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Indirect rebound effects in non-hotel tourism accommodation: behavioral insights from a high-social-capital destination

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ABSTRACT

The present study examines the indirect rebound effects resulting from energy savings in non-hotel tourism accommodation facilities in a high-social-capital destination in Sicily. The research examines the behavioral responses to hypothetical energy-saving scenarios of the area's operators. The findings highlight the influence of social and institutional trust, individual attitudes, and technology adoption preferences on rebound effects. They underscore the need for policies that integrate behavioral insights, foster community trust to align energy efficiency with sustainable tourism.

1. Introduction

Reductions in energy use from technological improvements in end-use energy system are frequently offset by the rebound effect, which occurs when efficiency gains lead to increased energy consumption through behavioral or economic responses. This phenomenon is deeply rooted in energy efficiency literature (Brookes, 1979; Jevons, 1865; Khazzoom, 1980; Sorrel and Dimitropoulos, 2008). and driven by market failures, barriers, and behavioral patterns (Gillingham et al., 2009; Greene, 2011).

Rebound effects can be direct, indirect, or economy-wide. In the present study we focus on indirect effects stemming from reallocating cost savings from efficiency gains to other energy-intensive activities (Sorrell, 2007; Chitnis et al., 2013). In tourism, indirect rebound effects are particularly relevant, as savings in costs and time often result in higher consumption and increased environmental impacts (Kim et al., 2020, 2023).

Although the rebound effect has been extensively studied in other sectors, its exploration within tourism remains limited. Transportation, a significant contributor to tourism-related emissions, has drawn some attention (Kim et al., 2020, 2023; Yang et al., 2023). Aall et al. (2016) highlight the importance of integrating mitigation and adaptation policies to avoid negative feedback loops and presents a model to identify intra- and inter-rebound effects, with examples from the tourism sector.

This study extends the discussion on the tourism indirect rebound effect by focusing on the indirect rebound arising from energy savings in no-hotel accommodations, such as bed and breakfasts and AirBnB accommodations, within a Destination Management Organization (DMO) in southeastern Sicily. The area is characterized by high social capital and a focus on sustainable development in local planning, provides an ideal context for analyzing the rebound effects among household-operated accommodations like holiday homes. These structures, differing from traditional hotel management, allow to investigate how sustainability measures interact with individual behavioral responses, including social and institutional trust, potentially exacerbating or mitigating rebound effects.

By integrating insights from broader energy efficiency research and the specific context of tourism, this analysis underscores the importance of addressing rebound effects as a critical factor in aligning energy transition goals with sustainable tourism development.

The next section introduces the data and method. The third discusses the results. The fourth concludes.

2. Survey and methods

In Autumn 2023, through an in-person survey, we interviewed operators or owners of 66 extra-hotel tourist accommodations in the Ragusa area listed in the 2022 Regional Tourism Observatory register comprising 625 facilities. A 10.5 % sample of facilities was selected using Halton draws. The response rate was 87 %, with no incomplete questionnaires. If a facility was unavailable or declined to participate, the next on the list was approached. Before starting, enumerators

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explained the questionnaire, and interviewers clarified questions when needed.

The questionnaire gathered the operators' opinions on climate change and related policies, collected detailed information about their properties, including low-carbon technologies already in place, and future plans to acquire such technologies, the operators' attentiveness to daily energy-saving practices, how much they trusted people, and government and their socio-demographic characteristics.

We also introduced a hypothetical scenario where operators were asked to assume the installation of a new low energy technology that would decrease the monthly energy bill of the tourist accommodation by €20. Respondents were then asked a set of contingent behavior questions aimed at estimating the indirect energy rebound effect arising from this saving. In particular, they were asked to state whether they would use the savings for: (i) activities or products that consume energy in the tourist accommodation they manage (such as for the purchase of additional electronic devices or for using appliances more often) (RB1); (ii) activities or products that consume energy in their home (RB2); (iii) expenditures outside the home that might involve energy consumption, such as travelling, dining out or buying a new car (RB3). These questions were repeated four times, under increased levels of savings - €100, €200, €500, €1000 - to explore the impact of energy savings on the rebound effect.

We assume that each respondent chooses either to spend or not to spend the energy savings to maximize their utility.

The utility of respondent *i* is a function of the energy savings offered *S* and a respondent's beliefs and attitudes, socio demographic variables and property characteristics ***X***. Since these preferences are not completely observable to the analyst, the underlying model is described by a random utility model.

The decision to spend the energy savings for RB1(RB2 or RB3) can be modelled as a binary choice, where respondent *i* will choose to spend the energy savings if the utility they obtain from spending it, U_{i1}, is greater than the utility from not spending it, U_{i0}. This can be expressed as:

$$P(Y_i = 1) = P(U_{i1} > U_{i0}) \tag{1}$$

Substituting the utility equations, and considering that each respondent answers five questions for the levels of energy savings. We estimate the following random effects logit model for RB1:

$$logit\ P(Y_i = 1) = P(\alpha_i + \beta S_i + X_i\theta + \epsilon_i) \tag{2}$$

where α is the intercept, β and θ are coefficients of the explanatory variables and ε is the error term. Eq. (2) was re-estimated with dependent variables RB2 and RB3 to investigate the different indirect rebound effects.

We estimate the coefficients using averaged-population panel method. This method is particularly advantageous in small-sample contexts such as pilot studies with limited data points as ours.

When the sample size is small, the averaged-population panel method has several advantages compared to random effects models, particularly in terms of mitigating bias and improving robustness (Cameron and Triverdi, 2010).

3. Data and results

Table 1 includes the descriptive statistics of the explanatory variables. Respondents report on average a moderate levels of social trust (*Social_trust*), a relatively low level of trust in government (*Parliament_trust*), a moderate to high level of perceived threat of climate change to their own families (*CCthreatfam*), of perceived cost of climate change policies to their own families (*CCcostfam*), of perceived cost of climate change policies to poorer groups in society (*CCcostpoor*), and of perceived benefits of climate change policies to future generations (*CCbenefitfuture*). About one-quarter of respondents have automation of appliance operation and lighting (*Auto*) in their rental accommodation, and half of the properties have double or triple glazing windows (*Windowglazing*). On average, respondents have adopted about three or four technologies to reduce energy consumption in their rental properties (*Technologies*), and plan to adopt a similar number of measures in the future (*Technologies_fut*). Finally, respondents report a moderate to high propensity to adopt energy savings behaviors on a daily basis (*Energy_saving_beh*). They are equally comprised by males and females, with about 31 % having a rental accommodation in a city centre (*Citycenter*).

Table 2, displays the impact of the variables significantly correlated to the three rebound effects.

The odds ratios for energy savings show a statistically significant positive association with indirect energy rebounds translating in increased expenses for activities or products that consume energy in the tourist accommodation, in the respondents' home, or in other activities, consistent with findings in the literature that suggest that even small savings may encourage increased consumption through the "income effect" (Sorrell et al., 2009). This modest, yet significant, impact highlights the challenge of completely neutralizing rebound effects, even with targeted interventions.

Social trust is found to significantly reduce the odds of all three

Table 1
- Descriptive statistics of the explanatory variables.

	Mean	Std. dev.	Min	Max
Social_trust	2.851	1.004	1	5
Parliament_trust	2.075	1.091	1	4
CCthreatfam	3.403	1.102	1	5
CCcostfam	3.388	0.937	1	5
CCcostpoor	3.746	1.119	1	5
CCbenefitfuture	3.746	1.078	2	5
Auto	0.269	0.447	0	1
Windowglazing	0.507	0.504	0	1
Technologies	3.537	2.357	0	10
Technologies_fut	3.627	3.895	0	11
Energy_saving_beh	3.687	1.076	1	5
Male	0.545	0.502	0	1
Citycenter	0.313	0.467	0	1

Table 2
– Averaged-population logit models: odds ratios.

	RB1	RB2	RB3
Energy savings	1.0002 (0.0004)	1.0007* (0.0004)	1.0011*** (0.0003)
Social_trust	0.3353*** (0.0986)	0.3892*** (0.1133)	0.5206** (0.1364)
Parliament_trust	1.8955*** (0.4471)		
CCthreatfam			0.4581*** (0.1358)
CCcostfam	0.3725*** (0.1275)		
CCcostpoor			1.7312* (0.4896)
CCbenefitfuture	2.0706*** (0.549)	2.4181*** (0.6595)	1.9259** (0.5483)
Auto	0.0468*** (0.0392)	0.0221*** (0.0248)	
Windowglazing	3.8746** (2.1911)		
Technologies		1.3645** (0.1956)	
Technologies_fut		1.2105*** (0.085)	
Energy_saving_beh			0.5206** (0.1364)
Male		4.1875** (2.4149)	
Citycenter	5.0051*** (2.483)		
Constant	0.9249 (1.0892)	0.0105*** (0.0151)	0.6979 (0.8937)

***, **, * denote significance at 1 %, 5 % and 10 % levels, respectively.

rebound effects, particularly those related to energy consumption in the touristic accommodation and in the respondent's home: a one-unit increase in social trust decreases the odds of RB1 and RB2 by about 66 % and 61 %, respectively. These results align with previous findings emphasizing that higher social capital correlate with pro-environmental behavior and energy-savings (e.g. Volland, 2017). In our work, social trust appears to mitigate rebound effects by fostering energy-conscious behavior across multiple domains.

People who exhibit high levels of parliament trust are associated with higher levels of energy rebound in RB1, thus potentially increasing energy costs in the tourist accommodation. This finding is supported by Nicita et al. (2025), who suggest that political trust can act as a mitigating factor of concerns over energy affordability.

A perception of climate change threats to one's family (CCthreatfam) significantly reduces the odds of spending savings in external activities (RB3) by about 54 %. This result aligns with the literature (e.g. Whitmarsh, 2008), which emphasizes that personal risk perceptions can lead to lower energy-intensive behaviors. Additionally, a higher perceived cost of climate policies for one's family reduces the odds of investing into new energy appliances in the owner's non-hotel accommodation by 63 % (as Davis et al., 2010). The perceived cost of climate change to poorer groups (CCcostpoor) strongly amplifies RB3, suggesting that when individuals feel that the financial burden of climate policies disproportionately affects vulnerable groups, they may use this perception as a rationale for increased consumption, believing their actions are a response to broader societal injustices (Steg, 2016). People's perceptions that climate policy will benefit future generations (CCbenefitfuture) show strong positive associations across rebounds, suggesting that altruistic perceptions may paradoxically drive higher energy consumption, possibly reflecting moral licensing (Mazar and Zhong, 2010; Reimers et al. 2021).

The type of low carbon technology available in the tourist accommodations contributes differently to the energy rebound behaviors of our respondents. The presence of automation of appliance operations and lighting significantly reduces the likelihood of RB1 and RB2. In contrast, the adoption of double- or triple-layer windows is linked to a significant increase in the likelihood of RB1. These two technologies differ in purpose: the former is specifically designed to enhance energy efficiency, while the latter serves multiple functions, providing both thermal and noise insulation. This multifunctionality suggests that double- or triple-layer windows may be less indicative of the owner's energy-saving preferences.

The actual and intended adoption of energy-saving measures significantly increases indirect rebound effects from increased energy consumption in the owner's home. These findings can be explained as moral licensing (Reimers et al. 2021).

A higher propensity to adopt energy savings behaviors on a daily basis reduces RB3, indicating that habitual energy-conscious behaviors translate into lower external rebound effects. This result supports findings that long-term habit formation is a critical predictor of sustained energy conservation (Abrahamse et al. 2005), although in our case this extends also to external activities.

Gender and urban residency influence energy use patterns, with male operators and those managing accommodations in city centers exhibiting higher RB2 effects. These insights align with existing research on energy-intensive behaviors (e.g. Balta-Ozkan and Le Gallo, 2018Clancy and Feenstra, 2019; Groh and Ziegler, 2022; Volland, 2017).

4. Conclusions

The results illustrate that indirect rebound energy consumption arising from energy savings from tourist accommodation is driven by a mix of individual and social factors and that social trust plays a main role.

Our findings resonate with established theories regarding the income effect, the role of trust, and the effectiveness of targeted technologies. However, the study contributes novel perspectives by emphasizing the intersection of these factors within the tourism sector and uncovering subtleties such as the paradoxical effects of perceived policy inequities and the dual role of political trust. These insights enrich the existing literature and suggest avenues for further investigation. Future research should explore how these factors interact across different geographic and cultural contexts.

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Data availability

The data that has been used is confidential.

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