DIRECTED TECHNICAL CHANGE AND ENERGY INTENSITY DYNAMICS: STRUCTURAL CHANGE VS. ENERGY EFFICIENCY

Christian Haas, Justus-Liebig University Giessen, Phone +49 641 99 22114, E-mail: christian.haas@wirtschaft.uni-giessen.de
Karol Kempa, Justus-Liebig University Giessen, Phone +49 641 99 22112, E-mail: karol.kempa@wirtschaft.uni-giessen.de

Overview

The relationship of energy use and economic activity has been a recurring theme in the political and academic debate, particularly since the energy crisis in the 70s. Numerous studies have analysed the development of energy intensities. The data-analyses on energy intensities shows the following trends:
(i) While energy intensities were constant or increasing in the majority of economies until the early 1970s, they systematically decreased since the energy crisis across economies. (ii) The contribution of energy intensity reductions within industries, e.g. through technological progress, or a structural change towards less energy-intensive economic activities to energy intensity reduction differs substantially across countries.

In contrast to the extensive data analyses on energy intensity developments, there is a lack of theoretical approaches to analyse the underlying mechanisms of the trends described above. Recent studies highlight the exploration of the determinants of these developments, including the role of technological change, as directions of future research. Our paper aims to fill this gap by providing a, to our knowledge, first theoretical analysis of energy intensity dynamics. The main aim of this paper is to analyse how endogenous technical change and energy price affect the direction and magnitude of the structural and the efficiency effect.

The paper is organised as follows: In Section 2 we present the model and characterise the equilibrium. Section 3 contains the main analysis. We decompose energy intensity into structural and efficiency effect and show how both effects are affected by technical change and energy price growth. In Section 4, we calibrate the model to empirical data for 26 OECD countries covering the period 1995-2007 to illustrate our results and cross-check them with empirical decomposition studies. In Section 5, we discuss our results and possible extensions of the model. Section 6 concludes.

Methods

Dynamic theoretical model with endogenous technological change and calibration to data for 26 OECD countries.

Results

First, in economies that are relatively more advanced in the labour-intensive sector, research is directed to this sector and the energy intensity developments are mainly driven by the structural effect.

Second, in economies that are relatively more advanced in industries with high energy intensities, the efficiency effect dominates energy intensity developments.

Third, energy price growth generally negatively affects energy intensity developments and strong positive (negative) growth rates of the energy price can ultimately redirect technical change.

Conclusions

We offer an explanation why structural adjustments drive energy intensity reductions in certain countries whereas they are dominated by within-sector efficiency improvements in other. The relative importance of the efficiency and the structural effect is determined by energy price growth and relative sector productivities, which drive the direction of research. Finally, we have calibrated the model to empirical data to illustrate how differences in energy price growth and sectoral productivities affect energy intensity trends across 26 OECD countries. In spite of our very stylised model, the results are largely consistent with empirical studies.

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