959***	0.548	-7.22	0.000

Pseudo r-squared	0.162	Number of obs	2537.000
Chi-square	568.099	Prob > chi2	0.000
Akaike crit. (AIC)	3009.065	Bayesian crit. (BIC)	3195.905

Analysis: marginal effects

	dy/dx	Std.Err.
Gender	0.059	0.019
Education	0.038	0.018
Age of respondents	0.004	0.001
Income		
Between 1701 euros and 2500 euros	0.089	0.043
Above 2500 euros	0.113	0.044
The respondent does not wish to respond	0.098	0.045
Loan	0.054	0.018
First owner	-0.055	0.020
Households with children	-0.043	0.020
How old is the building	0.005	0.001
Number of rooms	0.043	0.009
High temperature region	-0.093	0.043
Ease of agreement	**0.092**	**0.019**
Building manager helpfulness	**0.093**	**0.032**
No reserve fund	**-0.083**	**0.044**
A small amount of time spent at home (dummy)	**-0.244**	**0.145**
Importance attached to free-of-charge public energy counseling in the local community (dummy)	**-0.374**	**0.019**
PC2 – DIY identity	**0.013**	**0.006**
PC3 – Energy saving behaviour	**0.012**	**0.007**
PC7 - Spaciousness	**-0.013**	**0.008**

Interpretation of preliminary results

- First results reveal that **individual and household characteristics** (age, gender, higher income, education, loan, children in the household, being the first owner) significantly influence an individual's decision to perform EE retrofits.
- We have also found the significant impact of **dwelling and location characteristics** (the age of the building, home size (number of rooms) and certain regional characteristics – region with the highest annual average temperature) on the probability of EE retrofits.
- These empirical findings are in line with previous research.

Interpretation of preliminary results

- As anticipated, several aspects of social capital and housing-related lifestyle also turn out to play an important role in explaining households' EE retrofit behaviour.
- Related to **social capital**, variables explaining the ease of agreement among residents as well as the helpfulness of a building manager have a significant impact on an individual's decision to perform a retrofit, as well as the variable pertaining to the absence of a reserve fund and the importance attached to free-of-charge public energy counselling in the local community .
- Variables explaining **HRL** dimensions such as DIY identity and Energy saving behaviour have a positive impact on retrofit decisions, while Spaciousness and a small amount of time spent at home decrease the probability of EE retrofit.

Conclusions and further considerations

- Including social capital and HRL related variables does turn out to be important and can provide inputs for better-targeted energy efficiency policies, as well as for policies fostering good practices when it comes to residents' participation, prosocial norms and building's formal organization.

- Further considerations include operationalisation of the HRL instrument in terms of considering additional dimensions of HRL and exploring the impact of HRL and social capital in conjunction with other concepts, such as different information sources and energy literacy.