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Assessing the Impact of ICT on the Quality of the Environment in Iran and the Countries of the Persian Gulf

Arash Ketabforoush Badri¹, Mohammad Taheri² and Ramin Yahyavi³

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ABSTRACT: In recent decades, information and communication technology (ICT) have created massive social and economic changes in all spheres. ICT impacts on the environment can be of different dimensions. So that it can be expected that the use of technology can have a positive effect on the environment or vice versa and can have a devastating impact on environmental sustainability. Therefore, this study attempts to assess effects of ICT on quality of the environment in Iran and 7 countries in the Persian Gulf area in the period 2005 to 2012, using panel data methods. The results show that telephone lines as ICT indicators have negative and significant effect, GDP per capita variable positive effect and concentration of population and GDP per capita squared had negative effects on quality of the environment. Also it should be noted, the obtained results have approved the environmental Kuznets curve hypothesis.

KEYWORDS: ICT, Quality of the Environment, Panel Data, Iran, Persian Gulf.

¹ PHD of Economics, Faculty of Management and Accounting, Qazvin Branch, Islamic Azad University, Qazvin, Iran. *E-mail: arashkbadri@gmail.com*

² Department of Environmental Sciences, Faculty of Natural Resource, Tarbiat Modares University, Noor, Mazandaran, Iran. *E-mail: m.taheri677@yahoo.com*

³ Master of Education Management, Faculty of Management, Marand Branch, Islamic Azad University, Marand, Iran. *E-mail: raminyahyavi@yahoo.com*



1. INTRODUCTION

During recent decades, the importance of the environment has increased. Investigation, identification, anticipation and adaption to this changing environment require having adequate plans and strategies with a view to the future with creativity and innovation landscape. That it is essential for any organization, firms production, and each country (Hilty et al, 2006, 1620). Undoubtedly, the use of ICT capabilities in different fields leaves a significant impact on the environment. Therefore, each strategy and tool that can help countries in this regard, can be considered as a general solution. The use and application of ICT and its potential as a result of the transfer of activities in cyberspace, is considered as one of the most important platforms and solutions in this respect, whether in developed or developing countries. It can be said that, ICT has been one important factor in transforming human life in recent decades and almost impossible to find a part of human life today (directly or indirectly) that has not benefit from the capabilities of this technology (Ospina and Heeks, 2010). It should be noted substantial growth of developed countries in recent decades is related to the use of new technologies (Berkhout and Hertin, 2004, 907). However, the new developments in ICT, has increased the interest of countries in the use of modern technologies. So, it seems that to examine the implications of using ICT on the environment in different countries could have new achievements, particularly for policymakers. Therefore, this study seeks to examine the impact of ICT on the environment in Iran and 7 countries in the Persian Gulf area in the period 2005 to 2012.

2. LITERATURE REVIEW

Mei Ong and Kun Sek (2013) in a study have paid the impact of ICT on east Asian economic growth using panel data set from 1970-2008 in the three income groups: high, medium and low. The results showed that the variables of trade and inflation have very little effect on the quality of the environment. FDI also has a negative effect on the quality of the environment in low and middle-income countries.

Ahmed and Ridzuan (2013) have examined the interaction effect of economic growth and environmental quality in the period 1975 to 2006. The paper found out that labour, capital and telecommunications investment have positive relationship towards GDP. Thus, the study concludes that ICT has played an important role as engine of growth for sustainable development in ASEAN5 and ASEAN5+3 countries.

Hepburn and Bowen (2012) in a study investigated the relationship between economic growth, environment and climate change in the period 2008-2012. The results showed that, when sustained economic growth is desirable, that does not lead to detrimental effects on the environment.

Kawata (2011) has investigated the effect of the environment from economic growth by 2 priorities; natural environment and the opportunity cost of protecting the natural environment. Results indicate that the second factor plays a significant role in improving the quality of the environment.

Constantini and Martini (2010) in a study examined the effect of internet, fixed and mobile phones per 1000 people to release various contaminants. The results showed that the index of ICT has a positive impact on various contaminants including CO₂.

Zhang and Cheng (2009) have analysed the relationship between energy consumption, carbon dioxide emissions and economic growth in China. The results indicate that the energy consumption and carbon dioxide emissions have no significant relationship with the country's economic growth.



Annette (2009) has tried to analyse and explain effects of technology on the environment. Results indicated that use of technology in production of recycled and renewable products will have positive effects on the environment.

Lopez et al (2009) examined the effect of combining public spending on environmental quality. The results show that increasing public spending in areas such as the environment and communications can have a positive impact on improving the quality of the environment.

Ang (2007) has explored the dynamic causal relation between carbon dioxide emissions, energy consumption and production in France during the years 1960-2000. The results show that economic growth due to long-term energy consumption and environmental pollution, and a one-way causal relationship between the energy consumption is set to increase production in the short term. The findings also show that an increase in energy use, carbon dioxide emissions will increase.

Alam et al (2007) in their study have paid the effect of environmental factors during the years 1971 to 2005 in Pakistan. The main findings of this study suggest that the increase in GDP and energy intensity increased environmental pollution.

3. THEORETICAL FRAMEWORK

Information society, for the first time, was introduced in the 1970s by Malchap and Porat. Since then, the concept of information was considered as an important factor in the development process. At the same time, the emergence of this concept came into being, communication and process technologies in order to receive, transmit and analyses information that became known as ICT (Asgharpour, et al., 2011, 24). The role of these technologies in the development of societies that had spread as far as many specialists benefited from the information and technology related to it in order to explain differences in levels of development among countries and showed that ICT may provide a cheap and efficient way of data collection and evaluation tools that speed up the development process (Trug, 2007, 23). Even in this case, some acknowledged that integration with the world of information is impossible for developing countries without access to adequate levels of ICT. Stiglitz (1988), Hamelink (1997) and UNCTAD (2006) are some of these studies. Also the importance of technology and the need to identify the factors and events affecting the use of these instruments has gone so far that it is one of the most important approaches to reduce poverty and promote global development is the adoption of new technologies in less developed regions. However, Zhao (2005) believes that although the globalization process will be able to access these new technologies by many countries, but the intensity and size of acceptance will determine how the country will benefit from this process. Therefore, in the third millennium, information technology is considered as a major axis of development in the world. Also at present, many of relationships, exchange of scientific achievements and access to the latest technologies is possible through information technology (Mehrabi et al., 2011, 69).

Thus, ICT is effective comprehensive and inclusive as a phenomenon in the full range of human activities to the private use of political and economic activities. Also, it is intended as a means of multi-functional, flexible and has multiple capabilities that provide the possibility of appropriate solutions in the form of individual or local applications to meet different needs (UNDP, 2004). In the 1990s, a major transformation as a revolution in ICT, happened in the economy, in fact formed the basis of the new economy and have a significant impact on economic growth in America and some other countries. The semiconductor or semiconductors was in the centre of the transformation of information, which led to the rapid decline in the price of semiconductors and cheap semiconductor, rapid expansion in the production of computers and communications equipment and ultimately reduced prices severely in other economic



activities. The rapid decline in prices of goods, which had benefited from ICT would be a great investment in the goods and led to a deepening of capital and changes in the organization of production of other goods in the economy and brought the growth of productivity and production.

ICT is growing with astonishing speed. Virtualization of many products, digitization of information, the non-physical transfer, reducing the need for extensive space in offices and warehouses and shortening the supply chain, are among the positive results of the development of ICT, on the one hand makes reducing the need for communities to natural substances in the environment and on the other hand, reduces the amount of waste entering the environment. With an overview of the positive effects, the question arises as to whether ICT provides the possibility of obtaining economic growth and environmental protection, and sustainable development? However, one should not forget that the ICT equipment is made, usually with environmentally harmful substances and non-absorbable (Pade and Sewry, 2009, 82).

The relationship between ICT and environment is a complex and multidimensional topic. This technology can have both positive and negative impacts on environmental sustainability. ICT provides a powerful tool for communities to protect the environment. This technology provides facilities for human communication which makes reduce the need of communities to natural substances in the environment. As well as, ICT reduce the amount of waste entering the environment. On the other hand, production and distribution of ICT equipment itself requires energy and materials and the fact is ICT equipment, has a short life cycle, this will lead to Increase electronic waste into the environment that are very detrimental effects for the environment (Fallahi et al, 2012, 151). For example, computer systems have been the most harmful chemicals. Therefore, in addition to positive effects, ICT have negative effects on the environment and the effect of this variable needs to be studied (Sojudi et al, 2010, 98).

4. RESEARCH METHODOLOGY

4.1. Estimation Method

Panel data is data from a (usually small) number of observations over time on a (usually large) number of cross-sectional units like individuals, households, firms, or governments. In other words panel data analysis is a method of studying a particular subject within multiple sites, periodically observed over a defined time frame. With repeated observations of enough cross-sections, panel analysis permits the researcher to study the dynamics of change with short time series. The combination of time series with cross sections can enhance the quality and quantity of data in ways that would be impossible using only one of these two dimensions (Gujarati, 638). Some more advantages of panel data as given for example Since panel data relate to individuals, firms, states, countries, etc over time, there is bound to be heterogeneity in these units. The techniques of panel data estimation can take such heterogeneity explicitly into account by allowing for individual-specific variables. By studying the repeated cross section of observations, panel data are better suited to study the dynamics of change. Panel data can better detect and measure effects that simply cannot be observed in pure cross-section or pure time series data. By making data available for several thousand units, panel data can minimize the bias that might result if we aggregate individuals or firms into broad aggregates. Panel data analysis endows regression analysis with both a spatial and temporal dimension. The spatial dimension pertains to a set of cross-sectional units of observation. These could be countries, states, counties, firms, commodities, groups of people, or even individuals. The temporal dimension pertains to periodic observations of a set of variables characterizing these cross-sectional units over a particular time span. There are several types of panel data analytic models. There are constant coefficients models, fixed effects models, and random effects models etc. The Constant Coefficients Model has constant coefficients, referring to both intercepts and slopes. In the event that there is neither significant country nor significant temporal effects, we

could pool all of the data and run an ordinary least squares regression model. This model is also called the pooled regression model. The Fixed Effects Model would have constant slopes but intercepts that differ according to the cross-sectional (group) unit—for example, the country. Although there are no significant temporal effects, there are significant differences among countries in this type of model. While the intercept is cross-section (group) specific and in this case differs from country to country, it may or may not differ over time. The Random Effects Model assumes a regression with a random constant term (Greene, 2003). One way to handle the ignorance or error is to assume that the intercept is a random outcome variable. The random outcome is a function of a mean value plus a random error. But this cross-sectional specific error term which indicates the deviation from the constant of the cross-sectional unit must be uncorrelated with the errors of the variables.

4.2. Data and Statistics

The statistical societies of this study are Iran and 7 countries of the Persian Gulf, including Saudi Arabia, Bahrain, UAE, Qatar, Oman, Kuwait and Iraq. The period has been used 2005-2012. This is the time series data collected from WDI2015 and OECD site statistics. According to the theoretical framework presented in this section we attempt to examine the impact of ICT on the quality of the environment in the context of Environmental Kuznets Curve (EKC). To do so, the model of Grossman and Krueger used with some adjustments are as follows (Grossman and Krueger, 1991):

$$\text{Ln}(\text{CO}_2)_i = \alpha + \beta_1 \text{LnICT}_i + \beta_2 \text{Ln}(\text{GDPP}_i) + \beta_3 (\text{LnGDPP}_i)^2 + \beta_4 \text{LnPOPD}_i + \varepsilon_i \quad (1)$$

LnCO_{2i} : natural logarithm gas emissions per capita CO_2 (in tonnes)

LnICT_i : Logarithm number of fixed telephone lines per 100 people (as an index of information and communication technology)

LnGDPP_i : Log GDP per capita of country i

$\text{Ln}(\text{GDPP})^2_i$: square log GDP per capita of country i

LnPOPD_i : the logarithm of the concentration of the population per square kilometer index
 ε_i : including the error.

Also, as can be seen, according to the hypothesis of EKC variable square LnGDP also included in the model. According to this hypothesis, there is an inverse U-shaped relationship between GDP per capita and indicators of environmental degradation, so that in the early stages of economic growth, the increase in GDP per capita with more environmental destruction, but of a threshold level then, increase economic growth improves the quality of the environment.

In relation with the model of research results can be pre-judged based on the following formula:

A) $0 > \beta_2$ and $0 < \beta_3$: In this case, the equation can be expressed in the form of a U-shaped relationship.

B) $0 < \beta_2$ and $0 > \beta_3$ the equation for a hump-shaped relationship (U reverse) is given, the maximum function curve shows the point of return. This curve is the Environmental Kuznets Curve.

5. RESEARCH FINDINGS

5.1. F-Limer and Hausman Tests Results

Table 1 shows that the value of F test statistic using fixed effects would be more appropriate. Also Houseman test statistic indicates the suitability of the method for estimating the fixed effects model.

Table 1. Results of F- Lymr and Houseman test of the estimated model

Test	F- Lymr Test	Houseman Test
Statistics	129/6545	25/1108
Prob	0/0000	0/0000

Sources: research findings

5.2. The Results of the Estimation and Analysis of Findings

Accordingly, the results of model estimation is introduced to determine the effect of ICT on environment using a fixed effects panel data, are presented in Table 2.

Table 2. The results of estimating the model

Variables	Coefficient	StatisticsT	Prob
LnICT	-0/5396	-2/0559	0/0033
LnGDPP	1/2092	4/1880	0/0001
(LnGDPP)^2	-0/5819	-4/0358	0/0002
LnPOPD	0/7921	4/2079	0/0001
$R^2= 0/9876$	$R^2=0/9845$	D-W =1/8543	

Sources: research findings

As you can see, ICT indicator is effective in improving environmental quality. This suggests that increasing access to landline and infrastructure development in the field of communications can have a significant impact in reducing travel and this causes the reduction of energy consumption and pollution in the studied countries. The coefficient of per capita GDP is positive and equal to 1/20. This means that a one percent increase in GDP per capita, the growth in emissions of CO₂, 1/20 percent increase. This shows that the level of contamination was released, increased with increases in per capita income. Increasing environmental degradation stems from two reasons. First, in the early stages of economic growth, according to the priority of national production and employment levels, are used, the abundant natural resources and energy to achieve high economic growth. Second, due to low per capita income, economic enterprises, are unable provide the costs of pollution reduction. On the other hand, the coefficient obtained for the square of GDP per capita, is negative and equal to -0/58. In other words, with continued economic growth in Iran and the countries of Persian Gulf will decrease environmental degradation. Because with rising incomes, the target countries have attempted to import new technology which is in terms of environmental creates less pollution. So as you can see EKC was approved the countries studied. Coefficients obtained for the index population density is positive. This means that by increasing the (focus) on an area's population, increased pollution. This coefficient shows that if one percent of the population density increased, with fixing other conditions, pollution levels will increase by 0/79 percent. Also, as can be seen in the estimated amount of R² is equal to 0/98 that this shows the explanatory power of the independent variables.



6. CONCLUSION

The use of ICT in the whole society has a significant impact on sustainable development. This technology has been able to create new ways of business, learning and the provision of services to private and public life change. ICT can have both positive and negative effects on environmental sustainability. For this purpose, this study aimed to investigate the effects of ICT on the environment by using panel data for Iran and 7 countries in the Persian Gulf area in the period 2005 to 2012. The results show that fixed telephone lines as an indicator of ICT has significant negative relationship between CO₂ emissions in studied countries. The GDP per capita, the degree of openness of the economy and square GDP have a positive impact on CO₂ emissions in the studied countries. It should be noted that the results are consistent with the results of Ang (2007), Alam et al (2007), Hepburn and Bowen (2012). As well as to improve the structure and better position the following suggestions are offered:

- General use of ICT to achieve environment-friendly society
- Reduce energy consumption and increase energy efficiency on a global scale to promote education and awareness
- Environmental education and promotion of people
- Capacity Development in environmental management and planning
- Using the new system with lower pollution
- Adoption of new taxes, such as green taxes for industries with high emissions

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ETHICAL CONSIDERATION

Authenticity of the texts, honesty and fidelity has been observed.

AUTHOR CONTRIBUTIONS

Planning and writing of the manuscript was done by the authors.

CONFLICT OF INTEREST

Author/s confirmed no conflict of interest.

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