

The Effect of Energy Prices on Operation and Investment in OECD Countries: Evidence from the Vintage Capital Model

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Jevgenijs Steinbuks, Andreia Meshreky, and Karsten Neuhoff

Empirical analysis of the effect of energy prices on energy use has been so far limited by the ability of econometric models to reflect the adaptation of the capital stock to energy price changes. This paper attempts to address this limitation in by modelling the effect of energy prices on energy use. Our econometric model explicitly incorporates the capital stock, and separately accounts for operational and investment choices in different sectors. Specifically, we expand the traditional estimation of energy, materials, and labour responses to input price changes by including vintages for the capital stock. Each vintage of the capital stock has its own energy efficiency, which is a function of input prices at the time of investment, and the exogenous technological change. In our vintage capital model, a rational cost-minimizing firm chooses both the optimal input quantities and the efficiency of new capital stock. The model therefore separately accounts separately for the flexibility of substitution between input factors to for production (labour, energy and materials), and the potential for more efficient use of these inputs by choosing more efficient technologies at the time of investment. In doing so, our model allows for adaptation of the capital stock to energy price shocks.

Our analysis is based on a new panel dataset, which covers 23 OECD countries and four sectors (agriculture, commerce, manufacturing, and transport) between 1990 and 2005. Compared to earlier studies, our analysis relies on more accurate energy prices in different sectors and countries based on the end-use fuel prices and sector-specific energy mix. As a result, this study is among the few to analyze the effect of energy prices from a cross-country, cross-sector perspective.



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We estimate the vintage capital model using a translog cost function approach, allowing for non-linearity in factor prices. This introduces additional complexity for the estimation of the relevant parameters of the model, and provides a better explanation of energy demand at the sector level. The assumption of constant efficiency of capital stock is rejected for all sectors.

The results for all sectors indicate that rising energy prices result in substantial decline in the long-run energy use, and affect both the operation (input substitution) and the investment (energy efficiency of capital stock) components of energy demand. However, only the estimates for the manufacturing sector can be reconciled with the economic intuition. The vintage capital model predicts that between 1990 and 2005 the energy efficiency of capital stock in the U.S. manufacturing sector has improved by about 24 percent. Interpretation of the results for other sectors is plagued by exogenous structural shifts within and across sectors, regulatory distortions, and measurement error. More robust results would require longer time series and less aggregation across sectors, covering more variation in energy prices.

Contact
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js782@cam.ac.uk
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www.electricitypolicy.org.uk

