

HETEROGENEITY AND BARRIERS TO ORGANIZATIONAL ADOPTION OF CROSSCUTTING ENERGY EFFICIENCY MEASURES

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Overview

Cost-effective energy efficiency measures (EEMs) for companies experience notoriously slow adoption rates, to the frustration of policy makers. Barriers that can explain the disappointing adoption have been thoroughly theorized (Sorrell *et al.*, 2004; Cagno *et al.*, 2013; Gillingham and Palmer, 2014; Gerarden *et al.*, 2015), but large-sample empirical analysis of barriers experienced by companies have been few and have rarely accounted for the heterogeneity of EEMs and companies (Schleich, 2009; Schleich and Gruber, 2008). This paper uses data from a survey of a representative sample of 2,440 firms in the commercial and services sector in Germany. It econometrically analyzes how four cross-cutting EEMs - efficient lighting, building insulation, heating system replacement, and optimization of heating system operations - and their interaction with firm characteristics relate to their adoption and barriers to their adoption. We run simple and random effects probit regressions to test associations between technologies and company characteristics on the one hand and recent adoption of those technologies and thirteen barriers to their adoption on the other hand.

The paper's contribution is fourfold. First, it uses a large sample data set, which is rare for research on energy efficiency behavior among firms. Second, it shows that heterogeneity within crosscutting technologies matters, whereas literature usually, if at all, distinguished between crosscutting and specific measures only. Third, in addition to the sign of the effect, we determine effect sizes. Fourth, we investigate barriers for firms that were in the market for energy efficiency measures but decided not to adopt, which despite still relying on stated barriers renders responses less hypothetical.

Methods

This study focuses on the commercial and services sector in Germany, which accounts for 16% of total energy end use in Germany. We use a survey-based, econometric approach, a proven method in barrier research. The cross-sectional data are from a representative selection of 2,440 firms in the commercial and services sector in Germany, conducted in the Spring of 2014. We specify and estimate probit regression models to explain recent adoption of EEMs and barriers to adoption with company attributes and differentiate by four crosscutting EEMs related to energy use of the building: efficient lighting, insulation of the envelope, heating replacement, optimization of heating system operations.

In our econometric analyses, the dependent variables y_{ij} are dummies which indicate whether a company $i = 1, \dots, n$ adopted an EEM $j = 1, \dots, 4$ in the past six years (since 2008). In the first econometric approach, we estimate a binary random effects probit model, which accounts for unobserved heterogeneity over the different technologies. In our second econometric approach, we run binary probit models without random effects to separately estimate the determinants of the adoption of the four EEMs. We also employ a multivariate probit model to check possible correlations between the dependent variables. In the second set of econometric analyses, the dependent variables y_{ij} are dummies that indicate whether a company $i = 1, \dots, n$ reported a barrier $j = 1, \dots, 12$ to be a relevant reason for the company not having adopted an EEM in the past six years (since 2008).

Explanatory variables are dummies for the four focal EEMs, whether the company is a tenant of the space(s) it occupies, whether it is a subsidiary of a larger holding, if an energy management system is in place, whether an environmental or energy manager is present, whether the firm has had an energy audit. We further control for company size, energy intensity, the price of energy, and sectors.

The questionnaire and analyses account for thirteen different barriers of economic, behavioral and organizational nature.

Results

We find that it is 14 %-points more likely that efficient lighting was installed in the past six years than that heating system operations were optimized, which in turn was 3.8 %-points more likely than that insulation was applied to the building envelope. These differences seem to reflect the lifespan or turnover rate of the technologies rather than anything else.

The landlord-tenant dilemma negatively affects adoption of building-related measures to improve space heating efficiency. Companies renting (not owning) their spaces (53% of the sample) cited that fact as relevant

reason to their not adopting the measures in 86% of the cases. Adoption of efficient lighting is least hindered by the landlord-tenant dilemma and, as a consequence, is more likely to be rejected for other reasons.

What stands out is that firms that have had an energy audit show higher probability of adoption of any EEM. An audit increases the likelihood of recent adoption by 18 and 11 %-points for efficient lighting and heating operations, respectively. The effects for the other, more capital-intensive and cumbersome measures are smaller. Companies that had an energy audit are significantly less likely to report the landlord-tenant dilemma as a barrier. This suggests that audits may mitigate the landlord-tenant dilemma and foster the 'harvesting of the low-hanging fruit,' contingent on causation.

An environmental or energy manager has a positive bearing on adoption of operational measures, increasing the likelihood of recent adoption of optimization of heating system operations by 6 %-points on average. We find no effect on adoption of EEMs consisting of the installation of hardware.

We find that for each of the four EEMs the thirteen pre-defined barriers to adoption have very similar rankings in terms of their relevance for non-adoption. Consistently in the top three are *rented spaces*, *too high investment costs*, and *other priorities*; the bottom two for all EEMs are *technical risk for production* and *risk for product quality*.

Conclusions

Distinguishing between EEMs within the class of cross-cutting, building-related measures reveals how heterogeneity of measures and firms is significantly affecting adoption even within an already narrowed down set of EEMs. Key attributes affecting adoption rates seem to be the natural turnover rate or lifespan, trialability, and the landlord-tenant dilemma, which make that efficient lighting stands out from the other three, space heating efficiency measures. The hierarchy of the barriers, though, is quite similar for the four EEMs and puts the the role of heterogeneity into perspective.

Barriers are interdependent in the sense that more prominent ones can obfuscate other, though existing, barriers, which affects the comparing of barriers between technologies. Many barriers apply significantly more often to lighting than to any of the other measures, which we attribute to the fact that in the case of lighting the landlord-tenant dilemma is less over-shadowing the other barriers than in the case of the space heating efficiency measures.

For the space heating efficiency measures, the landlord-tenant dilemma is the first challenge to overcome. Our results suggest that energy audits can help to a certain extent. The second challenge lies in the fact that turnover rate of technology affecting space heating efficiency is low.

We find some evidence that audits promote adoption of capital extensive measures but not the capital intensive ones, just like an environmental or energy manager may promote operational measures only.

Our results warrant further investigation of heterogeneity in companies and EEMs to better understand adoption rates and evaluate policy efficiency. To find effects of EEM heterogeneity it is not enough to control for the individual measures and effects of other variables should be treated as contingent on the EEMs.

References

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