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Mobile Cellular Telephone: Fixed-line Substitution in Sub-Saharan Africa

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ABSTRACT: Mobile cellular telephones have been the success story of communications globally. In the developed world, mobile telephony is traditionally seen as being complementary to fixed-line telephony, primarily because of its pervasiveness but also because the fixed-line network provides access to other technologies such as broadband. This article finds that, in nine African countries, in contrast to the developed world, mobile telephony is a substitute for fixed-line telephony – across all income groups and not just low income households as previously thought. The article argues in addition that pre-paid payment options (not just for mobile phones) are key to increasing use by low income households because irregular incomes do not support regular financial commitments in terms of contracts.

Background

This article is based on data from household surveys conducted by Research ICT Africa! in nine African countries: Botswana, Cameroon, Ethiopia, Namibia, Rwanda, South Africa, Tanzania, Uganda and Zambia. The surveys were conducted with the aim of building an e-Access and Usage Index to measure information and communication technology (ICT) usage from the lens of consumers.[1] The purpose of this article is to understand ICT usage within countries by dividing the country into three major categories, namely, rural, urban and metropolitan areas. The study provides some insight into the disparities of access to ICTs according to geographic location.

Using the same data, this article makes a contribution to several debates; firstly, the issue of whether mobile is a substitute for, or a complement to, fixed-line phones.

Until recently, studies on this issue have focused mainly on the developed world – see Rodini *et al* (2003) for the United States of America (USA); Pita Barros & Cadima (2000) for Portugal – and have specifically looked at the impact of the expansion of mobile networks on the fixed-line network. An equivalent article on Africa has come from Hamilton (2003), and examines the impact of competition from the mobile sector on the fixed-line sector. Hamilton argues that "the important lesson is that, although there is some substitution between mobile and main line, mobile's role as a complement dominates" (Hamilton, 2003: 22). Moving away from the supply side of the equation, however, Hodge (2005) finds that amongst lower income households mobile is regarded as

1 Gillwald, A (ed.) (2005) *Towards an African e-Index: Household and individual ICT access and usage across 10 African countries*, www.researchictafrica.net.

a substitute for fixed-line telephony. While Hodge's data are based on the South African situation only, this article draws on data for eight African countries and consequently has more applicability to the developing world as a whole.

The second hypothesis of the article is that the strong growth of mobile penetration is due to the flexibility of payment options (specifically pre-paid) and the relatively lower income barriers at low call volumes. While evidence does not support this conclusion as convincingly as it supports the first hypothesis, the data indicate that households with mobile phones have lower incomes than fixed-line households. This would seem to demonstrate that the income barrier for access to communications has been significantly lowered by mobile telephony.

The data used in this report are further bolstered by the findings of the e-Access and Usage Focus Group survey conducted in South Africa in July 2005. While the data from the e-Index household survey provide much needed quantitative analysis on the use of communication technology, the focus groups are intended to bring some understanding to the decision-making processes behind some of the trends identified in the household survey.

Methodology

The e-Index household surveys were based on methodology developed by the World Health Organisation for the Expanded Programme on Immunisation (EPI). This methodology was used so that national representative results could be derived in developing countries where cost considerations are paramount and where records are often incomplete.

The survey was carried out using random sampling techniques and comprehensive questionnaires amongst users and consumers in urban and rural areas. The data were collected in such a way that gender, area, income and other significant factors could be analysed to determine relations between penetration and usage patterns and between policy and regulatory environments.

Table compiled from data obtained through the e-Index and Usage survey (2005).

Number of households sampled	Total	Major urban	Other urban	Rural
Botswana	780	269	212	299
Cameroon	1,136	782	195	159
Ethiopia	1,791	1,017	654	120
Namibia	854	354	249	251
South Africa	1,742	871	565	306
Tanzania	1,800	1,200	180	420
Uganda	1,653	963	334	356
Zambia	1,297	802	342	153
Total	11,955	6,618	3,084	2,253

Table 4.1: Households surveyed

Probability sampling was used as a means of ensuring that all individuals in the target population had a reasonable chance of being selected. For the sampling a three-stage process was used (Gillwald, 2005).

- Primary Sampling Units (PSU): Used in the first stage, and defined as metropolitan, urban and rural areas.
- Secondary Sampling Units (SSUs): Enumerator Areas (EAs), as defined by the national population censuses, were used as secondary sampling units, and were selected based on probability proportional to estimated size.
- Tertiary Sampling Units (TSUs): Defined as households that were randomly chosen within the selected EAs during the field work, using sampling intervals. The sampling intervals for each EA were determined by dividing the number of households present in an EA by the target sample of 27 households per EA.

The survey was complicated by the high level of diversity between countries. At the one extreme is Ethiopia, with a population of 70 million. At the other extreme is Botswana, with a population of 1.7 million. Furthermore, only 15% of Ethiopia's population is urbanised compared to 62% of Cameroon's population. Botswana, with the lowest population, has an urban population of over 50%, while South Africa, despite its strong economy, has an urban population of only 53%.

According to data from the International Telecommunication Union (ITU, 2004) Gross Domestic Product (GDP) is similarly diverse. South Africa remains well ahead, with a GDP of US$ 104 billion (2003). The GDPs of the other countries surveyed range from Cameroon (the next highest at US$ 10 billion), through Uganda (with US$ 6 billion), to Rwanda (the lowest with just over US$ 1.7 billion). In terms of GDP *per capita*, Botswana is the highest at US$ 2,939 and South Africa is next at US$ 2,293. However, Botswana has a tiny population of only 1.7 million people compared to South Africa's 44 million. Namibia is in the middle of the range of GDP *per capita* at US$ 1,593, but is followed by countries where the GDP *per capita* reflects some of the poorest economies in the world: Cameroon (US$ 670); Zambia (US$ 338); Tanzania (US$ 281); Uganda (US$ 243) and Ethiopia (US$ 93).

Access and usage

Of the surveyed countries, Botswana and South Africa have the highest fixed-line penetration, at 25.6% and 23.4% respectively. Botswana's high penetration is a function of its small population and relatively high level GDP. South Africa's penetration of 23.4% is also explained by its high GDP compared to the rest of Africa, although the penetration would be higher if were not for disconnections (due to exorbitant costs) of over 2.8 million lines since 2002. Uganda has the lowest penetration at 1.2% with Tanzania next at 2.6%. Ethiopia and Cameroon are grouped together at around 5%.

	Households with a fixed line	Households with one or more mobile phones
Botswana	25.6%	52.9%
Cameroon	5.3%	51.8%
Ethiopia	5.0%	1.1%
Namibia	13.0%	32.6%
South Africa	23.4%	56.7%
Tanzania	2.6%	33.3%
Uganda	1.2%	11.7%
Zambia	10.0%	24.6%

Table compiled from data obtained through the e-Index and Usage survey (2005).

Table 4.2: Fixed-line and mobile access

The role of mobile phones in extending access is clear from Table 4.2 (above). The number of households with a mobile phone (or more than one mobile phone) is often several times higher than the fixed-line penetration. The most striking example is Uganda, where fixed-line penetration is 1.2% and mobile penetration (per household) is 11.7%. Similarly, in Tanzania, mobile penetration is more than ten times greater than the fixed-line penetration. The only country where mobile telephony has not extended access is Ethiopia, where the number of fixed lines is actually greater than the number of mobile phones per household. The explanation for this discrepancy is that Ethiopia is the only country (of those surveyed) that has a state-owned monopoly providing all forms of communication (fixed-line, mobile and, until recently, Internet access). Even in countries with a relatively high GDP *per capita* (such as South Africa and Botswana), mobile telephony has doubled the number of households with access.

In nearly all of the countries, the most common monthly account is between US$ 1 and US$ 10 per month. The exceptions are South Africa, Uganda and Zambia, where the average monthly account is likely to be between US$ 11 and US$ 20. This amount includes the cost of rental and use of the phone. In South Africa and Namibia, a significant percentage (37.5% and 24.7% respectively) spend more than US$ 51. Since these countries

How much does your account for your fixed-line phone come to per month (US$)?						
	$1-$10	$11-$20	$21-$30	$31-$40	$41-$50	$51->
Botswana	47.6%	24.6%	10.3%	4.8%	4.0%	8.7%
Ethiopia	80.0%	9.3%	4.0%	2.7%	2.7%	1.3%
Namibia	30.6%	15.3%	11.8%	9.4%	8.2%	24.7%
South Africa	12.7%	19.2%	13.4%	10.4%	6.8%	37.5%
Tanzania	79.4%	17.6%	2.9%	0.0%	0.0%	0.0%
Uganda	22.2%	66.7%	0.0%	0.0%	0.0%	11.1%
Zambia	25.4%	41.3%	11.1%	7.9%	4.8%	9.5%

Table compiled from data obtained through the e-Index and Usage survey (2005).

Table 4.3: Average household fixed-line account, in US$

Monthly household income	Fixed-line household account converted to US$					
	$1-$10	$11-$20	$21-$30	$31-$40	$41-$50	$51->
$1-$250	58.8	19.6	10.6	2.0	2.0	7.0
$251-$500	42.5	24.8	9.7	7.1	6.2	9.7
$501-$750	21.4	35.7	14.3	7.1	8.9	12.5
$751-$1000	20.9	37.2	9.3	9.3	7.0	16.3
$1001-$1500	14.8	22.2	11.1	9.3	13.0	29.6
$1501-$2000	19.4	9.7	16.1	12.9	6.5	35.5
$2001->	11.5	7.7	9.0	11.5	3.8	56.4

Table 4.4: Household income versus fixed-line household account, in US$

Table compiled from data obtained through the e-Index and Usage survey (2005).

are also amongst the highest of those surveyed in terms of *per capita* GDP and household income, this is to be expected.

Household income has been placed alongside average spend per month on a fixed-line account. The last column in the table is indicative of how large the household fixed-line account can be when a fixed line is used, regardless of the level of income. A fixed-line account of more than US$ 51 is the only column that consistently increases as income increases.

Mobile phones: Substitutes or complements?

This section tests the hypothesis that in Sub-Saharan Africa mobile phones are substitutes for, rather than complements to, fixed-line telephones. The hypothesis seems to be intuitively correct given that there are more mobile phone subscribers than fixed-line subscribers in Sub-Saharan Africa. However, one might argue that for those households with a fixed-line phone, mobiles are complementary, while for those that do not have a fixed-line phone, mobiles are substitutes.

Generally, a household with a fixed-line phone is more likely to have household members that have mobile phones. While 67.1% of households with fixed-line phones had one or more mobile phones in the household, 27% of households without fixed-line phones had mobiles. However, mobile and fixed-line possession are linked to income. Households with fixed-line phones had, on average, a monthly household income of US$ 640.79, compared to US$ 246.03 for those without one.

Using the eight countries included in this survey, the table below replicates a comparison developed by Hodge (2005). To facilitate comparisons, the table uses the same income categories as in Hodge's paper.

The data presented in the figure below confirm Hodge's (2005) key finding; namely, that the higher the household income, the more likely it is for households to have both fixed-line and mobile telephony access. Even at the highest household income level (greater than $1390 per month) mobile phones are complementary for just a third.

Graph drawn up from data obtained through the e-Index and Usage survey (2005).

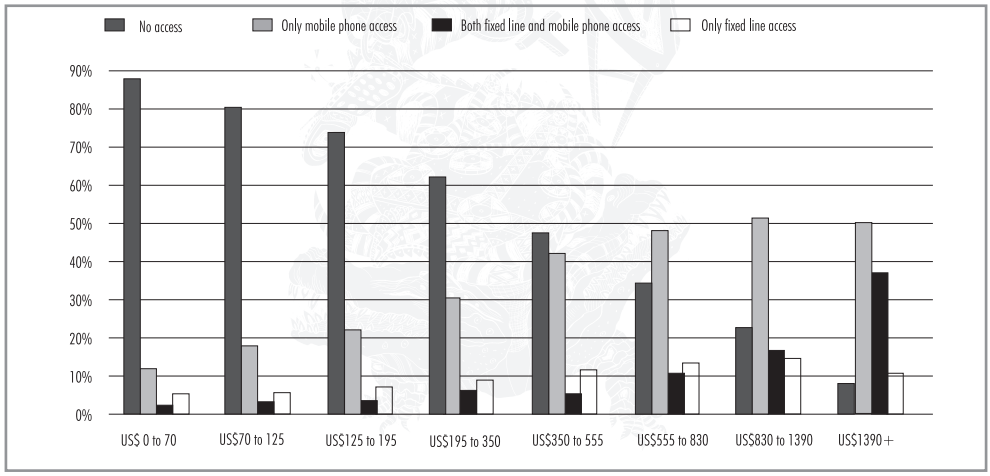


Figure 4.1: Household income compared to access

The following hypothesis makes an even stronger case: namely, that there is a difference in the average number of mobile phones per household when comparing households with or without fixed-line phones at a given income level. If this is the case, and if households without a fixed-line phone have a higher average number of mobiles per household, then a conclusion can be drawn that mobile telephony substitutes for fixed-line phones rather than complementing them.

Table compiled from data obtained through the e-Index and Usage survey (2005).

	Sample Group	Mean rank	Sum of ranks	Average number of household members
Households without a fixed-line phone	617	566.3404	349432	2.86
Households with a fixed-line phone	443	480.5824	212898	3.78
Total	1060			
Mann-Whitney U			114552	
Wilcoxon W			212898	
Z-test			-4.648290121	
Asymmetrical Significance (2-tailed)			0.000	
a	Grouping variable: Do you have a fixed-line phone at your home?			

Table 4.5: Average number of mobile phones per household[2] for the top 10% of households in terms of average household income per household member

Looking at the top 10% of households in terms of average household income per household member converted to US$ using the implied Purchasing Power Parity (PPP) conversion rate, it would appear that households without fixed-line phones have, on average, a higher number of mobiles per household than households with a fixed-line phone.

2 Average number of mobile phones = the number of mobile phones in a household divided by the number of household members.

	Household income grouped in US$						
	$1-$250	$251-$500	$501-$750	$751-$1000	$1001-$1500	$1501-$2000	$2001->
Poor service	4.4	13.8	8.3	8.7	0.0	16.7	14.6
Could not afford it	42.5	26.6	23.3	21.7	27.6	25.0	20.8
Billing problems	31.0	41.3	36.7	34.8	20.7	0.0	14.6
Did not use it often enough	5.3	1.8	3.3	4.3	0.0	8.3	4.2
Old technology	3.5	2.8	5.0	8.7	0.0	16.7	2.1
Have mobile phone/s	3.5	2.8	18.3	21.7	34.5	33.3	31.3
Corruption, bribes wanted	1.8	0.0	0.0	0.0	0.0	0.0	0.0
Other	8.0	11.0	5.0	0.0	17.2	0.0	12.5

Table compiled from data obtained through the e-Index and Usage survey (2005).

Table 4.6: Main reasons for households no longer having fixed-line phones

The Mann-Whitney U test confirms that the mean difference is significant. This clearly indicates that mobile phones substitute for fixed-line phones. (This holds even when omitting the South African households from a sample.)

A further table has been drawn up, for respondents who previously owned a household phone and relinquished it for various reasons. The answers have been converted into percentages of the total number of respondents who fitted into this category. Unsurprisingly, billing problems and the high cost of fixed-line connectivity feature high on the list of reasons given for people no longer having fixed-line phones. Interestingly, the percentage of households that could not afford fixed-line telephony is high, regardless of the level of income (although of course highest for those with the lowest monthly income).

Preference for pre-paid mobile phones

The argument of this section is that individuals (and households) prefer pre-paid mobile phones because pre-paid, as a model, lowers income barriers (at low call volumes) to communication. Pre-paid provides, in a word, *flexibility*. Individuals can plan their phone usage according to their income constraints.

Recent years have witnessed phenomenal growth in the number of mobile-phone subscribers. Today, mobile phones vastly outnumber fixed-line phones in most countries around the world. Yet this trend is a little puzzling since mobile phone calls are more expensive and less reliable than fixed-line calls.

Part of the explanation for this is that mobile phones offer a range of features in addition to flexibility. These features include phone books and diaries as well as the ability to play music, send text messages and take digital pictures. Basically, mobile phones have become fashion objects in their own right.

It is notable that, apart from having turned into a lifestyle product, mobile telephony's real breakthrough has been the introduction of pre-paid services. The latest ITU report (2004) states that, in Sub-Saharan Africa, 91.2% of all mobile phone users are pre-paid

Graph drawn up from data obtained through the e-Index and Usage survey (2005).

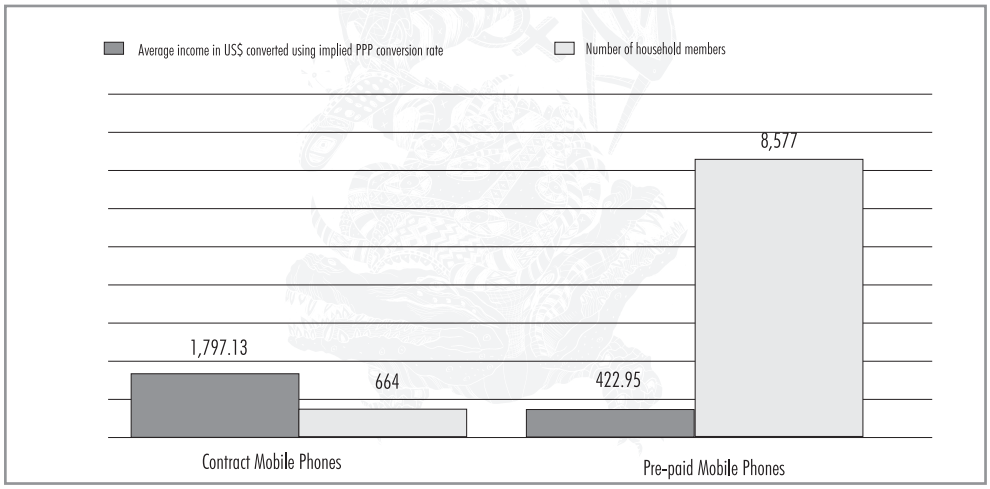


Figure 4.2: Income of pre-paid versus contract users

subscribers. The e-Access and Usage survey, carried out in nine African countries by Research ICT Africa!, collected information about 57,034 individuals.[3] Of all those who had mobile phones, 92.9% were pre-paid and 7.1% contract phones.

Households with contract mobile phones have far higher household incomes than pre-paid phone users. Individuals with contract mobiles have, on average, a monthly income of US$ 1797, while individuals with pre-paid mobiles have a monthly income of US$ 423, both converted at implied PPP conversion rate.

Generally, communication via fixed-line phones is cheaper than communication via mobile phones, and communication via contract mobile phones is cheaper than communication via pre-paid mobile phones in terms of per minute costs. Yet pre-paid is the preferred communication tool. Despite the fact that pre-paid is more expensive, it is far more prevalent in lower income households. This is mainly due to the lower relative prices of pre-paids, as Hodge (2005) demonstrates. He finds that relative prices for pre-paids are lower than those of fixed-line calls up to a certain call volume, due to the monthly subscription costs of fixed-line phones. The same reasoning can be applied to the preference for pre-paid over contract usage.

Figure 4.1 (above) confirms Hodge's (2005) findings. It shows that households without fixed-line phones and at least one mobile phone generally have lower average household incomes than households with fixed-line phones. This indicates that mobile phone usage has a lower income barrier than fixed-line phones. Figure 4.2 (above) further indicates that pre-paid has a lower income barrier than contract telephone access since the average individual income of pre-paid users is lower than that of contract subscribers.

3 Rwanda data were excluded from this report. No national representative results could be generated for Rwanda due to a sample bias, although the number of households surveyed includes the Rwandan figures.

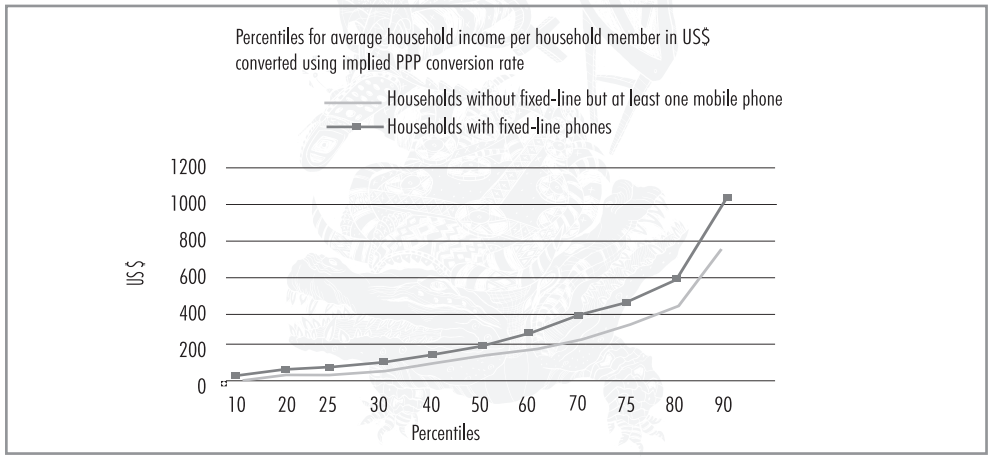


Table compiled from data obtained through the e-Index and Usage survey (2005).

Figure 4.3: Income compared

The success of pre-paid subscription in Sub-Saharan Africa can be attributed to its appeal to people with lower or irregular incomes, since its use does not require a bank account, a physical address or a postal address, and it allows users more control over their expenses – charging the phone as money becomes available, and not spending anything if it is not.

Focus groups conducted in South Africa support the conclusion that breaking down the cost of airtime into smaller packages increases usage. In South Africa, the dominant network amongst low income households is Vodacom and the reason for its dominance in this income group is attributed to the ability to purchase airtime in smaller increments (R12) in contrast to MTN (R30), Vodacom's major competitor. Smaller increments of airtime in conjunction with low-cost phones (not investigated in this research), can ensure that the income barrier is lowered still further.

Conclusion

Sub-Saharan Africa lags behind the global average in terms of the use of ICTs. Between 1996 and 2001, the digital divide has continued to increase, contrary to reports from publications such as the Economist (2005)[4] that it has decreased. Without the rapid growth of mobile telephony on the continent, this gap could have been even larger.

This study finds that mobile phones are substitutes for fixed-line phones not just for low-income households but across the household income range. This conclusion supports Hodge's (2005) finding that mobile phones are substitutes for fixed-line phones at lower call volumes. In addition, this article argues that it is the flexibility provided by pre-paid payment options and the lower income barrier (in contrast to fixed-line phones) that has

4 See Sciadas, G (2005).

created the mobile phone phenomenon. Communication devices that require regular (or consistent) financial commitment are less successful with poor people. The success of pre-paid regimes, whether for mobiles, electricity or fixed-line telephony, shows that the mechanism of controlling costs and providing greater flexibility is preferred over the cheapest form of communication. In short, households and individuals with low incomes do not have regular incomes. Pre-paid payment mechanisms answer the need to allocate resources based on income at any given point in time. Thus, a steady payment commitment on an irregular income does not appeal to consumers.

Focus group research conducted in South Africa provides the insight that low income consumers use a multiple communications strategy. This means that they will use that form of communication that they can afford at a particular place and time, given a particular level of income. While the poor will make use of different forms of communication devices, ranging from public pay phones to private phone kiosks, the pre-paid mechanism is the one constant. ❑

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