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Interfuel Substitution and Energy Use in the UK Manufacturing Sector

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The growing challenge of climate change has made economists concerned about the various ways that industries can adapt to the requirements of increasingly stringent carbon emission targets. Interfuel substitution is seen as a promising venue, as industrial consumers are expected to have greater incentives than residential or small commercial users to switch to non-fossil fuels (e.g. electricity from renewable energy sources), as relative fuel prices change.

Most of the existing literature on interfuel substitution is based on aggregate data, which makes existing estimates subject to a large measurement error. This happens because of the following reasons. First, studies based on the aggregate data fail to account for large differences in technological requirements for fuel types used in specific industries. For example, most cement kilns today use coal and petroleum coke as primary fuels, whereas aluminum smelters are based on electrochemical operational processes. Therefore, observable substitution of coal for electricity based on aggregate data may in fact reflect the exit of coal-intensive firms (e.g. manufacturers of cement), or entry of electricity-intensive firms (e.g. manufacturers of aluminium).

Second, studies based on aggregate data across fuel use do not capture idiosyncratic properties of different fuels in the manufacturing processes. Waverman (1992) pointed out that fuels used by industrial sectors for non-energy purposes, such as coking coal, petrochemical feedstocks, or lubricants, have few available substitutes, and should therefore be excluded from the data. Jones (1995, p. 459) found that "excluding fuels used for non-energy purposes yields larger estimates of the price elasticities for coal and oil and indicates generally greater potential for interfuel substitution than when using aggregate data." None of the existing studies, however, estimated the elasticities of fuel demand differentiated by fuel use for energy purposes in industrial processes. This is, however, very important because different manufacturing

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processes (e.g. lighting, cooling, or chemical processes) are bound for use with specific fuels (typically, electricity).

This study attempts to provide more reliable estimates of own-price and cross-price elasticities of fuel demand, that could be used for evaluating the effect of climate change policies on fuels' choice in manufacturing industries. In doing so, it excludes the consumption of fuels used in industrial processes with technological substitution possibilities limited to one or none alternative types of fuel based on the data disaggregated at both industry and the fuel use levels. Econometric models of interfuel substitution are applied to energy inputs aggregated by their energy use, and separately for thermal heating processes (which account for about 70 percent of total energy consumption), where interfuel substitution is technologically feasible. The results from 12 UK manufacturing sectors disaggregated at 4-digit SIC level between 1990 and 2005 indicate that compared to aggregate data, the own-price fuel demand elasticities for all fuels and cross-price elasticities for fossil fuels are considerably higher for thermal heating processes. Nonetheless, electricity is found to be a poor substitute to the fuels based on both aggregate data and separately for the heating process.

This study also exploits a natural experiment of an increase in real fuel prices between 2001 and 2005 to determine whether rising energy prices result in higher substitution elasticities. The study finds higher cross-price elasticities of fuel demand based on aggregate data, and lower substitution elasticities for the heating process. These results suggest that an increase in energy prices had a limited effect on fuels' choice in the direct manufacturing process, with major substitution coming from change in fuel demand for idiosyncratic energy-using processes, such as the machine drive, electrochemical processes, and conventional electricity generation. Counterfactual analysis is then performed to decompose observed differences in substitution elasticities. The results of the counterfactual analysis indicate that technological change was the major determinant of the differences in observed elasticities before and after the energy price increase. On the contrary, the effect of the change in economic environment (i.e. altered relative fuel prices) was limited.

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