

EXPLORING DETERMINANTS OF ENERGY EFFICIENCY AND RENEWABLE ENERGY INVESTMENTS IN SMES

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Motivation (1)

- **Energy efficiency (EE)** and **climate neutrality** are of paramount importance to EU Member States' energy policy objectives and overall development goals to improve:
 - societal competitiveness,
 - green growth, and
 - employment potential.
- As a part of **European Green Deal**, EU adopted a package of legislative proposals "Fit for 55".
 - EU aims to achieve **climate neutrality** by 2050 while reducing net emissions by at least **55% by 2030** compared to 1990 levels.
 - One of the focus areas of policy measures where to make transformative changes are **small and medium-sized enterprises (SMEs)**.

2030 Targets	Initial (2018)	Revised (2023)
EE	32.5% (compared to forecasts of energy use made in 2007)	11.7% (compared to forecasts of energy use made in 2020)
RES	32%	42.5%

Motivation (2)

- **Improving energy efficiency in SMEs**, especially in the manufacturing sector is typically **more challenging** compared to larger companies (Hrovatin et al., 2016).
- However, the **energy efficiency gap** persists (Jaffe & Stavins, 1994; Sorrell, 2000, 2011; Allcott & Greenstone, 2012; Gerarden et al., 2017).
- Implementation of EE investments in residential sector is hindered by various **barriers**, but also fostered by several **drivers**.
- There exists multiple theoretical **taxonomies** of barriers and drivers in the literature.
- Literature found that among both groups of factors **economic barriers** and **drivers** are the most important determinants of energy efficiency investment decisions in SMEs.

Motivation (3)

- There is still a long way to **climate neutrality in SMEs**.
- **The gap between potential and actual investments** in renewable energy sources (RES) is at least **as large** as for EE investments in SMEs.
- Only few theoretical taxonomies of barriers and drivers to RES investments exist.
- Literature found that **energy policy** is a key driver for investments in RES.
- Only one study simultaneously investigated both types of investments (Segarra-Blasco & Jove-Llopis (2019))
- Literature also found that in general SMEs are more inclined to invest in **EE than in RES**.

Objectives

- The **objective** of this study is to **analyze what factors, both barriers and drivers, influence SMEs' decisions to invest in energy efficiency measures and renewable energy investments.**
- In addition, this study aims to **determine whether different factors influence both types of investments in the same way** or whether firms' motivations for investment behavior differ in the two cases.

Methodology (1)

- **Bivariate logit** model employed
- In this way it is possible to **jointly analyse two** correlated binary outcomes
- 2 dependent variables (indicating the choice made for each type of investments):
 - **EEI** holds value 1 if firm invested in EE and 0 otherwise
 - **RESI** holds value 1 if firm invested in RES and 0 otherwise
- This type of econometric analysis allows us to simultaneously control for the effects of multiple influencing factors on two correlated binary outcomes.



Methodology (2) – explanatory variables

Variable	Variable description
Medium-sized SME (D)	Dummy, 1 = medium-sized firm, 0 = small- firm
Energy-intensive (D)	Dummy; 1 if share of energy costs accounts for at least 3.5 % of total costs; 0 otherwise
Manufacturing (D)	Dummy, 1 = manufacturing firm, 0 = other firm
Family ownership (D)	Dummy, 1 = family ownership, 0 = other owners
Foreign ownership (D)	Dummy, 1 = foreign ownership, 0 = other owners
Exporting (D)	Dummy; 1 = exporting, 0 = does not export
Perceive strong or very strong competition (D)	Dummy; 1 = the firm perceives strong or very strong competition, 0 = weak or no competition
Ownership of premises (D)	Dummy; 1 = the firm owns premises, 0 = does not own premises
Expected future increase in sales (D)	Dummy, 1 = expected future increase in sales, 0 = no increase expected
Share of energy costs (%)	Share of energy cost in %
Investment in R&D (D)	Dummy, 1 = investing in R&D, 0 = no
Very risk averse (D)	Dummy; 1 = very risk averse regarding investments, 0 = moderate or no risk averse
EE is important in the company (D)	Dummy; 1 = the firm perceives EE equally or more important than other matters in the firm, 0 = less important
Person responsible for energy in the company (D)	Dummy; 1 = the firm has an expert or a trained person responsible for energy issues in the firm, 0 = does not have)
Increase employee awareness of EE (D)	Dummy; 1 = the firm increases employees EE awareness, 0 = does not increase
High potential for EE improvements (D)	Dummy; 1 = very high or high, 0 = low or very low
Energy audit or energy advice (D)	Dummy; 1 = the firm carried out an external audit or obtain advice, 0 = did not carry
Do EcoFund subsidies stimulate investment in RES?	Dummy; 1 = yes; 0 = no
Do EcoFund credits stimulate investment in RES?	Dummy; 1 = yes; 0 = no
Energy literacy	Dummy, 1 = the firm knows the information, 0 = does not known

Methodology (3) – EE investments

- Barriers to energy-efficiency (Trianni et al., 2013):

Economic:

- funding is not available
- investment costs are too high
- energy prices do not stimulate EE investments
- too low return on EE investment
- additional risks in the company related to the EE investment
- other external risks related to EE investment
- other additional costs related to the EE investment (additional unforeseen costs, costs of interruption of production due to investments, etc.)

Other:

- competence barriers
- information barriers
- awareness of energy efficiency in the company
- behavioural barriers
- technological barriers
- organizational barriers

Methodology (4) – EE investments

- Drivers for energy-efficiency (Cagno & Trianni, 2013):

Internal:

- cost reduction due to lower energy consumption
- fear of rising energy prices (or uncertainty about prices)
- the company's environmental image
- ambition of management staff regarding energy efficiency
- long-term energy strategy in the company
- ambition and awareness of employees
- education and training programs in the company

External:

- external energy audits (consulting)
- public financing (subsidies, more favorable loans, tax deductions...)
- competition in the market
- accessibility, reliability and clarity of information on EE
- technological appeal of improvements
- exchange of experience between companies in the sector or region, publication of good practice examples
- legal requirements regarding energy efficiency

Methodology (5) – RES investments

- Barriers to RES investments (adapted from Moorthy et al., 2019):

Economic:

- high initial investment costs
- long investment return period
- grants too low (subsidies too low)
- difficult acquisition of credit sources (financing) from banks
- uncertainty regarding the purchase prices of RES
- uncertainty regarding the return on investment in RES
- competition from fossil fuels (cheaper fossil resources)
- the volume of the investment is too small to be worthwhile
- other hidden investment costs (lack of time, transaction costs – obtaining permits, documentation, etc., temporary suspension of production)

Technological:

- network connection problems (no network, access denied)
- maintenance problems of renewable energy sources (necessary replacement equipment is not available, lack of knowledge for maintenance)
- technological complexity (no appropriate technology, lack of batteries)
- there are no suitable RES installation companies on the market

Methodology (6) – RES investments

- Barriers to RES investments (adapted from Moorthy et al., 2019):

Regulatory:

- insufficient financial incentives for investments
- lack of adequate public free investment advice
- lack of a national energy policy for renewable energy investments
- complex administrative procedures for obtaining permits
- lack of standards and certification

Social and environmental:

- insufficient knowledge/awareness in the company
- unsuitable environmental location for investments
- investments would cause environmental damage
- lack of external experts and technical skills

Data (1) – survey

- LIFE IP CARE4CLIMATE (LIFE17 IPC/SI/000007) – EU project
- In the analysis we use two data sources:
 - **telephone survey** conducted in 2020 (March – June) using a self-administered questionnaire
 - the Slovenian Business Register (AJPES)
- The final sample consists of **270 small and medium-sized** Slovenian companies.
- Data include:
 - Company- and business- related characteristics
 - Energy and energy-efficiency-related characteristics
 - Perceived barriers and drivers to EE and RES investments



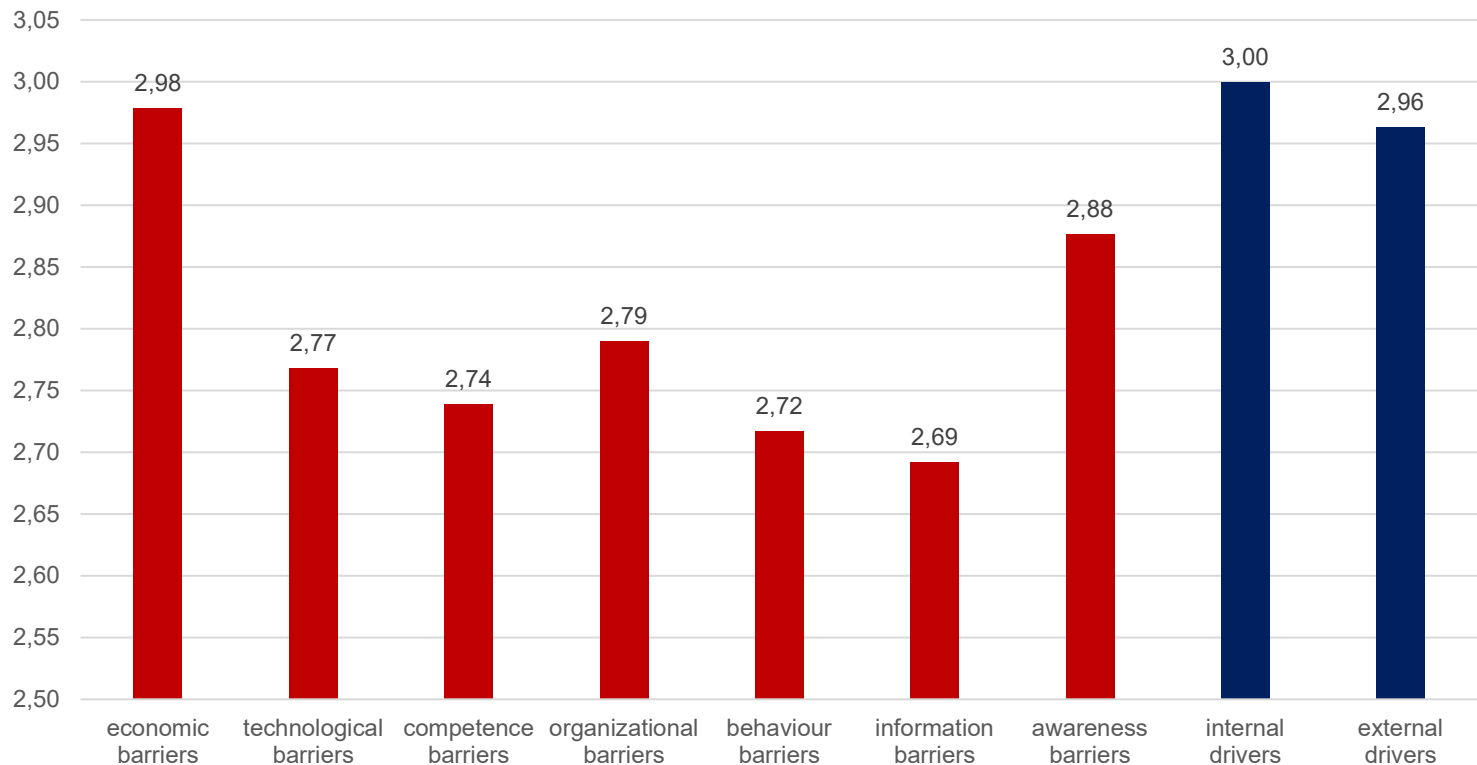
Data (2) – descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
Medium-sized SME (D)	0.267	0.443	0	1
Energy-intensive (D)	0.289	0.454	0	1
Manufacturing (D)	0.585	0.494	0	1
Family ownership (D)	0.604	0.49	0	1
Foreign ownership (D)	0.156	0.363	0	1
Exporting (D)	0.496	0.501	0	1
Perceive strong or very strong competition (D)	0.907	0.29	0	1
Ownership of premises (D)	0.748	0.435	0	1
Expected future increase in sales (D)	0.115	0.319	0	1
Share of energy costs (%)	10.607	14.153	1	80
Investment in R&D (D)	0.507	0.501	0	1
Very risk averse (D)	0.311	0.464	0	1
EE is important in the company (D)	0.785	0.411	0	1
Person responsible for energy in the company (D)	0.237	0.426	0	1
Increase employee awareness of EE (D)	0.73	0.445	0	1
High potential for EE improvements (D)	2.678	1.086	1	4
Energy audit or energy advice (D)	0.47	0.5	0	1
Investment in EE in previous 3 years (EEI)	0.596	0.492	0	1
Investment in RES in previous 3 years (RESI)	0.2	0.401	0	1
Do EcoFund subsidies stimulate investment in RES?	0.374	0.485	0	1
Do EcoFund credits stimulate investment in RES?	0.311	0.464	0	1

Data (3) – descriptive statistics

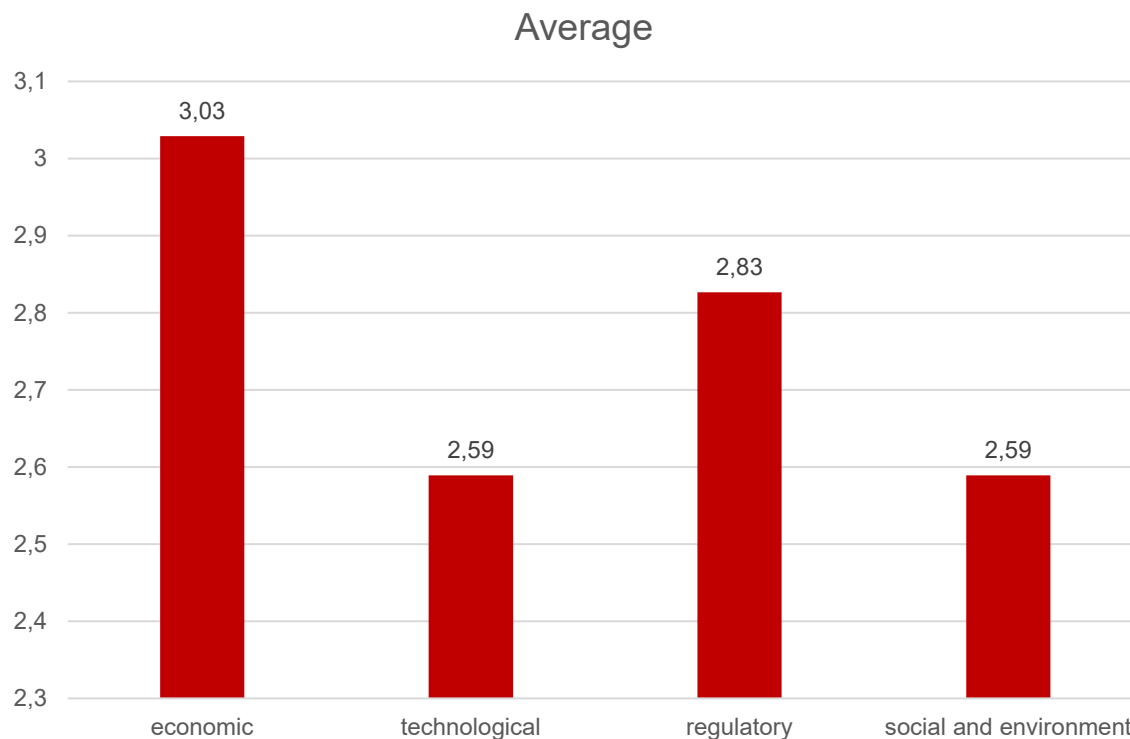
Barriers and drivers to EE investments

Average



Data (4) – descriptive statistics

Barriers to RES investments



Results

Variables	Investment in EE (EEI)		Investment in RES (RESI)	
Medium-sized SME (D)	0.322	(0.276)	-0.0486	(0.270)
Energy-intensive (D)	-0.151	(0.217)	-0.0398	(0.237)
Manufacturing (D)	0.0977	(0.199)	-0.00313	(0.216)
Family ownership (D)	0.226	(0.226)	0.253	(0.247)
Foreign ownership (D)	-0.237	(0.320)	0.301	(0.303)
Exporting (D)	0.119	(0.206)	-0.177	(0.235)
Perceive strong or very strong competition (D)	-0.0755	(0.368)	-0.100	(0.365)
Ownership of premises (D)	0.540**	(0.218)	0.861**	(0.335)
Expected future increase in sales (D)	0.360	(0.331)	-0.191	(0.324)
Share of energy costs (%)	-0.00246	(0.00712)	0.00175	(0.00819)
Investment in R&D (D)	0.633***	(0.203)	0.113	(0.238)
Very risk averse (D)	-0.260	(0.210)	0.0692	(0.242)
EE is important in the company (D)	0.430*	(0.254)	0.352	(0.341)
Person responsible for energy in the company (D)	0.428	(0.295)	0.434*	(0.258)
Increase employee awareness of EE (D)	0.136	(0.237)	0.425	(0.331)
High potential for EE improvements (D)	-0.132	(0.102)	-0.0403	(0.107)
Energy audit or energy advice (D)	0.841***	(0.217)	0.518**	(0.242)
Do EcoFund subsidies stimulate investment in RES?	-0.110	(0.265)	-0.340	(0.295)
Do EcoFund credits stimulate investment in RES?	0.114	(0.276)	0.0453	(0.319)
Energy literacy – EU EE 2030 targets	0.124	(0.387)	0.118	(0.440)
Energy literacy – electricity price	-0.000932	(0.00260)	-0.00187	(0.00247)
Energy literacy – savings with LED light bulb	-0.0111	(0.224)	0.392*	(0.227)
Energy literacy – PC consumption	0.214	(0.230)	-0.122	(0.244)
Economic barriers to investment in EE	0.326	(0.293)	0.240	(0.315)
Other barriers to investment in EE	-0.0403	(0.263)	-0.205	(0.276)
Internal drivers for investment in EE	0.329	(0.294)	0.284	(0.335)
External drivers for investment in EE	-0.546*	(0.305)	-0.322	(0.361)
Economic barriers to investment in RES	-0.388	(0.320)	-0.439	(0.352)
Technological barriers to investment in RES	0.208	(0.268)	-0.218	(0.305)
Regulatory barriers to investment in RES	-0.211	(0.323)	0.483	(0.345)
Social and environmental barriers to investment in RES	0.107	(0.245)	0.110	(0.266)
athrho	-0.113	(0.154)		16
Constant	-0.293	(0.996)	-2.344*	(1.203)
Observations	270		270	

Conclusions (1)

- Which manufacturing firms are more likely to invest in EE?
 - With ownership of their premises
 - That invest in **R&D**
 - **EE is important** for them
 - Higher **energy costs**
 - That conducted energy audit or obtained energy advice
 - That perceive **external drivers** to EE as less important
- Which manufacturing firms are more likely to invest in RES?
 - With ownership of their premise
 - That employ person **responsible for energy**
 - That conducted energy audit or obtained energy advice
 - That are **energy literal**

- Interestingly, public funds (subsidies) are not among the driving forces.
- Perceived barriers/drivers for EE and RES are less important than the firm's business and energy-EE efficiency-related characteristics.

Conclusions (2) – policy implications

- The results of this study provide answers to the question of which factors should be **promoted** and which should be **restricted** in common energy policies to improve EE and increase the use of RES.
- For example, we can find that companies that **own their buildings** and **receive energy advice** are more likely to make investments in **both EE and RES**:
 - importance of split incentives (needs to be addressed)
 - public funds to support free-of-charge energy advice (audits)
 - firms' networks should be stimulated (exchange of ideas, good practices, benchmarking)
- **For EE**: promotion of innovativeness (also through financial incentives, grants, subsidies, tax exemptions)
- **For RES**: energy literacy should be promoted, employment of a person for energy-related issues

THANK YOU FOR YOUR ATTENTION!

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