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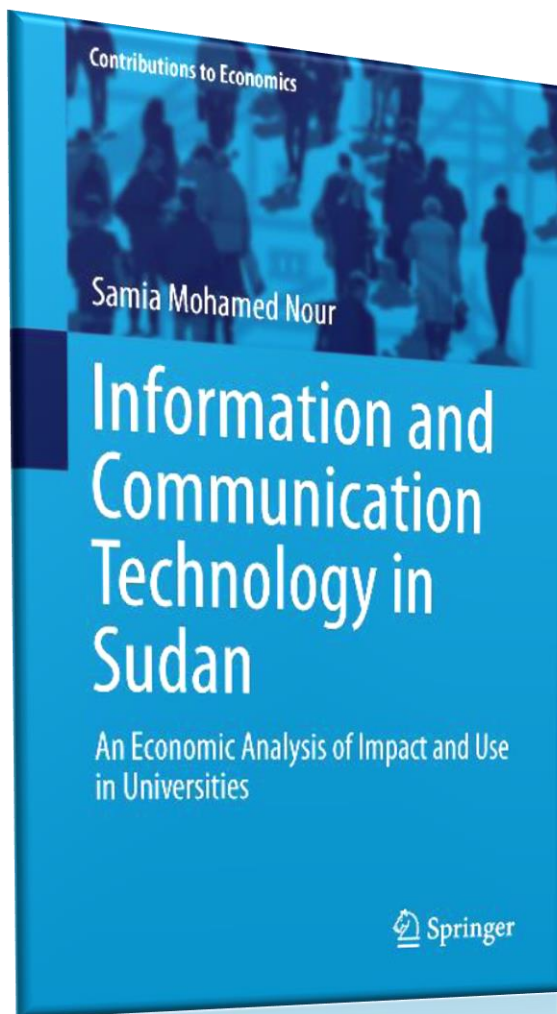
# Information and Communication Technology in Sudan: An Economic Analysis of Impact and Use in Universities

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S. Mohamed Nour

**Information and Communication Technology in Sudan**

An Economic Analysis of Impact and Use in Universities

Series: Contributions to Economics

- **Compares ICT impact on private versus public universities in Sudan**
- **Based on an in-depth micro level primary survey data**
- **Provides recommendations for ICT policy improvements to enhance knowledge transfer within and across universities**

This book discusses the use, economic importance and impact of Information and Communication Technologies (ICT) in public and private Sudanese universities. The author provides an in-depth analysis of the economic impact of ICT from the demand perspective as well as from the public-private perspective. This book also examines the status, pattern, structure, trend and determinants of the demand for ICT in public and private Sudanese universities. It investigates the economic impacts of the uses of ICT, the potential opportunities and challenges that ICT is expected to create for public and private Sudanese universities, and explains the role of ICT in facilitating the production, creation and transfer of knowledge in Sudanese universities.



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# Outline

- Introduction
- Aims of the Research
- Stylised facts on the case of Sudan
- Review of the Literature
- Relevance and Contribution of the Research
- Research Methodology
- Main Results
- Conclusions and Policy Recommendations



# Introduction

- ❑ Rapid increase in the diffusion of information and communication technology (ICT)
- ❑ Increasing use of ICT in higher education institutions in both developed and developing countries
- ❑ Increasing utilization of ICT in higher education institutions in Sudan



# Aims of the Research

□ **Analyse the use and economic impact of the use of ICT in public and private Sudanese universities. In particular:**

- (1) Examine from public-private perspective, the status, pattern, structure and determinants of the demand for ICT in public and private Sudanese universities
- (2) Explain the role of ICT in facilitating the production, creation and transfer of knowledge in Sudanese universities and collaboration with international knowledge institutions
- (3) Investigate from the public-private perspectives the impacts of ICT: the potential opportunities and challenges that ICT is expected to create for public and private Sudanese universities

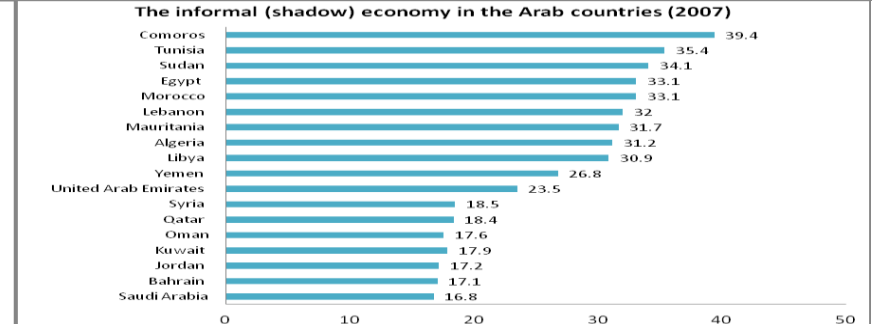
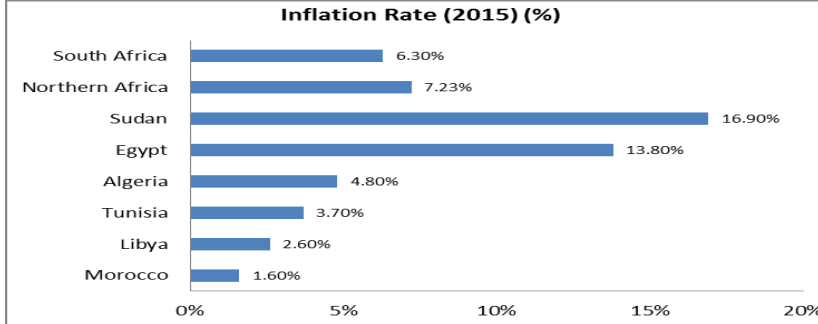
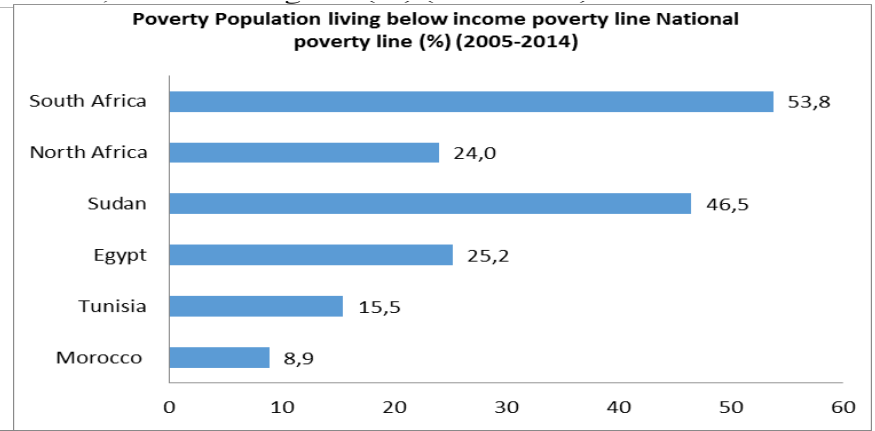
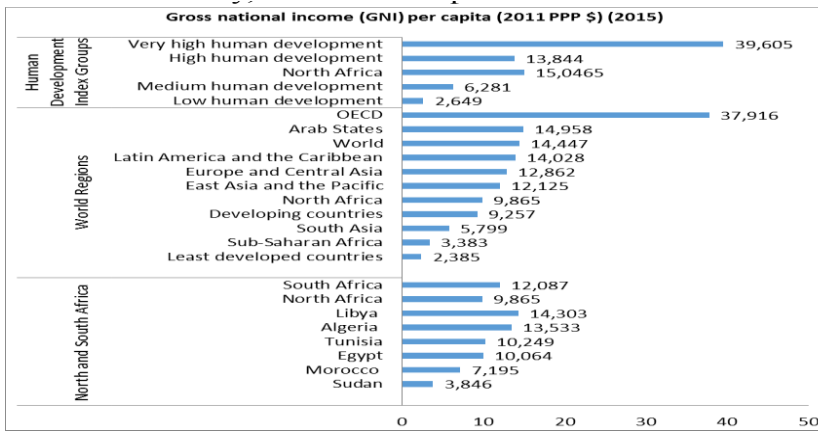


# Stylised facts on the case of Sudan (1)

- ❑ **Least developed country (The World Bank, 2017)**
- ❑ **Lower medium income economy (The World Bank, 2017)**
- ❑ **Low standard of economic, social and human development.**
  - Low Gross National Income (GNI) Per capita
  - Low human development index (165 out of 188, UNDP, 2016)
  - High poverty rate (46.5%) (Central Bureau of Statistics, 2009)
- ❑ **High population number (39.58 Millions, The World Bank, 2017)**
- ❑ **High unemployment rate and youth unemployment rate**
- ❑ **High share of the informal economy**
- ❑ **High inflation rate**



# General socio-economic characteristics of Sudan economy (1999-2015)



Sources: Adapted from (1) UNDP - Human Development Report (2016), (2) The World Bank World Development Indicators (2017), (3) International Labour Organization, ILOSTAT database (2017)

# Stylised facts on the case of Sudan (2)

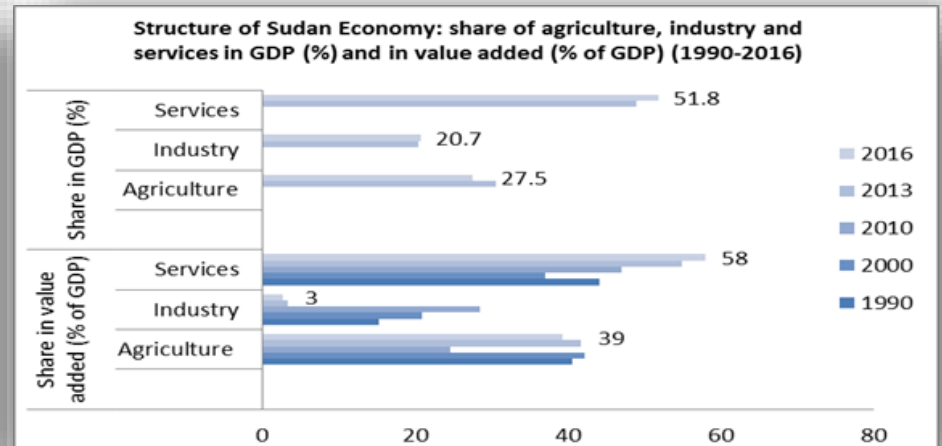
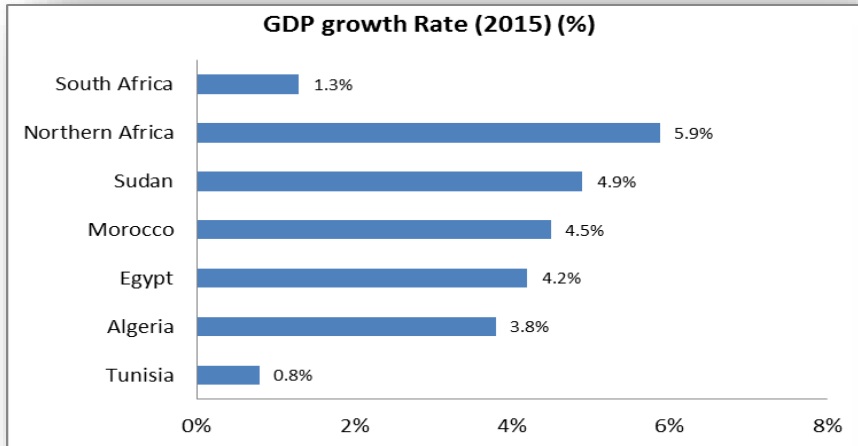
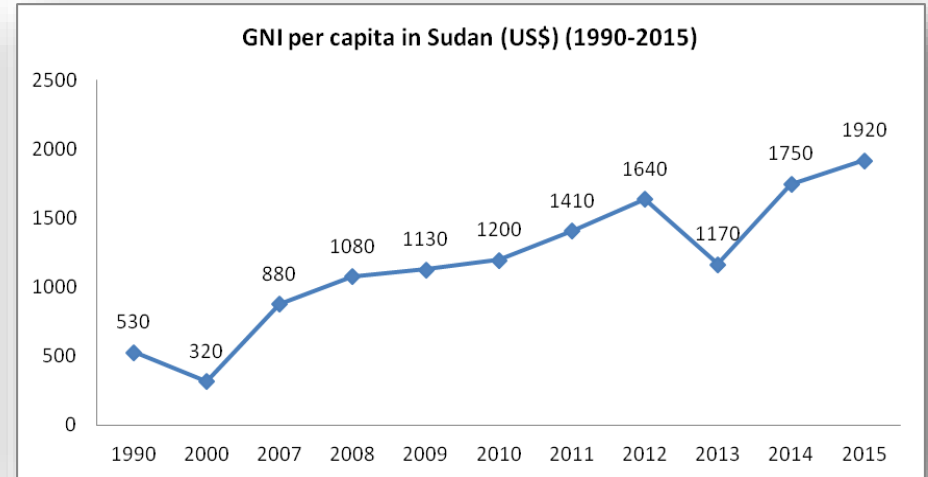
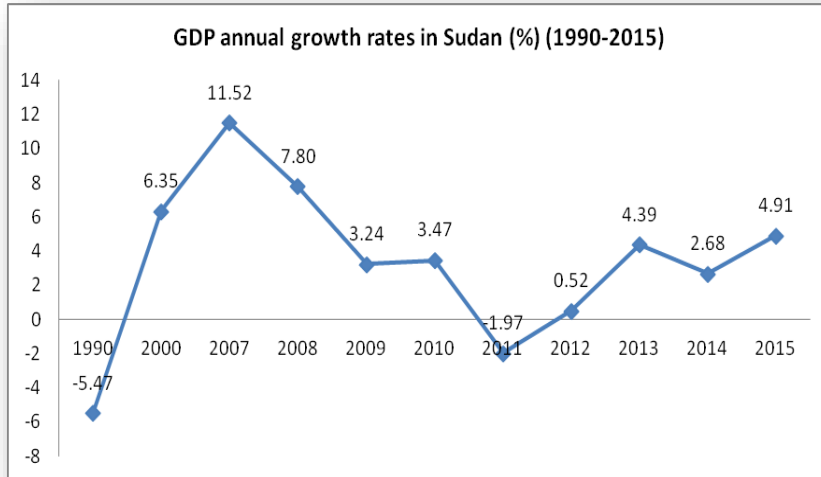
- ❑ **Imbalanced economic structure: high(services-agriculture)-low(industry)**
- ❑ **Major shifts in the structure of Sudan economy from predominantly reliant on agriculture for growth and exports to its reliance on oil: turned into an oil dependent economy (1999-2011)(WB, 2008)**
- ❑ **Primary Export Economy (natural resources - oil dependent economy)**
- ❑ **Debate: Oil blessing and curse:**
  - Turned from low to lower medium income economy (WB)
  - Uncertainty and high fluctuation in economic growth: GDP annual growth rates and GNI per capita income (1990-2015)
- ❑ **Implications of Southern Sudan separation from North Sudan:**
  - About 75% of Sudan's proven oil reserves (IMF Report, 2011)
  - About 90% of Sudan's oil and total exports (IMF Report, 2011)
- ❑ **Implications of:**
  - International financial crisis
  - Drop in global oil prices in the international markets
  - Arab Spring





# Stylised facts on the case of Sudan (3)

Fluctuation in GDP annual growth rates and GNI per capita and structure of Sudan economy (1990-2016)



Source: Adapted from the World Bank: World Bank Development Indicators (2017)



# Stylised facts on the case of Sudan (4)

## □ UNDP-HDR (2016): Data for (2010-2015):

- Rapid diffusion of ICT: mobile is faster than the Internet in Sudan, Arab and World regions
- Use of internet and mobile: less than Arab States and less than World level

## □ Language: Arabic

Diffusion of ICT in Sudan compared to the World regions (2010-2015)

	Internet users	Mobile phone subscriptions	
	(% of population)	(per 100 people)	(% change)
	2015	2015	2010–2015
Sudan	26.6	70.5	69.8
<b>World Regions</b>			
Arab States	40	111	46.1
East Asia and the Pacific	44.9	101.5	335.8
Europe and Central Asia	52.3	114.9	26.5
Latin America and the Caribbean	54.4	110.6	14.1
South Asia	24.5	79	58.1
Sub-Saharan Africa	22.2	76.4	71.4
Developing countries	36.2	92.9	78.5
Least developed countries	12.6	68.3	254.2
Organisation for Economic Co-operation and Development	77.2	115.9	9
World	43.7	98.5	59.1

Source: UNDP-HDR (2016), Table 13, pp. 245-249.



# Stylised facts on the case of Sudan (5)

## □ World Bank (World Development Indicators) (2017): Data for (1990-2015):

- Digital divide: use of telephone main lines, computer, mobile and Internet in Sudan less than Arab World, MENA and World level
- Rapid diffusion of ICT: mobile is faster than Internet and fixed telephone

## □ Use of mobile fourteen times higher than fixed telephone (NTC, 2012)

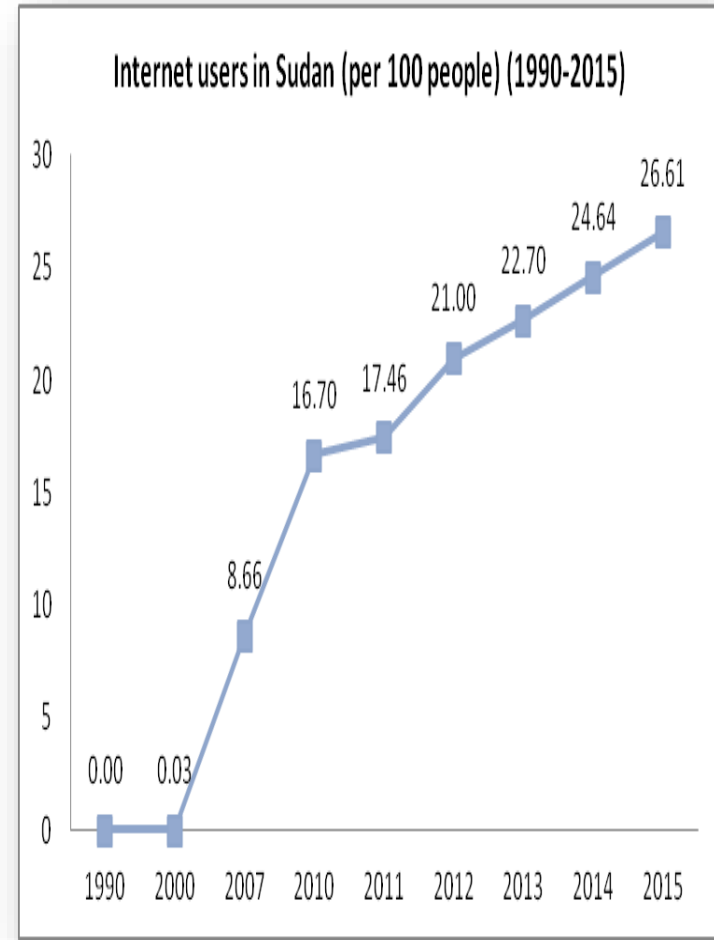
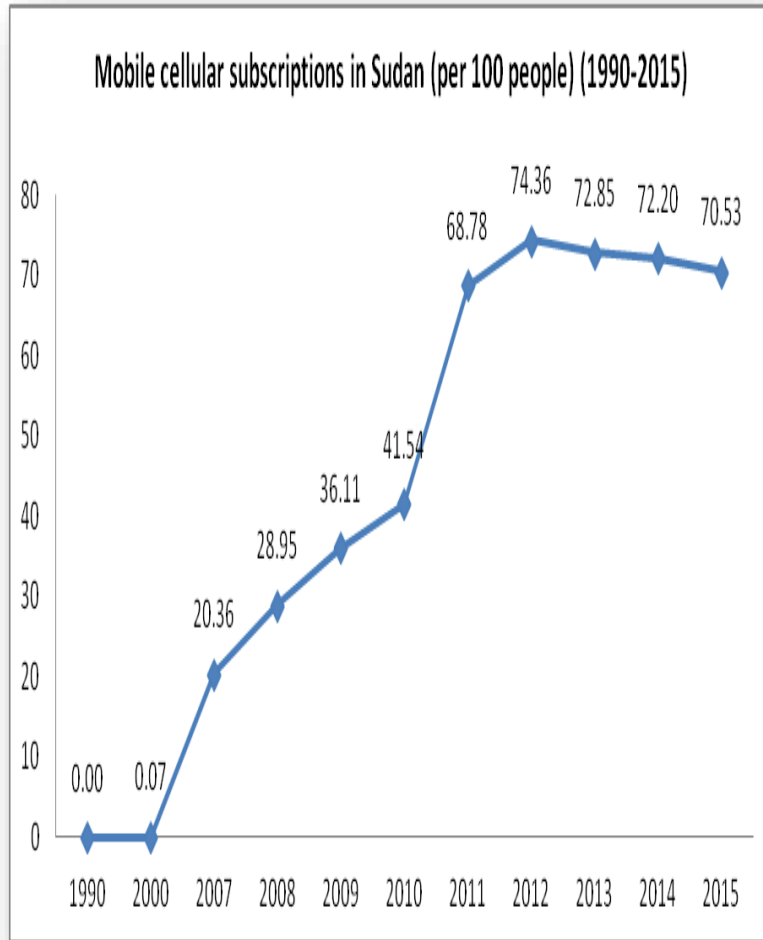
Diffusion of ICT in Sudan Compared to the World Regions (1990-2015)

	Fixed telephone subscriptions (per 100 people)				Mobile cellular subscriptions (per 100 people)				Internet users (per 100 people)			
	1990	2000	2010	2015	1990	2000	2010	2015	1990	2000	2010	2015
Sudan	0.23	1.13	1.25	0.30	0.00	0.07	41.54	70.53	0.00	0.03	16.70	26.61
World Regions (income level)												
High income	41.29	54.76	47.38	41.19	1.08	49.22	108.84	124.49	0.26	30.59	72.22	81.01
Middle income	2.55	8.32	12.98	10.08	0.01	4.51	74.42	97.46	0.00	1.57	22.30	39.80
Lower middle income	1.18	3.37	5.61	3.52	0.00	1.05	67.62	90.54	0.00	0.56	11.80	28.63
Low income	0.43	0.58	1.01	0.86	0.00	0.33	28.68	59.96	0.00	0.11	3.33	9.46
World Regions												
OECD members	38.28	50.73	43.94	37.99	0.99	45.24	101.36	115.98	0.25	27.88	67.62	77.24
North America	53.66	67.67	48.52	38.19	2.08	37.49	89.78	114.03	0.74	43.88	72.54	75.94
Europe & Central Asia	26.08	37.51	37.48	32.74	0.41	34.11	120.09	126.85	0.05	13.18	56.12	71.74
Latin America & Caribbean	6.22	14.52	17.94	17.44	0.03	12.14	96.37	110.37	0.00	3.90	34.71	54.46
East Asia & Pacific	5.38	13.93	22.32	17.30	0.09	11.39	73.74	104.22	0.01	5.59	34.23	49.82
Middle East & North Africa	4.57	10.29	16.73	15.33	0.04	4.62	92.92	112.99	0.00	1.69	24.85	43.71
Arab World	3.39	6.98	9.83	7.83	0.04	3.18	87.63	110.11	0.00	1.14	24.54	39.53
Sub-Saharan Africa	1.00	1.38	1.47	1.09	0.00	1.72	44.41	75.74	0.00	0.50	9.78	22.39
Least developed countries	0.27	0.52	1.00	0.89	0.00	0.27	33.11	68.18	0.00	0.10	4.30	12.63
World	9.77	15.95	17.76	14.34	0.21	12.08	76.51	98.62	0.05	6.77	29.15	44.00

Source: World Development Indicators (2017) (access 03 January 2017)



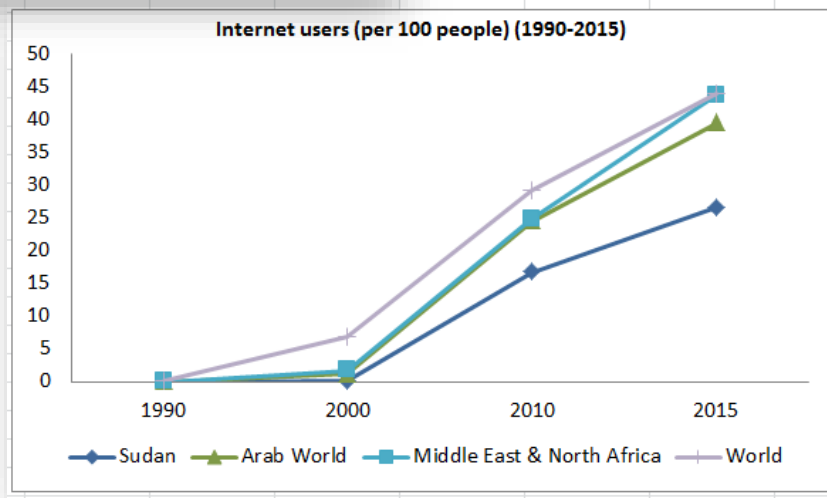
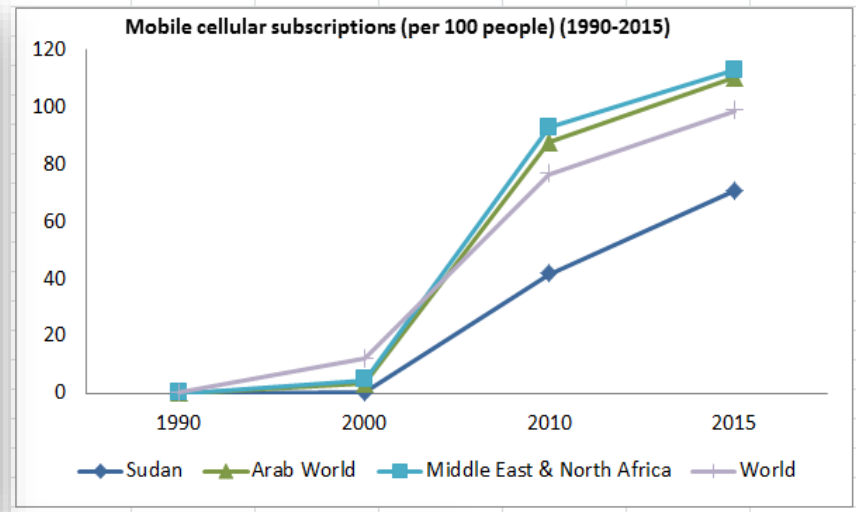
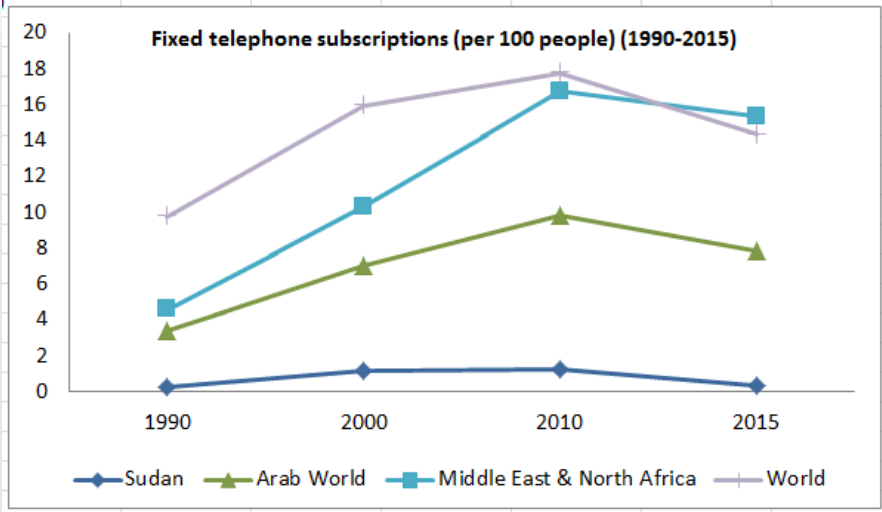
# Rapid diffusion of ICT: Mobile and Internet in Sudan (1990-2015)



Source: Adapted from the World Bank: World Bank Development Indicators (2017)



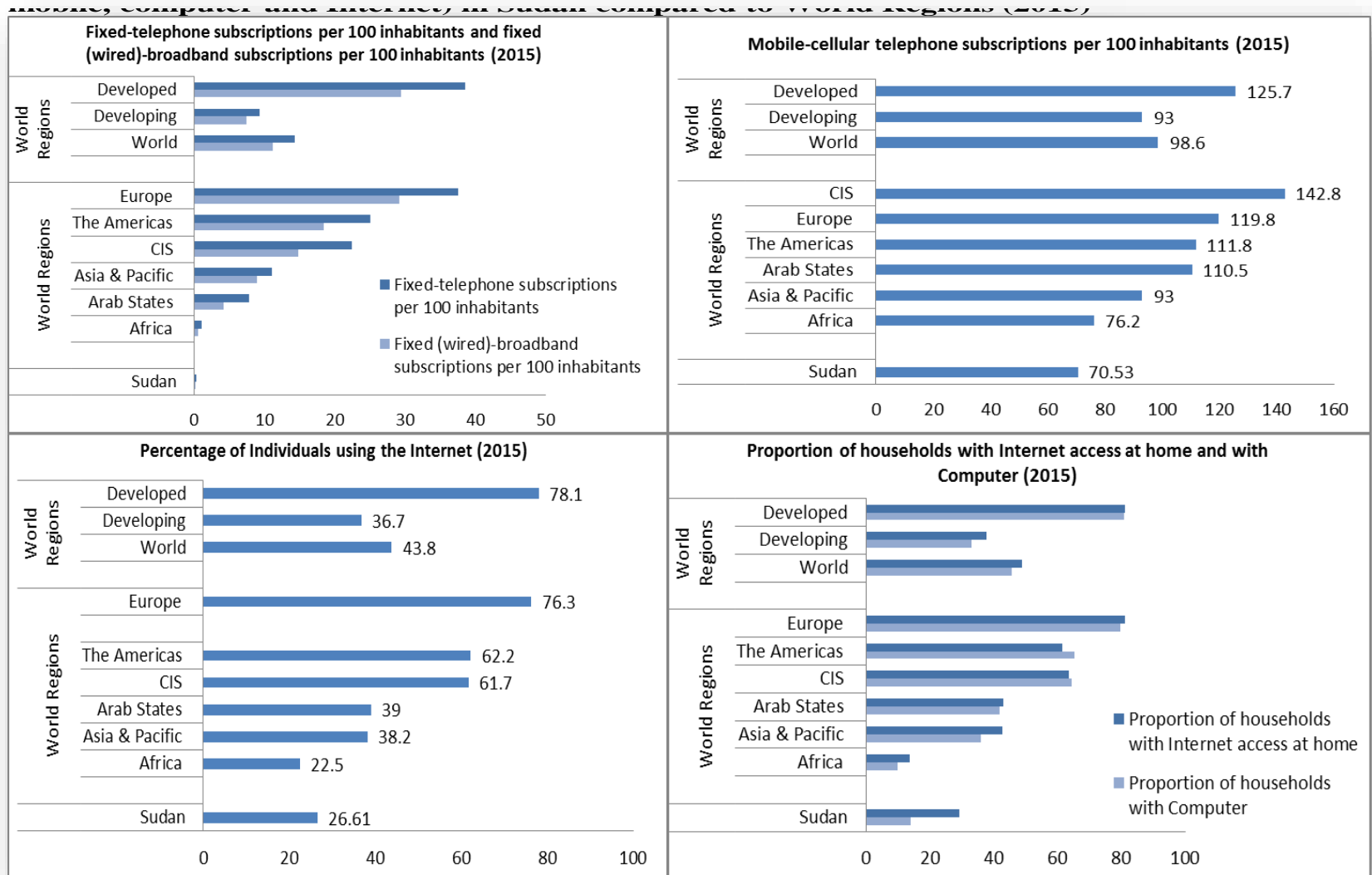
# The digital divide between Sudan, Arab and MENA regions: ICT indicators (fixed telephone, mobile and Internet) (1990-2015)



Source: Adapted from the World Bank: World Bank Development Indicators (2017)



# The digital divide between Sudan and World regions: (fixed telephone, Computer and Internet) (2015)



Source: International Telecommunication Union (ITU) (World Telecommunication /ICT Indicators database (2017))

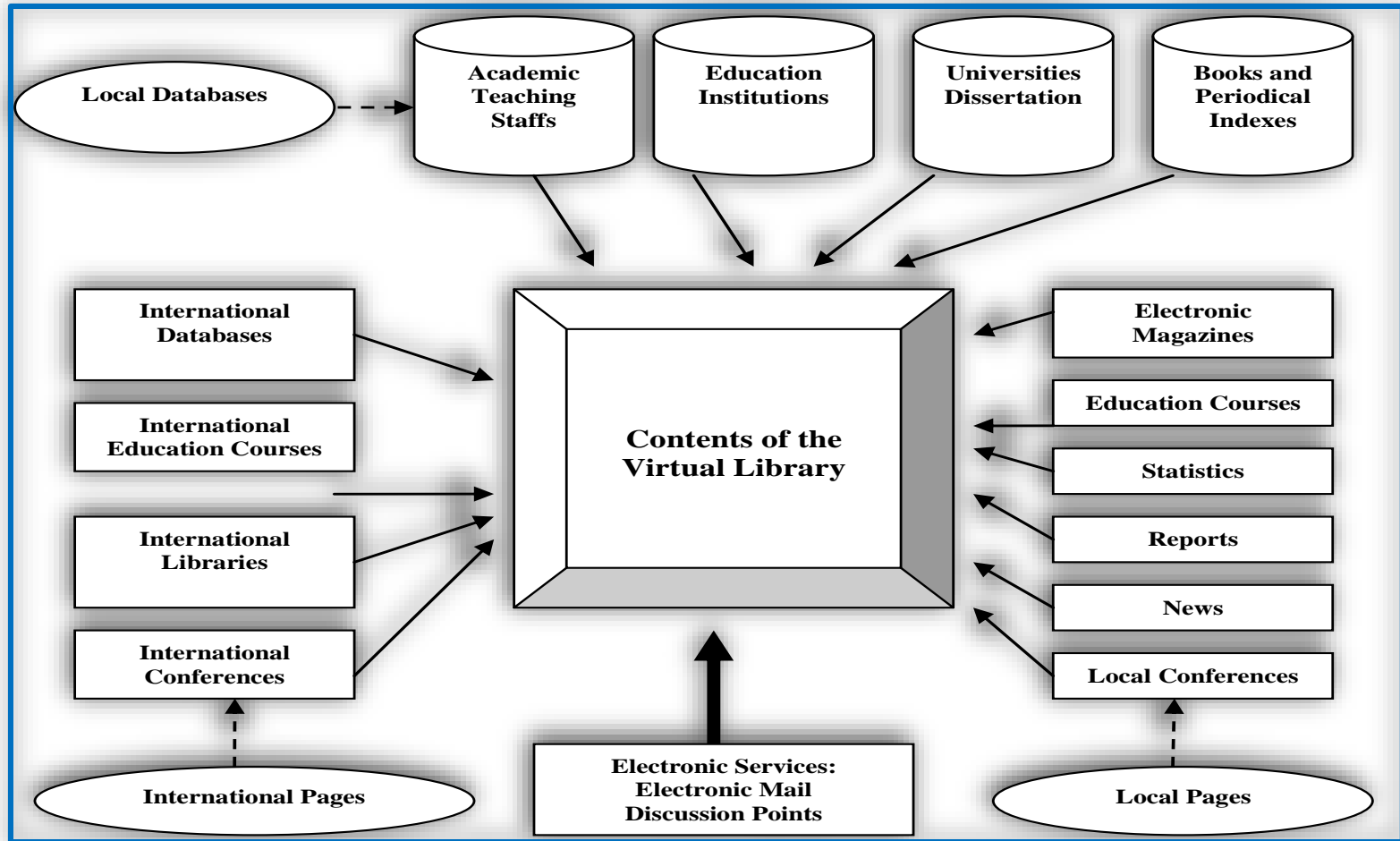
# Stylised facts on the case of Sudan (6)

- ❑ Increasing utilization of ICT in higher education institutions in Sudan
- ❑ Arab Open University (2002)
- ❑ Open University of Sudan (2003)
- ❑ Increasing utilization of ICT in University of Khartoum:
  - Information Technology and Communication Center
  - Faculty of Mathematical Sciences: Information Technology Research Unit
  - Faculty of Distance Learning
  - Deanship of Distance Learning
  - Long distance learning: on-line education and training programmes
  - University Electronic Collections (publications and online-courses)
  - Electronic registration of students



# Stylised facts on the case of Sudan (7)

□ Use of ICT facilitates access to and transfer of knowledge in Sudanese Universities (Sudanese Universities Virtual Library (SUVL))



Source: Sudan Ministry of Higher Education and Scientific Research (2008)



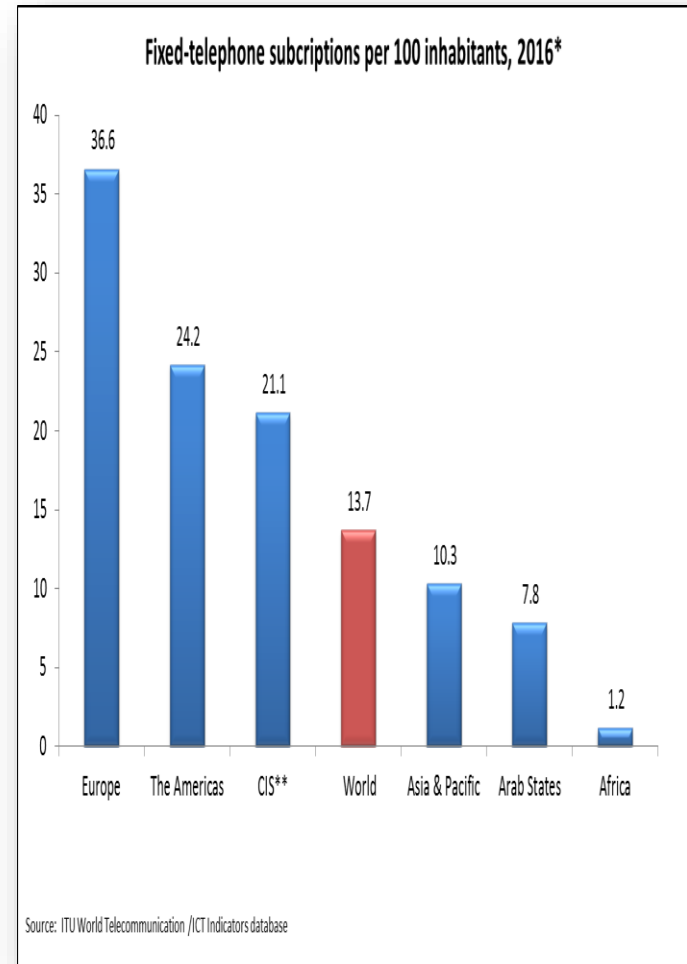
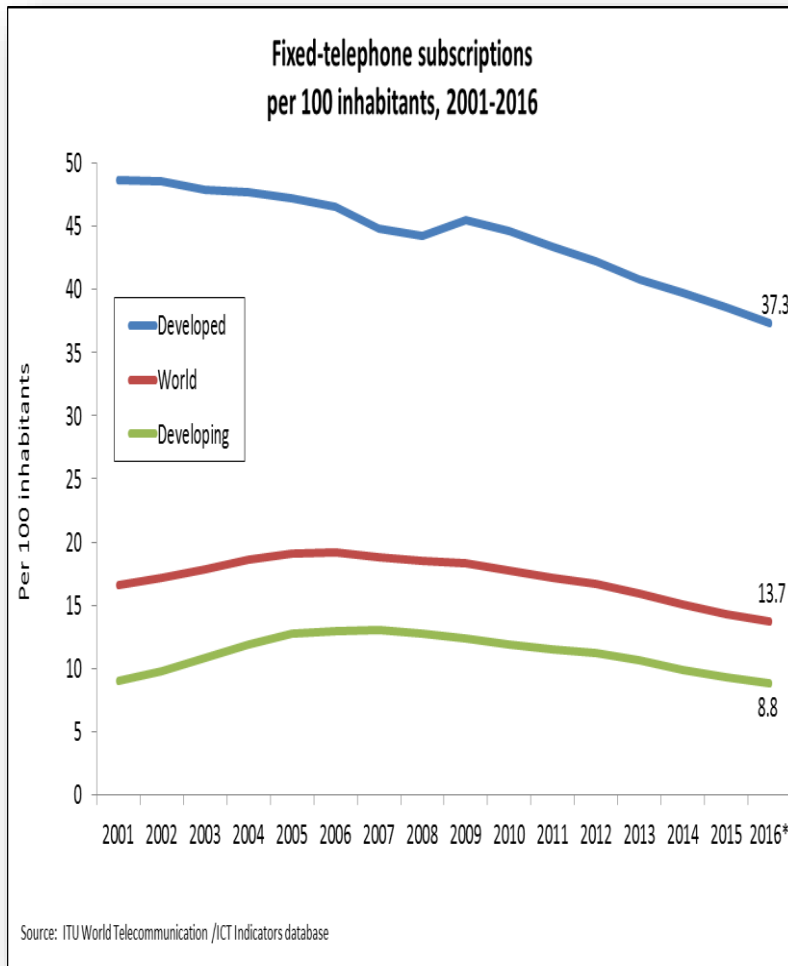


# Review of the Literature

- ❑ Theoretical and empirical literature confirmed the economic importance and impacts of ICT (cf. Bound and Johnson, 1992; Freeman and Soete, 1985; 1994; Jorgenson and Stiroh, 1995; Acemoglu, 1998; Goldin and Katz, 1998; Phojola, 2000; 2001)
- ❑ Use of many ICT indicators to measure the economic impacts (e.g. IT, computer, computer equipment, investment/expenditures on ICT)
- ❑ Dual-implications: 'creative-destruction' effects (cf. Aghion and Howitt, 1998)
- ❑ ICT enhancing:
  - Human capital and skills (cf. Goldin and Katz, 1998; Acemoglu, 1998)
  - Knowledge (Smith, 2000; Lundvall and Foray, 1996) and knowledge production (Beebe, *et-al.*, 2003; Radwan, 2003; Nour, 2013; 2016)
- ❑ The digital divide: describes a gap between those who have ready access to ICT and the skills to make use of it and those who do not have ICT access or skills:
  - Global digital divide (cf. OECD, 2001; ITU, 2007), and
  - Digital divide (within country) (rural-urban; males- females, etc.)
  - Gender digital divide (males- females) (cf. Hilbert, 2011; ITU, 2013)



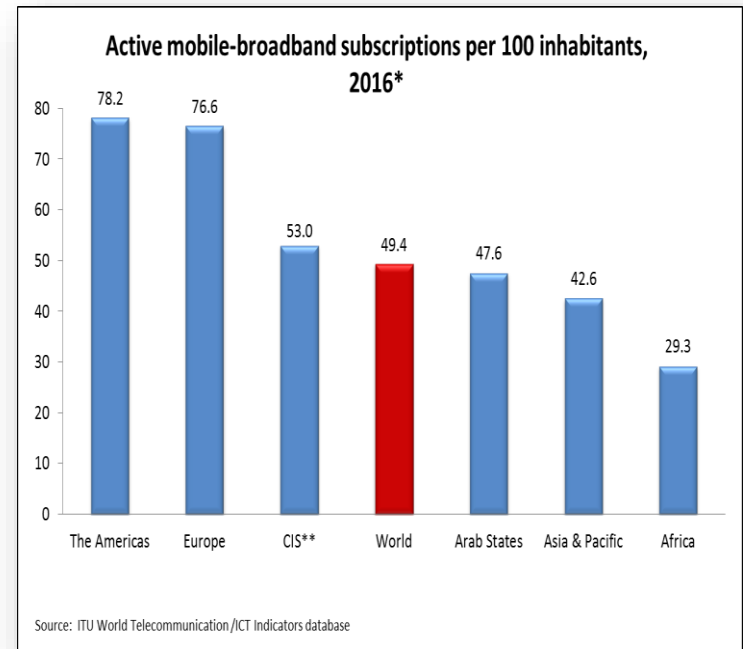
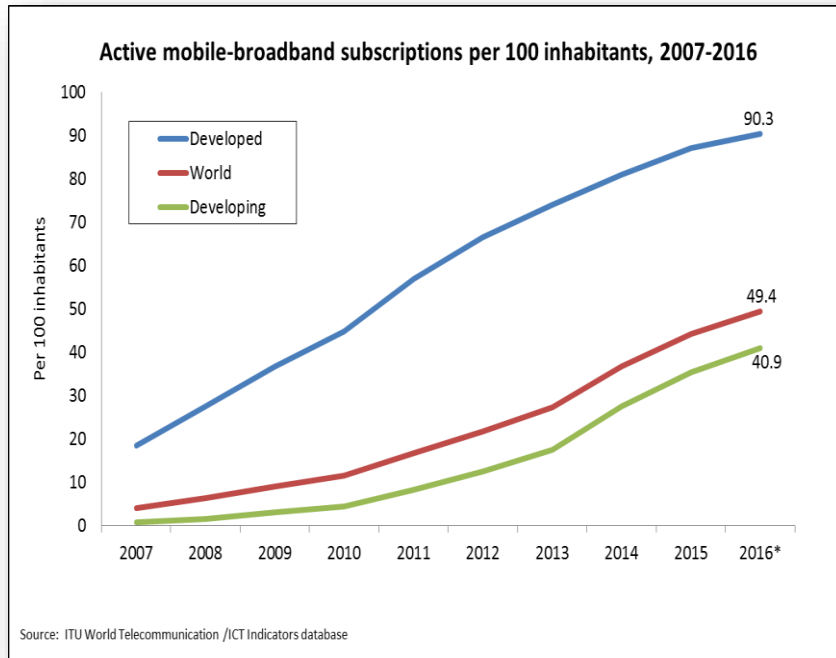
# The digital divide between World regions : ICT indicators (fixed telephone, subscriptions per 100 inhabitants) (2001-2016)



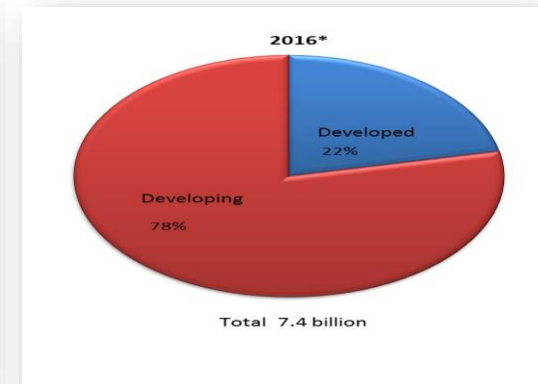
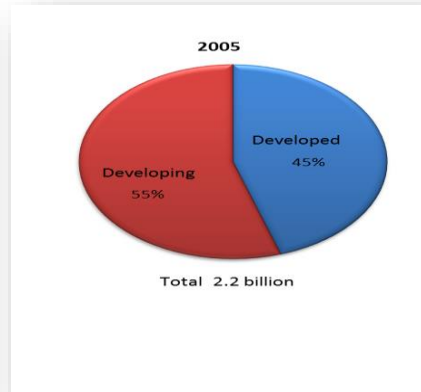
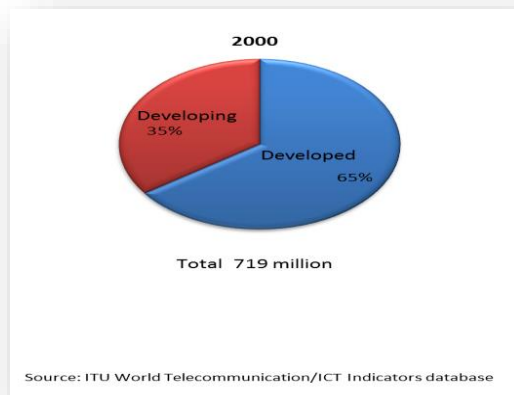
Source: International Telecommunication Union (ITU) (World Telecommunication /ICT Indicators database (2017))



# The digital divide between World regions: ICT indicators (active mobile-broadband, subscriptions per 100 inhabitants) (2000-2016)

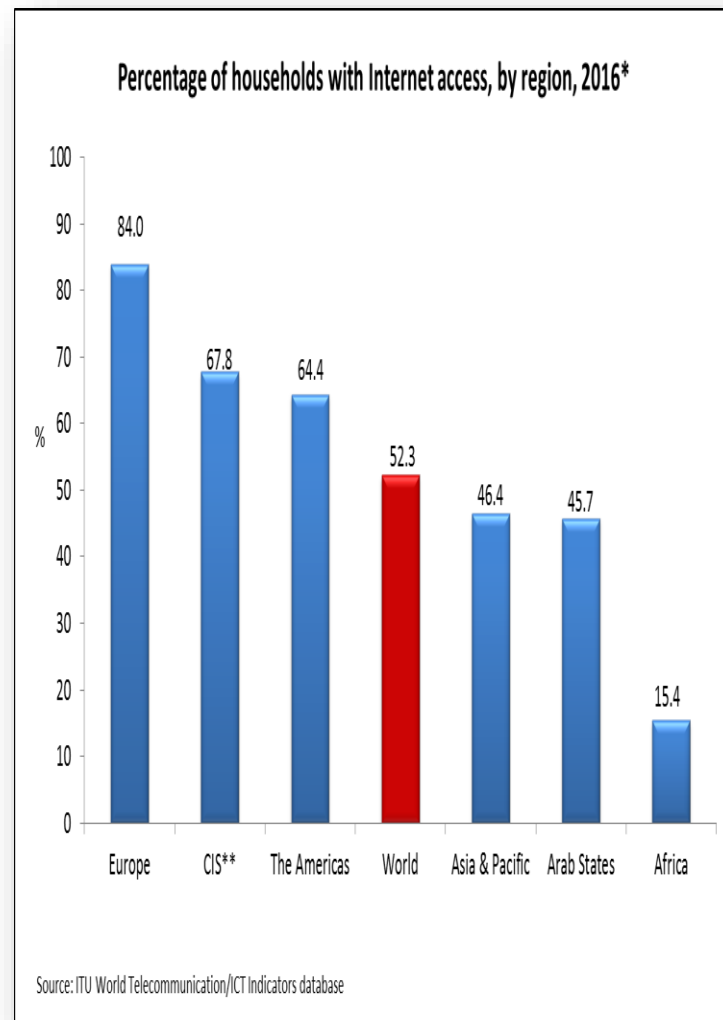
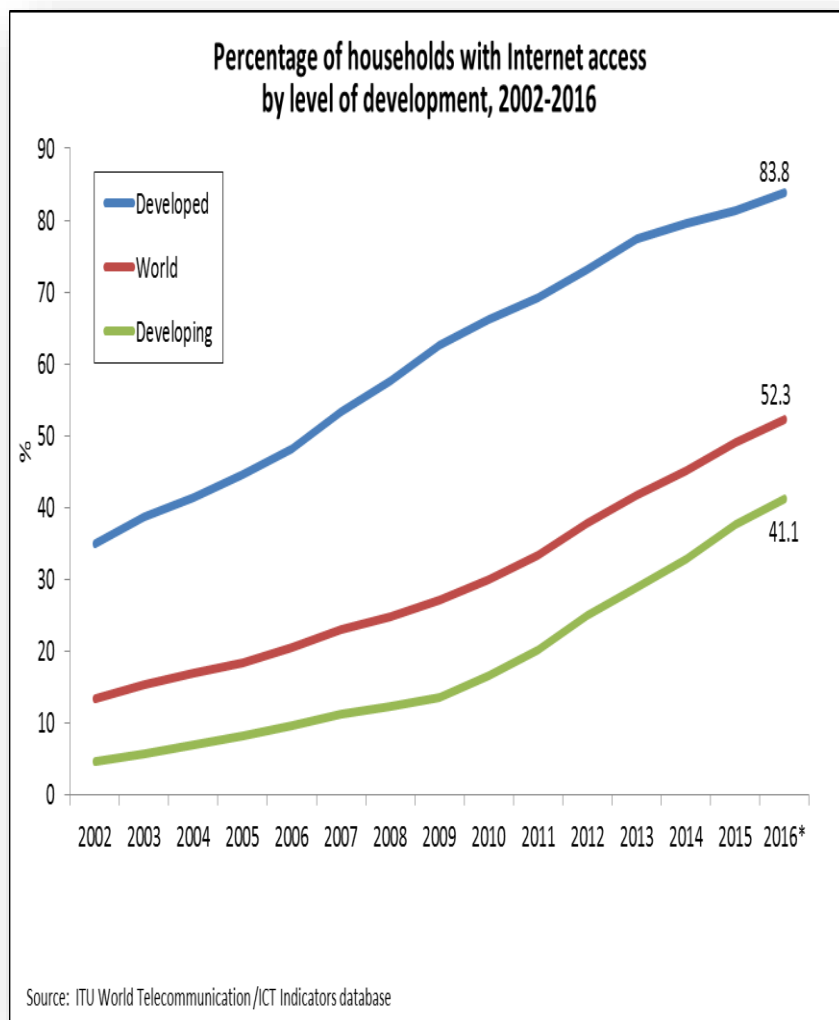


## Mobile-cellular subscriptions, by level of development (2000-2016)



Source: International Telecommunication Union (ITU) (World Telecommunication /ICT Indicators database (2017))

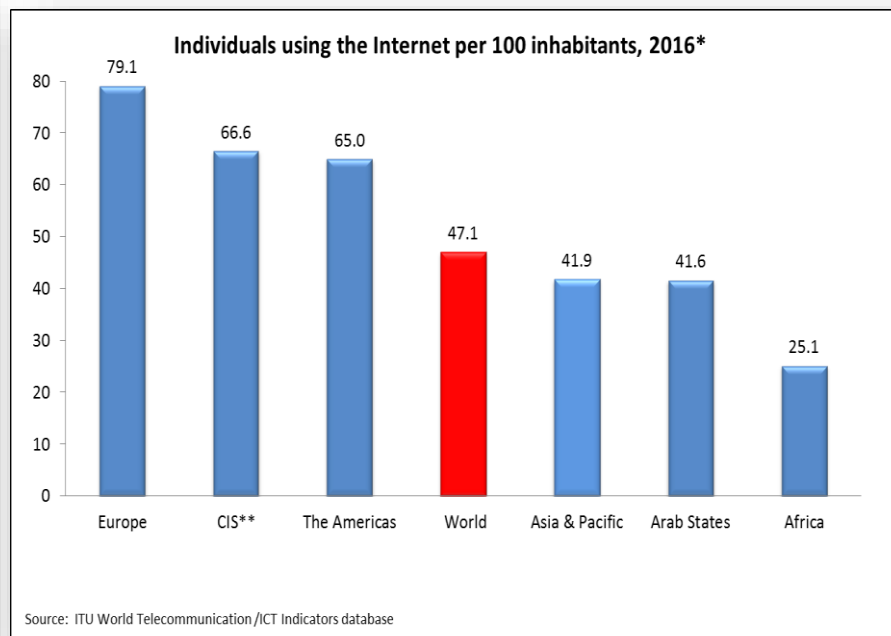
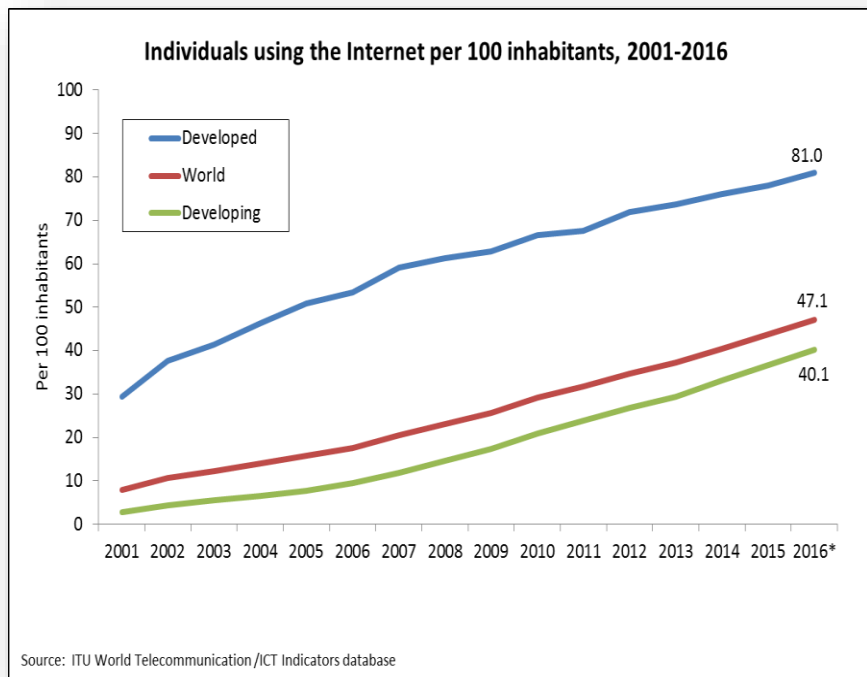
# The digital divide between World regions: ICT indicators (percentage of households with Internet access) (2002-2016)



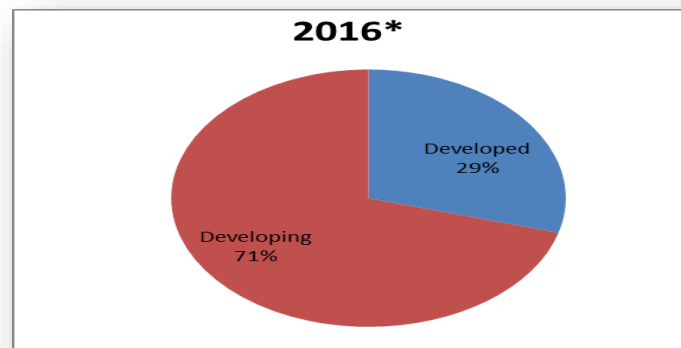
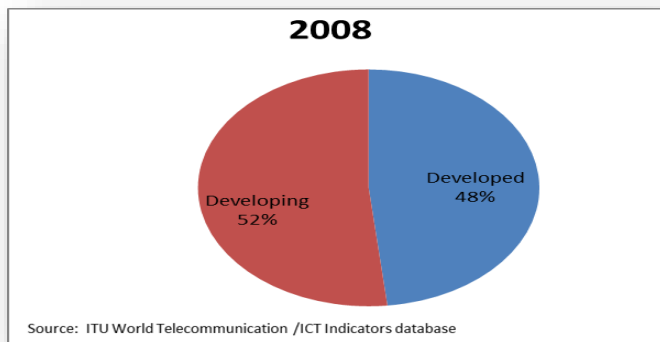
Source: International Telecommunication Union (ITU) (World Telecommunication /ICT Indicators database (2017))



# The digital divide between World regions: ICT indicators (individuals using the Internet, per 100 inhabitants) (2001-2016)



## Individuals using the Internet, by level of development (2008-2016)



Source: International Telecommunication Union (ITU) (World Telecommunication /ICT Indicators database (2017))



# Relevance and Contribution

- ❑ Fill the gap in the Sudanese literature: supply - demand analysis of the use and impact of ICT (macro-micro analysis of supply of and demand for ICT)
- ❑ Based on an in-depth micro level primary survey data
- ❑ Provides an in-depth analysis of the economic impact of ICT from the demand perspective as well as from the public-private perspective
- ❑ Presents an interesting public-private comparative analysis: compares the use and impact of ICT in public and private universities in Sudan
- ❑ Investigates the use, trend, determinants of demand, economic importance and impacts of the ICT: potential opportunities and challenges that ICT is expected to create and role of ICT for enhancing the production, creation and transfer of knowledge in public and private universities in Sudan
- ❑ Provides a comprehensive analysis investigating the incidence and determinants of the digital divide related to the use of ICT in Sudan
- ❑ Provides recommendations for ICT policy improvements to enhance knowledge transfer within and across universities



# Research Methodology (1)

- ❑ **Scope of analysis: (public-private Sudanese universities 2009)**
- ❑ **Data: Secondary and primary (quantitative and qualitative)**
  - Secondary data: National Telecommunication Corporation (2012)  
“Households and individuals ICT survey 2012”
  - Primary data: ICT University Survey (2009) and interviews in Sudan in 10 public (5) and private (5) Sudanese universities
    - ▶ ICT university survey: 131 academic teaching staff, support staff and students in 10 public-private Sudanese universities
    - ▶ Qualitative analysis: examines the use and economic impact of the use of ICT in public and private Sudanese universities



# Research Methodology (2)

- ❑ **High response rate of ICT University survey for:**
  - All academic teaching staff, support staff and students (85%)
  - Academic teaching staff (81%)
  - Sector: Public Universities (86%) and Private Universities (82%)
  - Support staff (100%); and Students (100%)
  - Table 1 below explains the representative in University survey

**Table 1 - Composition of the ICT University Survey in Sudan, 2009**

Representation	Institutions		Individuals			
	Number in sample	Total response	Response rate (%)	Number in sample	Total response	Response rate (%)
<b>Academic teaching staff</b>						
<b>Public universities:</b>						
1. Khartoum University	77	67	87%	60	50	83%
2. Sudan University of Science and Technology	6	6	100%	6	6	100%
3. Juba University	10	9	90%	6	5	83%
4. Al-zaim Al-azhari University	5	4	80%	3	2	67%
5. Omdurman Islamic University	5	3	60%	3	1	33%
<b>Total public</b>	<b>103</b>	<b>89</b>	<b>86%</b>	<b>78</b>	<b>64</b>	<b>82%</b>
<b>Private universities:</b>						
6. Ahfad University for Women	5	5	100%	3	3	100%
7. University of Medical Sciences and Technology	4	4	100%	4	4	100%
8. Computerman University	12	9	75%	8	5	63%
9. Sudan International University	5	3	60%	5	3	60%
10. Sudan Academy for Banking and Financial Studies	2	2	100%	2	2	100%
<b>Total private</b>	<b>28</b>	<b>23</b>	<b>82%</b>	<b>22</b>	<b>17</b>	<b>77%</b>
<b>Grand Total</b>	<b>131</b>	<b>112</b>	<b>85%</b>	<b>99</b>	<b>81</b>	<b>81%</b>
Support staff				5	5	100%
Students				26	26	100%

Source: Own calculation based on the ICT University Survey (2009).





# Main Results (1)

## ❑ Internet facilitates connections, network and communication:

- Inside the institutions (public and private universities)
- With other national higher education institutions in Sudan
- With regional higher education institutions
- With international higher education institutions

## ❑ Internet facilitates integration of Sudanese universities into the system of global knowledge production

**Table 2 - The effect of Internet in facilitating connection, networks and communication**

	All	Public	Private	Students	Support staff
Inside the institution	73%	70%	81%	81%	80%
with international institutions	70%	74%	59%	80%	60%
with regional institutions	68%	68%	71%	86%	60%
with other institutions in Sudan	59%	58%	65%	86%	60%

Source: Own calculation based on the ICT University Survey (2009).



# Main Results (2)

- ❑ **Rapid growth on the use of ICT in public and private Sudanese universities**
- ❑ **Significant structural change in the demand for ICT in Sudan**
- ❑ **The demand for ICT is determined by:**
  - Income
  - Education attainment level
  - Gender
  
- ❑ **Dual-implications: use of ICT introduces ‘creative-destruction’ effects in public and private universities in Sudan:**
  - Positive impacts (opportunities): facilitating creation and transfer of knowledge in Sudanese universities, but simultaneously also
  - Negative impacts (challenges): creating the digital divide adding a new dimension to the existing challenge of inequality in Sudan



# Main Results (3)

- ICT introduces some opportunities: facilitates production, creation and transfer of knowledge in Sudanese universities

Table 3 - The impacts, opportunities and advantages of the use of Internet in facilitating creation and transfer of knowledge

Internet opportunities/ advantages	All staff	Public staff	Private staff	Students	Support staff
Increasing access to digital knowledge for academic and researchers	100%	100%	100%	100%	80%
Rapid quantitative and qualitative increase in transferring information	100%	100%	100%	100%	80%
Development of a new model for disseminating and distributing electronic information to moved towards the user	99%	98%	100%	91%	80%
Increase creation and transfer of knowledge	97%	97%	100%	100%	80%
Encourage and increase process of integration in world international knowledge	97%	97%	100%	95%	60%
Increase free access to electronic publications for academic purposes	96%	95%	100%	95%	80%
Increase the use of long distance learning, training and education	93%	92%	100%	91%	80%

Source: Own calculation based on the ICT University Survey (2009).



# Main Results (4)

❑ ICT creates some challenges for creation and transfer of knowledge

**Table 4 - The impacts of difficulties and problems for the use of Internet in hindering creation and transfer of knowledge**

Internet challenges/ difficulties	All	Public staff	Private staff	Students	Support staff
Lack of or inadequate regular budget adequate for universities libraries to pay for access to scientific and technical information, author's rights and have licenses or subscriptions	96%	95%	100%	100%	80%
Inadequate and lack of the required technical skills	94%	95%	93%	95%	40%
Lack of assessment policies and evaluation programmes	93%	91%	100%	90%	60%
Easy change and adjustment of original documents and impacts on author's moral and financial rights and impacts on hindering management of Intellectual Properties Rights (IPR) and preventing piracy for academic documents when transferring adjusted unoriginal documents for users	92%	90%	100%	90%	60%
Difficulties of correcting and controlling the digital and electronic documents in digital and electronic libraries	90%	89%	94%	74%	40%
Creating gap (related to training and financial ability to communicate) between those who own and those who do not own the Internet technology	90%	87%	100%	95%	40%
Problem of access to scientific and technical information for creation and transfer of knowledge	89%	90%	87%	96%	80%
Difficulty of regular access to Internet	89%	88%	94%	85%	60%
High costs of acquiring licenses for access to electronic libraries for individuals and institutions	89%	91%	81%	85%	60%
Creation of isolation for illiterate people who do not know how to use the Internet	89%	91%	82%	89%	60%
Inadequate electronic capacity	73%	75%	65%	75%	40%

Source: Own calculation based on the ICT University Survey (2009).



# Main Results (5): Stylised facts in the literature

❑ **The digital divide: use of ICT (mobile, computer, Internet) defined by:**

- Ownership
- Spending
- Knowledge of use
- Purposes of use

❑ **The digital divide: use of ICT (mobile, computer, Internet) defined by:**

- Region (geographic location)
- Mode of living (rural-urban)
- Gender
- Age
- Educational level

❑ **Lack of electricity hinder computer use at home and lack of Internet services hinder the use of Internet in rural twice than in urban areas**



# Main Results (6)

## ❑ The determinants of the digital divide in Sudan:

### ❑ The use of computer and the Internet:

- Educational level (positive)
- Age (negative)

### ❑ The use of mobile

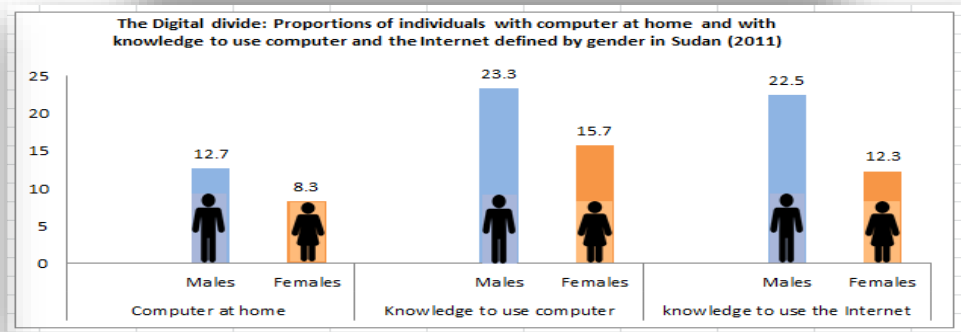
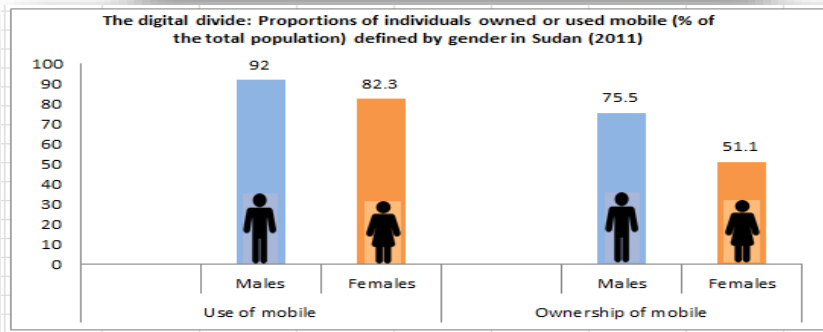
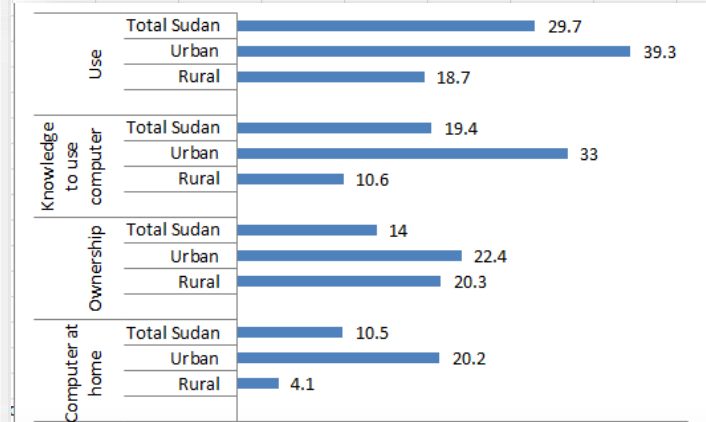
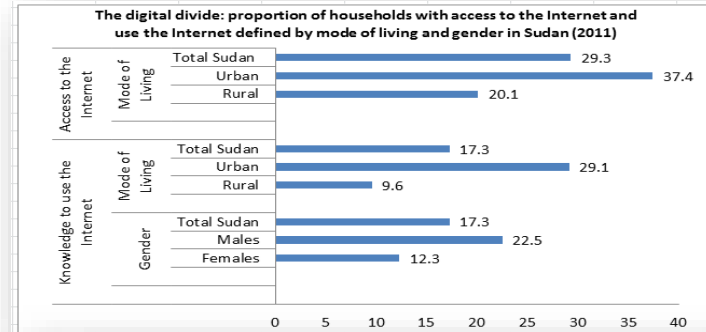
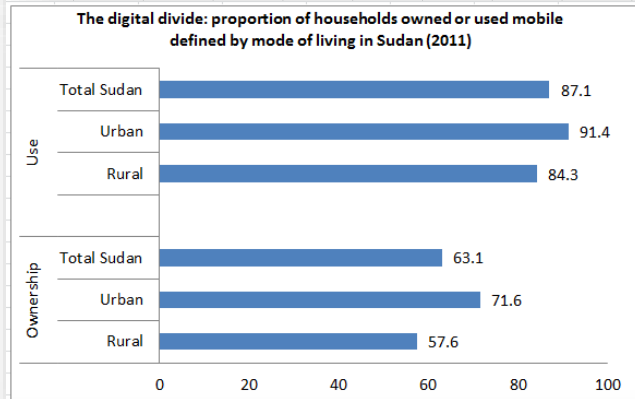
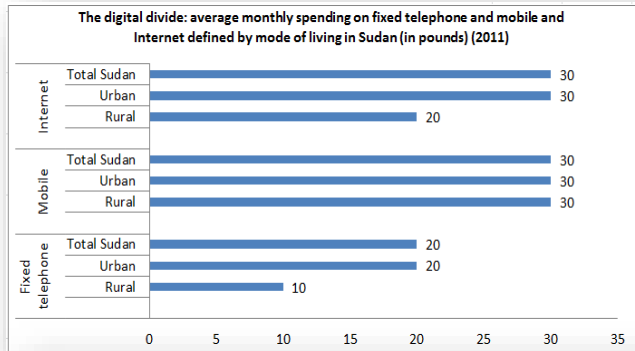
- Educational level (inconclusive)
- Age (negative)

### ❑ The use of ICT

- Educational level ((positive: computer and Internet), (inconclusive: mobile))
- Age (negative)
- Per capita income (positive)
- Net enrolment rate in primary education (positive)
- Literacy rate (positive).
- Rate of urbanization (positive)
- Poverty gap ratio (negative)

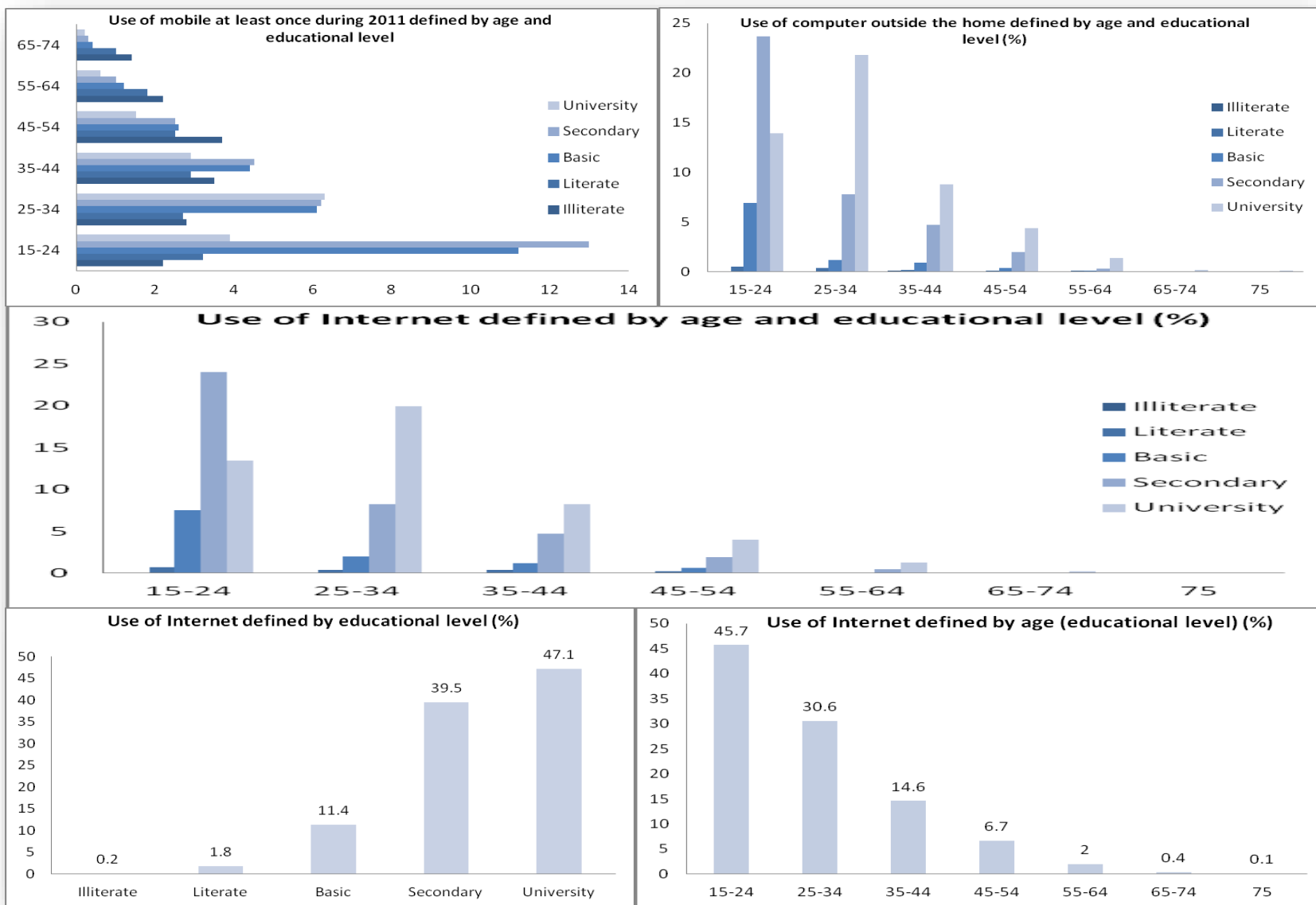


# The digital divide in Sudan: use of ICT (computer, mobile and Internet) defined by mode of living and gender (2011)



Source: Adapted from National Telecommunication Corporation (2012) "Households and individuals ICT survey 2012"

# The digital divide in Sudan: use of ICT (computer, mobile and Internet) defined by educational level and age (2011)

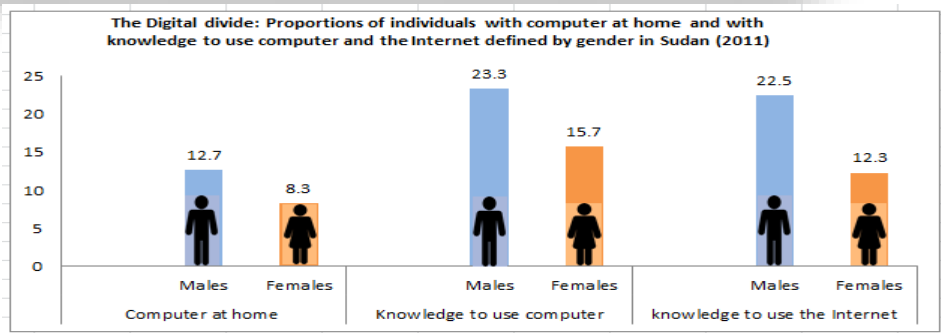
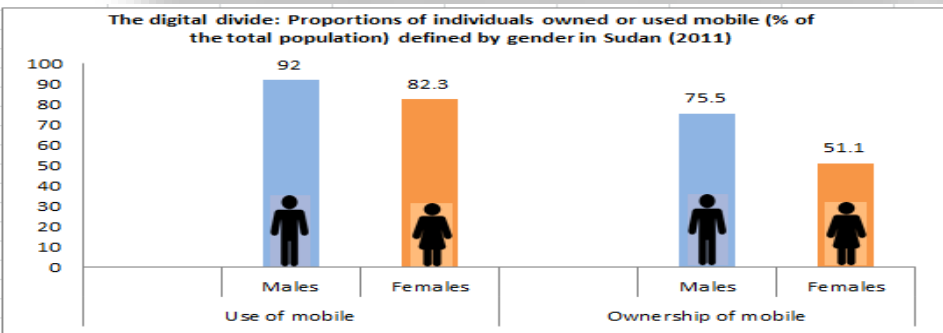
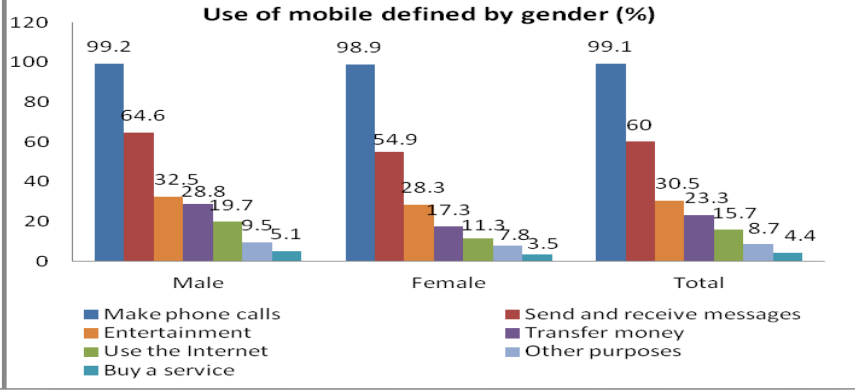
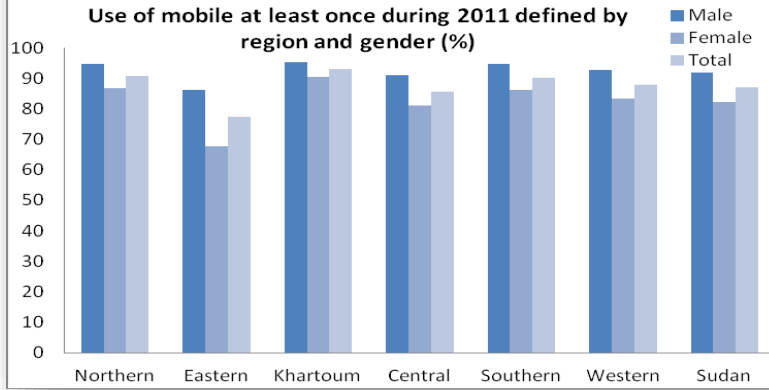
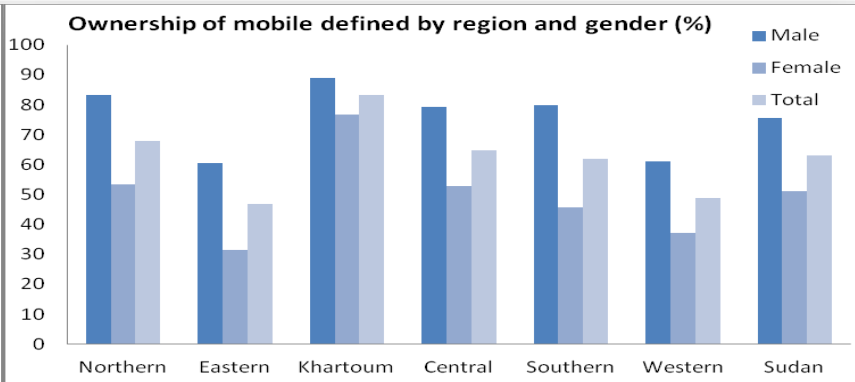
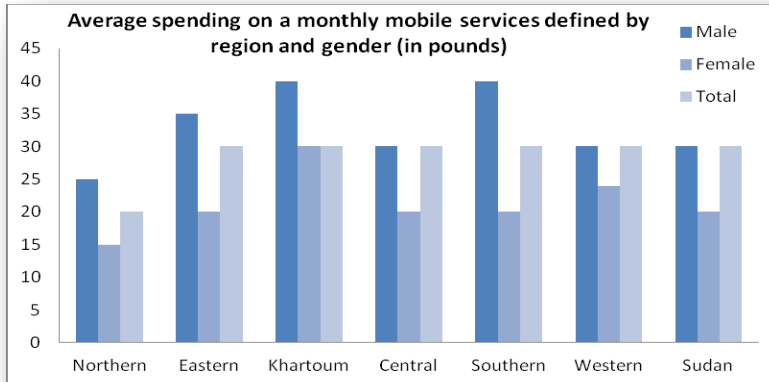


Source: Adapted from National Telecommunication Corporation (2012)"Households and individuals ICT survey 2012"



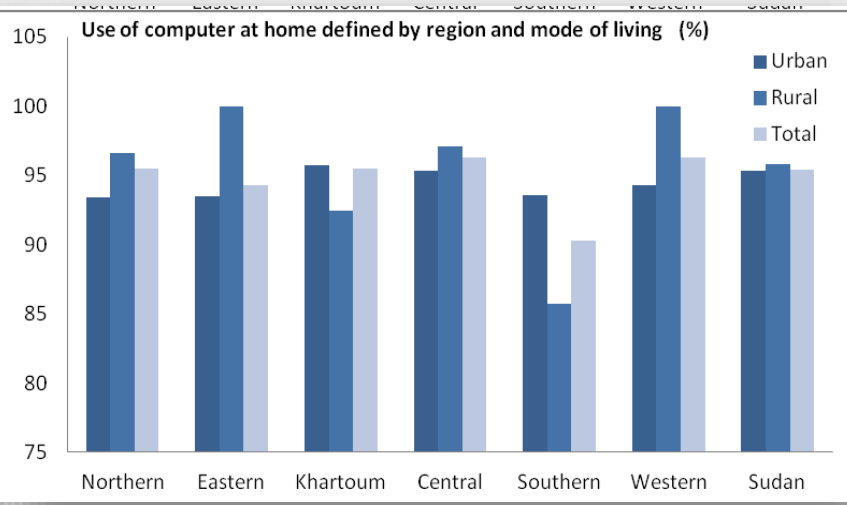
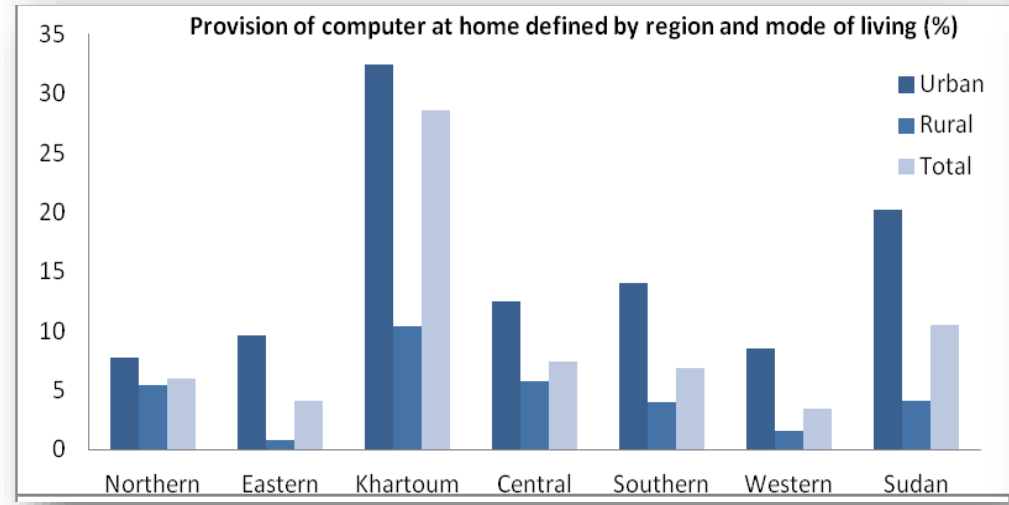
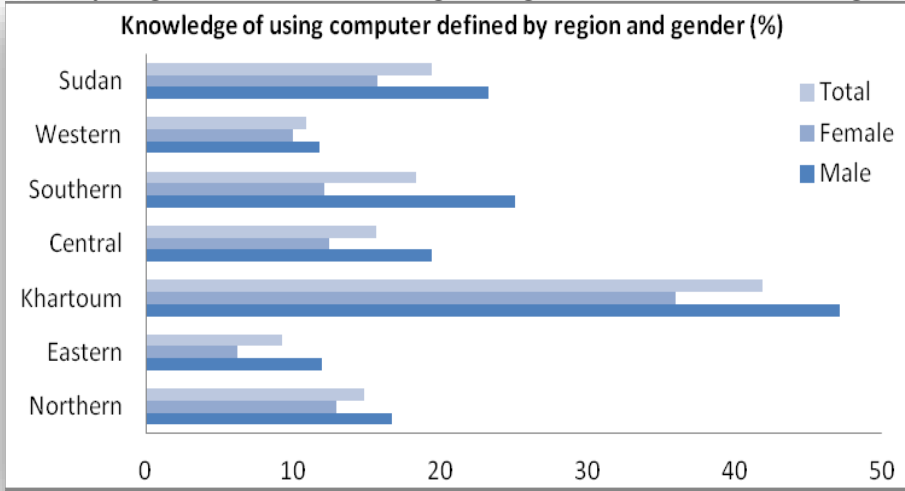
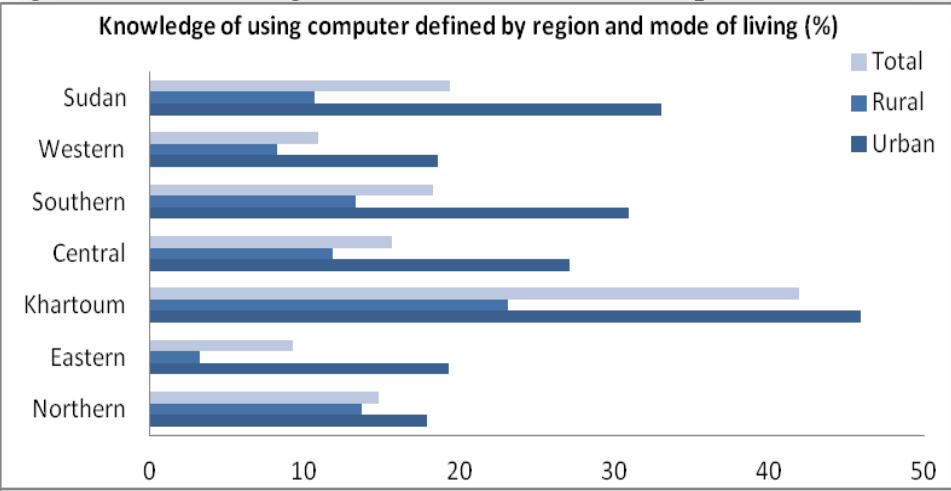


# The gender digital divide in Sudan: (mobile, computer and Internet) defined by gender (2011)



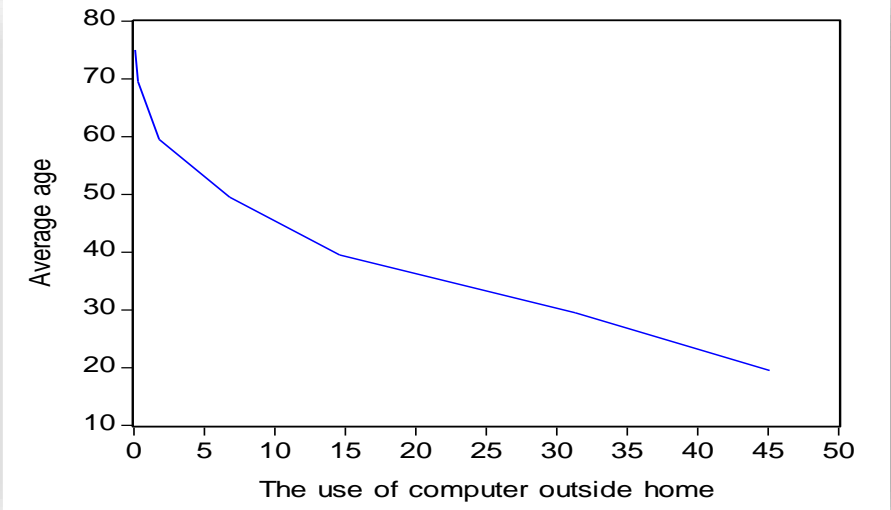
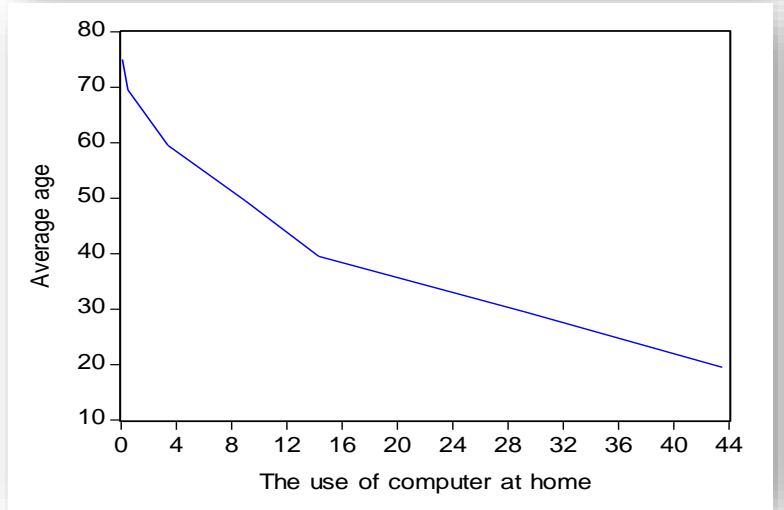
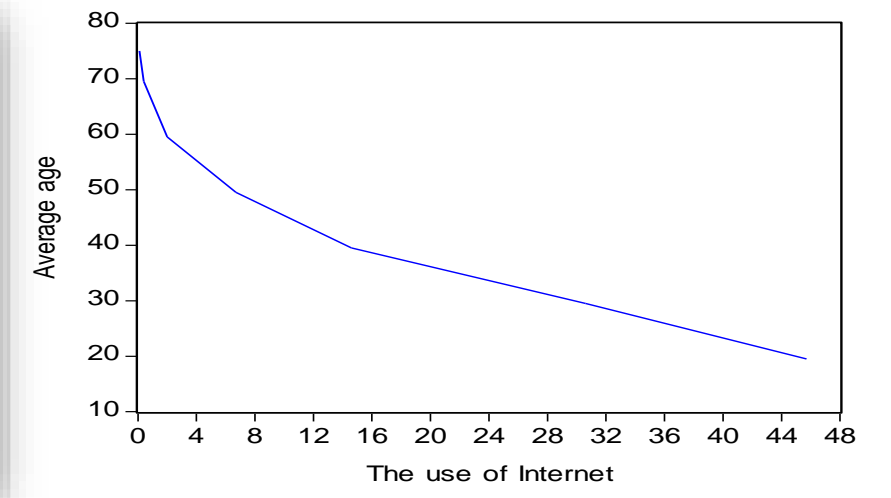
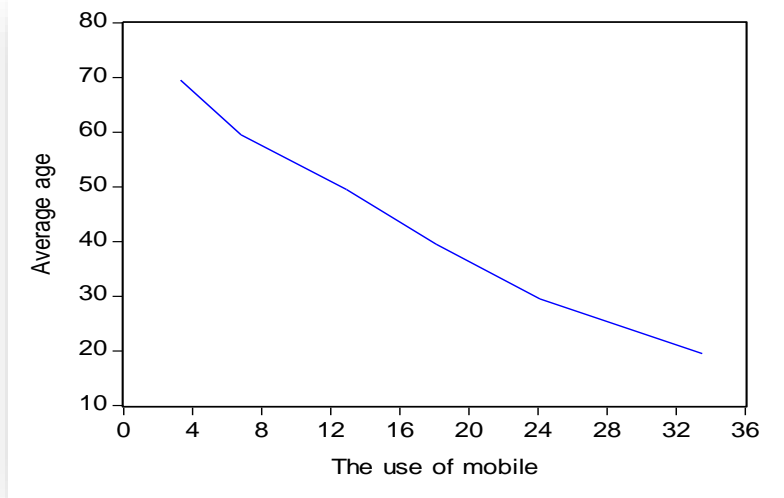
Source: Adapted from National Telecommunication Corporation (2012) "Households and individuals ICT survey 2012"

# The digital divide in Sudan: use and knowledge of computer defined by region, mode of living and gender (2011)



Source: Adapted from National Telecommunication Corporation (2012) "Households and individuals ICT survey 2012"

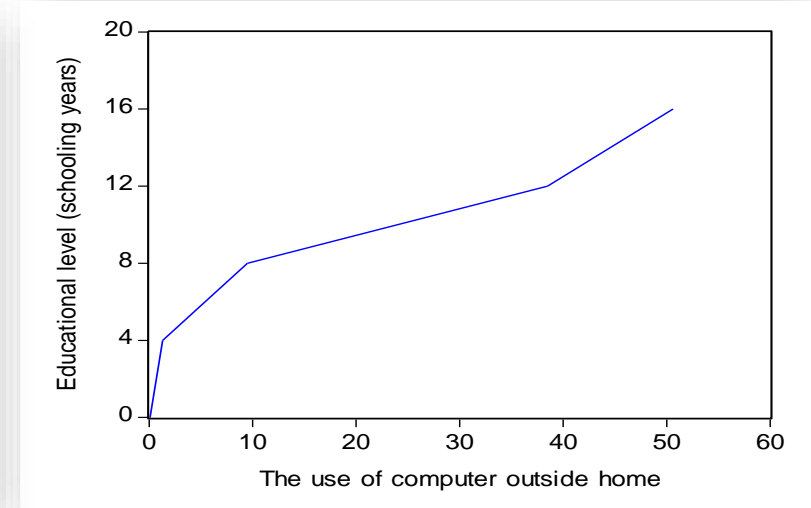
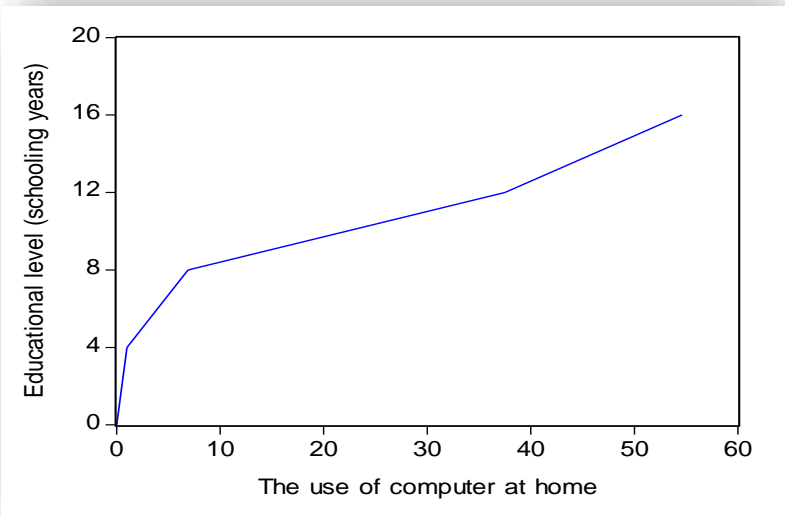
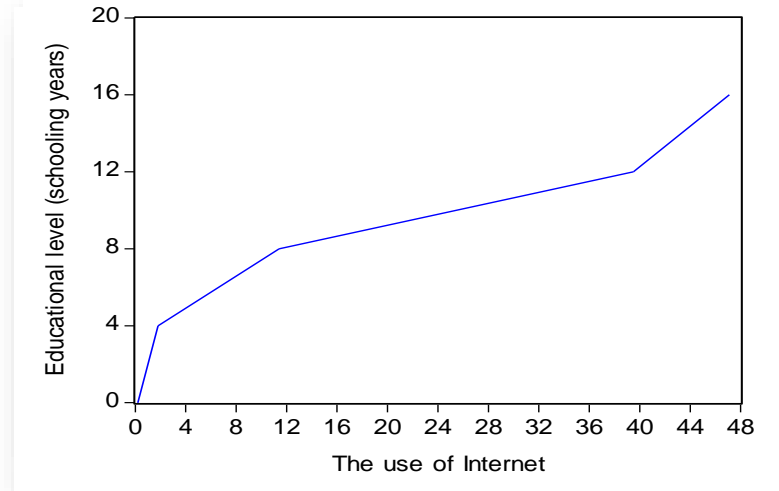
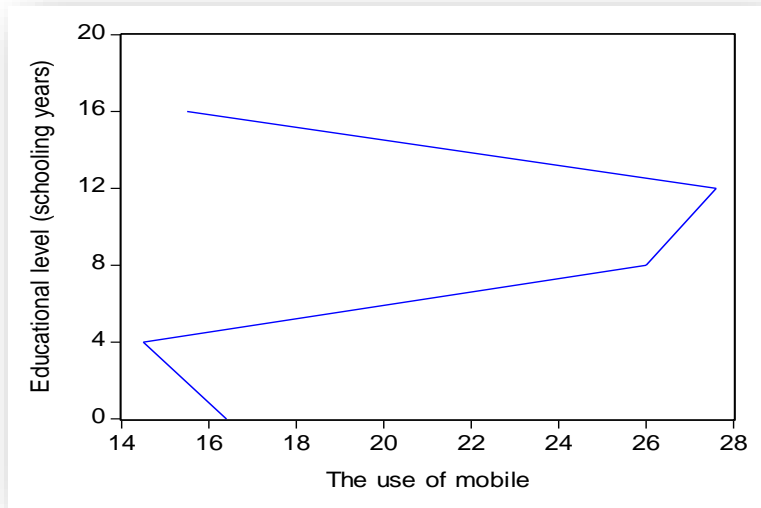
# The digital divide in Sudan: use of ICT (computer, mobile and Internet) defined by age (2011)



Source: Adapted from National Telecommunication Corporation (2012) "Households and individuals ICT survey 2012"



# The digital divide in Sudan: use of ICT (computer, mobile and Internet) defined by educational level (2011)



Source: Adapted from National Telecommunication Corporation (2012) "Households and individuals ICT survey 2012"

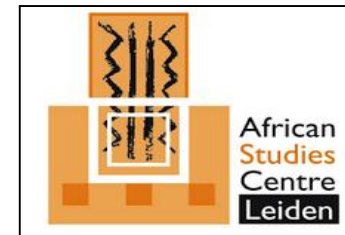


# Conclusions and Policy Recommendations

- ❑ **The use of ICT in public and private Sudanese universities facilitates**
  - Connections, creation, access to and transfer of knowledge
  - Collaboration with international universities and integration of Sudanese Universities in the system of global knowledge production
- ❑ **Major policy recommendations:**
  - Encouraging the effective use of ICT for creation and transfer of knowledge
  - Enhancing quality and accumulation of human capital and skills
  - Offering adequate budget for enhancing ICT in Sudanese Universities
- ❑ **Coherent policies on the demand side to bridge the digital divide:**
  - Alleviating poverty, and improving per capita income, and education attainment
  - Improving access to ICT for rural areas and for women
- ❑ **Coherent policies on the supply side to bridge the digital divide:**
  - Increase government investment and spending on ICT/ICT related infrastructure
  - Improve quality, efficiency and speed of ICT services and technical skills
  - Improve ICT and electricity infrastructure (availability of electricity)
  - Enhance public-private partnership in investment in ICT related infrastructure



# Thanks for Your Kind Attention



اللَّهُمَّ لَكَ الْحَمْدُ كُلُّهُ، وَإِلَيْكَ يَرْجِعُ الْأَمْرُ كُلُّهُ، عَلَانِيَتُهُ وَسِرُّهُ فَحَقَّ أَنْتَ أَنْ تُعْبَدَ، وَحَقَّ أَنْتَ أَنْ تُحْمَدَ، وَأَنْتَ عَلَى كُلِّ شَيْءٍ قَدِيرٌ