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Internet subscription in Africa: policy for a dual digital divide

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Abstract

African nations face a dual digital divide: First, the majority of the population lacks basic infrastructure for Internet access. Second, low Internet subscription rates characterize those who have the potential for access. Factors hypothesized to influence Internet subscription among those with the potential for access include: Economic development, international Internet bandwidth, domestic Internet hosts, ISP market structure, the cost of a local telephone call, and whether English is an official language. Statistical results indicate the strongest influences on subscription are whether English is an official language, monopoly ISP market structure, overall economic development, and the amount of international bandwidth.

Keywords: Internet; Infrastructure; Language; Market structure

1. Introduction

This paper provides an empirical analysis of factors influencing Internet subscription in Africa. Data on the number of dial-up Internet subscribers for each of Africa's 54 nations is analyzed to evaluate which factors influence the likelihood that individuals within a nation will utilize Internet services. African nations face a dual digital divide. At one level, the major problem contributing to the digital divide facing Africa's developing nations is the lack of basic telephone networks needed to reach Internet service providers (ISPs). However, even among the portion of the population that has access to a telephone, Internet subscription is limited, presenting a second digital divide. Among African nations the median percentage of telephone users with a dial-up connection to the Internet is 5.5%. Given this dual digital divide it is useful to examine factors influencing Internet subscription by those who have access to basic telephone facilities. Are these factors similar to those in the developed world, or do special circumstances exist that will require policy actions

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unique to Africa to encourage Internet subscription once the basic infrastructure needed to access the Internet is present?

The paper begins with an overview of the structure of the Internet and of the unique problems that this structure presents in developing nations, especially those in Africa. A review of the literature regarding Internet access in Africa will then follow. The paper then reports the results of statistical analysis of factors that are hypothesized to influence Internet subscription in Africa.

2. Internet structure

At first glance, a distinguishing feature of the Internet is its packet switching and best effort service architecture. Unlike the telephone network which provides a dedicated circuit when a user initiates or receives a call, packet switched networks like the Internet dynamically share telecommunications paths among multiple users. Information (data) that is transmitted over the Internet is broken apart and these "packets" of data may traverse widely differing routes between the point of origin and the point of destination. All packets are multiplexed together and share common transmission facilities, leading to tremendous economies in transmission. Rather than requiring multiple incompatible networks to transmit information (e.g., telephone and cable television), a single network technology can accomplish the goal. The data packets can contain a wide variety of information content, such as text, video, images, facsimile documents, voice, or music. The other critical component of the Internet is the Internet content, applications, and services which allow users to communicate, to gain access to information, or conduct electronic commerce activities.

The Internet has provided unprecedented opportunities for economic growth in the United States and in much of the developed world. Less developed nations, however, face barriers to the application of Internet services to assist with economic growth and development. The structure of the Internet is largely concentric to the United States. The Internet infrastructure in the United States is the core of the global Internet. Diagram 1 shows a simplified representation of the structure of the Internet for users in a developed nation, like the US. The Internet is not ethereal "cyberspace" but is physical infrastructure which is made of public and private sector networks and content providers. The vast majority of global Internet infrastructure is based in the United States. Infrastructure in the US Internet includes Internet backbone facilities, which provide high-capacity network connections. There are multiple nationwide backbone providers in the US at this time.[1] Some of the largest providers of backbone facilities include companies such as Sprint, AT&T, and Verizon's Genuity. These companies have national and international networks that provide high-capacity circuits between their switching centers. The extensive scope of these US backbone networks, which traverse more than 150,000 route miles with fiber optic cable in the US, should be compared with Africa. Africa presently has no Internet backbone facilities.[2] The lack of Internet backbone facilities is a major impediment to Internet development in Africa.

[1] See, for example: http://www1.internetpulse.net/ Accessed October 22, 2002. See also Kende (2000).

[2] Construction of a high-capacity network that will provide connectivity to some of Africa was recently completed. However, the network infrastructure is undersea cable deployed offshore. See, http://www.africaone.com/english/about/about.cfm

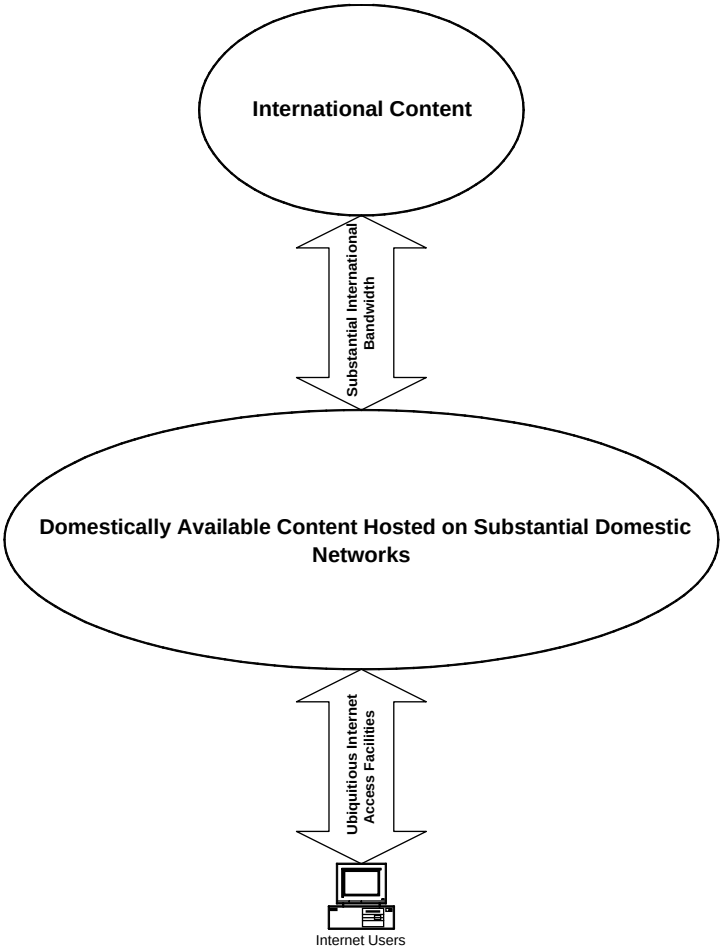

Diagram 1. US Internet Profile.

Without backbone networks, the interconnection of networks is more difficult, and may require extensive backhauling of traffic from interconnection points located elsewhere in the developed world.

The Internet, however, is more than the backbone network capacity that allows communication to take place. Another critical aspect of Internet infrastructure are Internet "host" computers. These are computers that are connected to the Internet and provide content, information, and e-commerce activities. According to Telcordia, the vast majority of all global Internet hosts are located physically in North America. The number of Internet hosts located in the US results in a host penetration rate of approximately 2.4 persons per US Internet host. In Africa, the number of Internet hosts is only a tiny fraction of that in the US, resulting in approximately 3700 persons per African host.[3]

[3] For US statistics, see, "Internet Hosts Reach 100 Million Worldwide." Telcordia, January 2001. Accessed October 22, 2002 at: http://www.telcordia.com/newsroom/pressreleases/01052001.html

The existence of Internet hosts in Africa is important for several reasons. First, locally produced content is more likely to be associated with domestic Internet hosts. The availability of locally produced content can provide unique and beneficial information that would make Internet subscription more attractive to the local population. Second, locally produced content is more likely to be in languages that are spoken locally. Finally, local hosts can also serve to store information retrieved from other, remote, computers. This process is commonly known as "caching" of content. Providing content caches may be critical as the amount of international bandwidth connecting an African ISP to the rest of the world is limited.

The US has another unique feature, the amount of international bandwidth connecting the US-based Internet facilities with the rest of the world. For users of Internet services who reside in the US, the amount of international bandwidth may not be of much concern. As was mentioned earlier, most Internet content is located in the US, thus the typical US Internet user would likely receive a satisfactory Internet experience if the amount of international bandwidth connecting to the rest of the world was reduced to zero. For example, if a physician located in the US wanted to utilize the online version of the Merck Manual (a common medical reference book), this information could be retrieved without using any international bandwidth. However, in African nations, a physician would be entirely dependent on the international bandwidth connecting the local ISP to the rest of the Internet to access the same information.[4] Given the US-centric nature of the Internet, developing nations are heavily dependent on international bandwidth to access valuable Internet content. In Africa, however, there is a dearth of international bandwidth. According to Telegeography, Inc. US international bandwidth exceeds 270,000 Megabits per second.[5] In contrast, consider the international bandwidth available for the top 25 African nations, shown in Table 1. It is instructive to note that the amount of international bandwidth available for the 24th and 25th-ranked nations, Benin and Cape Verde, at 1.024 Mbps, is less than what is available to an individual residential subscriber in the US through a cable modem or telephone company digital subscriber line. Nine (9) African nations had 64 kilobits of international bandwidth available during 2001, about the same amount of bandwidth that a residential dial-up subscriber in the developed world enjoys.

Finally, the last major difference when considering the deployment of Internet technology in the US and in developing nations is the issue of Internet access facilities. These facilities include the Public Switched Telecommunications Network, which the vast majority of US residential customers utilize to dial up a connection to the Internet, cable television company broadband networks that have been upgraded to provide data communication capacity, satellite systems, emerging fixed wireless systems, and dedicated facilities that connect businesses and college campuses to the Internet. These facilities are widely deployed in the US and in most of the developed world. In Africa, however, deployment of infrastructure that is capable of providing Internet access is limited. The teledensity of Africa is about 1 telephone per 200 individuals. The lack of access facilities presents another critical barrier to Internet usage in Africa. Without the basic telecommunications infrastructure in place, the chances of the population taking advantages of Internet services are greatly reduced. Diagram 2 shows a summary representation of Internet

[4] This assumes that no cache of the information was available. Cache can serve as a substitute for bandwidth.

[5] "Internet Bandwidth Expands Around the Globe" Telegeogeography Inc. October 9, 2001. Accessed October 22, 2002 at: http://cyberatlas.internet.com/big_picture/hardware/article/0,,5921_900241,00.html

Table 1
International bandwidth ranked for top 25 African Nations, August 2001 http://demiurge.wn.apc.org/africa/afrmain.htm#NWdata

Country	International bandwidth (Mbps)
South Africa	300
Morocco	136
Egypt	112.5
Senegal	48
Tunisia	41.5
Botswana	14
Nigeria	9.216
Kenya	6.144
Cote D'Ivoire	5.120
Zimbabwe	5.120
Seychelles	4.098
Ghana	4.096
Mauritius	4.096
Tanzania	4.096
Namibia	3.072
Zambia	3.072
Madagascar	2.556
Algeria	2.048
D.R Congo	2.048
Libyan Arab Jamahiriya	2.048
Mozambique	2.048
Uganda	2.048
Togo	1.536
Benin	1.024
Cape Verde	1.024

facilities from the developing world's viewpoint: limited Internet access facilities, limited domestically available content on limited national data networks, and the proportionally much larger volume of international content only available through limited international bandwidth.

3. Other factors affecting Internet usage in Africa

As the discussion above indicates, Internet development has been concentric to the developed world, primarily to the US. Developing nations face major challenges in attempting to join the Internet economy. Additional challenges facing African nations are discussed in more detail below.

Economics always plays an important role in encouraging the use of technology in developing countries. In Africa, there are no "High-Income" countries, and 33 countries are classified as "Least Developed." The only countries classified as "Upper-Middle Income" are Gabon, Mauritius, Reunion, Seychelles, and South Africa (UN Economic Commission for Africa [ECA], 1999).

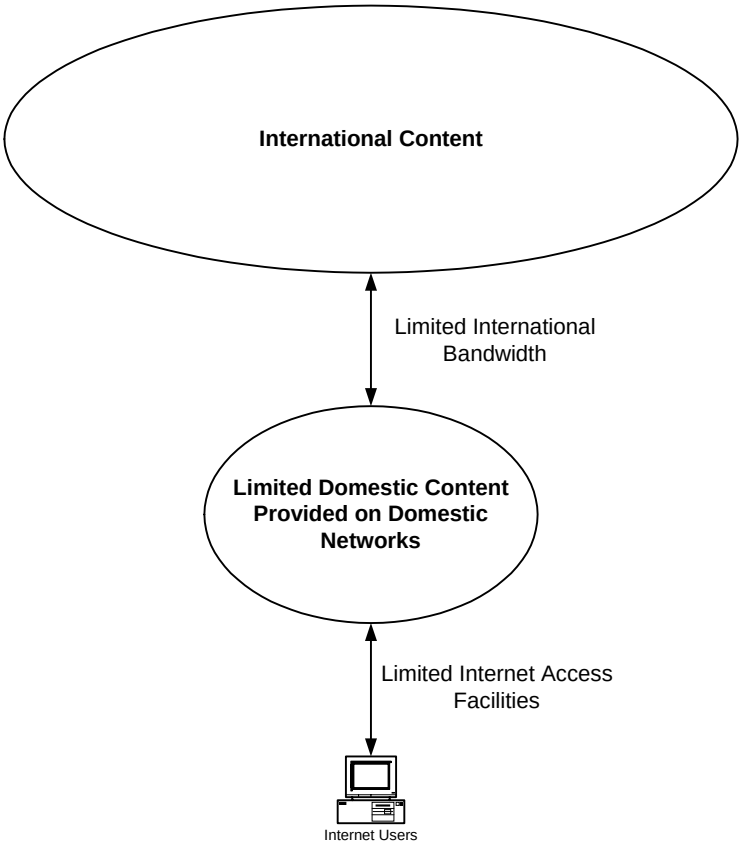

Diagram 2. Developing World Profile.

Most telecommunications infrastructure in Africa is deployed in capital cities. Only 17 million telephone lines have been installed on the continent (ECA, 2000). The overall teledensity is still only about one per 200 inhabitants (ECA, 1999). Additionally, ISPs are also primarily located in the capital cities, while more than 70% of Africa's population is in rural areas. Therefore, people in the rural areas who have access to telecommunications have to make a costly long distance call in order to connect to the Internet (ECA, 1999).

Jensen (2001) compared the cost of Internet access between the Western and African countries. In Africa, the average total cost of using local dial-up Internet for 5 hours a month is about $68 per month (including usage fees and telephone time, but not telephone line rental). Put in the perspective that average per capita income in sub-Saharan Africa is less than $1500 (US) per year, Internet access in Africa is a luxury that only a fraction of the population could consider.

4. Overview of Internet policy perspectives on Africa

The issue of policy to promote Internet access in developing countries has attracted the attention of scholars in recent years. Afullo (2000) studied the information infrastructure in Africa

and contends that the issues influencing Internet penetration include infrastructure, pricing, policies, literacy, income, and education. He reports that the vast majority of Internet hosts are in developed nations and argues that wealth and education are major factors affecting Internet diffusion. He also suggests that Internet accessibility in Africa can be remedied "through liberalization, unrestricted market access, eradication of under-investment and inefficiency through privatization and private sector involvement, and tariff reform" (p. 212).

World Bank (2001) emphasizes that issues requiring immediate attention for the use of the Internet include pricing structures, monopoly control of Internet access, and licensing charges for content. Additionally, World Bank suggests the policies should be directed at liberalization of telecommunications networks and Internet service provision, as well as lower tariffs on computer and telecommunications equipment.

Adams (1997) discusses some challenges to universal access in Africa, which include the deteriorating rural infrastructure, low education level, statist nature of telecommunications operations, and hierarchical government institutions. He states his concern that high prices set by existing local ISPs in Africa may deter the academic and research community from accessing global resources.

Jensen (2000) discusses the development of Internet content among African countries. Among the increasing numbers of organizations having a web site with basic descriptive and contact information, "many are hosted by international development agency sites, and very few actually used the web for their activities" (p. 217). He notes that this phenomenon results from a small number of local people having access to the Internet, limited skills to create web pages, and high costs of local web-hosting services.

Ngwainmbi (2000) discusses the problems of information technology in Africans' daily life. He states that the computer is out of reach for the majority of African people because of its high initial cost. The high cost of maintenance also limits the use of computers. He finds that the major impediments to the implementation of information technology in most African countries include obsolete and dilapidated telecommunications infrastructures, high costs of links to Internet backbones, shortages of technical staff, and limited availability of electricity. He also notes that some African governments may view the Internet as a threat to African culture, or even national security, thus resulting in the restriction of public accessibility.

In the study of information transfer to African nations, Edoho and Udo (2000) argue that poverty is a major challenge that restrains African countries from utilizing information technology. Many countries have low per capita income and declining standards of living, therefore policymakers are concentrating their efforts to meet the basic needs of the poor people. They also argue that the absence of infrastructure makes it extremely difficult for the African region to receive and utilize information technology. Electricity breakdowns cause prolonged power outages that disrupt business operation and increase costs. In sub-Saharan Africa, the infrastructure is concentrated in the urban areas and access to telephones are limited to a few elite. Poverty contributes to inter-ethnic strife and civil war devastating the region, policymakers are more concerned with investing in internal security, rather than in information technology.

Chisenga (2000) finds factors affecting the Internet connectivity in the sub-region include the slow development of telecommunications infrastructure, high cost of telecommunications, and high telecommunications tariffs in most countries.

Smith (2000) conducted a case study on bringing Internet access to a sparsely populated and remote province in South Africa. He indicates that underdeveloped infrastructure is the main problem in African remote rural areas, in which the majority of homes and businesses do not have telephones. Only three out of 71 schools in the areas Smith studied had electricity and none had telephones.

5. Statistical analysis

The main focus of this paper is to study factors that influence Internet subscription among those in Africa who have a telephone. The results from the analysis will allow for evaluation of potential policy measures that will encourage Internet subscription among portions of the populations in developing nations that may currently have the potential to utilize the Internet.

In order to approach the question of how Internet subscription among those with a telephone may be influenced, it is first necessary to identify factors which are hypothesized to influence Internet subscription among those with access to a telephone. These factors are:

(1) The general level of economic development in a nation. It is expected that higher levels of economic development will result in higher levels of Internet subscription among those who have access to a telephone.
(2) The amount of international bandwidth connecting the nation to the rest of the international Internet. Most Internet content is located outside of developing nations. Larger amounts of international bandwidth improve the performance of Internet applications such as those associated with the World Wide Web. It is expected that larger amounts of international bandwidth will result in higher levels of Internet subscription among those who have access to a telephone.
(3) The availability of domestically provided content. Domestically produced content may be highly relevant to the population of a developing nation, making it more likely that a telephone user would subscribe to an Internet service provider.
(4) The market structure in the nation's ISP industry. Competition among ISPs in the developed world has promoted Internet subscription as the competition has resulted in innovative services which are tailored to the needs of subscribers, and lower prices. It would be expected that a similar outcome would hold in the developing world.
(5) The cost of local calls. If local calling is charged on a measured basis, an Internet user will incur additional charges to dial-up an ISP. It is expected that higher costs of local calling will make it less likely that Internet subscription will take place for those with a telephone.
(6) The languages spoken in the country. English-language content currently dominates the Internet. It would be expected that nations where English is more widely spoken would be more likely to have higher levels of dial-up subscription.

6. Data sources

Data must be identified to account for the factors identified above which are hypothesized to influence Internet subscription among those who have access to a telephone. The data set that was created contains information on a number of variables for all 54 African nations.

Data on the number of dial-up Internet subscribers for 2001 was collected from the African Internet Connectivity website.[6]

To control for the level of economic development in a nation, the United Nation's Human Development Index (HDI) is used. The HDI is a composite index which is based on life expectancy at birth; adult literacy; primary, secondary, and tertiary educational enrolment ratios; and GDP per capita. Values for the HDI are taken from the United Nation's Human Development Report 2002, which contains values for 2000.[7]

In order to control for the local availability of domestically produced content, the number of Internet hosts in each country is utilized. It would be expected that there would be a high degree of correlation between domestic content available in a nation and the number of Internet hosts present in the nation. Data on the number of Internet hosts for 2001 is drawn from Network Wizards,[8] an organization that tracks Internet hosts worldwide.

Data on international bandwidth for 2001 is also drawn from the African Internet Connectivity website. In order to better assess the distribution of international bandwidth within a nation, the international bandwidth for each nation was divided by the number of cities in the nation with ISP points-of-presence (POPs). This calculates the amount of international bandwidth that is available per city with an ISP POP and thus adjusts overall international bandwidth to acknowledge that the total amount may be shared among multiple POPs within a nation.

Information on the market structure in the ISP industry for 2001 (whether or not there are competing ISPs and the number of cities within a nation with an ISP point of presence) was also available on the African Internet Connectivity website. A dummy variable was created to identify nations where the ISP market was characterized by a single provider (i.e., monopoly market structure).

The cost of local calls was available from the African Internet Connectivity website. However, unlike the other variables, only partial data (37 out of 54 nations) was available for the per hour cost of a local phone call in $US.

To measure the impact of English language content, information on a nation's official language is drawn from CIA reports and the *World Fact Book*. A dummy variable which takes the value of "1" if English is an official language in the nation was created using this information.

The statistical model of the relationship between the dependent variable of the percentage of telephone users with dial-up Internet access and the explanatory variables described above is shown below:

$$Y_i = b_0 + b_1 X_{1i} + b_2 X_{2i} + b_3 X_{3i} + b_4 X_{4i} + b_5 X_{5i} + b_6 X_{6i} + e_i,$$

where b_i = the regression coefficient to be estimated; Y_i = dialup connections expressed as a percentage of telephone lines in the ith country; X_{1i} =human development Index for the ith country; X_{2i} = amount of international bandwidth per city with a point of presence in the ith country; X_{3i} = number of Internet hosts in the ith country; X_{4i} = dummy variable which takes a value of "1" if the ith country has a monopoly ISP; X_{5i} = cost per hour in US dollars of a local

[6] http://www3.sn.apc.org/africa/afrmain.htm

[7] For countries not listed in the 2002 Human Development Report, values from the 2000 Human Development Report were utilized.

[8] http://www.nw.com/

Table 2
Expected coefficient signs

Variable Name	Expected sign
Human Development Index	Positive
Number of Internet Hosts	Positive
International Bandwidth per City with POP	Positive
English Official Language	Positive
Monopoly ISP	Negative
Cost of a Local Call	Negative

Table 3
Dependent variable: percentage of telephone lines with dialup connection

Variable name	Estimated coefficient	Standard error	Asymptotic T-ratio	Significance level (%)
Constant	0.023376	0.014652	1.5954	11
Human Development Index	0.076374	0.018726	4.0784	1
Number of Internet Hosts	0.00000015675	0.000000088434	1.7725	8
International Bandwidth/City with POPs	0.0000009905	0.00000020893	4.7408	1
English Official Language	0.047937	0.0081304	5.896	1
Monopoly ISP	−0.034861	0.0099305	−3.5105	1
Cost of a Local Call	0.00051749	0.0013005	0.39791	69

Squared correlation coefficient between observed and predicted: 0.28685.
Likelihood Ratio Test: 40.37 (P-value = 0.00).

telephone call in the ith country; X_{6i} = dummy variable which takes a value of "1" if English is the official language in the ith country; e_i = is a random error term.

Expected coefficient signs are shown in Table 2.

Ordinary Least Squares was initially performed on the data set. Diagnostic tests indicated that heteroskedasticity was present. Maximum likelihood estimation was then applied to the model to correct for heteroskedasticity. The results of the maximum likelihood estimation are shown in Table 3.

7. Discussion of results

The results of the likelihood ratio test rejects the null hypothesis that none of the variables hypothesized to influence Internet subscription have an impact, i.e., the hypothesis that

$$b_0 = b_1 = b_2 = b_3 = b_4 = b_5 = b_6 = b_7 = 0$$

is rejected at a significance level of 1%, indicating that the identified coefficients have a statistically significant impact on the level of Internet subscription. Signs of the statistically significant

regression coefficients are as expected, indicating that the data is consistent with the hypothesized impact of the variable. With the exception of cost of a local call, and the number of Internet hosts, all coefficients are significant at 5% (the number of Internet hosts is significant at 10%). These results indicate that the factors which have been hypothesized to influence Internet penetration do have a statistically significant impact.

It is important to note that the results of the analysis allow the impact of each explanatory variables to be considered, holding constant the effects of the other explanatory variables. Thus, the results are interpreted as the impact of each explanatory variable on the level of Internet subscription among those who have a telephone, holding constant the influence of the other explanatory variables. In light of this interpretation, the results in Table 3 are discussed below:

- The Human Development Index shows a statistically significant positive impact on Internet subscription. While it is commonly accepted that the level of Internet subscription between the developed world and the less developed world is different, this result shows that variation in the level of development in Africa's nations results in statistically significant differences in Internet subscription.
- The results show that higher amounts of international bandwidth has a statistically significant positive impact on Internet subscription. This result likely reflects the demand for international Internet content. More international bandwidth allows for better access to content that is available outside of the home country's network.
- The presence of English as an official language has a statistically significant positive impact on Internet subscription. Given the dominance of English-language content on the Internet, this result may point to a higher value being placed on the Internet by users where the ability to interpret English-language content is more likely.
- Monopoly in the ISP market has a statistically significant negative impact on the level of Internet subscription. This may be the result of higher prices that would be associated with monopoly provision, or the lack of diversity of Internet services provided by the ISP. The success of the Internet in the developed world, and especially in the US has been driven by competition among Internet service providers, which had led to innovative services which have attracted more Internet users.
- The number of Internet hosts shows a positive impact on Internet subscription. As was noted above, the level of significance is at the 10% level, which leads to some caution in interpreting the result. Given this qualification, the results indicate that the more domestic hosts that are present in a nation, the higher will be Internet subscription. This may indicate that the availability of domestic content attracts more Internet users.
- The cost of a local call is not statistically significant. The lack of statistical significance may be the result the fact that only partial data was available for this variable.

The coefficients shown in Table 3 cannot be directly compared. However, by standardizing the coefficients, direct comparisons between coefficients can be made. The statistically significant values of the standardized coefficients shown in Table 4 tell an interesting story. The factor which shows the strongest positive influence on dial-up Internet subscription is the presence of English as the official language in a country. Given the dominance of English-language content, this result indicates that the language barrier is a significant one for encouraging Internet subscription. Other statistically significant positive influences include (in the order of relative impact) the Human

Table 4
Standardized coefficients

Variable name	Standardized coefficient
Human Development Index	0.19395[a]
Number of Internet Hosts	0.062118[b]
International Bandwidth per City with POP	0.11112[a]
English Official Language	0.38704[a]
Monopoly ISP	−0.27834[a]

[a] Coefficient significant at 5%.
[b] Coefficient significant at 10%.

Development Index, the amount of international bandwidth per city with an Internet POP, and the number of Internet hosts.

With regard to statistically significant negative influences, the presence of monopoly in the ISP market shows a relatively strong negative impact. This result is indicative of the negative impact that an ISP monopoly can introduce for Internet subscription rates.

8. Discussion and conclusions

As policy makers grapple with the problems presented by a growing digital divide between the developing and developed world, the focus will likely be on the deployment of basic telecommunications infrastructure. However, it is also critical to take every measure to encourage adoption of Internet technology *given existing infrastructure levels*. Infrastructure deployment is the most critical factor leading to Internet subscription. However, the prospects for far-reaching infrastructure build-out are not promising in the near term. Thus, it is important to promote the adoption of Internet technology to the fullest, given existing infrastructure levels. The process of catch-up will only be lengthened if policies to encourage adoption of the technology are ignored. An established base of Internet users will allow for a more rapid dissemination of Internet technology as the basic infrastructure (e.g., electricity and telephone services) is built out. Furthermore, an established base of Internet users can promote economic growth within the nation.

The results of the statistical analysis discussed above points to the relative importance of certain factors that affect Internet subscription that can be influenced by policy makers, namely:

- Encouraging the growth of native-language Internet hosts would help increase Internet adoption. The fact that the presence of English as the official language shows a significant positive relationship on Internet subscription in African nations lends support to the proposition that encouraging the adoption of Internet technology requires the availability of content in languages that can be understood by the nation's population. A policy encouraging native-language content would also reinforce the number of domestic hosts, which was also shown to have a positive impact on Internet subscription.

- Expansion of international bandwidth could lead to further increases in Internet subscription rates among those with telephone facilities, as the availability of international bandwidth also has a significant positive impact on subscription.
- Encouraging competition in the ISP market would appear to be prudent policy to promote Internet adoption, as monopoly in the ISP market significantly dampens Internet subscription.

The second component of the strategy for Africa must address those that have no access to even the most basic infrastructure. Policy makers, when considering the approach for this portion of the population must grapple with resource allocation issues, such as whether safe drinking water or Internet access is given a higher priority. It is likely that basic Internet applications that are highly scalable, such as e-mail, could provide powerful tools for economic development. Deployment of Internet technology using the telecentre model might be the most efficient means to make Internet access available, and this strategy is already being successfully utilized on a limited basis (Hudson, 2000; BBC, 2002). Scalable applications also have the advantage of requiring small amounts of bandwidth, thus leading to flexibility with regard to the needed Internet access facilities. Terrestrial wireless or satellite transmission will likely be sufficient for such applications (Rao, 1999). A combined policy strategy of promoting Internet use given existing Internet access infrastructure, along with strategies to overcome the deficiencies in basic infrastructure that would allow the Internet to reach a larger portion of the population, will be needed to overcome the dual digital divide facing African nations.

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