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The effects of Internet usage and economic growth on CO_2 emissions in OECD countries: A panel investigation

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ABSTRACT

This paper estimates the short- and long-run effects of Internet usage and economic growth on carbon dioxide (CO_2) emissions using OECD panel data for the period 1991–2012. The Pedroni panel cointegration test confirms that the variables are cointegrated. Although Pooled Mean Group (PMG) estimates indicate a positive significant long-run relationship between Internet usage and CO_2 emissions, the coefficient is very small and no causality exists between them, which both imply that the rapid growth in Internet usage is still not an environmental threat for the region. The study further indicates that economic growth has no significant short-run and long-run effects on CO_2 emissions. Internet use stimulates both financial development and trade openness. The findings offer support in favor of the argument that OECD countries can promote their Internet usage without being significantly concerned about its environmental consequences. But the future emissions effect of Internet usage cannot be ruled out, as is evident from the variance decomposition analysis. Therefore, this study recommends that in addition to boosting the existing measures for combating CO_2 emissions, OECD countries need to use ICT equipment not to simply reduce its own carbon footprint but also to exploit ICT-enabled emissions abatement potential to reduce emissions in other sectors, such as the power, energy, agricultural, transport and service sectors.

Contents

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1. Introduction

The world has witnessed a significant increase in the growth of Information and Communications Technology (ICT) use over the past three decades [7]. Although this rapid growth in ICT usage is believed to lead to improvements in productivity and energy efficiency, its effects on the environment are still inconclusive. Some studies support the positive role of ICT in mitigating greenhouse gas emissions [18,32,39,45,7,72,73], while others conclude that ICT use exerts pressure on energy use [41] through the resultant increase in electricity consumption [41,62], which is one of the key reasons for global CO_2 emissions [25].

It is argued that data centers have grown robustly by 11% per year over the past decade [22]. Statistics indicate that 1.1–1.5% of the world's total electricity consumption is related to the data center industry [16]. Also, globally, electricity consumption caused by ICT products and services has increased from about 3.9% in 2007 to 4.6% in 2012 [26]. A significant percentage of domestic electricity consumption in Europe is attributed to ICT products and services [19]. The rapid growth in ICT use, especially Internet usage, exerts pressure on domestic demand for electricity consumption [62]. According to some estimates [20,66], the ICT industry is responsible for around 2% of global CO_2 emissions.

OECD governments are funding Internet network rollouts worth billions of dollars for further expansion of ICT use [42]. ICT use, especially Internet use as the leading ICT variable, has been transforming the economies of OECD countries over the past 20 years [77]. Internet usage has been expanding in these countries at a staggering speed.

OECD economies are characterized by the highest level of energy consumption in the world, and electricity is one of the key sources of this huge energy supply [63]. The same authors argue that about 80% of the power generation is still sourced from non-renewable resources in these countries; as a result, there has been a sharp increase in CO_2 emissions. To exacerbate this, ICT-related electricity consumption has increased significantly [30]. Due to the ongoing growth in the data centers, demand for electricity-operating data centers can increase by 15–20% annually [16]. The massive growth in Internet use in the region is likely to exert pressure on energy demand, especially on electricity demand which may or may not cause emissions to rise.

In the light of the twin reality of huge energy demand and massive growth in Internet use in OECD countries, undertaking an investigation into the Internet–CO_2 emissions nexus is a worthy one. In addition, to the best of the authors' knowledge, no study has so far investigated this association for OECD countries and as such, this study is the first ever attempt to fill the void. It exploits OECD panel data for the investigation.

The current study also includes real GDP per capita as a proxy for economic growth as an independent variable. The reason for including real GDP per capita is that usually, simple bivariate models may fail to appropriately capture the empirical relationship between the series [43,5]. Also, since the mid-1980s, the income–emissions nexus has been a central focus in the empirical works of energy researchers [25]. Therefore, the inclusion of real GDP per capita in this study as a proxy for economic growth is justified.

This empirical exercise is expected to result in a number of contributions to this area of research. First, it is believed that the Internet–CO_2 emissions association is a very promising but a relatively unexplored area. Second, although literature on the effects of income on CO_2 emissions is abundant, the current study further enriches the panel literature with the use of most recent data from OECD countries. Third, the study also makes a methodological contribution by employing the Pooled Mean Group Regression (PMG) technique that has never been used before for such investigation, although findings from the application of such a technique are potentially more policy-oriented. Fourth, the results of this study are expected to have important implications for ICT policy, energy policy and growth policy in OECD countries.

The rest of this paper is structured as follows: Section 2 presents a literature review; data and methodology is discussed in Section 3; Section 4 presents the estimation results; and the paper ends with Section 5, with conclusions and policy implications of the findings.

2. Literature review

2.1. Energy impacts of ICT

The environmental implications of ICT were not researched until the early 1990s, and since then, research on the energy impacts of ICT use began emerging. Cohen et al. [9] and Jokinen et al. [36] were among the authors who first examined such relationships from theoretical and conceptual perspectives. Although the findings of both studies were inconclusive, they remain important as providing a starting point for further research. Roome and Park [59] provided a framework to address information, communication, computing and electronic technologies (ICCE). They concluded that such technologies have both positive and negative implications for sustainability.

Sui and Rejeski [69] cautioned environmental policymakers about the complexity and uncertainty in the relationship between information technology and environmental performance, despite highlighting the positive roles of emerging ICT such as dematerialization, decarbonization and demobilization. Matthews et al. [40] compared the environmental and economic performances of traditional retailing and e-commerce logistic networks in the United States and Japan. The study failed to reach a conclusion about which of the two methods was energy efficient. Toffel and Horvath [72], in their research, concluded that reading newspapers online and video teleconferencing have lower environmental impacts than their traditional counterparts.

Takase and Murota [70] developed and employed economic and energy models to assess the effects of ICT investment on energy consumption in Japan and the USA. Their findings indicated that increases in IT investment would lower energy intensity in Japan and, as such, Japan should conserve more energy by promoting IT. For the USA, future IT investment will have a positive income effect, which is likely to increase domestic demand for energy consumption. Hilty et al. [27], using scenario techniques and expert consultations, contributed towards a general understanding of the environmental impacts of ICTs. Hilty [28] argued that ICT development contributes towards dematerialization through substitution and optimization of energy consumption.

Erdmann and Hilty [18] identified two green ICT waves. The first one focuses on the rising Internet economy and the second one addresses the potential of ICT in reducing emissions. It is argued that ICT can play a significant role in reducing the negative effects of climate change by improving energy efficiency and reducing renewable energy costs [41]. Ropke and Christensen [60]