The United Nations University

INTECH

Institute for New Technologies

Discussion Paper Series

#2002-5

Internet Access in Africa: An Empirical Exploration

Banji Oyelaran-Oyeyinka
Catherine Nyaki Adeya

May 2002

United Nations University, Institute for New Technologies, Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands
Tel: (31) (43) 350 6300, Fax: (31) (43) 350 6399, e-mail: postmaster@intech.unu.edu, URL: http://www.intech.unu.edu

INTERNET ACCESS IN AFRICA: AN EMPIRICAL EXPLORATION

Banji Oyelaran-Oyeyinka
Catherine Nyaki Adeya[1]

UNU/INTECH Discussion Papers

ISSN 1564-8370

UNU/INTECH discussion papers intend to disseminate preliminary results of the research carried out at the institute to attract comments

[1] Banji Oyelaran-Oyeyinka and Catherine Nyaki Adeya are Senior researchers and researcher respectively with the United Nations University (UNU/INTECH). The study cited in this paper at the country level had as co-ordinators, Dr. Boladale Abiola, Nigeria, and Dr. Heywood Ouma Absaloms, Kenya. Our thanks to an anonymous reviewer and Anthony Bartzokas for useful comments on earlier drafts. The usual disclaimer however stands.

TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

Using empirical and new field data, this exploratory study investigates the pattern of adoption of constraints to the use of the Internet in Africa. Cross country exercise using regression shows that Internet use is constrained by structural as well as cost-related factors. Field data from interviews of over two hundred academics in ten universities in Kenya and Nigeria confirmed much of the aggregate country level findings. Our study found that initial investment cost of end-user equipment limits the ownership of PCs, compelling academics to seek Internet access in cyber cafes and other public places.

Keywords: Internet access, Africa, adoption, universities.

1.0 INTRODUCTION

As with all innovations, effective exploitation of the Internet, itself a cluster of innovations, depends on a host of innovative absorptive factors. African countries either do not possess the basic infrastructure, in some cases, efforts have been made but not nearly enough. In others, technological infrastructure is obsolete as a result of the rapid developments of digital technologies. Among the most important technologies are telecommunications and computing infrastructure, which range from basic telephones, power supply to personal computers (PCs). Poor connectivity infrastructure manifests in lack of affordable access to PCs, Internet devices, modems, telephone lines and Internet connections, (Rao, 2001). Studies have found that wide disparities exist in Internet adoption within and between countries.2. At the regional level, the share of Sub-Saharan Africa (SSA) rose from a meagre 0.1% in 1998 to 0.4% in 2000. Internet services cost seven times that of the United States largely due to the monopolistic structure of Internet service in Africa, (Speight, 1999).

Wide inter-country disparities in the access and user intensity of the Internet is due as much to regulatory factors, tariffs structures, levels of technological development, and educational levels as much to socio-economic differences. For example in 1997, corporate access to a 64 Kb line was $350 per month, while in Italy and France the average was $2500 per month. In the United States, 20% of all households had Internet access while only 5% of households in Western Europe had such access. According to (Pospischil, 1998), costs were the binding constraint. Income therefore is a strong determinant of Internet access and just as differences exist within the affluent countries of the OECD, one expects even wider differences not only between rich countries but wider disparities between rich and poor countries in Africa. We expect equally wide differences between the different social groups in Africa due in part to income differentials, and levels of education. For these reasons, distinct demographic differences have appeared among Internet users across countries.

In sum, mere exposure to a technology does not guarantee usage, and as such the existence of information in society does not assure its use and concomitant acquisition of knowledge. Exposure to information sources such as the Internet tend to be correlated to income and socio-economic status. In other words, societies with predominantly low income groups, are less

[2] The United States has the most inexpensive Internet service. In 1996, the US hosted 64% of Internet servers, Germany was a distant second with 5% and the UK, third with 3%. The US also had the highest number of its citizens connected. In the year 2000, 54.3% double the number in 1998 used the Internet, while the rest of the high income OECD share was 28.2% up from a mere 6.9% two years earlier

likely to have access to the Internet. Knowledge acquisition will for this reason be constrained by low income and low levels of education due to unequal access and more so because of unequal utilisation of the technology.

In this paper we examine factors that explain the pattern of adoption of the Internet in Africa. There is a dearth of empirical work on this subject in Africa and as far as we know, this is the first study of its kind to quantitatively investigate the use of the Internet in African universities. The study is therefore an important first step in understanding the adoption and use of ICTs in the acquisition, validation and utilisation of knowledge within higher education, in poor countries.

Specifically, we carried out empirical analysis using ordinary least squares (OLS). To validate our findings at the national level, we illustrate with case studies of ten universities from Nigeria and Kenya. This paper proceeds as follows: the second section provides the framework which analyses the connectivity infrastructure within the national system of innovation (NIS), while section three briefly examines the state of telecommunication and connectivity infrastructure in Africa. Section four provides an empirical exploration of cross-country determinants of Internet access, while we follow with an illustration of the factors with a study of pattern of Internet adoption among academics in Kenya and Nigeria. The final section concludes and makes suggestions for future research.

2.0 CONNECTIVITY INFRASTRUCTURE IN THE NATIONAL INNOVATION SYSTEM

This study investigates ICTs adoption within the context of underdevelopment. In much the same way that electricity remains indispensable to the process of industrialization, ICTs would undergrid development of the new economy, the so-called network society, (Castells, 1996). The identification of electricity and telecommunication with the industrial and information societies respectively is more than symbolic. A network of machines, gears and cables mediates electricity generation, transmission and distribution much in the same way that the Internet is a network of linked computers and fibre optic cables, among others. The productivity of a particular process is a function of the use of the energy forms and extant technical knowledge bases. In the agrarian mode of production, the source of increasing surplus is the quantitative levels of labour and natural resources, (Castells, 1996). In the industrial mode of development, productivity increase comes from the variety and quality of new energy sources, and in the ability of society to efficiently deploy such energy resource.

The pre-eminence of ICTs, is therefore a paradigmatic shift from a technology based on cheap inputs of energy, "to one based predominantly on cheap input of information derived from advances in micro-eletronic and telecommunications technology", (Freeman, 1987). Innovation becomes crucial since energy resource by itself remains dormant until, in the Newtonian sense, an appropriate force is exerted to convert what is largely a potential into a kinetic force. In the new economy, driven in part by ICTs, the source of productivity "lies in the technology of knowledge generation, information processing, and symbol communication", (Castells, 1997)[3].

ICT infrastructure may be divided broadly into three components which are telecommunications, computing and connectivity infrastructure. Historically, the key telecommunication actor had been the Public Switched Telecommunications Networks (PSTNs). In the last two decades, privatisation and market liberalisation led to public divestment leading to the entry of private telecommunications operators (PTOs) into the sector. Massive restructuring had resulted, however, more remain to be done in order to create truly competitive markets in the telecommunication sector in Africa. While some progress has been made in improving connectivity infrastructure, there remains strong reliance on the US Internet

[3] Certainly, other modes of development depend on information and knowledge. The difference here as Castells aptly expresses it is that in the information age, "Information processing is focused on improving the technology of information processing as a source of productivity, in a virtuous circle of interaction between the knowledge sources of technology and the application of technology to improve knowledge generation and information processing".

backbone. Skills, innovations, and major investments are concentrated in the triad of USA, Japan and Europe. In other words, while users have some form of control on the provision of private computing facilities, access to, and the quality of telecommunication and connectivity available to a user depend on geographic space. In effect, the economic environment of a country is a determinant of the access, speed and types of data and for that matter, information and knowledge to which users have access[4].

At the very basic level, countries have highly differentiated access to telephone and electricity services which in high income countries are taken as given. The quality of these basic engineering and physical infrastructure are important for the simple reason that information, coded in files, travel through series of linked nodes within the ICT network. The slowest link in the network node becomes the rate-determining step and thereby defines the overall speed of data transmission, (Dholakia, 1997).5 On the other hand, local and regional telecommunications infrastructure such as server connectors, local loop telecommunication lines, inter-nodal connections, and switching systems among others, determine the cost and quality of access. Users in high-bandwidth telecommunications environment are likely to have access to lower cost connections. Most developing countries face capacity constraints, largely a result of thin-bandwidth and frequent power outages.

The combined effects of poor infrastructure result in high average cost of access to the Internet. Cost components include local calls charges, charges for line rentals, and costs due to ISP services. In a study of the differential connectivity within the OECD, (Paltridge, 2001) identifies pricing structure as an important factor for access to electronic commerce and the Internet. Telecommunication regulation, the wealth of a nation and the presence of commercial access providers are the other important predictors of Internet access, (Paltridge, 2001). Poor countries have relatively inferior ICT infrastructure and predictably lower quality connectivity. In a correlation exercise, close to 80% of countries classified as having high Human development Index (HDI) have full Internet access, while less than 5% of low HDI countries had the same level of connectivity. More than 80% of high HDI countries with full Internet connectivity have commercial access providers (CAPs), (Hargittai, 1999). Historically, there has been a strong correlation between basic domestic and industrial technological artefact adoption such as telephone and computers and levels of development.

From the foregoing we propose to study Internet access employing a modification of a framework proposed by (Walcott et al, 2001). The factors we considered are: connectivity

[4] Castell cites (Porat, 1972) and defines Information as simply: “data that have been organized and communicated”.
[5] For example, a 28.8kbps modem on a home computer may yield a transmission speed of no more than 24.6, a speed loss of 14.5% as a result of the quality of telephone lines.

infrastructure, Internet penetration and actor configuration (ISPs market structure). The three structural factors and have been discussed earlier. However, the authors provide numeric values that assign quantitative weights to the complex factors that make up what might be termed 'National Internet capability', an imprecise but useful proxy. While their study takes the nation as the unit of analysis, we are focused on the individual and institutional user levels. Connectivity infrastructure has four components which are: (a) the aggregate bandwidth of the domestic backbone(s), (b) the aggregate bandwidth of the international IP links, (c) the number and type of interconnection exchanges, and (d) the type and sophistication of local access methods in use. Internet penetration, defined as pervasiveness represents the number of users per capita, which can be proxied with either the Internet hosts counts or individual users. The pervasiveness of Internet use is a function among others of, access to services, perceived value to users, acceptable costs to users and ease of usage which depend crucially on content language. Finally the structure of the ISPs market is an important factor influencing access. The presence of and the institutional regimes in which ISPs operate is also important to market competitiveness and as such cost to end-users. For instance, Internet diffusion may be slow where state policies restrict barriers to ISPs entry, or where cultural limitation leads to persistent disparity in girl-boy education, or for that matter where security concerns create a hostile competition regime. Table 1 shows the framework for our analysis. The configuration shows an evolution from an emergent to a highly competitive market. Connectivity infrastructure follows a similar pattern. Access at the individual level is achieved using modems at early stages of development, while more sophisticated infrastructure such as leased lines are used in later stages of development.

Table 1: National Systems and ICT Infrastructure Framework

	Low	**Stages of development**			**High**
	1	2	3	4	5
Configuration of service providers and market structure	No ISP in country	Single ISP; State monopoly	Few ISPs; controlled market, ISPs linked to monopoly Telecom provider	Many ISPs; competitive market; Local competition	Many ISPs; Low barrier to entry; Vibrant local and international competition
Internet penetration	Internet does not exist **Non existent**	Internet users per capita < 1 in 1000 (0.1%) **Low**	Internet users per capita >1 in 1000 **Emergent**	Internet users per capita ≥ 1% **Established**	Internet user per capita ≥10% **Mature**
		Domestic backbone	International links	Internet exchanges	Access methods
Connectivity infrastructure*	**Low** Stage 1	None	None	None	None
	Stage 2	< E-1	≤ 128 Mbps	None	Modem
	Stage 3	T-3 – OC-4	T-1 – T-3	1	Modem 64 Kbps leased lines
	Stage 4	OC-4 – 100 Gbps	T-3 – 10 Gbps	More than 1; Bilateral or Open	Modem > 64 Kbps leased lines
	High Stage 5	≥ 100 Gbps	≥ 10 Gbps	Many; Both Bilateral and Open	< 90% modem > 64 Kbps leased lines
Other Structural and infrastructure determinants	Internet Hosts: High Electricity: 8500 KWH per capital Teledensity: 600/1000 people GTSER: 11-27 Income (high)		Internet Hosts: Low Electricity: <500-1000KWH per Teledensity: 10-30 to 80 GSTER: 0.1-4.0 to 6.0 Income (low)		

Data sources: UNDP (2001). For details of the typology used in specifying connectivity and Internet penetration, see, Walcott(1999).
GTSER= Gross tertiary enrolment in science and engineering ratio
* Read vertically

3.0 CONNECTIVITY AND TELECOMMUNICATIONS IN AFRICA

The telecommunications sector in Africa is undergoing deep-going reforms with the decision of Governments to liberalize the market and privatize the sole carrier. A number of countries have adopted the Global Systems of Mobile Communications (GSM) which has boosted the overall available telephone lines. In Nigeria, Zimbabwe, Uganda for example governments have licensed three GSM operators and they have since carried out network roll out. By the end of 2002, the Nigerian government plans to install 4 million lines, which include 2 million mainlines and 1.2 million digital mobile lines. The launch of the GSM and the licensing of the other operators has led to demand for telecommunications equipment and accessories such as mobile phones, cellular, transmission and switching equipment. Kenya has some 400,000 lines to a population of 30 million people but has set an ambitious target of 1 line per 100 people by the year 2015. The main carrier, Kenya Posts and Telecommunications Corporation (KPTC) has been broken into three entities. In response to market liberalization, the private sector in Africa has introduced innovative services such as Internet Cafes, prepaid calling cards, and voice mail.

Table 2 shows indicators of information and telecommunication infrastructure for selected countries. We examine two broad discernable group of countries. The first comprises those with relatively good infrastructure and the second group are those with poor level of infrastructure, mostly in Africa's Least Developed Countries (LDCs). Telecommunications infrastructure in most African countries lags far behind that of the regional industrial leader, South Africa with close to 5 million connected telephone lines and 2.5 million cellular subscribers and a density of 114 per 1000 people (2000**),** a figure close to thirty times that of Nigeria. For more details on Africa's regional and country connectivity infrastructure data, see (Jensen, 2001).

Computing infrastructure consists of both hardware and software components and includes services such as programmes design, training and networks development. The Internet with its linked computer systems is an important component of the national connectivity infrastructure. Data on the number of installed personal computers are largely estimates due to the dynamic nature of the PCs market. Dial-up email providers are still few compared to the overall population. The few existing operators are localized in big cities and operate on low bandwidth links[6]. The data on Internet hosts and Internet users vary widely among the countries.

---

6 Digital transmission is measured in Bits per second (Bps). Narrow band is a slice of bandwidth for transmission of voice and data signals. The T-1 (T-carrier) has an operating speed range of 2.6 kilobits per second to 1.5 megabits per second. Wideband or broadband with deliver services at speeds between T-1 and T-3 (45 Mbps)

A number of ISPs now operate largely within the big cities in Africa, some with their own VSAT linked directly into the US backbone, bandwidth wireless links. However, computer penetration is low, and Internet penetration lower still, and remain a luxury item, restricted to certain institutions and groups as with most other African countries. The 1997 average cost of using a local dial-up Internet account for 20 hours per month is about $68 (including usage fee and local call time). In the US, the average cost is $29 for 20 hours/month including telephone charges. This comes to $1.45 per hour compared to $3.4 per hour for Africa, with less than one-tenth per capita income, and relatively poor Internet services. ISP subscription rates vary widely in Africa between $10 and $100, a reflection of the relative competitiveness of the markets, varying tariff policies of telecom operators, differences in the regulations on private wireless data services and in the access to international telecom bandwidth.

For now the most serious constraint to Internet adoption is thin bandwidth, non-existing intra-regional connectivity and the low level and inefficient fixed lines network that is equally constrained by inter-exchange congestion[7]. In addition African countries suffer erratic power supplies while per capita electricity consumption is low. For instance while South Africa's electric power consumption is 3882 Kwh per capita that of Nigeria is 85 Kwh per capita. The average for the OECD is 8500 Kwh per capita, 100 times that of Nigeria. Table 2 shows the wide disparity in connectivity and end-user equipment availability.

[7] According to Tele-geography, African bandwidth to the United States is 0.7 Gbps, while it is 14 Gbps from Latin America and 42 Gbps to Asia/Pacific. The value for Asia/Pacific is 60 times that of Africa.

Table 2:Information Infrastructure for selected African Countries (2000)

Country	**Telephone mainlines per 1,000 people**	**Internet Hosts per 10,000 Inhabitants**	**Interband width outgoing (Kbps) 2001**	**Waiting time (years)**	**Mobile phones per 1,000 people**	**PC's per 1,000 people**	**Internet users (thousands)**
Algeria	57	0.01	2048	5.4	3	6.5	50
Tunisia	90	0.03	41500	0.9	6	22.9	100
South Africa	114	42.95	300,000	1.1	190	61.8	2,400
Namibia	63	18.51	3072	0.7	47	34.2	30
Mauritius	235	27.44	4096	1.0	151	100.5	87
Kenya	10	0.53	6144	8.1	4	4.9	200
Zimbabwe	18	2.16	5120	10.0	17	11.9	50
Egypt	86	0.35	112,500	1.9	21	22.1	450
Angola	5	0.01	14000	8.5	2	1.1	30
Guinea	8	0.25	128	0.1	5	3.7	8
Ethiopia	4	0.01	512	7.8	0	0.9	10
Lesotho	10	0.47	512	10.0	10		4
Mauritania	7	0.45	384	10.0	3	9.4	5
Niger	2	0.16	192	1.1	0	0.5	5
Nigeria	4	0.07	9216	1.4	0	6.6	200
Rwanda	2	0.47	128	4.0	5		5
Uganda	3	0.08	2048	3.6	8	2.7	40
Zambia	8	0.86	3072	6.7	9	6.7	20
Ghana	12	0.25	4096	1.5	6	3.0	30

Source: UNDP, Human Development Report, 2001

4.0 EMPIRICAL ANALYSIS

The quantitative analysis is supplemented with a cross-sectional analysis of countries using Ordinary Least-Squares method (OLS). We measure Internet access by the number of Internet users per capita. We chose a number of independent variables based on the review of factors affecting Internet adoption in our framework. We hypothesize that infrastructure variables such as telephone density, bandwidth, electric power supply, TV sets, per capita, and public spending on education, schools enrollment literacy as well as income per capita affect the dependent variable. We allow for one period time lag as structural factors take time to impact the dependent variable, (Bauer et al., 2002).

The variables are as follow:

VARIABLE:

DEPENDENT

NETUSE: Internet Users per capita mid- 2001

INDEPENDENT

Teleden telephone mainline per 1000 population 2001

Intban Interband width Outgoing (Kbps) 2001

Pubsp Public Spending on Education as % of GNP 2000

Elecpow Electricity kWh per capita 2000

Percom Personal Computers (PCs) penetration per 10,000 population, 2000

GDPcap Gross Domestic Product per Capita.

The results of the OLS regression are shown in Table 3.

Table 3: Results of the OLS

Model	**Unstandardized Coefficients (B)**	**Std. Error**	**t**	**Significance.**
Constant	-113.367	43.215	-2.623	.012
Intband	-.158	.058	-2.719	.009
Telden	7.997	.519	15.409	.000
Pubspen	13.058	10.577	1.235	.223
Elecpow	-8.52E-02	.039	-2.180	.034
GDPCAP	2.435E-02	.003	7.647	.000
Percom	3.776	1.310	2.884	.006

R = .983; R Square + .965, and Adjusted R Square = .961, Std. Error of the Estimate = 139.763 and F = 218.067

Discussion of the Results

From table 3, the national telecommunication and computing infrastructure is represented by telephone mainline and electrical power consumption and Personal computers per capita. Network connectivity is represented by inter bandwidth. Human capital was proxied by schools enrolment literacy level and per capita spending on education; national wealth is represented by GDP per capital. We tested systematically various models and the above model tends to give the best fit. Other models in this study show that adult literacy, and secondary enrolment are not significant and that public spending does not explain the variation in the use of the Internet. While lack of adult literacy is counterintuitive, previous studies show that demographic variables do not always move in the same causal direction. For instance, an earlier OECD study, (Hargittai, 1999) conceptually relates Internet connectivity to human capital by the population's level of education and its proficiency in the English language. However, in a test of eight different models, " the effects on both education and language competency disappears", once certain variables are added to the model. The study in fact concludes: "it was hypothesized that a native English speaking population (i.e. the base value in this model) would encourage Internet spread… However, it seems that having a population of native speakers versus good English speakers does not make a difference". Literacy rate as a predictor in our study moved in the same contrary direction. In the sic models examined, it was the first to be dropped in the backward elimination of variables; it showed no association with Internet adoption.

Public spending on education is subjected to a number of conditions within a given context. According to (Colclough et al., 2000), "Taken alone, trend data showing public expenditures on schooling have limited explanatory value". These variables include the proportion of the population of school age, the proportion of GNP spent by households on primary schooling, the proportion of GNP spent by government on primary schooling, and the unit costs per child in

school as a proportion of GNP per capita. The last two show the widest variations, and wider still are the overall spending as a proportion of GNP on education. In other words, averages hide substantial inter-country differences and this would lead to differential behaviour of Gross Enrolment Ratios (GERs) across countries. For instance while some countries spend relatively lower proportion of GNP on education as a result of low teachers' salaries, this does not automatically translate to high GERs because these are ordinarily very poor countries[8].

All the other variables are significant at 99% level except the electric power variable at 95% level. Our model explains 96% of the variance in the data set used and confirms much of what the literature has to say about the explanatory power of these factors. The studies in the context of the OECD confirm these findings, (Bauer et al, 2002; Hargittai, 1999). While connectivity depends in the main on state policy and the level of technological development of the country, availability of networking and end user facilities such as modems and PCs is often left to individuals and organizations to provide. Terminal equipment is however expensive relative to the income levels of Africans in academics and within firms. Institutions in Africa are equally hard pressed to provide individuals with terminal equipment facilities and often result to pool provision in form of "computer room", where individuals go to access. In the next section we examine the pattern of use and the ways in which the variables in our study impact on adoption of Internet in ten African universities in Kenya and Nigeria.

[8] The countries include Sierra Leone, Uganda, Zaire, Malawi, Chad and Tanzania. On the other hand, moderate unit cost and strong commitment to education in countries such as Namibia, Lesotho, Swaziland, Botswana, Zimbabwe, Togo and Mauritius have led to the achievement of universal primary education (UPE).

5.0 PATTERN OF ADOPTION OF INTERNET IN KENYA AND NIGERIAN UNIVERSITIES

In order to illustrate the general findings at the national level, we present empirical results of a study that examined the pattern of adoption of the Internet in ten African universities and the constraints to adoption and use[9].

5.1 Internet Use and Access

The study included 171 respondents in Nigeria and 56 in Kenya. In Nigeria, four universities were involved while six were covered in Kenya. The study was carried out over a three months period through the use of questionnaires and in-depth interviews. We sought to understand what Internet is used for, who the users are, and the constraints to usage.

In Kenya, 90.7% of the respondents used the Internet and have done so for the last 1-5 years spending on average 1-2 hours per day. Those who did not use the Internet attributed this to lack of facilities and financial resources. Of the Internet users 64% have full Internet access.

E-mail and the use of full Internet serviced increased mostly in the last five years. The cost and convenience of access, however, has limited this use to institutionally provided facilities therefore, access times are short largely due to cost and convenience. Another factor is the slow dial-up connection to the Internet. This means that setting up connection just can be as problematic as keeping the connection once it is made. This is due to the poor quality of telecommunication links, a phenomenon that frustrates users and discourages surfing of the Internet.

[9] The findings draw from a larger study titled: "The Internet in African Universities: case studies from Kenya and Nigeria" by Catherine Nyaki Adeya and Banji Oyelaran-Oyeyinka, UNU/INTECH, March 2002.

5.2 Specific Uses of the Internet

Table 4 shows the degree of full Internet use as well as a comparison of users in Kenyan and Nigerian universities. Academic users in Kenya score consistently higher in Internet use.

Table 4: Specific uses of the Internet

Usage Category	**NIGERIA** %	**KENYA** %
e-mail	50.8	85.7
Academic Research	57.7	79.6
Teaching Materials	19.2	57.1
Current Affairs	14.6	51.0
Networking with peers	36.2	34.7
Publishing work in progress	18.5	12.2
Entertainment (sport)	13.8	8.2
E-commerce	6.2	4.1
Others	3.8	10.2

Computer, email use, and the cost of Internet use is borne by someone — normally the institution — other than lecturer/researcher. Most research is still done using traditional print periodicals and lecturers/researchers still publish their academic work through the traditional publishing process. Internet and e-mail use is increasing in the academic publishing process but not nearly fast enough. Only 19.2% use the Internet for collecting teaching materials and 18.5% for publishing purpose. 36.2 use it for networking exchanging, 57.7% for academic research, 6.2% for e-commerce.

The low intensity of Internet use for e-commerce is symptomatic of the deeper problems of underdeveloped finance sector. The reasons give include lack of credit cards to poor finanical resources. The lack of credit facilities compounds the problem, since it is a necessary component for online shopping. Obtaining an international credit card from African financial institutions requires proof of a healthy bank balance and above average income. This locks out most lecturers/researchers and limits their involvement in e-commerce. In addition the access costs for online commerce could be expensive, further inhibiting its use. Another factor is the general underdevelopment of e-commerce locally for those who want to use local currency. Respondent who shop for books on-line result to using the assistance of colleagues currently living abroad.

There is evident frustration especially among respondents that had studied abroad in better-equipped institution. On return to Africa, they is a lack of comparable facilities even where their research is dependent on access to current literature sources which are often unavailable locally. Some would like to subscribe to online journals and databases but are constrained by limited access.

In Nigeria, 69% of respondent use the Internet while those that do not gave reasons such as lack of access (given by 10.5% of respondents), lack of knowledge and skills, 4.7%, and high cost of accessing the Internet, 2.3%. 48.9% of respondents have used the Internet between 1-5 year, 4.1% between 5-10 years and 25.1% have used it less than a year ago. Most users had their first contact under different circumstances and spend varying working hours on the Internet.

5.3 Internet Service Provision, Access and Costs

Internet access and cost of access are significantly correlated. Two major sources of Internet access provision were identified within the university community, which are academics themselves or institutional provisions. Where institution access points are not available, private (home-based) Internet access and/or public facilities such as cyber cafes are the main sources. According to our respondents, cost constraints largely foreclose individual ownership of PCs and for this reason academics look for alternative avenues to use the Internet. In Kenya, 43.2% of respondents had Internet service costs covered by institutions and 54.1% paid their own way, while 2.7 % had costs covered through other sources. In Nigeria, most academic staff have private Internet accounts with the few existing ISPs while the occasional users tend to rely on Internet cafes. Institutional provision is far lower at 12.8% while 86.2% cover cost of Internet themselves, table 5. Unlike e-mail services, there is relatively less access to the full Internet services in Nigerian and Kenyan universities. While the institutions may provide e-mail access, they fall short of providing full Internet accesses due to the high costs. As a result, academics access the full Internet from external commercial sources where there is generally higher quality connections and less congestion. Internet initiatives within the universities in Kenya are expected to lead to concessionary rates of telephone tariffs that should increase access. This would make it more likely for institutions to provide full Internet accesses to both academic staff and students. Similar university-based initiatives are going on in Nigeria through the National University Commission (NUC). Much of the initiatives are being supported through multilateral agencies but it remains to be seen how far the efforts would go in improving the quality of access.

Table 5: Who Covers Cost of Internet Use

Provider	Kenya	Nigeria
Self	54.1	86.4
University	43.2	12.8
Others	2.7	0.8

Source: Survey 2001

Given the limited provision, we sought to know where academics use the Internet within the university, a pointer to who pays for use. In Nigeria, 23.4% access the Internet from their offices while 30.4% access the Internet at the institution access points, and 35.7% at cyber cafes, table 6. Only 9.4% use other public access points, 10.5% access the Internet at home and 8.2% do so at friends/colleagues place. The figures for Kenya are similarly shown. We found that use within the institution often refer to common pool computers within a department or faculty, a perfectly logical solution where individuals cannot afford PCs. On the other hand, more dynamic academics with access to research grants, tend to own PCs and as such have the facility in their offices.

Table 6: Where Internet is accessed

Place	**Nigeria%**	**Kenya%**
Office	23.4	38.9
Institution	30.4	25.0
Cyber café	35.7	30.6
Public access	9.4	2.8
Home	10.5	NA
Friends/Colleague	8.2	NA
Other places	2.8	2.8

5.4 Internet Content

We also tried to understand the sophistication of use of the Internet. When staff members in Nigeria were asked to indicate preferred content, on the Internet, majority chose "academic articles" strongly, which ranks by more than 80% on a scale of 1-5. Other interests are far behind.

Respondents were also asked what would be their ideal Internet contents and services. Interaction with peers globally ranked highest and suggests what users lack most presently. Most respondents repeated this preference during the interviews. The sense of isolation due to lack of access is a major problem for researchers. Access to electronic publications and conducting on-line lectures were highly rated as desirable. These responses suggest that the low

intensity use of the Internet may well be a result more of lack of opportunity than lack of willingness. Table 7 shows the types of content needed but not easily available.

Table 7: Content Desired by Respondents.

Add the following uses	Nigeria%	Kenya%
1. More correspondence with peers globally	51.5	69.8
2. Students assignments	14.6	46.5
3. Hold lectures on line	38.5	51.2
4. Access on-line database	41.5	48.8
5. Access e-publication	59.6	51.2
6. Publish my work on-line	49.1	62.8
7. Others	2.9	7.0

Respondents in both countries were interested in websites focused on academic publications, followed by current affairs and least interested in e-commerce websites. They were ambivalent about the others. This result gives further insight into what most academics use or need from the Internet. Given the limiting factors discussed earlier, academics pointed to slow speed of access as a major problem. Lecturers therefore tend to go directly to recommended websites as sources for crucial material, rather than engage in "time-wasting, costly search on the web". While researchers devote a relatively small proportion of time to their own research, respondents still use the Internet to keep abreast of new research and developments in their areas of specialization. Current affairs were ranked highly and indicate the desire to keep abreast of global developments, which do have implications for research. In sum, there is an appreciation of the importance of ICTs amongst lecturers/researchers at the universities but cost and lack of sufficient infrastructure are major constraints.

5.5 Determinants of Internet Use

The severity of constraints to Internet usage and by extension, e-mail and computing is shown in table 8, and Figure 1. The determinants are grouped into five categories namely connectivity infrastructure, skills, ease of use, costs and advantages of the Internet. The scales are both positive and negative ratings, which might mean constraint or advantage. The scales on connectivity, costs, infrastructure and ease of use are constraint categories. The variables are rated on a five point Lickert scale and we elicited responses by asking questions such as "please rate on a scale of 1 (not severe) to 5 (very severe) how telephone costs affect your use of the internet". The table shows the total as well as the mean for each category of determinants disaggregated into their components. In the constraint categories, cost ranks highest in Nigeria, followed by skills and physical infrastructure, closely followed by connectivity infrastructure,

while ease of use was not a severe a problem. In Kenya, connectivity was ranked the most severe followed closely by costs. Unlike Nigeria, ease of use was considered a far more severe constraint than skills and physical infrastructure. This may well reflect the relatively better state of power supply in Kenya

Table 8: Determinants of Internet Use

Constraint	Nigeria	Kenya
CONNECTIVITY INFRASTRUCTURE	**15.41 (2.57)**	**18.67 (3.11**)
Availability of Internet connection	2.36	3.13
Access points (computers) availability	2.67	2.53
Logging on	2.23	3.41
Speed of connection	2.68	3.41
Telephone access	3.05	3.06
Number of Internet sites	2.42	3.13
SKILLS AND PHYSICAL INFRASTRUCTURE	**7.79 (2.60)**	**7.03 (2.34)**
Computer skills	2.18	2.13
Power supply	3.07	2.35
Searching skills	22.54	2.55
EASE OF USE	**9.30 (1.86)**	**12.54 (2.51)**
Level of privacy	2.32	2.65
Availability of time	2.31	2.65
Language of content	0.73	1.90
Accessibility of sites	2.15	2.87
Quality/accuracy of information	1.69	2.47
COSTS	**5.80 (2.90)**	**5.86 (2.93)**
Telephone costs	3.14	2.93
Internet subscription fees	2.66	2.93
ADVANTAGES	**19.04 3.17**	**19.30 3.21**
Traditional books and journal articles are of higher quality than on line articles	2.72	3.11
The Internet has increased the quality of my academic work and enhanced my academic career	3.49	3.05
The Internet has improved the quality of academic research and research papers	3.51	3.15
Access to the Internet enhances the learning process of students	3.75	3.88
The internet has improved the currency, depth and breadth of my lecture material	3.05	3.11
Internet increases the information gap	2.52	3.00

1 = Not a constraint; 5 = severe constraint

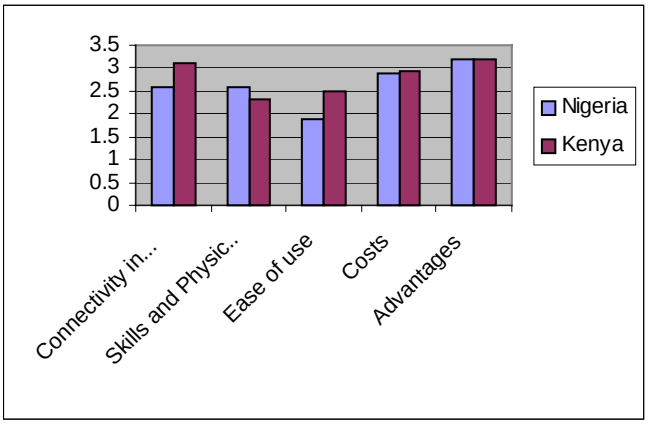
The most binding constraints are therefore inadequate access points, connectivity problems as well as affordable computing accessories. These are strong factors since they are extra costs to end-users. Non-users of the Internet gave reasons such as “not needing it”, “don’t know how”, “no access” “non availability”, “too expensive” and “no time” among others. As a result, they do not venture into using the Internet. This group of non-users therefore are unable to relate to the specific constraints that limit Internet usage such as telecommunications connectivity.

We also found that costs for the services such as Internet subscription fee constitute an important determinant of use where the service is available. One infrastructural constraint, that of ‘lack of computer terminals’, is often a result of improper deployment of computers when they do exist. It is common to find a relatively new computer in an academic department with full Internet access but located in the Head of Department’s office where it is hardly used. This limits the use of the computer for other academic staff. While departments justify this action as a means to reduce costs it tends to defeat the purpose for acquiring the machines that are often under-utilized. Again, e-mail correspondence is retrieved at a common terminal where a secretary prints them out for various staff members. This of course has implication for individuals’ privacy, and tends to limit the use for which institutional facility is used.

Respondents in Kenya did not share as critical a view as the Nigerian academics on unreliable power supply or availability of time as a major hindrance though these are expected to be significant inhibitions. Nigeria suffers particularly aggravating power outages, which has had significant productivity implications for firms, and organizations. Academics therefore rely considerably on Uninterrupted Power Supply (UPS) units and other backup systems to mitigate power outages and fluctuations. This is as true individually owned computers as it is for facilities within the institutions; in fact the absence of these back-up units lead to damage to end user terminals equipment. These are again extra costs to access.

The language of content was not a significant factor since Kenya and Nigeria are both British colonies and the medium for educational instructions from early years is English language. English is the predominant language on the Internet. Privacy in the use the facilities was important but not as significant a factor as the content accessed. According to the academic purposes, for which most respondents use the Internet, was not of a private nature. The skill constraint was not a limiting factor and did not come out a significant problem in using the computer. Some claimed that their searching skills were good but considering that these are people who only spend 23% of their time on research, this is a matter for conjecture. Many, however, admitted dissatisfaction with their skill levels to use the Internet productively. This is consistent with the suggestion by respondents for further training towards enhancing their computer skills.

Figure 1: Determinants of Internet Adoption



6.0 CONCLUSIONS

This paper represents an important first step in understanding the ways in which ICTs are adopted and used within higher education in Africa. The findings show that certain structural variables are important predictors of Internet adoption and usage in Africa. Among these are telecommunications and connectivity infrastructure variables as well as the income level at the aggregate country as well as at the individual and organizational levels. The empirical results show that all the dependent variables were significant in explaining the variations among countries of Internet usage. We also show that access is constrained by subscriptions costs, which is a bundle of charges including telephone costs and subscription paid to local ISPs

Specifically at the aggregate country level, nations with thin bandwidth tend to be the least intensive users while countries that have higher Internet user per capita have moved into relatively expanded bandwidth. Most of the countries are at early stages of Internet absorption and the structure of the market for Internet services provision is still embryonic except for a handful of countries like South Africa with advanced data services and superior telecommunications infrastructure. The Least Developed Countries (LDCs) are far behind in terms of connectivity and computing infrastructure.

Finally our interviews with academics in ten African universities show that much of what we found at the aggregate country level translate to an arid Internet user environment. Given that universities are the gatekeepers of advanced technologies as well as the first users of the Internet in most countries, Internet penetration remains a problematic proposition in poor countries. The kinds of state support system that led to the rapid diffusion of the Internet in the US and other Internet-rich countries is yet to be seen in African countries.

However, our work is exploratory and much remains to be understood about the pattern of diffusion and usage of the Internet in Africa. Future research will need to cover a wider sample of countries and a diverse set of institutions taking into account additional structural and demographic variables. Research need to be carried out on the ways in which essentially codified information acquired through the Internet can benefit knowledge creation in poor countries, and create for instance, an optimal situation of networking among academics in Africa and colleagues in advanced nations be created. Further theoretical and empirical studies should widen the range of variables beyond the ones used in this study. These may include regulatory factors, investments and trade in ICTs software and hardware and importantly the role of institutions (broadly defined) in promoting adoption and usage in African universities and societies.

7.0 REFERENCES

Bussels, R. Reagan. J, Finkletin B and Jackson K, (1999), " Factors affecting use in a saturated-access population, Telematics and Informatics. Vol. 16, pp 45-58

Castells, M., (1996), The Rise of the Network Society, Blackwell Publishers

Colclough, C. and Al-Sammarrai, S. (2000), "Achieving Schooling for All: Budgetary Expenditures on Education in Sub-Saharan Africa and South Asia", World Development, Vol. 28, No. 11, pp 1927-1944.

Dholakia N (1997), The Webs and Web-notes: Access issues in the information age, Telematics and Informatics, vol. 14 no 2, pp 197-207

Freeman C, (1987), Technology Policy and Economic Performance: Lessons from Japan, Frances Pinter, London.

Hargittai E, (2001), Holes in the net: The Internet and International Stratification, www.isoc.org/inet98/proceedings/5d/5d_/htm

Hargitta E, (1999), Weaving the Western Web: explaining differences in Internet connectivity among OECD countries, Telecommunications Policy 23, pp 701-718

ITU, (1999), Trends in telecommunication reform: convergence and regulation, Geneva, ITU

Jensen M, (2001) The African Internet - a status report,
www3.sn.apc.org/africa/afstat.htm

Lin C.A., (1994), Audience fragmentation in a competitive vide market place, Journal of Advertising Research, pp 30-38

Lin C.A., (1998), Exploring personal computers adoption dynamics, Journal of Broadcasting and Electronic Media, vol. 42, pp 95-112

Lundvall B A, (1992), National Innovation Systems: towards a theory of innovation and interactive learning, London, Frances Printers

Mytelka, L., and Tessfachew, T, (2000) "The Role of Policy in Promoting Enterprise Learning During Early Industrialization: Lessons for African Countries", Cambridge Journal of Economics (forthcoming)

Mont C L, (1999), The social uses of Internet in Mexico: a case study, Telematics and Informatics, vol. 16, pp 91-98

Nelson R.R. and Winter S.G., (1982), An evolution theory of economic change, Cambridge M.A., Harvard University Press

Nigerian Institute of Social and Economic Research, (2001), Nigeria review of Nigerian Development, Ibadan

OECD, (1998), The Emerging Digital Economy, Paris

Paltridge S, (2001), Local Access Pricing and the International Digital Divide, www.isoc.org/oti/articles/1000/paltridge.html

Polanyi M, (1966), The tacit dimension, M.A., Gloucester

Porat, M. (1977), The Information Economy: definitions and Measurements, Washington D.C.: US Department of Commerce, Office of the Telecommunications Publications, 77-12 (1)

Pospischil R, (1998), Fast Internet; an analysis about capacities, price structures and government intervention, Telecommunications Policy (October) 745-755

Rao M, (2001) "How Real is the Internet Market in Developing Nations"? On the Internet, March

Rosenberg N, (2001), Challenges to the Social Sciences in the new millenium, in OECD (2001), Social Sciences and Innovation, Paris, OECD

Solow R.M., (1997) Learning from Learning by doing: lessons for economic growth, Stanford

Speight K, (1999), Gaps in the worldwide information explosion: How the Internet is affecting the worldwide knowledge gap, Telematics and Informatics, vol. 16, pp 135-150

Wilson M, (1999), The development of the Internet in South Africa, Telematics and Informatics, vol. 16, pp 99-111

Wolcott, P., Press, L. McHenry, W., Goodman, S. and Foster, W. (2001), "A Framework for assessing the global diffusion of the Internet", Journal of the Association for Information Systems, Vol. 2 (6), November.

World Bank, (2000), Labour Market Prospects of University Graduates in Nigeria, Washington, World Bank

www.telegeography.com

THE UNU/INTECH DISCUSSION PAPER SERIES

2002-5 Internet Access in Africa: an Empirical Exploration By Banji Oyelaran-Oyeyinka and Catherine Nyaki Adeya, May 2001

2002-4 Institutional Support for Investment in New Technologies: The Role of Venture Capital Institutions in Developing Countries By Sunil Mani and Anthony Bartzokas, May 2001

2002-3 Manufacturing Response in a National system of Innovation: Evidence from the Brewing Firms in Nigeria By Banji Oyelaran-Oyeyinka, April 2001

2002-2 Prospects for the Digital Economy in South Africa: Technology, Policy, People, and Strategies By Derrick L. Cogburn & Catherine Nyaki Adeya, April 2001

2002-1 TRIPS and Capability Building in Developing Economies By Rajah Rasiah, March 2001

2001-11 Government, Innovation and Technology Policy, An Analysis of the Brazilian Experience During the 1990s By Sunil Mani, December 2001

2001-10 Innovation Systems, Institutional Change and the New Knowledge Market: Implications for Third World Agricultural Development By Norman Clark, December 2001

2001-9 Working with the Market: The Israeli Experience of Promoting R&D in the Enterprise Sector and the Lessons for Developing Countries By Sunil Mani, December 2001

2001-8 Conditions for Successful Technology Policy in Developing Countries– Learning Rents, State Structures, and Institutions By Ha-Joon Chang Ali Cheema, December 2001

2001-7 Technological Change and Corporate Strategies in the Fertiliser Industry By Anthony Bartzokas, October 2001

2001-6 A Framework for Policy-Oriented Innovation Studies in Industrialising Countries By Anthony Bartzokas and Morris Teubal, September 2001

2001-5 Networks and Linkages in African Manufacturing Cluster: A Nigerian Case Study By Banji Oyelaran-Oyeyinka, September 2001

2001-4 Financial Markets and Technological Change: Patterns of Technological and Financial Decisions by Manufacturing Firms in Southern Europe By Anthony Bartzokas, August 2001

2001-3 Role of Government in Promoting Innovation in the Enterprise Sector An Analysis of the Indian Experience By Sunil Mani, April 2001

2001-2 Government and Innovation Policy An Analysis of the South African Experience since 1994 By Sunil Mani, February 2001

2001-1 Firm Size, Technological Capabilities and Market-Oriented Policies in Mauritius By Ganeshan Wignaraja, February 2001

2000-9 Policy Instruments for Stimulating R&D in the Enterprise Sector: The Contrasting Experiences of Two MNC Dominated Economies from Southeast Asia. By Sunil Mani, December 2000.

2000-8 Industrialisation Meets Globalisation: Uncertain Reflections on East Asia Experience. By Larry Westphal, October 2000.

2000-7 The Dynamics of Technological Learning in Industrialisation. By Linsu Kim, October 2000.

2000-6 The Policy Relevance of Innovation Studies. By Anthony Bartzokas, October 2000.

2000-5 Local Clusters, Innovation Systems and Sustained Competitiveness. By Lynn Mytelka & Fulvia Farinelli, October 2000.

2000-4 Korea's Innovation System: Challenges and New Policy Agenda. By Joonghae Suh, July 2000.

2000-3 Exploring the Challenges and Opportunities for Africa in the Information Economy. By Derrick L. Cogburn and Catherine Nyaki Adeya, July 2000.

2000-2* Special Series of UNU/INTECH Discussion Papers: Information Revolution and Policy Implications for Developing Countries

- #2000-2 Download the full series (274 pages, 620KB) or download your choice of the individual papers listed below:
- #2000-2a Charles Cooper, "Some Themes for the Workshop: An Outline for Policy Analysis"
- #2000-2b Constantine Vaitsos, "Policy Agenda for the Information Revolution and Exclusion Phenomena in Developing Countries"
- #2000-2c Shulin Gu and W. Edward Steinmueller, "National Innovation Systems and the Innovative Recombination of Technological Capability in Economic Transition in China: Getting Access to the Information Revolution"
- #2000-2d Carlos M. Correa, "Implications of Intellectual Property Rights for the Access to and Use of Information Technologies in Developing Countries
- #2000-2e Cecilia Ng Choon Sim, "Making Women's Voices Heard: Technological Change and Women's Employment with Special Reference to Malaysia"
- #2000-2f Ludovico Alcorta, "The Information Revolution and Economic and Social Exclusion: The Experiences of Burkina Faso, South Africa and Tanzania"

2000-1 Exports of High Technology Products from Developing Countries: Is it Real or a Statistical Artifact. By Sunil Mani, May 2000.

9903 Implications of National Innovation Systems for Developing Countries--Managing Change and Complexity in Economic Development. By Gu Shulin, November 1999.

9902 Public Innovation Policies and Developing Countries In a Phase of Economic Liberalisation. By Sunil Mani, October 1999.

9901 The Determinants of Firm-level Technological Performances - A Study on the Indian Capital Goods Sector. By Mohan Babu, September 1999.

9805 Flexible Automation and Location of Production in Developing Countries. By Ludovico Alcorta, May 1998.

9804 Foreign Firms and Technology Transfer Knowledge Spillovers to Indian Manufacturing Firms. By Vinish Kathuria, January 1998.

9803 The Experience of Technological Collaborations by Mercosur Companies. By Ludovico Alcorta, Guilherme Ary Plonski and Celso Augusto Rimoli, January 1998.

9802 The North-South Dimension of the Environment and Cleaner Technology Industries. By Jonathan R. Barton, January 1998.

9801 Environmental Regulation and International Competitiveness: A Review of Literature and Some European Evidence. By Rhys Jenkins, January 1998.

9707 Inter-Firm Technological Cupertino Effects of Absorptive Capacity, Firm-Size and Specialisation. By Frederico Rocha, December 1997.

9706 Technology Trends in Pollution-Intensive Industries: A Review of Sectoral Trends. By Anthony Bartzokas and Masaru Yarime, December 1997.

#9705 The World Market for Telematics Applications to Education: Challenges and Opportunities for Industrialised and Developing Countries. By Maria Bastos, November 1997.

#9704 Multinational Enterprises and export-Oriented Industrialisation in the Host Countries: An Empirical Analysis for the US and Japanese Affiliates. By Nagesh Kumar, September 1997.

#9703 Technology Acquisition, De-regulation and Competitiveness: A Study of Indian Automobile Industry. By Krishnan. Narayanan, September 1997.

#9702 Technology Generation and Technology Transfers in the World Economy: Recent Trends and Implications for Developing Countries. By Nagesh Kumar, June 1997.

#9701 China's National Innovation System Approach to Participating in Information Technology: The Innovative Recombination of Technological Capability. By Gu Shulin and Edward Steinmueller, May 1997.

#9606 Foreign Direct Investments and Technology Transfers in Development: A Perspective on Recent Literature. By Nagesh Kumar, August 1996.

#9605 Toward an Analytical Framework for National Innovation Systems. By Gu Shulin, April 1996.

#9604 EST (Environmentally Sound Technologies) from the West - Asymmetry, Regimes and Polish Policy Implementation. By Mikael Sandberg, April 1996.

#9603 Environmentally Sound Technology: Is Poland Overcoming Soviet-Type Learning Barriers? By Mikael Sandberg, April 1996.

#9602 Multinational Enterprises, New Technologies and Export-Oriented Industrialisation in Developing Countries: Trends and Prospects. By Nagesh Kumar, January 1996.

#9601 The Relevance of Environmental Legislation for the Transfer of Environmentally Sound Technology: The Tanzanian Experience. By Yvonne Ruijters, January 1996. (now only available as a Working Paper)

#9516 Changing Character of Foreign Direct Investment from Developing Countries: Case Studies from Asia. By Nagesh Kumar, December 1995.

#9515 The Relevance of Environmental Legislation for the Transfer of Environmentally Sound Technology: The Mexican Experience. By Yvonne Ruijters, December 1995.

#9514 The Implications of New Organisational Techniques for Developing Countries. By Raphael Kaplinsky, 1995.

#9513 Technology, Manufactured Exports and Competitiveness. By Charles Cooper, 1995.

#9512 Does New Technology bode well for Working Women? An Evaluation and analysis. By Swasti Mitter, 1995.

#9511 Information and Communication Technologies: Growth, Competitiveness, and Policy for Developing Nations. By Edward Steinmueller and Maria-Inês Bastos, 1995.

#9510 Technological Change and Dual Economies. By Charles Cooper, 1995.

#9509 Innovation Systems and Technological Specialisation in Latin America and the Caribbean. By Ludovico Alcorta and Wilson Peres, October 1995.

#9508 The Impact of Industrial Automation on Industrial Organisation: Implications for Developing Countries' Competitiveness. By Ludovico Alcorta, October 1995.

#9507 International Linkages, Technology and Exports of Developing Countries: Trends and Policy Implications. By Nagesh Kumar, August 1995.

#9506 Technological Upgrading, Manufactured Exports and Optimal Accumulation. By Charles Cooper and Roy Turner, September 1995.

#9505 What Hope can Democracy bring to S&T Policy Making in Latin America?. By Maria-Inês Bastos, June 1995.

#9504 Industrialisation, Liberalisation and Two Way Flows of Foreign Direct Investment: The Case of India. By Nagesh Kumar, June 1995. [same as article published in Economic and Political Weekly]

#9503 Telecommunication Industry in Brazil: Public-Private Relationship and Technology Development. By Maria-Inês Bastos, April 1995.

#9502 New Technologies, Scale and Scope, and Location of Production in Developing Countries. By Ludovico Alcorta, March 1995.

#9501 Intellectual Property Protection, Market Orientation and Location of Overseas R&D Activities by Multinational Enterprises. By Nagesh Kumar, March 1995.