

# ***CREDIT CONSTRAINTS, ENERGY MANAGEMENT PRACTICES, AND INVESTMENTS IN ENERGY SAVING TECHNOLOGIES: GERMAN MANUFACTURING IN CLOSE-UP***

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## **Overview**

We analyze the drivers and barriers that influence investments increasing the energy efficiency of firms' production processes or buildings in the German manufacturing sector based on microdata. In particular, we shed light on the relationship between financial barriers (e. g. credit constraints), information and knowledge (e.g. energy management practices), salience of energy-related topics, and the investments in energy saving technologies. A better understanding of firms' investment behaviour regarding energy saving technologies is crucial to design efficient policy measures, which are necessary to achieve the imposed ambitious climate and energy policy targets. We use data from 701 structured telephone interviews in combination with commercial and confidential firm-level data. Our results suggest that energy management practices have a statistically significant positive relationship with investment decisions on energy saving technologies for production processes and buildings. Credit constraints are a barrier to investments in the energy efficiency of firms' production processes. Furthermore, high energy cost shares of heating or cooling, high energy intensity, energy self-generation and structured internal decision making processes influence the investments in energy efficiency positively.

## **Methods**

We first develop an analytical framework regarding investments in energy saving technologies by extending a basic net present value model, cf. Brealey et al. (2011), in order to discuss potential drivers of and barriers to investments in energy saving technologies. To investigate our research question empirically, we use the results of structured telephone interviews combined with commercial and confidential firm-level data. The survey sample and further firm data were selected from the Mannheim Enterprise Panel, a microdata base of companies in Germany. Building on the intuition developed from our theoretical decision model, we use econometric modeling techniques in order to empirically examine the determinants of the investments for German manufacturing firms. Our first econometric approach assumes a firm's investment decision to be a binary decision problem. The dependent variable takes the value 1 if the firm invested in energy saving technologies and 0 otherwise. Using probit and logit models, we investigate the influence of determinants, such as the firm's characteristics, on the probability of investing in energy saving technologies at all. Our second econometric approach takes the censored character of the investment volume into account. In particular, we estimate two-part and selection models to understand the relationship between the decision whether to invest and how much to invest. These approaches allow us to draw conclusions on the effects of different determinants on the investment volume.

## **Results**

Our results suggest that there is a positive relationship between credit ratings and the investment decision in energy saving technologies to increase the energy efficiency of firms' production processes. The better the firm's credit rating, the higher is the probability of investing in energy saving technologies. Thus, credit constraints seem to be a barrier to these investments. Furthermore, energy management practices play a significant role both for the investment decision and in the simultaneous analyses of investment decision and volume. The most important management practice is the implementation of energy consumption targets by firms, but as our analysis of the

intensity of the implemented energy management practices shows this should not be the only energy management practice. If there are two or more practices implemented the probability of investing in energy efficiency is higher than with only one or no energy management practice installed. On the other hand, energy management practices do not or only weakly explain the volume invested by these firms. Thus, to increase the number of firms which invest in energy saving technologies, programs promoting energy management practices seem to be a feasible instrument. If energy costs are a more important cost component, the probabilities of investing and the volume tend to be higher, too. Firms generating their own energy are also more likely to invest in energy saving technologies.

## Conclusions

The increase in energy efficiency is one of the main goals of current energy and climate policies. Therefore, it is crucial to identify important drivers of investments in the energy efficiency of firms to assist decision makers in implementing effective management tools. If policy makers want to increase the number of firms investing in energy efficiency and achieving the overarching energy efficiency targets, it could be, for example, feasible to adjust the requirements for loans and thus provide better incentives to firms to invest in energy efficiency. Comparing the heterogeneous results for the different investment categories (production processes and buildings), we can conclude that analyses of investments in energy saving technologies should take this heterogeneity into account. This insight should also influence the discussion about and implementation of tailored policy instruments for the different investment categories.

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