

Energy prices and firm's behavioural responses - plant-level evidence from German manufacturing census

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Overview

In order to achieve the goal of climate neutrality by 2045, the energy transition is necessary in all areas, politically, economically and technically (see e.g. Araújo, 2014). Considering Germany and the production side of the economy, the German government has introduced a number of policy-measures (e.g. Renewable Energy Sources Act (EEG), CO2 certificate trading) to promote the energy transition and internalize negative external effects of greenhouse gas production. In addition, companies are facing more and more uncertainties and exogenous shocks due to increasingly critical geopolitical times such as the Russian war on Ukraine. Both, endogenous as well as exogenous developments, could and have already led to electricity price increases.

Such an increase in energy prices results in an increasing financial burden for the manufacturing industry. The German government has provided various exemptions and relief measures for energy-intensive companies. However, these exemptions only apply to a small proportion of companies. Many of manufacturing companies are energy-intensive, small and medium-sized companies, but do not receive any subsidies. Yet, they are the foundation of the industrial sector in Germany. Although the energy consumption of these companies is not sufficient to qualify for relief measures, energy costs often make up a significant proportion of their production costs, meaning that rising electricity prices represent a substantial competitive disadvantage compared to companies in other countries. While electricity and energy prices are (partially) linked within the European Union and price differences between the individual countries remain on a relatively small scale, globally, there are large differences.

However, an increase in electricity prices does not necessarily have to have a negative impact on companies, the manufacturing industry and the economy as a whole. Much depends on how companies react to higher electricity prices and adjust their behaviour. An analysis of possible behavioural adjustments to rising electricity prices is important in order to develop an understanding of how changing / rising energy prices will affect the competitiveness of companies, the entire sector and the national economy. These findings can then be used to derive policy measures that incentivise companies to invest in energy efficiency or other activities so that positive results can unfold at the sectoral and macroeconomic level. The study is based on the studies of von Graevenitz & Rottner (2022, 2023) and Horbach & Rammer (2024) and deepens and expands the investigation at the company level. Previous studies (e.g. Sievers et al., 2019) have mostly carried out investigations at an aggregated level.

Methods

We use a unique administrative panel dataset for German manufacturing firms and plants, the German manufacturing census (*Amtliche Firmendatenbank, AFiD*), provided by the German Federal Statistical Office and the Statistical Offices of the Länder. For that, we merge five different *AFiD* panels and data-modules (*AFiD Panel Industrial Companies, AFiD Panel Manufacturing Plants, AFiD Module Energy Usage, AFiD Module Products and AFiD Module Environmental Protection Investments*) with external data sources to one unique panel dataset. To address firm's heterogeneity as well as the hierarchical data structure of company and plant data, we use a multi-level modelling approach (see e.g. Hox, 2017) to account for the dependence of observations. In addition, and for comparison, we use a number regression based methods like fixed effects panel models, (multinomial) logit/probit models, pass-through rate analysis to quantify firm's behaviour in response of changing energy costs. We estimate and test the effects of rising energy costs on

- firm's own-price elasticity of energy,
- firm's product price adjustments (input price pass-through)
- firm's energy efficiency,
- firm's electricity/energy intensity,

- firm's self-production of electricity and,
- wages.

In a second step, we analyse the impact of changing energy costs on the competitiveness of companies. For that, we analyse and test the effects of energy costs increases on firm's key economic indicator like output, revenues, employment, investments or capital stock. Based on the empirical results, in a follow-up paper, an agent-based macroeconomic model is used to analyze the effects of various electricity price scenarios on sectoral and macroeconomic development and the effectiveness of potential economic and energy policy measures, taking particular notice of heterogeneous adjustment strategies of companies.

Results

First test estimations indicate that:

- rising energy prices lead to significantly falling energy demand,
- higher energy prices stimulate own-production of electricity and decentralization,
- energy intensity do not change significantly over time, and
- competitiveness indicators are not statistically significant negatively affected by rising energy prices.

The analysis is still ongoing and will be significantly extended in the next weeks, drawing on the unique data set for Germany on the company level merged with external data on producer prices, energy prices, and trade taxes. These results will include a comparison of fixed effects panel model results, (multinomial) logit/probit model results, and machine-learning models, like random forest results.

Conclusions

The research project aims to combine two innovative methods, i.e. multi-level modeling (MLM) as an empirical tool and agent-based modeling (ABM) as a computer-based simulation approach. The research project is the first study to use and combine these two methods to investigate the impact of energy policy on sectoral and macroeconomic developments. It is expected to provide new insights on firm's behavioural and competitive situation facing rising energy prices as well as nuanced and novel insights by adequately modeling the behavior, heterogeneity and interactions of firms at both the micro and macro levels. The results of the project can contribute to providing policy makers with important orientation knowledge when formulating appropriate policy measures that take into account the impact of the energy transition on industry and the economy.

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