THE EFFECT OF INFORMATION AND COMMUNICATION TECHNOLOGIES ON ENERGY DEMAND: EVIDENCE FROM OECD COUNTRIES

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Overview

Information and communication technologies (ICTs) are transforming industrial structures, employment patterns and business processes throughout the world, with potentially far-reaching implications for energy consumption and carbon emissions. On the one hand, ICTs offer many opportunities for reducing energy demand - for example through optimising the control of buildings, industrial processes, logistics and other systems, or by substituting for travel and material goods. On the other hand, the digital economy has a large and rapidly growing energy footprint, with the continuing improvements in the energy efficiency of individual devices being offset by the continuing increases in the number, power, complexity and range of applications of those devices (Galvin 2015). As a result, it is unclear whether ICTs have contributed to a net increase or a reduction in economy-wide energy consumption. The complexity of ICT systems, the rapidity of technical change and the variety of impact pathways (including the emergence of entirely new services) make it difficult to estimate the overall impacts of ICTs on energy demand. Despite bold claims about their environmental benefits (Laitner and Ehrhardt-Martinez 2009), most studies of ICT's focus upon a subset of applications or fail to control for confounding variables (Sorrell 2020). To overcome these limitations, this paper uses panel data to estimate the impact of ICTs on energy consumption within 28 manufacturing and service sectors in 17 OECD countries over a period of 12 years. These sectors, in turn, account for around half of final energy consumption in these countries.

Methods

Similar to Schulte et al 2014, based on a Translog variable cost function, the energy cost share equation estimated is as follow:

$$S_E = \beta_E + \beta_{EE} \ln\left(\frac{P_E}{P_L}\right) + \beta_{EK_{ICT}} \ln\left(\frac{K_{ICT}}{Y}\right) + \beta_{EK_N} \ln\left(\frac{K_N}{Y}\right) + \beta_{EY}^{*} \ln Y + \delta_{ET} t \qquad (1)$$

where
S_E: share of energy in the variable costs
P_E: price of energy inputs
P_L: price of labour inputs
K_{ICT}: compensation of ICT capital services
K_N: compensation of non-ICT capital services
Y: value of output
t: time trend

We also add sector, country and year (where appropriate) dummy variables to control for unobserved heterogeneity. The coefficiecnt of interest is $\beta_{EK_{ICT}}$ which measures how the energy cost share changes in response to changes in ICT capital service. If $\beta_{EK_{ICT}}$ is positive (negative), increases in ICT capital service intensity are associated with increases (reductions) in the energy cost share. The sign of $\beta_{EK_{ICT}}$ is uncertain.

Our main interest is the impact of ICT on energy demand. To explore this, we derive the following expression for the elasticity of energy demand with respect to ICT capital services:

$$\eta_{K_{ICT}}(E) = \frac{\beta_{EK_{ICT}}}{s_E} - s_{K_{ICT}} \qquad (2)$$

Where S_{KICT} is the ratio of ICT capital service compensation to variable costs. Hence, if $\beta_{EK_{ICT}} < 0$, increases in ICT use are associated with *reductions* in energy use. However, if $\beta_{EK_{ICT}} \geq 0$ the impact of ICT on energy use depends upon the magnitude of the first term in Equation 2 relative to the second.

We estimate models for three dependent variables (energy cost share, electricity cost share and non-electric energy cost share) and for four groups of sectors (all sectors, manufacturing sectors, service sectors and other sectors). In each case, we estimate models using both OLS and quantile regression techniques, and for three of the models we use interaction terms to estimate the ICT elasticity for individual sectors. We also check the robustness of the OLS results by estimating models with samples that exclude post-communist countries and countries with missing data.

The main data source is EU-KLEMS, 2009 release, combined with World Input Output Database, 2013 release, and IEA Energy Prices and Tax Database. Furthermore, we use total Purchasing Power Parity (PPP) taken from the OECD database, as it is necessary to transform the nominal values to real values in a cross-country and cross-sector dataset. Thus, the estimating sample is a cross-country and cross-sector panel dataset for 17 countries (EU countries, UK, Australia, Japan and USA) with 28 sectors, covering the period 1995-2007.

Results

Our preliminary results suggest three main conclusions. First, we find no strong evidence that ICT is associated with lower energy consumption in our sample as a whole. The relevant coefficient is not statistically significant, the magnitude of this coefficient is small and our estimates are sensitive to the share of ICT capital services in variable costs. Second, we find that ICT is significantly associated with lower energy consumption in the service sector, but not in the manufacturing sector. Third, we find that ICT is significantly associated with lower electricity consumption, but there is only limited evidence of a negative relationship with fuel consumption.

Conclusions

Comparison of our preliminary results with those other studies suggests a lack of consensus on the relationship between ICT and energy consumption, and limitations in the available methodologies and datasets. Hence, we should treat claims of the energy-saving benefits of ICTs with caution.

References

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