

WHAT IMPACTS THE STRENGTH OF PERCEIVED BARRIERS AND DRIVERS TO ENERGY EFFICIENCY IN MANUFACTURING SMALL AND MEDIUM SIZED ENTERPRISES?

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Overview

Energy efficiency (EE) is of paramount importance to the objectives of the EU member states' energy policies and overall development goals, especially because of its potential to improve society's competitiveness, green growth and employment potential. Energy efficiency makes an important contribution to ensuring strategic security of supply by reducing dependence on fossil fuel imports and promoting the sustainable use of energy resources. Energy efficiency is also seen as one of the most cost-effective measures to reduce greenhouse gas (GHG) emissions and increase the share of renewable energy sources (RES) in the balance of gross final energy consumption. Slovenia follows the EU Energy Strategy with targets to increase energy efficiency by at least 32.5% by 2030 compared to the base year 2007 (Directive 2018/2002, 2018). In 2020, Slovenia also adopted the NECP and set key strategic objectives, among others, to increase energy efficiency by at least 35% compared to the 2007 baseline (NECP, 2020).

European countries offer a wide range of policy interventions to improve energy efficiency, such as subsidies and soft loans for energy efficiency measures, pricing instruments, efficiency standards and subsidies for research and development of energy efficient technologies and materials. These interventions are often complemented by various education and awareness programs, such as training programs for professionals, product labelling, and awareness campaigns aimed at improving energy efficiency. These programs aim to overcome barriers that exist in companies and prevent them from making investments in energy efficiency. Although barriers and drivers to energy efficiency are relatively well-identified and characterized in the literature, little attention has been paid to the factors that influence their perceptions in firms. This is particularly important for small and medium-sized enterprises (SMEs) in the manufacturing sector, as closing the energy efficiency gap can represent a greater challenge due to the lack of financial resources and energy professionals.

Our study empirically examines how firm and market characteristics affect firms' perceived relevance of barriers and drivers. Empirical analyses of the determinants of barriers and drivers of energy efficiency measures (EEM) in the SME sector are scarce (García-Quevedo and Massa-Camps, 2019), with those that exist mostly using a case study approach rather than an econometric one requiring a large sample of firms (e.g. Rohdin and Thollander, 2006). Using a relatively large sample of manufacturing SMEs, which covers around 10 % of all firms in this sector, we contribute to the scarce knowledge on the perception of the relevance of barriers and drivers based on econometric modelling.

Methods

To empirically assess the influence of different determinants of barriers and drivers of energy efficiency, this study employs econometric methods that can provide a basis for policy implications. A sample of 220 Slovenian manufacturing SMEs surveyed in 2019 is considered. Separate regression models are estimated for each of the barriers and drivers, using the same set of explanatory variables, similar to DeGroot et al. (2001) and Schleich (2004), but supplemented with numerous firm- and business-related characteristics (such as firm size, profitability, indebtedness, market competitiveness, etc.) as well as energy- and energy-efficiency-related characteristics (including energy intensity, energy responsible person, EE awareness, energy literacy etc.). The study employs ordered logit regression models, which enable estimation of the relevance of various factors for perceived barriers and drivers of EEM. This type of econometric analysis allows us to simultaneously control for the effects of multiple influencing factors. The dependent variable is a random variable indicating the firm's rating of barriers and drivers on an ordinal scale (from 1 – not important at all to 4 – very important).

After an extensive literature review, we identified 13 barriers and 14 drivers to energy efficiency in SMEs. These barriers and drivers to energy efficiency can be further categorised into several groups. Barriers include economic, competence-related, information, behavioural, technological, and organisational groups. Drivers are divided into two groups, internal (firm related) and external (market-related), where each of these two groups is further divided into economic, regulatory, information and vocational training related drivers.

Results

The most influential factors of perceived barriers include energy intensity and export orientation, which are associated with lower perceived barriers, while debt contributes to higher intensity of perceived barriers. Surprisingly, the size

does not matter. Market competition and ownership of the firm's premises have also proved to be relevant. As regards the perceived importance of drivers, the most influential factors are the size, the presence of an energy manager and the employee awareness program in the firm. Among the approaches to improve energy efficiency, the implementation of energy policy or energy management system and certifications have the greatest influence on tackling barriers, while energy counselling did not prove significant. On the other hand, drivers are mainly positively influenced by the energy audit. These results provide useful policy implications on how to address the energy efficiency gap in manufacturing SMEs by targeting factors that would most effectively influence the barriers and drivers.

The results further show that economic barriers are generally perceived as more intense in firms with a higher share of debt in financing, with a stronger perception of competition in the market, and with a large expected energy savings potential in energy-efficient investments. In contrast, they are perceived as less intense in firms that sell their products in foreign markets, that own premises, and in energy-intensive firms. The latter confirms the common finding in the literature (e.g. Schleich (2004) and Sorrell et al. (2011)), that energy-intensive firms perceive barriers as less intense. Firms that perceive economic barriers as more intense are more likely to use an energy advice network to improve energy efficiency. Energy literacy reduces the strength of other barriers. The size of the firm was found to be significant only for the barrier of additional risks in the firm related to EE investments, while the literature claims that almost all economic barriers are determined by the size (Cagno et al., 2017). Moreover, we found that barriers of high investment costs and low return on EE investment are more pronounced in firms that invested in EE in the past. Other barriers (competence, information and awareness related, behavioural and technological) are generally more present in firms that use an energy advisory network, but less relevant for firms with some kind of energy or environmental management standards. The strength of these barriers is also lower in firms with higher energy literacy of their managers.

Conclusions

The contribution of this study relates to the identification of the factors that determine the perceived barriers and drivers in Slovenian manufacturing SMEs to invest in energy efficiency and provides insights for policymakers. This study contributes to knowledge in three important ways. First, it provides new knowledge on what impacts the firms' perceptions of barriers and drivers for the adoption of EEM based on the evidence from Slovenian firms. Second, the data covers a representative sample of 10% of SMEs in the manufacturing sector, which allows for generalisations of the obtained results to the whole manufacturing sector. Third, the depth of the study with a large number of factors related to energy and energy efficiency extends previous studies and thus reveals new dimensions on the persistence of the energy efficiency gap. Specifically, our study found that energy consultations are effective in overcoming barriers only when energy prices do not stimulate investment, while they are ineffective in other cases. More effective approaches to improving EE by removing barriers include implementing corporate energy policies and energy management systems and achieving energy or environmental standards. Firms that have used energy advice also see EE drivers as important, implying the need for additional support for these firms. Our study also found that firms that employ energy managers are more likely to be motivated by internal drivers. The goal of improving EE in manufacturing SMEs should be addressed with a mix of targeted interventions aimed at overcoming the barriers and strengthening the drivers of EE.

References

- Cagno, E., Trianni, A., Spallina, G., & Marchesani, F. (2017). Drivers for energy efficiency and their effect on barriers: empirical evidence from Italian manufacturing enterprises. *Energy Efficiency*, 10(4), 855–869.
- De Groot, H., Verhoef, E., Nijkamp, P. (2001). Energy saving by firms: decisions-making, barriers and policies. *Energy Economics*, 23(6), 717–740.
- Directive 2018/2002. (2018). Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 amending Directive 2012/27/EU on energy efficiency. Retrieved 7.1.2022 from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32018L2002>.
- García-Quevedo, J., & Massa-Camps, X. (2019). Why firms invest (or not) in energy efficiency? A review of the econometric evidence. IEB Working Paper 2019/07.
- NECP. (2020). National Energy and Climate Plan of the Republic of Slovenia. Retrieved 4.2.2022 from https://ec.europa.eu/energy/sites/ener/files/documents/si_final_necp_main_en.pdf.
- Rohdin, P., & Thollander, P. (2006). Barriers to and driving forces for energy efficiency in the non-energy intensive manufacturing industry in Sweden. *Energy*, 31(12), 1836–1844.
- Schleich, J. (2004). Do energy audits help reduce barriers to energy efficiency? An empirical analysis for Germany. *International Journal of Energy Technology and Policy*, 2(3), 226–239.
- Sorrell, S., Mallett, A., Nye, S. (2011). Barriers to industrial energy efficiency: A literature review. Development Policy, Statistics and Research Branch, Working paper 10/2011. United Nations, Industrial Development Organization. Vienna.