DECOUPLING AND ENERGY EFFICIENCY: A STOCHASTIC FRONTIER APPROACH

Victor von Loessl, Institute of Economics - University of Kassel, +49 561 804 7706, vonloessl@uni-kassel.de
Heike Wetzel, University of Kassel, +49 561 804 7750, heike.wetzel@uni-kassel.de

Overview

The ascending global energy demand is one well-documented driver of greenhouse gas emissions. Despite the fact that the CO_2-emissions of the U.S. peaked in 2007 and were about 10% lower in 2015, the U.S., as the 2nd-largest emitter, still substantially contribute to global CO_2-emissions. By providing the possibility to reduce or even reverse rising energy demand and thereby emissions, a wide range of literature agrees that energy efficiency marks a substantial resource to tackle the presented challenge.

In traditionally regulated energy markets, energy providers maximize their profit by selling electricity or heat as long as their marginal costs of production do not exceed their marginal revenue. This so called 'throughput incentive' fundamentally restricts the motivation of utilities to invest in energy efficiency. Therefore, alongside other efficiency-policies, the concept of 'decoupling' was developed to address this misleading incentive for sales-maximization.

In a nutshell, decoupling aims to separate the total energy sold by an utility from the utility's profit, thus creating an independence of the revenues from sales fluctuations. In general, utilities revenues in a to be defined baseline year serve as limiting benchmark for future profits. Such reference values are adjusted continuously to occurring changes in conditions, such as increasing customer numbers. The most prominent decoupling approaches are total-revenue-caps and revenue-per-customer-caps. By 2016, different types of decoupling were implemented in 23 U.S. states and the District of Columbia. In 19 of those states decoupling was implemented in the electricity sector.

There is a substantial debate regarding the several implication shemes and the conceptional details of decoupling as wall as the distributional and socio-economic effects of such policy implementations. While acknowledging those controversial issues and additionally documenting the ongoing discussion regarding the definition of energy efficiency, this paper aims to investigate the effect of decoupling on electricity customers' energy efficiency in the U.S. To do so, we follow the argumentation of Filippini and Hunt (2015a) to understand energy (in-) efficiency based on the microeconomic theory of production.

Previous research includes the work of Datta (2015), who, while focusing on Demand Side Management (DSM), addresses the influence of decoupling on energy efficiency expenditures of electric utilities. Using fixed effect models and utilizing company specific data for the period of 2007 to 2011, the study implies that utilities which have been decoupled, spend on average four times as much money on energy efficiency measures than non-decoupled utilities. Kahn-Lang (2016) uses a game-theoretical approach to analyze potential connections between decoupling, residential energy consumption and utilities expenses in DSM. The author uses data for 218 non-governmental electricity utilities from 2001 to 2010. In summary the results show that decoupling has an indirect influence on decreased energy consumption as it promotes DSM spending and DSM efficiency.

In addition to following a different approach we further deviate from the latter study by taking all major electricity consumers into account and not solely residential usage.

Methods

To process the research question at hand, we will implement state of the art Stochastic frontier analysis (SFA) approaches. Hereby we follow the argumentation of Filippini and Hunt (2015b) and furthermore utilizing the recently developed approach by Filippini and Greene (2015), who propose to use a generalized true random effects model (GTREM) that allows to account for persistent as well as transient efficiency (long- and short-term evolutions in efficiency levels). Thus we address the latest developments in the discussion on efficiency measurement to differentiate between time-variant and time-invariant changes in efficiency levels.

An unbalanced panel data set for the period of 2001 to 2015, that includes utility specific information regarding revenues, sales and customer shares (commercial, industry, transport and households) as well as state-level data regarding Cooling Degree Days (CDD), Heating Degree Days (HDD), real gross domestic product (GDP), income values per head and energy prices, builds the basis for our analysis. Furthermore, we include whether Energy Efficiency Resource Standards (EERS) are implemented on the state-level and, of course, whether a utility is decoupled or not. Additionally, we control for the results of Kahn-Lang (2016), namely include DSM spending, to verify a potential indirect effect of decoupling on energy efficiency. However, due to data restrictions, this will be limited to the period of 2001 - 2012.

Results

At the current time results are only preliminary, yet very promising. Estimating a traditional random effects SFA model (Pitts and Lee 1981) we find a statistically significant and negative effect (about -7%) of decoupling on the energy demand. The preliminary results are robust with regard to a number of variable specifications.

The next step will be the estimation of efficiency scores, allowing the benchmarking of the electric utilities. Furthermore, variable specifications are not yet completed. While investigating different approaches to deal with potential endogeneity problems regarding the energy price variable we also consider the possibility to further differentiate between different decoupling approaches which could lead to more detailed and precise results.

Conclusions

As the estimation procedure has not been finalized, a comprehensive conclusion cannot be drawn at this point. However, as described in the previous section, preliminary results are encouraging and allow a first cautious interpretation. While expecting to confirm to some extent the findings of Kahn-Lang (2016), we furthermore are optimistic to determine a statistically as well as economically significant effect of decoupling on the energy efficiency of customers of investor-owned electricity utilities. Thus we aim on the one hand to contribute to the on-going discussion about the overall repercussions of decoupling and on the other hand extent the empirical literature that differentiates persistent and transient efficiencies, by presenting a recently developed tangible state of the art SFA approach.

References

Datta, S. (2015), 'Decoupling and demand-side management', Working paper presented at the European Association of Environmental and Resource Economists (EAERE), 21st Annual Conference, Helsinki.

Filippini, M. and Greene, W. (2015), 'Persistent and transient productive inefficiency: a maximum simulated likelihood approach', Journal of Productivity Analysis 45(2), 187–196.

Filippini, M. and Hunt, L. C. (2015a), 'Measurement of energy efficiency based on economic foundations', Energy Economics 52, S5–S16.

Filippini, M. and Hunt, L. C. (2015b), 'Measuring persistent and transient energy efficiency in the US', Energy Efficiency 9(3), 663–675.

Kahn-Lang, J. (2016), 'The effects of electric utility decoupling on energy efficiency', The Energy Journal 37(4).