

In the name of Allah the Most Gracious the Most Merciful

ICT-Environment Nexus: An Empirical Analysis

by

Dr. M.Tariq Majeed and Tayba Ayub
Quaid-i-Azam University, Islamabad

Email: tariq@qau.edu.pk

Presentation Outline

- ✓ Motivation of Research
- ✓ Objectives of the Study
- ✓ Introduction
- ✓ Literature Review
- ✓ Methodology
- ✓ Data Sources
- ✓ The Results and Discussion
- ✓ Findings of the Study
- ✓ Conclusion
- ✓ Policy Recommendations

Motivation of the Research

- ✓ Environmental degradation is an immense concern across the globe.
- ✓ ICT has made the world just like a global village. If we compare last few decades with today's era, we can observe a huge difference in terms of ICT uses and technological advancements.
- ✓ Today, People throughout the world are much connected and aware. In effect, ICT has made “**Communication**” easier, quicker and more convenient.
- ✓ ICT affects almost every aspect of life such as health, education, culture, and business.
- ✓ It is hard to argue that the global eco-system is not under pressure because of global warming and environmental degradation.
- ✓ Unfortunately, **the 15 out of 24 natural ecosystem services have been consumed unsustainably and degraded** (Assessment of Millennium Ecosystem, (2005)).

Objectives of the study

- 1) To check the impacts of ICT on environmental degradation at global level.
- 2) To find the efficiency of ICT on environmental degradation in the presence of EKC and different control variables.
- 3) To estimate the empirical models both in cross sectional and panel data sets.
- 4) To perform the sensitivity analysis in order to confirm the robustness of obtained results.



Introduction

✓ ICT refers as creation, processing and storage of the data that includes: system software, operating network system, programming languages, software applications, hardware and computer networks (World Bank, 2012).



✓ For the last few decades the significant changes can be observed with regards to ICT as witnessed by numerous developed countries.



✓ ICT can be decomposed in some important dimensions (Hilty Hercheui, 2014). Present research mainly focuses on the ecological dimension of ICT that deals with the connection between ICT and environment.



✓

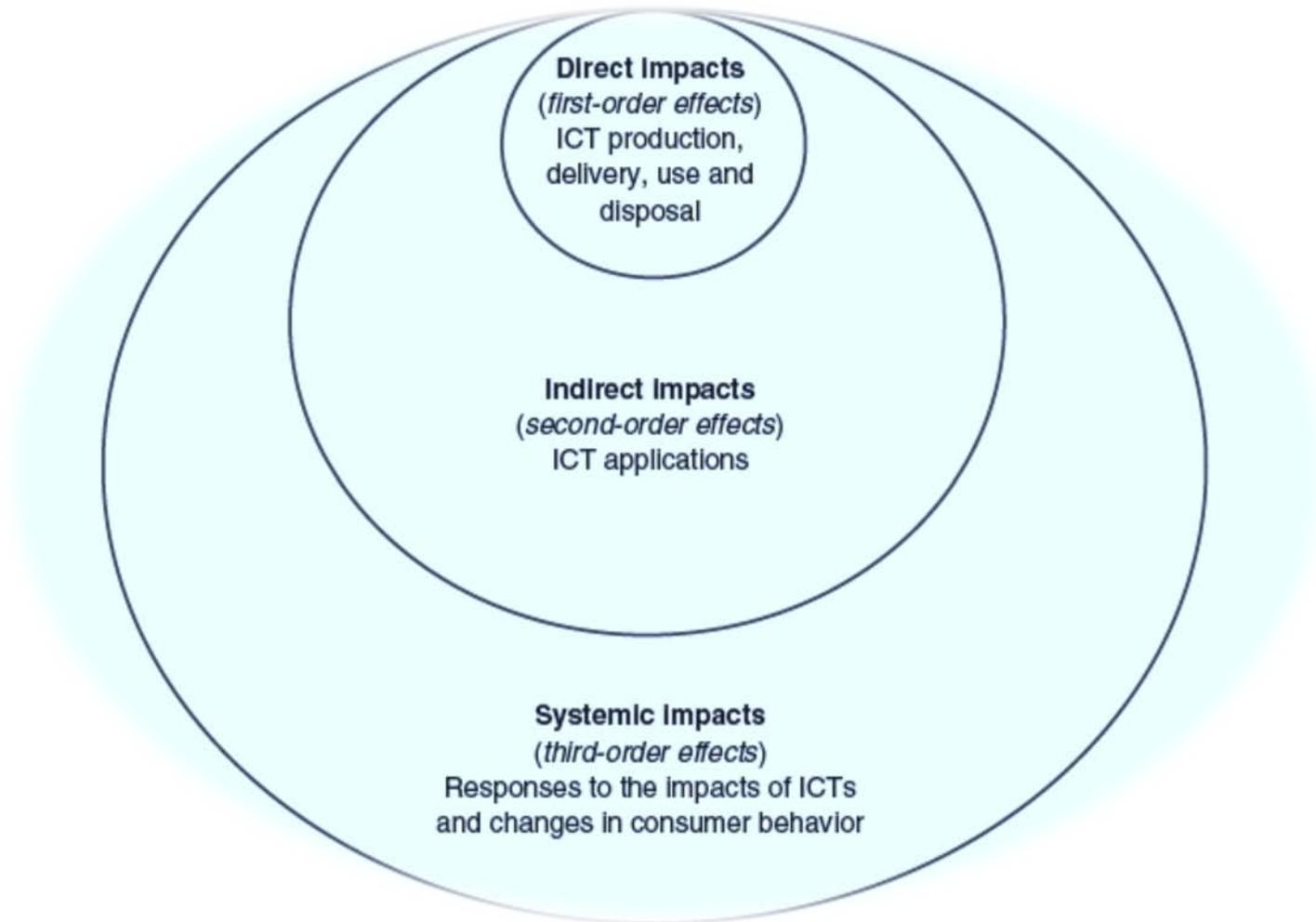
The impacts of ICT on the environment

- ***Direct impacts (first-order effects)***: include the positive and negative environmental impacts of ICT equipment, services, and related processes. These include impacts throughout the life cycle arising from materials extraction and **manufacturing processes**, ICT industry operations, **transport** and distribution, end-user operations, and equipment decommissioning, **recycling**, and **disposal**.
- ***Enabling impacts (second-order effects)***: include the many ways in which ICTs can be used to reduce the environmental impacts of a wide range of economic and social activities, because **ICTs can affect how other goods and services are designed**, produced, distributed, used, and disposed of. There may also be negative effects such as **greater energy use in ICT** enabled systems compared with conventional systems.

The impacts of ICT on the environment

- **Systemic impacts (third-order effects)**: involve the intended and unintended consequences of the application of ICTs arising through **behavioral change**. Realizing positive environmental outcomes from ICT applications often depends on user acceptance, so systemic impacts include the adjustments of corporate and individual users' processes and lifestyles that are necessary to make the best use of ICTs for the environment (see Figure on next slide).

The impacts of ICT on the environment



The Literature on ICT and Environment

Authors	Study	Findings
Li and Thomas (2007)	Theoretical	No appropriate work available on the measurement of ICT impacts on different aspects of environment. There is need of new techniques to fill this gap.
Lashkarizadeh and Salatin (2012)	2003-2008 with 43 countries.	ICT is a very important factor to minimize the pollution in developed countries as compare to developing countries.
Hiltey and Hercheui (2014)	Theoretical	There are many challenges associated to quantify ICT impacts on sustainable development.
Erdmann and Hilty (2016)	Theoretical	ICT has both negative and positive impacts on GHG emissions which depend on ICT applications.

Literature Conclusion

- ✓ Literature shows both positive and negative impacts of ICT on environment and there is further need of new techniques and innovative methods to capture the ICT impacts on environment.



Methodology and Analytical Framework

$$\text{Log } C_{it} = \beta_0 + \beta_1 \text{Log } GDP_{it} + \beta_2 \text{Log } GDP_{it}^2 + \beta_3 \text{ICT}_{it} + \beta_4 \log X_{it} + \epsilon_{it}$$

Where

C_{it} = CO₂ emissions

GDP_{it} = GDP per capita

GDP_{it}^2 = square of GDP per capita

ICT_{it} = represents six different measures of ICT

X_{it} = Vector of control variables

Cross Sectional and Panel estimation techniques are used in study including OLS, Pooled OLS, 2SLS, Fixed and Random effects and GMM.

Data Sources and Period of Analysis.

Period:

The Cross sectional and panel data are used for the period of 1980 to 2015 for 149 countries.

Data Sources:

- ✓ World Bank Indicators (2016)
- ✓ United Nations Public Administration Network (2016)
- ✓ International Telecommunication Union (2016).

Empirical Results and Discussion

OLS Results of CO₂ Emissions and ICT

VARIABLES	(1) LCO2	(2) LCO2	(3) LCO2	(4) LCO2	(5) LCO2	(6) LCO2
Fix-Tele-Subs	-0.0129*** (0.00324)					
Fix-Broad-Subs		-0.0202*** (0.00628)				
Tele-Infra-Index			-0.814** (0.317)			
Online-Ser-Index				-0.274 (0.231)		
E-Gov-Index					-0.641** (0.313)	
ICT PCA						0.0742 (0.0539)
Constant	-16.00*** (1.060)	-16.22*** (1.082)	-16.18*** (1.105)	-16.50*** (1.160)	-16.85*** (1.162)	-15.51*** (1.181)
Observations	132	132	125	125	125	131
R-squared	0.963	0.962	0.961	0.959	0.960	0.960

2SLS Results of CO₂ Emissions and ICT

VARIABLES	(1) LCO2	(2) LCO2	(3) LCO2	(4) LCO2	(5) LCO2	(6) LCO2
Fix-Tele-Subs	-0.0110*** (0.00397)					
Fix-Broad-Subs		0.0294 (0.0224)				
Tele-Infra-Index			-1.089*** (0.332)			
Online-Ser-Index				-0.336 (0.289)		
E-Gov-Index					-0.774** (0.345)	
ICT PCA						-0.364*** (0.138)
Constant	-16.01*** (1.033)	-15.88*** (1.297)	-16.08*** (1.068)	-16.50*** (1.142)	-16.91*** (1.135)	-18.26*** (1.570)
Observations	132	132	124	124	124	129
R-squared	0.963	0.943	0.962	0.960	0.961	0.944
Sargan (score) chi2	p = 0.2501	p = 0.2632	p = 0.2479	p = 0.2101	p = 0.2470	p = 0.1570
Basmann chi2(2)	p = 0.3054	p = 0.3199	p = 0.3044	p = 0.2616	p = 0.3034	p = 0.1980

Pooled OLS Results of CO₂ Emissions and ICT

VARIABLES	(1) LCO ₂	(2) LCO ₂	(3) LCO ₂	(4) LCO ₂	(5) LCO ₂	(6) LCO ₂
Fix-Tele-Subs	-0.00714*** (0.000670)					
Fix-Broad-Subs		-0.00225** (0.00113)				
Tele-Infra- Index			-0.462*** (0.138)			
Online-Ser- Index				-0.203*** (0.0740)		
E-Gov-Index					-0.232* (0.119)	
ICT PCA						-0.00784 (0.0150)
Constant	-16.51*** (0.231)	-17.15*** (0.343)	-17.05*** (0.459)	-17.55*** (0.461)	-17.50*** (0.464)	-17.39*** (0.346)
Observations	2,694	1,269	598	598	598	1,225
R-squared	0.959	0.953	0.963	0.963	0.962	0.953

Fixed Effect Results of CO₂ Emissions and ICT

VARIABLES	(1) LCO ₂	(2) LCO ₂	(3) LCO ₂	(4) LCO ₂	(5) LCO ₂	(6) LCO ₂
Fix-Tele-Subs	0.000315 (0.000665)					
Fix-Broad-Subs		0.000101 (0.000494)				
Tele-Infra-Index			0.176** (0.0832)			
Online-Ser-Index				-0.0124 (0.0299)		
E-Gov-Index					0.0926 (0.0617)	
ICT PCA						0.00757 (0.00752)
Constant	-16.27*** (0.419)	-16.83*** (0.665)	-14.12*** (0.881)	-14.48*** (0.878)	-14.15*** (0.890)	-16.27*** (0.645)
Observations	2,694	1,269	598	598	598	1,225
R-squared	0.650	0.647	0.717	0.714	0.716	0.681
Number of id	131	130	124	124	124	129

Random Effect Results of CO₂ Emissions and ICT

VARIABLES	(1) LCO2	(2) LCO2	(3) LCO2	(4) LCO2	(5) LCO2	(6) LCO2
Fix-Tele-Subs	-0.000136 (0.000666)					
Fix-Broad-Subs		0.000262 (0.000442)				
Tele-Infra-Index			0.0245 (0.0830)			
Online-Ser-Index				-0.0186 (0.0316)		
E-Gov-Index					0.0563 (0.0633)	
ICT PCA						0.00744 (0.00626)
Constant	-16.64*** (0.384)	-17.58*** (0.549)	-16.15*** (0.665)	-16.19*** (0.669)	-16.06*** (0.673)	-17.14*** (0.521)
Observations	2,694	1,269	598	598	598	1,225
Number of id	131	130	124	124	124	129

GMM Results of CO₂ Emissions and ICT

VARIABLES	(1) LCO ₂	(2) LCO ₂	(3) LCO ₂	(4) LCO ₂	(5) LCO ₂	(6) LCO ₂
Fix-Tele-Subs	-0.00713*** (0.000818)					
Fix-Broad-Subs		-0.00376** (0.00149)				
Tele-Infra-Index			-0.877*** (0.325)			
Online-Ser-Index				-0.441*** (0.162)		
E-Gov-Index					-0.569** (0.236)	
ICT PCA						-0.559*** (0.101)
Constant	-16.35*** (0.275)	-16.90*** (0.485)	-15.67*** (0.889)	-17.05*** (0.668)	-16.84*** (0.697)	-17.28*** (0.562)
Observations	2,690	1,131	241	241	241	1,222
R-squared	0.959	0.951	0.966	0.966	0.965	0.900

Sensitivity Analysis with four different Control Variables

	Sensitivity Variables			
	Industry value added	Agriculture value added	Agricultural methane emissions	Combustible and renewable and waste
Variables	Dependent Variable: Environmental Degradation			
Fixed telephone subscriptions	-0.000460	-0.00533***	-0.00719***	-0.00827***
R-Squared	0.9618	0.9576	0.9638	0.9601
Fixed broadband subscriptions	0.00157	-0.000295	-0.00470***	-0.00410***
R-Squared	0.9568	0.9502	0.9547	0.9521
Telecommunication infrastructure index	0.0244	-0.507	-0.730**	-0.937***
R-Squared	0.9715	0.9613	0.9686	0.9666
Online service index	-0.0313	-0.348*	-0.371**	-0.452***
R-Squared	0.9715	0.9615	0.9686	0.9663
E-government index	0.209	-0.479	-0.379	-0.601***
R-Squared	0.9716	0.9608	0.9680	0.9657
ICT PCA	-0.0248	-0.380***	-0.548***	-0.801***
R-Squared	0.9579	0.9239	0.9189	0.8508

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Findings of the Study

- ✓ Almost all econometric findings confirm the positive role of ICT in mitigation of CO₂ emissions.



Concluding Remarks

- ✓ This study provides firm evidence that ICT reduces the environmental degradation.
- ✓ The findings remained robust to different robustness checks.



Policy implications

- ✓ In the light of empirical findings this research suggests following policy recommendations:
- ✓ The government and policy makers need to rely on online services and e-government to protect the environment.
- ✓ The role of ICT in improving the environment should be more highlighted and emphasized.
- ✓ Government needs to spend considerable amount on ICT installation in public sector .
- ✓ The removal of technical barriers in growth of ICT should be ensured to enjoy its gains.

Research Limitations and Further Research

This study contains some limitations:

- ✓ The analysis is for short term because of unavailability of data on ICT indicators.
- ✓ It does not analyze ICT and environmental degradation nexus in the different regions around the world.
- ✓ It is not performed exclusively for Pakistan because of gaps in ICT data in case of Pakistan.
- ✓ So, further studies can expand the research for developing and developed countries or for specific regions of world or in time series dimension.

Hopefully, the present research will contribute to collective endeavor for the ICT benefits to promote better environment and economic sustainability at a global level.





**THANK
YOU**