The use of mobile phones by microentrepreneurs in Kigali, Rwanda: Changes to social and business networks

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Abstract

A survey of mobile phone users in Kigali, Rwanda suggests that mobiles are allowing microentrepreneurs in the developing world to develop new business contacts. The results detail the impact of mobile ownership on the networks of microentrepreneurs in low teledensity areas, focusing on the evolving mix of business and personal calls made by users. The study differentiates between contacts which users amplify through mobile ownership (friends and family ties) and those which are enabled by mobile ownership (new business ties).

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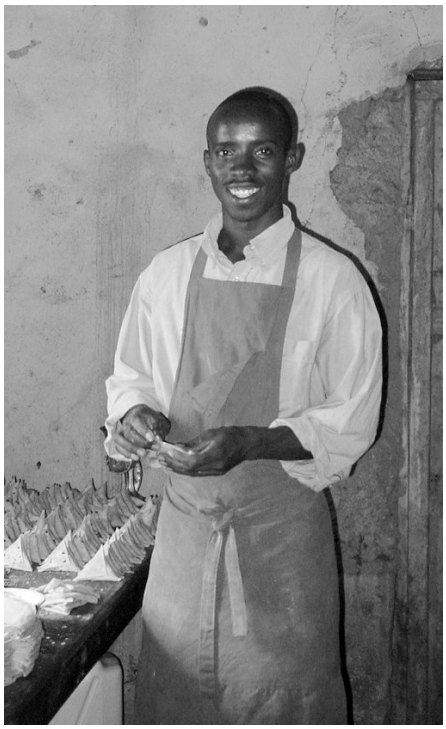
Introduction



James is a baker in Kigali, Rwanda. Working from his home, he makes bread for nearby shops and restaurants. Recently, James purchased a mobile phone—his first telephone of any kind. Now, customers call him to place orders, he calls suppliers to order flour and other materials, and he and his employee stay in touch no matter where they are in the city. He now can respond to orders from throughout the country, not just in his neighborhood in Kigali. He has begun to branch out, taking phoned-in requests to prepare wedding cakes for clients throughout Rwanda. He estimates that his business has increased 30% due to the mobile, so much so that he has been able to move his family into a larger and more comfortable home. At the same time, he can use the mobile to speak to his wife, to check on the kids, or to send a SMS to a friend to plan an evening visit.

Throughout the developing world, millions of people like James are purchasing mobiles. The World Bank estimates that 80% of the world's population lives within range of a mobile/cellular network (Global ICT Department, 2005). At least 1.3 billion mobiles are currently in use, (ITU, 2004) with a billion or more soon to follow (International Herald Tribune, 2005). Although overall adoption in developing nations still lags well behind that richer ones, current growth rates in the developing world are astounding. This rapid adoption, particularly in urban areas, has raised hopes within the economic development community that people in the developing world will benefit from the technology (Gamos, 2003; Lopez, 2000). Some of this hope, shared also by the popular press (Economist, 2005; Rai, 2001; Ross, 2004; Tobar, 2004), and the telecommunications industry (Vodafone, 2005) focuses on the way the smallest and most numerous businesses, called microenterprises, are using mobiles.

The adoption of mobiles by self-employed microentrepreneurs like James is a recent phenomenon, but it lies at the intersection of two ongoing theoretical discussions: the role of telecommunications in economic development, and the broader role of mobile information and communication technologies (ICTs) in society. This study, based on a survey of microentrepreneurs in Kigali, Rwanda, uses two analyses to contribute to these theoretical discussions. First, it looks at the evolution of mobile ownership over time, tracking how a device first used by the elites for business purposes has found wider acceptance and a greater range of uses. Second, it explores how mobile use is associated with changes the social networks

of microentrepreneurs, by analyzing patterns of calls with people who are new to the users' social networks. The results of both analyses suggest that mobiles are allowing microentrepreneurs in the developing world—particularly those for whom the mobile is the first and only telephone—to develop new business contacts.

Theoretical Background

Mobiles in Rwanda: a growing community of first-time telephone owners

Rwanda is a small, densely populated, landlocked nation in central Africa, home to 8 million people. In 1994 Rwanda descended into civil war and genocide, an almost unimaginable tragedy even for a part of the world that has seen more than its share of political, economic and environmental upheaval. But now, 10 years later, daily life in Rwanda shares much in common with that in other sub-Saharan nations. Most of its population is rural and quite poor, getting by on small-scale agriculture. Its capital, Kigali, is small and increasingly vibrant, with about 400,000 residents.

As in all the nations in the region, mobile penetration in Rwanda is a fraction of that in higher-income nations. The ITU (2004) estimates that in 2003 there were 16 mobile users per 1000 people, roughly 134,000 subscribers. Since mobiles were introduced to Rwanda in 1998, their adoption has eclipsed that of landlines. There are only 23,000 landlines in the nation. Though MTN RwandaCel, the monopoly mobile provider, supplies GSM coverage throughout the nation[2], mobile ownership and use is still too expensive for the majority of rural Rwandans (Panos, 2004). Most mobile users in Rwanda are concentrated its capital, Kigali, and in its other cities. In these areas, mobiles are perhaps the single most advertised product, a common symbol of prosperity and individuality (Donner, 2004; Varbanov, 2002). In Kigali, as elsewhere throughout the developing world, pre-pay cards (Beaubrun & Pierre, 2001; Minges, 1999), low-priced text messages, and (relatively) inexpensive used handsets have brought mobile ownership within the reach of many its citizens, including many of its microentrepreneurs (Panos, 2004). Though calls are still expensive, with a local off-peak mobile-to-mobile call costing 125 Francs (about 25 cents) per minute, mobile use is becoming a fixture of daily life is for a wide range of urban users, not just the elites.

In Rwanda, as in other parts of the developing world, many mobile users do not own a landline at home or at work. This is not to say that landline phones are unavailable in the urban areas–anyone in Kigali with 200 Francs and the patience for a short walk can visit a public phone shop. But mobile ownership offers obvious advantages over public phone use: mobile owners have a number where they can always

[2] MTN coverage map available at http://www.mtnrwandacell.co.rw/coverage.htm

be reached, and have an outgoing line always at their fingertips. Thus there is an important difference between the function of the mobile phone in the wealthier countries, where it is often a complement to a landline, and in the developing world, where it is often a substitute (Hamilton, 2003; Hodge, 2005). This difference demands careful differentiation between the benefits of *basic connectivity*, verses those of mobility (Mante-Meijer et al., 2001), perpetual contact (Katz & Aakhus, 2002), micro-coordination (Ling & Haddon, 2003; Townsend, 2000), safety (Ling, 2000), and status/display (Lycett & Dunbar, 2000; Plant, 2002), which have been observed in places where the mobile is purchased as a complement to landlines. In some ways, we can turn back to the literature on the sociology of the landline telephone in the developed (Fischer, 1992; Pool, 1977) and developing (Hudson, 1984; Saunders, Warford, & Wellenieus, 1994) worlds to understand the significance of mobile ownership to those which have not other phone. Like the landline before it, the mobile eliminates isolation, by dramatically reducing the cost (in time or transport) of communicating with people, regardless of whether they are hundreds of miles away, or simply a short stroll down the street.

The Information and Communication Needs of Microentrepreneurs

Businesses with five or fewer employees, called microenterprises, support households in developing nations, and are a critical part of their economies (Mead & Leidholm, 1998; Santos, 1979). In urban areas, microenterprises include trading stalls and retail stores, small manufacturers, transport providers, and services such as tailors and plumbers. In rural areas, microenterprises are both agricultural and non-agricultural. The degree of permanence, productivity and formality varies considerably between microentrepreneurs. Indeed, some are 'entrepreneurial', growing, firms with skilled owners and productive business models (Duncombe & Heeks, 2001), but the majority are simply self employed and often struggling to get by, and will never grow their businesses into larger enterprises (Mead & Leidholm, 1998). Barriers to starting these enterprises are generally low, thus households or individuals may engage in more than one microenterprise, or may use a microenterprise to augment or temporarily replace wage salaries. Nevertheless, even if the majority of microenterprises are not sources for phenomenal growth, any gains in productivity, profitability and even basic stability are of the utmost importance to the livelihoods of the households involved.

Given the informality of many microenterprises, the distinctions between the ICT use of the enterprise and those of the individual/household can be very blurry[3]. When it comes to ICT use by

[3] Microenterprises are often lumped together for discussion purposes with "Small and Medium Sized Enterprises" (SMEs), which are generally considered to have between 5 and 100 employees. However, the lack of formality and relative simplicity of microenterprises in the developing world distinguishes them from SMEs. Though less numerous than microenterprises, SMEs are often more stable and more productive. Thus it is not surprising that

microentrepreneurs, recent popular and development practitioner enthusiasm for Internet-related services has obscured the importance of basic telephone connectivity (Besemer, Addison, & Furguson, 2003; Kenny, 2002). Duncombe and Heeks (1999) comment on the relative importance of the phone relative to other ICTs. They explain that the telephone is:

> …the information-related technology that has done the most to reduce costs, increase income and reduce uncertainty and risk. Phones support the current reality of informal information systems, they can help extend social and business networks, and they clearly substitute for journeys and, in some cases, for brokers, traders and other business intermediaries. They therefore work "with the grain" of informality yet at the same time help to eat into the problems of insularity that can run alongside. Phones also meet the priority information needs of this group of communication rather then processing of information. (p. 18)

Duncombe and Heeks conducted their assessment of firms in Botswana in 1999, and did not differentiate between landline and mobile telephony. However, the accessibly and affordability of mobiles, relative to landlines, makes them a new and particularly viable telecommunications option for even the smallest of enterprises.

No discussion of mobile phones and micro-businesses is complete without a mention of Bangladesh's Grameen Village Phone program, which is famous for developing a financial and technological model to empower thousands of women entrepreneurs to act as "phone ladies" for a village (Bayes, von Braun, & Akhter, 1999; Richardson, Ramirez, & Haq, 2000) Grameen is replicating the model in Uganda, in collaboration with MTN (USAID, 2004), and similar ventures, both formal/franchised (Reck & Wood, 2003) and informal/independent (Dymond & Oestmann, 2003; Sey, 2005), have sprung up wherever there are large populations of people who can not afford mobiles of their own.

Studies of mobile use by other kinds of microenterprises are rare, Samuel, Shah, and Hadingham (2005) highlight the importance of mobiles to micro-businesses in South Africa, and Egypt; roughly 60% of the microentrepreneurs they surveyed in each country reported that the mobile had increased the profitability of the business. An earlier study in Rwanda (Donner, 2003) looked at the mix of instrumental and intrinsic elements structuring microentrepreneurs' attitudes towards their mobiles. Some reported using the phone to improve firm productivity or for personal convenience, others valued the status and intrinsic returns of mobile use, others simply considered the mobile indispensable. Initial (descriptive-only) results from the survey discussed here appear in (Donner, 2005); these indicate that roughly 2/3 of calls on microentrepreneurs call logs had to do with personal issues – calls to friends and family – while 1/3 of calls were business-related. These proportions, mixing business and personal motivations, were broadly

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there has been more research on the Information and Communication Technology (ICT) needs and behaviors of SMEs (la Rovere, 1996; Lind, 2000; Matambalya & Wolf, 2001; Müller-Falcke, 2002) than of microentrepreneurs.

similar to those observed in earlier studies of public phone users in rural areas in Ghana (Bertolini, 2001) Costa Rica (Saunders et al., 1994), India (Blattman, Jenson, & Roman, 2003), Bangladesh (Bayes et al., 1999; Richardson et al., 2000), and elsewhere in Sub-Saharan Africa (Gamos, 2003).

Theoretical approaches to understanding microentrepreneurs and mobiles

This analysis draws on and contributes to two literatures: one focusing on the role of telecommunications in economic development, and a second, focusing more broadly on the impact of ICTs on social structures, and particularly on social networks. Of course, what is meant "impact" is itself complex; but a contribution to the ongoing tension between technological determinism and social constructivism (see (Fischer, 1992) for an outline) is beyond this paper's scope. Instead, the paper takes as given that attributes of the technology enable users to act in some ways and not in others, and to, in turn, to alter both their environment and the conventions of use of technologies themselves (Orlikowski, 2000; Poole & DeSanctis, 1990). In this sense, the language of cause, effect, and impact is best replaced with that of use, choice, agency, and adaptation. For this approach, detailed studies of what users actually ***do*** with the technologies at their disposal are important building blocks in any larger discussion of social (or technological) change (Fischer, 1992).

Within this more bounded inquiry, there is nevertheless much to explore and debate. A selection of user-focused studies from either the ICT and society or the ICT and development literatures will quickly reveal a difference in 'frames' to understanding ICTs. While some emphasize are arguments about *productivity* (the ability to do the same or similar things faster, more frequently, or at lower cost), others choose to emphasize behavioral (and consequently structural/social) *change*, where changing patterns of ICT use are associated with significant transformations in the availability of information, contacts, customers, associates, and in the constitution of communities, networks, or organizations. The paper will carry both the productivity and the change frames forward into the analysis, both to help highlight the conditions that are critical to understanding microentrepreneurs' use of mobiles, and to shed further light on the implications of the distinction between the frames on the larger ICT and development and ICT and society literatures.

There is a research tradition in development studies and in communication that looks at the role of telecommunications in economic development (Hardy, 1980; Hudson, 1984). Saunders, Warford, and Wellenieus's (1994) broad review is helpful. They conclude that telecommunications contributes to economic development by providing: better market information; improved transport efficiency and more distributed economic development; reduced isolation and increased security for villages, organizations, and people; and increased connectivity to (and coordination with) international economic activity. The

review captures the productivity frame, as represented by studies which focus on the lower transaction costs facilitated by replacing travel with phone calls (James, 2002; Norton, 1992), as well as the change frame, represented more recently by Eggleston, Jensen, and Zeckhauser, (2002), who found that the addition of even a single phone in a village could reduce costly price uncertainty, both about crops the village had to sell, and about foodstuffs the village wished to consume.

A different discussion is being carried out about the influence of new communication technologies on social structure. One approach suggests that by increasing the ease and reach of communication, ICT use reinforces existing social structures (Agre, 2002; de Gournay & Smoreda, 2003; Kavanaugh, Reese, Carroll, & Rosson, 2005). For example, Harper (2003) argues that mobile use is "invigorating" existing social relationships, allowing users another means to do the kinds of things that they do with the people already in their social network. He contrasts this interpretation of mobile use with that of Wellman (2002) and Castells (1996), who have argued that communication technologies have enabled individuals to create more specialized, issue-specific communities and networks that transcend traditional geographic boundaries. This second approach, emphasizing structural change, can be seen in the addition of weak ties in a personal or community network (Hampton, 2003; Haythornthwaite, 2002), or in the reconfiguration of an economic network to cut out middlemen (Sawyer, Crowston, Wigand, & Allbritton, 2003). Closest to the topic at hand in this study, Goodman (2005) interprets self-report survey data from mobile users in South Africa and Tanzania, observing that mobiles are being used more frequently to manage strong ties, particularly family, then for maintaining or adding weak ties.

The current incarnation of this discussion (centered on the internet, and to a lesser extent, on mobiles) has antecedents in earlier examinations of the effects of landlines, for example on the re-distribution and specialization of personal relationships at the expense of face-to-face interactions (Ball, 1968), and the amplification of existing social ties (Thorngren, 1977). In all, the distinctions indicate that one can view mobile communication, like the internet and landlines before it, as a system which changes and creates new relationships and networks, and/or one which amplifies and strengthens existing ones.

Research Questions

Given the enthusiasm surrounding the spread of mobiles in the developing world, and given the background of theoretical complexity, it is helpful to carefully assess the way microentrepreneurs are using mobiles. Duncombe and Heeks' comments about the basic impact of the telephone on SMEs in Botswana point the way, suggesting we explore how mobiles, like landlines, might "*extend business and social networks*". This study examines actual calling behavior, looking particularly at two factors: the mix of business vs. personal uses for the mobile, and landline ownership. By isolating these factors, the study

will be able to assess impacts of mobile ownership on microentrepreneurs' communication networks, with an eye toward differentiating between the "change" and the "productivity/amplification" frames introduced above.

Migration from Business to Personal Use

The first analysis treats the mix of business vs. personal use as dynamic over time. Early adopters (Rogers, 2003) of personal communication devices are likely to be business people, while later adopters may use the devices to pursue personal goals (Wei & Lo, in press). Katz (1999) reports that primary cellular use in the US crossed from business to personal functions as early as 1992. In Hong Kong, Leung & Wei (1998) found that later adopters or pagers were more motivated by intrinsic factors than for instrumental factors. Conventional wisdom suggests we should find a similar pattern *vis a vis* mobile phones in Rwanda–that a shift is underway from business-focused uses of mobiles to more of a mix of personal and business uses. Earlier adopters of the technology might be expected to retain a more business-focused approach.

> Hypothesis 1: Earlier adopters of the mobile will have a higher proportion of business-related calls on their mobile

It is possible that mobile owners' usage patterns evolve; both the relative proportion and the overall number of business calls made by users could rise or fall over time. However, without multiple measures of the proportion or number of calls made by users over time, this change can not be easily observed.

Network Change

An individual's network represents the sum of interactions with a variety of different people, about different subjects, using different channels (face to face, landline, mobile, mail, etc). Thus, establishing the impact of mobile use on the totality of an individual's network is difficult. One approach is to observe the relative *frequency of new ties* to the network. This allows a comparison of the strength of the "change" lens to that of the "amplification" lens; the higher the proportion of new entrants observed on a call log, the more it can be argued that the mobile is facilitating a change in network structure, rather than and amplification of an existing structure.

Two hypotheses are proposed. First, new entrants are expected to be concentrated in business relations. In business relationships, microentrepreneurs will behave as Wellman (2002) describes, and as the telecommunications and development literature would suggest, using the mobile to *change* their network by adding new customers and suppliers. When it comes to personal matters, however, they will behave as Harper (2003) describes, using the mobile to *amplify* (deepen, strengthen) ties they already have

established. Part of this is common sense, since the composition of family ties in a network is certain to change more slowly, while business ties (particularly customers and suppliers) can easily be made, particularly if the opportunity for new communication ties exists.

Thus the last hypothesis (3a and 3b) about network change is the one most central to the analysis. The presumption is that the purchase of the **first** telephone presents the best opportunity to change the shape of a network by allowing for new contacts, whereas the purchase of subsequent phones are more likely to afford additional productivity and amplification benefits. Thus, we expect to see a higher proportion of new entrants on the mobile logs of those without landlines (home or business) of their own. Recall James's whose business went up 30% after he purchased his first phone; we should be able to see similar examples in the aggregated call data of the microentrepreneurs in the survey.

> Hypothesis 2: New entrants found on mobile call logs are more likely to be business-related ties than friends or family
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> Hypothesis 3a: New entrants are more likely to be found on the call logs of those without a business landline
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> Hypothesis 3b: New entrants are more likely to be found on the call logs of those without a home landline

Methods

The survey was conducted in Kigali in December, 2003. Six tri-lingual Rwandan interviewers gathered respondents by visiting businesses in markets and on streets throughout the city. Screener questions ensured respondents had a mobile, were at least eighteen years old, and owned a small business with no more than five employees. Random recruitment is preferable, but many businesses were informal, and all used pre-pay cards, so no list of users was available. Recruitment was face-to-face, which captured shops, market stalls, and roaming vendors. Home-based manufacturing and food production enterprises were missed. Similarly, interviews were conducted on weekdays, so weekend and evening calls may be underrepresented.

The survey asked about three types of calls recorded on the mobiles' call logs: outgoing voice, incoming voice, and SMS. For each type, the interview proceeded through the log, starting with the most recent call, until five unique callers were identified or until ten calls had been reviewed. Calls the respondent could not recognize were skipped. In this way, the interviews captured actual call behavior, rather then relying on recall or self-report mechanisms (Cohen & Lemish, 2003)

Similar to Bertolini (2001), the survey recorded the type of person–the alter–with whom each call was made (spouse, friend, business partner, etc), what the call was about, and where it was made to/from. Multiple answers were encouraged to the "who and what" questions, so an alter could be classified as both 'friend' and 'business partner'.

There are two primary dependant variables under review. Proportion of business calls observed on the call log, and the call alter's status as "new to the network"

For the proportion of business calls observed, the analysis sums across three kinds calls: outgoing voice, incoming voice, and SMS[4]. Due to time constraints, and to work with the structure of the call logs on the mobile phones, which often do not simultaneously display calls of all kinds, participants were randomly assigned to one of three conditions: *incoming call+outgoing call*, *incoming call+SMS*, or *outgoing call+SMS*. Each condition asked about two of the three kinds of calls. In each case, the most recent 5 calls of each kind were sampled; calls to voicemail or to the telecommunications provider to add airtime were excluded, as were incoming SMS advertisements. A discrete call was coded as a business call if the relationship was described as "customer", "employee", "colleague/partner", or "suppler". The proportion is simply the count of calls coded as "business", divided by the number of calls with a description of the relationship. The elements for this analysis are the 277 observations of call logs, one per interview participant.

For the second dependant variable, new to network, another analysis treats discrete calls as elements, drawing on a created binary variable "New Entrant". Call alters are coded as new (or not new) to the respondent's network, relative to the time the respondent purchased his/her mobile. For each alter, the variable is constructed using participant's responses to the items "before getting the mobile, how often did you communicate with this person, overall?" and "since getting the mobile, how often do you communicate with this person, overall?" Response options for both items were: "never", "less than once a month", "monthly"; "weekly"; "daily" and "more than once a day". Only alters in the "never" category for the "before" question were coded as New Entrants. To calculate communication change, the difference between the two items was used – alters whom respondents reported more frequent contact with after purchasing the mobile were coded as "increased". For this analysis, mobile purchase date is entered as a control variable. This frequency of communication item was asked for 5 of the 10 call alters, bringing the total number of calls (elements) for some analyses down to 1293.

[4] Compared to voice calls, SMS was used relatively more frequently to communicate with friends, and less with customers. Further analyses could be undertaken to isolate effects and patterns for voice vs. text calls.

Results

Of 502 people approached, 125 refused, 87 screened out, and 13 stopped partway, resulting in 277 (55%) completed interviews, providing detail on 2700 discrete calls. The final respondent sample was 69% males, with a median age of 32. Most had completed primary (26%) or secondary (54%) school; some (20%) had post-secondary or university certificates. Their businesses included retail (32%), services (15%), food sales (8%), construction/trades (7%), and transport (6%).

Respondents had no difficultly recognizing the numbers on their call log; 80% of the calls had names programmed into the SIM card. Of those not programmed, roughly 80% were recognizable.

Descriptive Results on Call Profiles

As Table 1 indicates, call alters were most frequently categorized as friends (45%), followed by business contacts (32%) and family members (26%). Customers were the most frequent form of business contact. The proportion of calls made with business alters is the subject of analysis 1.

Table 2 illustrates the general change in communication, across all alters, for each of the telephone ownership categories. Respondents reported communication increases with roughly 40% of call alters, while new entrants comprised roughly 20% of all alters. The distribution of that 20% of alters classified as new entrants is the subject of analysis 2.

Table 1: Relationship of Call Alters to Interview Participants, across all Sampled Calls

Relationship with call alter (check all that apply)	Total (n=2676)	Mobile Only (n=1817)	Landline Owners			
			All Landline Owners (n=859)	Home Only (n=306)	Work only (n=345)	Home and Work (n=208)
Friend	45%	49%	37%	42%	34%	37%
Business	32%	31%	32%	25%	37%	33%
Customer	17%	18%	16%	16%	18%	13%
Partner/Colleague	7%	7%	7%	5%	9%	8%
Supplier	5%	6%	5%	4%	5%	5%
Employee	3%	2%	4%	1%	6%	6%
Family member	26%	22%	35%	34%	32%	40%
Non-spouse	23%	19%	30%	28%	29%	33%
Spouse	3%	3%	5%	6%	3%	8%
Other	6%	6%	6%	8%	5%	4%

Note. Other category includes supplied options: "Government, health or NGO worker" and "Company representative", as well as open-ended responses.
Proportions sum to more than 100% due to 'all that apply' option

Table 2: Change in Overall Communication with Call Alters

Change in Overall Communication with Alter After Mobile Purchase	Total (n=1291)	Mobile Only (n=894)	Landline Owners			
			All Landline Owners (n=859)	Home Only (n=145)	Work only (n=168)	Home and Work (n=84)
Decreased	5%	5%	4%	5%	4%	2%
No Change	35%	36%	34%	35%	27%	44%
Increased	40%	38%	46%	43%	49%	45%
New Entrant	20%	22%	16%	18%	19%	8%

Note. Total number of alters in this table is smaller than in table 1, since the communication change items were only asked for 5 (not 10) alters per respondent.

Analysis 1: Migration from Business to Personal Use

To examine the proportion of business-related calls appearing on each participant's call logs, a quasi-likelihood regression model was employed, following Papke and Wooldridge (1996) and McDowell and Cox (2004). This model is most appropriate for proportional (fractional) dependent variables, particularly those with observations taking the extreme values of zero or one, since the zeros would have to be dropped as missing cases by a conventional logit transformation approach.[5]

Controls were used for *year purchased mobile* (range from 1997 to 2003); *mobile spending per month* (re-coded as a 4-category variable with cuts at approximately $10, $20, and $40 per month); *gender*, *age*, *education level*, and *number of employees*. *Landline ownership* was also a control in this analysis.

Table 3: Fractional Logit Model Results for Proportion of Business Calls on Call Log

	Coef.	Robust Standard Error
Control Variables		
Spending Per Month	0.34	.082
Gender (male)	-0.011	.178
Age	-.002	.011
Education	-.2748***	.094
Number of Employees	.013	.068
Has Landline at Home	-.622***	.201
Has Landline at Work	-.008	.178
Research Variable		
Year Purchased Mobile	-0.13***	.059
Constant	261.4**	118.7
Number of cases	215	

Note. *,**,*** represents significance at p<.1, .05, and .01 respectively.

As the results in table 3 indicate, there was a significant inverse relationship between level of education and the proportion of business calls on the mobile. Owning a landline at home was also associated with lower levels of business calls. The control for spending per month is particularly important, since it excludes the possibility that the observed differences are due to large differences in the overall number/frequency of calls between early and later adopters.

[5] The procedure can be applied in the Statistical Package Stata, using a General Linear Model with the *family(binomial), link(logit)* and ***robust*** options selected (McDowell & Cox, 2004).

There was a significant inverse relationship between year the mobile was purchased and the proportion of business calls on the mobile's call log. Newer phones had a lower proportion of business calls, supporting Hypothesis 1.

Analysis 2: Network Change

Table 4 details the results of the second analysis, which use a logistic regression to predict the likelihood that an alter was new to a respondent's network.

Table 4: Logistic Regression Results for Alter as New Entrant to User's Network

	Beta	SE	Wald	Exp(B)
Controls for Owner Attributes				
Gender (male)	0.086	0.208	0.171	1.090
Age	-0.026**	0.011	5.507	0.974
Education	0.228**	0.101	5.130	1.256
Year Purchased Mobile	-0.163**	0.064	6.569	0.850
Number of Employees	-0.044	0.070	0.394	0.957
Spending Per Month	0.155*	0.094	2.723	1.168
Research Variables				
Business Relationship	0.948***	0.179	28.103	2.580
Family/Spouse Relationship	-1.326***	0.286	21.564	0.265
Has Landline at Home	-0.280	0.263	1.131	0.756
Has Landline at Work	-0.621**	0.264	5.541	0.538
Constant	324.367**	127.270	6.496	0.000

Note. Nagelkerke R-squared =.165
1019 call alters captured on call logs of 216 mobile owners.

Two variables were entered to control for the effects of time. Both were significant in ways that could be expected. First, there was a significant inverse relationship between the age of the user and the likelihood that an alter was new to the user's network. Similarly, the longer a user had owned a mobile, the higher the likelihood that he/she first met the alter after purchasing the mobile.

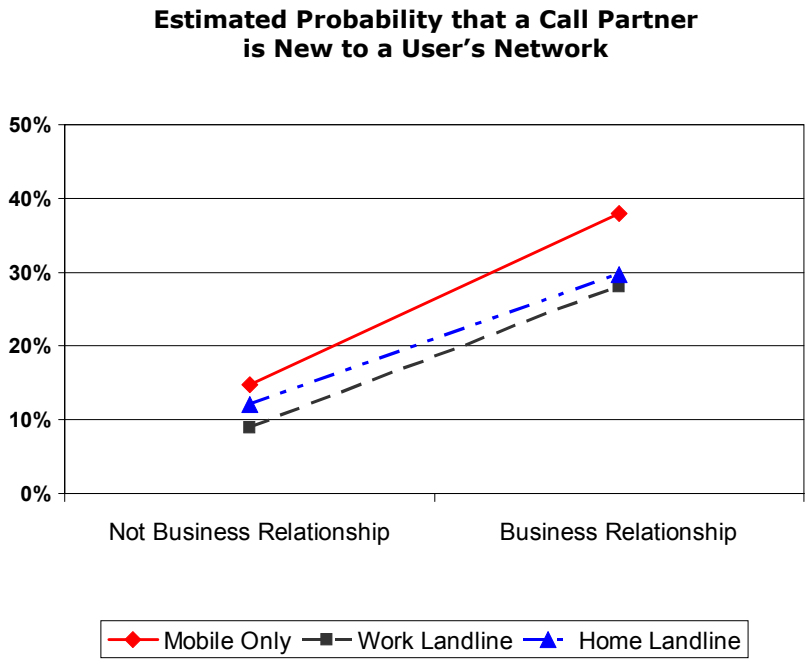
Two other control variables in the model were significant. Level of education was significant; an alter was significantly more likely to be a new entrant among those users with higher. Similarly, monthly

spending was significant; an alter was significantly more likely to be a new entrant among those users spending more per month on their mobile (and making more calls).

In terms of the research variables, the relationship between the alter and the user strongly impacted the likelihood that the alter was new to the network. Business-related alters were more likely to be new entrants, whereas family relationships were less likely to be new entrants. Hypothesis 2 is supported.

Of the two landline ownership variables, a user's ownership of work landline was associated with a lower likelihood that the call alter was new to the network. Home landline ownership was not significant in the model. Thus, hypothesis 3a is supported, and 3b is not. For easier interpretation, figure 1 presents the predicted likelihoods (from the logistic regression model) that an alter was new to a network, for each of the combinations of the independent variables.

Figure 1: Predicted Probabilities that a Call Partner is new to the user's network



Discussion

The analyses provide some insight into what microentrepreneurs do with their mobiles, and into how their networks might be changing as a result.

Migration to Personal Uses

The first set of findings reveal a difference in the call profiles of those who purchased a mobile early in its availability in Rwanda, and more recent buyers. It appears that newer users complete a lower overall proportion of business calls than do early users. It is possible, of course, that this difference is the result of a distinction in the kind of businesses, or in the success of the business, between early and late adopters. The earliest adopters could find their businesses are more demanding, or perhaps more successful, than more recent adopters. It is also possible that the cross-sectional comparison masks a change in user behavior over time–that mobile users begin by using the device for business calls, but then slowly shift to a mix of calls that involves more friends and family. Additional studies, which the capacity to generate within-subjects time series data might be helpful to resolve this question.

It is likely, however, that the results are identify new users who are more interested in using the phone for maintenance of friends and family toes than for business purposes. Further evidence for this assertion can be found in a rough additional analysis of open-ended survey responses. Respondents were asked to saw, in their own words, why they purchased the mobile in the first place. 84% of respondents who purchased their first mobile between 1997 and 1998 mentioned business purposes in their open end responses, compared with 65% of those purchasing between 2000 and 2001, and 50% between 2002 and 2003.

Both analyses of the call mix underscore a fundamental point, also made in earlier papers (Donner, 2004, 2005) that even in Rwanda, where calls are relatively expensive compared to total purchasing power of their users, and even among microentrepreneurs, who might be expected to be particularly business-focused, the mobile is already *personal* device. 2/3 of calls were not business related, and that proportion might be growing. This will make it harder, not easier, to identify the overall microeconomic impact of the mobile on microenterprises and the households they support. In addition, it underscores how personal (household) and business uses of the mobile are blurred (Chen & Dunn, 1996; Gant & Kiesler, 2001; Peters & Allouch, 2005). Though researchers (and journalists) interested in the economic impacts of the mobile may be tempted to ignore the personal calls, and though researchers (and journalists) concerned with the evolution of a mobile society may be tempted to focus on personal calls, each kind of call is important–and each is facilitated with the purchase of the same $2 pre-pay airtime card. Future study designs should try to account for both kinds of behaviors.

Change

The second set of findings concerns changes to users' social and economic networks, facilitated by mobile phone ownership and use. Roughly 20% of all the call alters (individuals appearing on respondents' mobile phone call logs) were new to respondents networks; of the 80% whose relationships predated the mobile, half showed an increase in overall frequency of contact, the other half showed unchanged or decreased frequency. The study used the proportion of new entrants appearing on call logs as an indication of expanding networks, and compared respondents who owned only a mobile phone with those who also owned a landline. Not surprisingly, for both landline owners and mobile-only users, new entrants were concentrated in business calls. What is more interesting–and more important for discussions about the role of mobiles in economic development–is that the proportion of new entrants was highest (a predicted 38%) among the business-related call alters of those who own only a mobile phone. This difference was particularly strong relative to the group which owned a landline at their workplace.

In short, this analysis supports both those approaches to "ICT and society" and "ICT for development" which emphasize structural change, and those approaches which emphasize increased productivity and amplification. Returning to Duncombe and Heeks' (1999) comment on the impact of phones on entrepreneurs, they explain that phones "help extend social and business networks." This study modifies and deepens that assertion. *Kigali's microentrepreneurs use their mobiles to increase the frequency of their contact with friends, family, and existing business contacts, and to facilitate new contacts with business partners, suppliers, and customers.*

The fact that there was a significantly higher proportion of new entrants on the call logs of microentrepreneurs who own only a mobile phone illustrates a dynamic that is unique to the developing world. All across the developing world, people like James the baker are finally able to own a telephone line of their own. This is not to say that mobiles don't provide complementary benefits to those who own landlines. Landline and non-landline owners alike share in the ease of constant reachability, safety, and convenience mobiles provide. However, the more sudden changes to the network–the introduction of a slew of new weak ties (Granovetter, 1973; Marsden & Campbell, 1984) and the expansion of a network–is being experienced by those who are purchasing the first phone of their lives. These days, those phones are overwhelmingly mobile handsets, not landlines.

The observations from this study are quasi-experimental, not randomized. There are likely to be substantial differences between the businesses of those who can afford landlines and many of the new mobile owners who can not. Landline owners in places like Kigali are more prosperous, and on balance probably run more established businesses. However, at this moment of rapid change in the

telecommunications landscape in the developing world, these substantial differences are the key to the story, not a complication. The call logs of the new mobile owners, with a high proportion of new business contacts, may provide evidence for businesses which are growing or changing more rapidly; the mobile enables this growth partially by enabling new contacts (an effect unique to the low-teledensity developing world), and partially by amplifying communication with repeat customers (an effect shared in the low and high-teledensity regions of the world).

Further research

This paper has not delved deeply into the shape of the networks, or in their actual economic value to microentrepreneurs. Instead, it has used "new entrants" as a rough proxy for business growth. However, there is a research tradition that looks at these networks in more detail, using the lens of informal relationships and/or social capital (Coleman, 1988) to assess their impact on enterprise health and growth (Barr, 2002; Fafchamps, 2001; Geertz, 1978). The technique of call log analysis used in this study may be a way to reveal these networks in more detail.

Certainly, it is worth further exploring this population's use of mobile telephony, perhaps with long-term evaluation studies which would capture change in networks over time, as well as with other research designs which would capture "return on investment" more directly by asking difficult questions about profits and revenues. In addition, though they are difficult to field, studies which gather a more comprehensive view of microentrepreneurs' networks (including both mediated and face-to-face communication) would help further integrate the "telecommunication and development" and the social capital threads discussed earlier. A complementary, perhaps simpler, approach would be to survey microentrepreneurs, comparing the proportion of new customers that come into the network via the mobile vs. via face-to-face, world of mouth, or other non-mediated channels. Finally, replication and expansion of this line of inquiry into other populations and cultural contexts, for example in the growing mobile markets in South and East Asia, would be helpful.

One of the control variables from call mix suggests that home landline ownership is associated with lower proportion of business calls (and a higher proportion of calls to friends and family). This raises interesting questions about the influence of other, complementary communication technologies accessible to mobile users—in this case, the landline in the home environment. There is an ongoing discussion about whether mobiles best understood as substitutes for (Hodge, 2005; Oestmann, 2003). Or complements to landlines in the developing world (Hamilton, 2003). This micro-level data is one indication of possible complementarity among that segment of the population prosperous (and patient) enough to afford a

landline as well as a mobile. Further analysis should seek to understand micro-level mobile use in the context of other devices (landlines, other mobiles, internet use), rather than in isolation

Concluding thoughts

This paper was not intended to address deterministic vs. constructivist approaches towards technology use. Nevertheless, it is interesting to look at the behavior of a set of users who, initially, were not the intended market for the technology. Mobiles started as a tool for professionals (Roos, 1993), and moved into the mainstream (Katz, 1999) and the on to the youth (Castells, Fernandez-Ardevol, Qiu, & Sey, 2004). Yet the take-up in the developing world has exceed all expectations, and has resulted in significant new investments in infrastructure, marketing, and even R&D (Baines, 2005) to serve the surprising demand. This evolution is strong evidence for the power of the user in the technology adoption process.

That said, we can consider actions at a number of levels that could help further increase mobile telephone user by microentrepreneurs. At the regulatory level, policymakers should continue to look at ways to reduce mobile tariffs, particularly through encouraging rigorous competition between mobile providers (Gebreab, 2002; Wallsten, 2001). At the market level, telecommunications providers should continue to find ways to expand the ways in which people can use mobiles, such as the "Smart Load" system–the card-less, small-denomination top-off services offered by Smart Communications in the Philippines (Smith, 2004). At the local level, NGOs and donors may want to look at ways to enable phone ownership, such as designing micro-loans specifically to lessen the impact of the purchase of the handset, or insurance to guard against its theft or loss. Finally, at the technological level, entrepreneurial companies and engineering teams should continue to push for new innovations, such as Voice-over-IP, and Wireless Local Loop solutions (O'Neill, 2003), which could further reduce the cost of phone ownership.

As the analysis suggests, this pattern–enabling new business contacts and amplifying existing social relationships–may not apply to users in other contexts, including users in the developing world who already own landlines. But the evidence for this pattern raises a more general issue, one which will become increasingly salient as the mobile is adopted in every country on Earth. For those users with easy access to landlines, the most important benefits of the mobile may be a mixture of mobility, constant availability, and display/status. Those whose first and only phone is the mobile may experience all these same benefits, but will also experience a dramatic increase in the ease and affordability of basic mediated communication. Even if the bulk of calls end up being with friends and family, it is difficult to underestimate the importance to an entrepreneur of simply having a reliable and affordable telephone connection, which is what the mobile finally brings.

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