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Modelling OECD industrial energy demand: Asymmetric price responses and energy-saving technical change

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Abstract

The industrial sector embodies a multifaceted production process consequently modelling the 'derived demand' for energy is a complex issue; made all the more difficult by the need to capture the effect of technical progress of the capital stock. This paper is an exercise in econometric modelling of industrial energy demand using panel data for 15 OECD countries over the period 1962–2003 exploring the issue of energy-saving technical change and asymmetric price responses. Although difficult to determine precisely, it is tentatively concluded that the preferred specification for OECD industrial energy demand incorporates asymmetric price responses but not exogenous energy-saving technical change.

JEL classification: C33; Q41

Keywords: OECD industrial energy demand; Asymmetry; Energy-saving technical change; Modelling

1. Introduction

Given the importance of the global environmental agenda, never before has it been so important to understand the determinants of industrial energy demand in the developed world in order to assist international policy makers in their deliberations. They require sound and dependable models to support their projections of future industrial energy demand to underpin policy; for example the allocation of emission trading permits. However, the industrial sector embodies a

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multifaceted production process so that modelling the 'derived demand' for energy is a complex issue; made all the more difficult because of the need to capture the effect of technical progress of the capital stock and its subsequent effect on improved energy efficiency and hence energy consumption. Consequently, an understanding of this issue is vitally important — whatever modelling approach is adopted. This paper is an exercise in econometric modelling of OECD industrial energy demand in a panel context in order to explore the relationship between energy-saving technical change and asymmetric price responses since, as far as is known, modelling of the industrial sector has not been undertaken in this way before. In particular an attempt is made to determine whether an industrial energy demand model that incorporates *either* asymmetry in the price response *or* exogenous energy-saving technical change *or* both is accepted by the data in order to better understand the determination of OECD industrial aggregate energy consumption.

The sharp increases in crude oil prices during the early 1970s stimulated a significant interest in energy demand research. This interest was maintained with the further increases in crude oil prices in the late 1970s and early 1980s followed by the collapse in the mid-1980s. The effect of these changes on the real OECD industrial energy demand price is illustrated in Fig. 1 along with the index of production and energy consumption.[1] It can be seen that OECD industrial energy demand was rising consistently until the early 1970s and the first crude oil price hike, but since then has fluctuated with total consumption in 2003 for the countries in the sample being below that in 1974. At first sight this would appear to suggest an asymmetric price response with the large increases in the real energy price causing a significant reduction in consumption that was not reversed as prices subsequently eased.

Most of the earlier studies of industrial energy demand followed the seminal work of Berndt and Wood (1975) and concentrated on factor substitution and subsequently inter-fuel substitution models. However, these models were based on a 'strict' neoclassical production and cost structure (normally represented by the translog function) that were often at odds with the data and, as Waverman (1992) states, the results from such models were "based mainly on intuition and thus incorrect" (p. 23). More recently, as Table 1 illustrates, a number of studies of industrial energy demand published since 1990 have continued to employ factor substitution models but in addition a number of studies have used a single equation approach often with a constant elasticity of demand (linear in logs) function. This procedure has become standard in energy demand estimation given its simplicity, straightforward interpretation, and limited data requirements and, as noted by Pesaran et al. (1998), it generally outperforms more complex specifications across a large variety of settings. Table 1 also illustrates that all cited studies assume that the estimated elasticities are symmetric; however, they do differ in terms of the country or countries, data frequency and period, the dynamic specification, the econometric technique used and the allowance for technical progress (or the underlying energy demand trend). For example Hunt and Lynk (1992) estimated a cointegrating error correction model (ECM) for the UK manufacturing sector with a deterministic trend using annual data from 1952 to 1988. Hunt et al. (2003a) and Dimitropoulos et al. (2005) used the structural time series model (STSM) to capture a non-linear underlying trend with an autoregressive dynamic lag (ARDL) model with UK quarterly and annual data respectively. Whereas Jones (1995, 1996), estimated a dynamic linear–logit factor substitution model using annual data but for the USA and the G-7 countries. Chang and Martinez-Chombo (2003), on the other hand, used a cointegrating ECM with time varying parameters to estimate electricity demand in Mexico using annual data but made no allowance for exogenous

[1] This refers to the 15 OECD countries used in this study. The definition and calculation of these data are given in Section 3 below.