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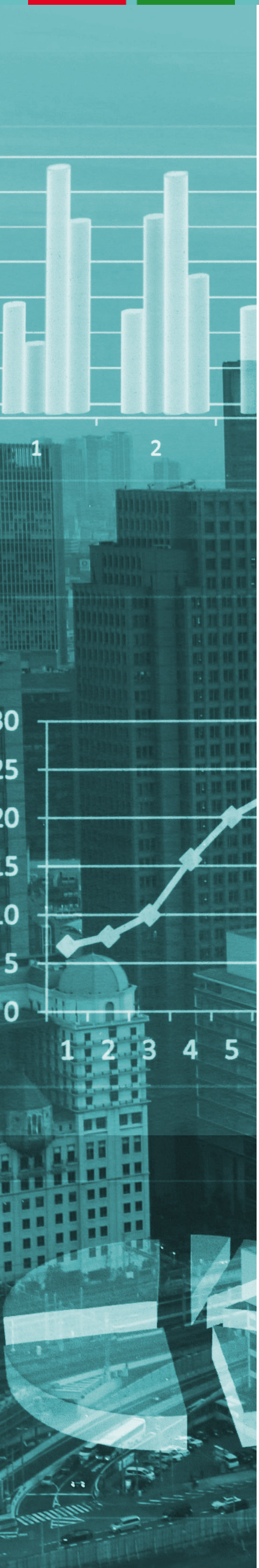

The Impact of Energy Prices on Product Innovation: Evidence from the UK Refrigerator Market

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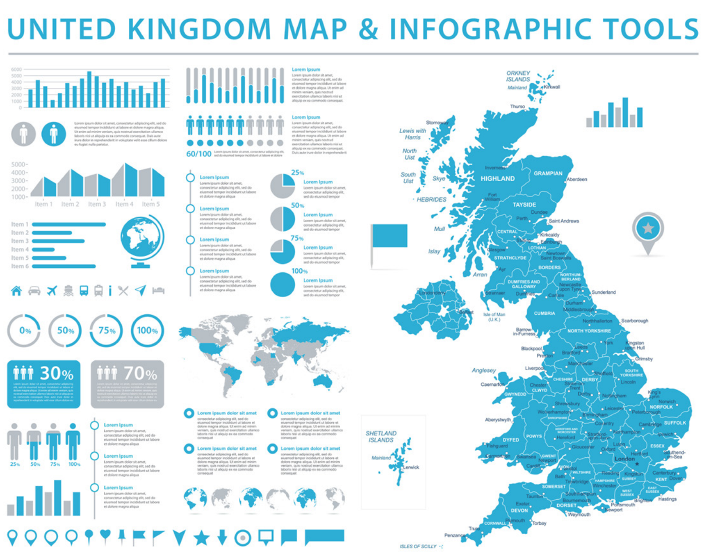
The influence of energy prices on green innovation has attracted a lot of attention in recent years. In particular, empirical studies, pioneered by Newell, Jaffe, & Stavins (1999), have estimated the impact of energy price variations on the level of innovation in various sectors and technology fields: e.g. the auto industry (e.g. Aghion et al., 2016; Crabb & Johnson, 2010), energy conservation (Popp, 2002; Noailly, 2012) and renewable energy (Diaz Arias & van Beers, 2013).

Policy relevance is the primary reason for this interest. The production and use of energy strongly contribute to increasing greenhouse gas emissions. Meeting climate policy targets – in particular, the commitments formalized in the Paris Agreement to limit global warming below 2 °C above pre-industrial levels – require drastic emission cuts that are only feasible with the development and diffusion of new energy technologies. Against this background, assessing the impact of energy prices on innovation is useful to predict how price-based policy instruments like emissions taxes and carbon markets can influence the pace of climate-friendly innovation. These investigations contribute to a broader literature on the relationships between green innovation and public regulation (for a survey, see Popp, Newell, & Jaffe, 2010).

Previous papers have primarily relied on patent data for measuring the level of innovation. Patent data have advantages and weaknesses (for a discussion, see Griliches, 1990). On the positive side, they are easily available; they provide a wealth of information on both the nature of the invention and the applicant; they can be disaggregated into specific technological areas, a particularly useful characteristic when conducting sector- or technology-specific analyses. On the negative side, patents are a better measure of invention than they are of innovation. Schumpeter (1939) already makes the argument that many forms of innovation can occur without the production of any scientific novelty. On the other hand, the economic reception of an invention is uncertain. It follows that the future economic value of individual patents is heterogeneous: Many patents have very low value, and as a consequence the number of patents does not perfectly reflect the value of technological innovation. Furthermore, all inventions are not patented because some inventors may prefer secrecy to prevent public disclosure of the invention imposed by patent law, or to save the significant fees attached to patent filing; the propensity to patent differs across sectors and technologies.

This paper takes a different approach by looking at the result of innovation. Using product-level data from the UK refrigerator market, we examine the impact of electricity prices on the characteristics of the products actually sold on the market and we derive the impact on the energy consumption of sold appliances. In comparison with patent-based studies, the main advantage of the approach used in this paper is that it produces estimates of the impact of energy prices on the level of energy use induced by product innovation, which matters more for policy makers than the count of new patents. Doing so, we actually come closer to the strategy adopted by Newell, Jaffe, & Stavins (1999) in their seminal study.

Looking at energy efficiency improvements in the white goods



sector has strong policy relevance. Domestic appliances are responsible for a large share of the energy consumed by households: 16% of energy consumed in the residential sector and more than 60% of residential electricity consumption in 2009 (Enerdata, 2010). At the same time, there is high potential for energy efficiency improvements; for example, an energy efficient refrigerator consume up to five times less energy than an energy inefficient one.

Methodologically, our approach starts from Lancaster (1966)'s view that, at any point of time, the refrigerator market includes many differentiated models, each being a particular combination of product characteristics (e.g. capacity, energy consumption, height, colour). Product innovation amounts to the launch of new models that substitute older ones. We then take advantage of the fact that we observe the dates of launch and exit of each model sold in the UK market between 2002 and 2007. We use a dynamic panel-data probit model (Wooldridge, 2005) to identify the impact of energy prices on the probability that a given model is commercialized.

This method faces two main econometric challenges. The first one results from the inclusion of refrigerator prices as a control variable in the product offer equation. This creates a simultaneity problem: A high price arguably increases the incentives to launch the product, but new products also modify the market equilibrium and thus the prices. We solve this issue by adopting a strategy inspired by Hausman et al. (1994), i.e. using the price of similar products as instrumental variables. The identification assumption is that prices in outside markets reflect underlying product cost and that stochastic market-specific factors are independent from those observed in the refrigerator market. The second challenge is that information on the price of refrigerator models that are not commercialized is not observed. We circumvent this problem by predicting prices for non-commercialized products by using multiple imputations. This gives unbiased standard errors when prices of non-commercialized products are used.

In the last stage of the analysis, using the econometric estimates, we produce a micro-simulation in order to calculate the impact of a 10% energy price increase on energy consumption of the models commercialized. We find that a 10% increase in the price of electricity reduces the energy consumption of commercialized products by 2%. A large share of this reduction is explained by a reduction of freezing space. We also show that the exit of energy-inefficient products contributes more to the reduction than the launch of new energy-efficient models. These findings suggest that innovative improvements in energy efficiency – the development of new energy-saving technologies embodied in new products – is not the primary response to energy price increases.

Acknowledgements

This research was funded by the Swiss National Science Foundation under the Sinergia programme, Project «Innovation, Diffusion and Green Growth» No CRSII1_147612. For useful comments, we would also like to thank Louis Gaëtan Giraudet, Sébastien Houde, Xavier Labandeira, Francesco Vona, three anonymous reviewers and workshop participants at La Toxa 2016. We are also grateful to GfK Retail and Technology for providing the data.

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