Energy Policy 48 (2012) 130–136

Contents lists available at SciVerse ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Information communication technology and electricity consumption in emerging economies

Perry Sadorsky*

Schulich School of Business, York University, 4700 Keele Street, Toronto, Ontario, Canada M3J 1P3

HIGHLIGHTS

- ICT usage is growing rapidly in developing countries.
- ICT usage affects electricity consumption.
- Three different measures of ICT are examined.
- Short-run and long-run ICT elasticities are calculated.
- Implications for energy policy are discussed.

ARTICLE INFO

Article history:
Received 26 January 2012
Accepted 27 April 2012
Available online 2 June 2012

Keywords:
Electricity consumption
Information communication technology
Emerging economies

ABSTRACT

This study examines the impact of information communication technology (ICT) on electricity consumption in emerging economies. The empirical results, obtained from dynamic panel demand models, show a positive and statistically significant relationship between ICT and electricity consumption when ICT is measured using internet connections, mobile phones or the number of PCs. Long-run ICT elasticities are smaller than income elasticities but because ICT growth rates are so much higher than income growth rates, the impact of ICT on electricity demand is greater than the impact of income on electricity demand. One implication of these results is that policies designed to close the "digital divide" between developed and developing economics by increasing the adoption of ICT in developing countries are put at odds with energy policies to reduce GHG emissions.

1. Introduction

The relationship between information technology and energy use is a topic of research that dates back at least as far as the 1950s with Thirring (1958) but the topic did not really start to develop until the early 1980s (e.g., Walker, 1985, 1986).[1] Coming on the heels of two oil price shocks in the 1970s there was a general interest in how to reduce energy consumption in economies by adopting a greater usage of information technology (IT).[2] Information technology was seen as one possible way to drive economic growth more efficiently and with less energy. The idea that energy demand in industrialized countries can fall while economic growth can rise is based on a Schumpeterian view that new information technology will provide large energy saving gains (Walker, 1985). The effect of greater information technology use on electricity was often ignored or deemed to be of less of an interest since many of these papers were written before the widespread adoption of the internet and mobile phones. In the 1980s, some forward looking authors were pointing out that, while overall energy demand could decrease as economies move towards greater use of information technology, an increased usage of information technology would increase electricity consumption.

> While overall energy demand may not rise strongly, information technology will however tend to increase electricity's importance in the economy. (Walker, 1985, p. 458).

In the 1990s, the adoption of information communication technology (ICT) increased dramatically. Mills (1999) estimated that at least half of the growth in US electricity consumption in the past decade had come from equipment connected to the internet. Moreover, for every 2000 kB of data moving on the internet, the energy from a pound of coal is needed to create the necessary kilowatt-hours. In his view, any increases in traditional electricity efficiency (e.g., lighting, motors, and refrigeration) will

*Tel.: +1 416 736 5067; fax: +1 416 736 5687.
E-mail address: psadorsk@schulich.yorku.ca

[1] Thirring (1958) appears to be the first person to calculate the total energy cost of information and communications.

[2] Recent papers looking into how to reduce energy usage in economies by adopting a greater usage of information technology include Chen (1994), Campos Marchado and Miller (1997), Watanabe et al. (2005).

0301-4215/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.enpol.2012.04.064

be more than offset by the tremendous increases in electricity demand coming from the increased usage of the internet. More recently, Mills (2011) calculated that watching a live stream of a baseball game on a broadband wireless connected tablet uses as much energy as driving 30 miles. Owen (2007) writing on how consumer electronics is dominating UK household electricity consumption, estimates that by 2020, consumer electronics will account for 45% of the electricity use in a home.

The information communications technology (ICT) industry has grown very rapidly over the past 20 years with the widespread adoption of computers, the internet and mobile phones. While the actual electricity usage of an individual product like a mobile phone may not be great the impact on electricity demand from using millions of ICT devices can be significant. The ICT industry relies on an extensive electricity hungry network of semiconductors, communications towers and vast data centers located in air conditioned buildings around the world to send, receive and store data. Moreover, traditional mobile phones (phones used primarily to send and receive calls and text messages) are rapidly being replaced with new smart phones which allow users to surf the web and watch streaming video. Smart phones and other personal ICT devices create positive network effects among users by allowing people to share data, pictures and video but these activities increase the demand for electricity. By some estimates, the ICT sector is responsible for about 2% of global carbon dioxide emissions (Kanter, 2008). This is an amount similar to the emissions from air transport. In 2000, data centers consumed 0.6% of the world's electricity and 1% in 2005 (The Economist, 2008), Some predict that emissions from data centers and services over the internet will grow four-fold by 2020, making emissions from ICT greater than emissions from air travel (The Economist, 2008). In 2006, businesses around the world spent $55 billion on new servers and they spent $29 billion (slightly more than half of the cost of the equipment) to power and cool these servers.

Information communication technology is playing a larger role in economies around the world and some of the fastest growth rates in the adoption of ICT can be found in the developing countries of the world. For example, between 2000 and 2010, mobile cellular subscriptions per 100 inhabitants increased by 107% in the developed countries of the world, 187% for the world as a whole and 255% in the developing countries of the world.[3] Between 2000 and 2010, internet users per 100 inhabitants increased by 102% in the developed countries, 153% for the world as a whole, and 235% in the developing countries of the world. Over the period 2002–2010, the proportion of households with internet access increased 62% in developed countries, 75% for the world and 123% for developing countries. This increased adoption of internet connections, mobile phone subscriptions and personal computers brings up an interesting question. How does the increased use of ICT affect electricity demand?

ICT and e-business can affect the demand for electricity primarily by the fact that ICT requires electricity to operate and the installation and operation of ICT increases the demand for electricity. What is not known is how different measures of ICT affect electricity consumption and what are the short-run and long-run elasticities of electricity demand with respect to ICT. Answers to these questions can help in developing a more complete understanding of the impacts of ICT on electricity demand. The purpose of this paper is to investigate the impact that ICT has on electricity consumption.

This paper makes four contributions to the literature. First, while most authors have studied the relationship between ICT and electricity consumption at the country or sector level for developed economies, there is little known about this relationship for emerging or developing economies. Emerging economies are currently adopting mobile phone usage, internet connections and personal computers (PCs) much faster than in developed economies and the impact that ICT adoption has on electricity consumption in emerging economies is an important yet under studied area. Second, this paper presents what is believed to be the first panel data study of electricity consumption and ICT in emerging economies. Panel data approaches have several advantages over individual country studies especially when the time dimension is short. More specifically, panel approaches yield more precise parameter estimates and estimates of short-run and long-run elasticities. The panel estimation approach in this paper uses generalized method of moments (GMM) techniques designed to control for endogeneity between the response variable and explanatory variables. Third, in this paper, three measures of ICT are used: the number of internet connections per 100 inhabitants, the number of mobile phone subscriptions per 100 inhabitants and the number of PCs per 100 inhabitants. This provides a more complete understanding of how these different measures of ICT affect electricity demand. Fourth, if ICT is found to affect the demand for electricity then this relationship can affect energy policy and carbon emissions reduction strategies. In particular, attempts at closing the "digital divide" between developed and developing economics could lead to conflicts with greenhouse gas (GHG) emissions reductions initiatives if the greater adoption of ICT increases electricity consumption and GHG emissions.[4,5]

The purpose of this paper is to investigate the impact of ICT on electricity demand for a sample of emerging economies. The following sections of the paper set out the theoretical background material, empirical model, data, empirical results and discussion, policy analysis and conclusions.

2. ICT and electricity consumption

The relationship between ICT and electricity consumption is an important and timely topic that is understudied. Most of the previous work investigating the impact that ICT has on electricity consumption has been conducted for developed economies at the country or industry level.

In studying the U.S. economy, Romm (2002) finds that ICT sectors are less energy intensive than manufacturing sectors. In the pre-internet period (1992–1996) U.S. GDP and energy consumption grew at average yearly rates of 3.2% and 2.4%, respectively. By comparison, in the internet era (1996–2000) U.S. GDP and energy consumption grew at average yearly rates of 4% and 1%, respectively. There are two different effects behind this decoupling of economic growth and energy growth. First, the IT sector is less energy intensive than traditional manufacturing. Second, the internet economy appears to be increasing efficiency in every sector of the economy. According to Romm (2002) the internet is not driving an acceleration of electricity demand instead, it appears likely to be driving efficiencies.

Laitner (2002) argues that the energy needs of IT are often over exaggerated and that in his view, about 3% of total U.S. energy consumption is required to power current information technology

[3] ITU Statistics (http://www.itu.int/ict/statistics).

[4] The term "digital divide" refers to the gap in ICT access and usage between developed and developing economies. Closing this gap is desirable because ICT is often identified as a driver of productivity and wealth creation.

[5] By some estimates, electricity generation accounts for approximately 25% of global GHG emissions (http://cait.wri.org/figures.php?page=World-FlowChart&view=100).