

Aker, Jenny C.; Ksoll, Christopher; Lybbert, Travis J.

Conference Paper

Building Functional Adult Literacy and Numeracy with Mobile Phones: Can you Text me Now?

Proceedings of the German Development Economics Conference, Hannover 2010, No. 62

Provided in Cooperation with:

Research Committee on Development Economics (AEL), German Economic Association

Suggested Citation: Aker, Jenny C.; Ksoll, Christopher; Lybbert, Travis J. (2010) : Building Functional Adult Literacy and Numeracy with Mobile Phones: Can you Text me Now?, Proceedings of the German Development Economics Conference, Hannover 2010, No. 62, Verein für Socialpolitik, Ausschuss für Entwicklungsländer, Göttingen

This Version is available at:

<https://hdl.handle.net/10419/40241>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Building Functional Adult Literacy and Numeracy with Mobile Phones: Can you text me now?

Jenny C. Aker, Christopher Ksoll and Travis J. Lybbert^{*}

Abstract: We report the short-term results from a randomized evaluation of a mobile phone literacy program (ABC) in Niger, in which adult literacy students learned how to use mobile phones as part of a literacy class. Students in mobile phone literacy villages showed substantial gains in numeracy exam scores. There is also evidence of heterogeneity in program effects across regions, suggesting the impact is context dependent. These results were stronger in one region, for women and for participants younger than 45. There was also evidence of learning dynamics: six months after the end of the first year of classes, students in ABC villages retained what they had learned better than the non-ABC students.

^{*} Jenny C. Aker, The Fletcher School and Department of Economics, Tufts University, 160 Packard Avenue, Medford, MA 02155; Jenny.Aker@tufts.edu. Christopher Ksoll, Department of Economics, Oxford University, christopher.ksoll@gmail.com. Travis J. Lybbert, Department of Agricultural and Resource Economics, University of California-Davis, tlybbert@ucdavis.edu. This research was partially funded by the Blum Center for Developing Economies (UC-Berkeley), CITRIS and Oxford University. We would like to thank participants at seminars at the Center for the Study of African Economies (CSAE) at Oxford University, the University of Gottingen, and the German Economic Association's Sixth Annual Research Committee on Development Economics Conference for their helpful comments and suggestions. All errors are our own.

1. Introduction

Few topics in the economics have received as much attention as the social and private returns to human capital investments (e.g., Acemoglu 1996, Becker 1962, Galor and Moav 2004, Schultz 1961). Decades of econometric wrangling with measurement error and endogeneity bias have produced compelling evidence that education that effectively builds cognitive skills can improve productivity, earnings, health outcomes, and social networks (Case 2000, Akerlof and Kranton 2002, Hanushek 1995, Hanushek and Woessmann 2008, Krueger and Lindahl 2001). Moreover, human capital investments have been found to improve an individual's ability to “deal with disequilibria” (Schultz 1975) by refining one’s ability to acquire and process information and to discover and benefit from new technologies (e.g., Foster and Rosenzweig 1996).

Yet despite the importance of education in the development process, educational achievements in some of the world’s poorest countries remain remarkably low. It was estimated that over 880 million adults worldwide were unable to read and write in 2000 (UNHCR 2000).¹ Such figures have long spurred major educational investments to address supply-side constraints (school infrastructure and inputs) and demand-side factors (conditional cash transfers, school feeding and scholarships). Children are the common focus of these investments, but governments in developing countries have also invested in adult literacy programs with the hopes of reaping more immediate private and social returns. Despite decades of efforts, however, adult literacy programs have largely failed to meet expectations.² There is limited evidence suggesting that such programs have improved the functional literacy of adult populations, and any literacy gains have depreciated quite rapidly (Oxenham et al., 2002). These

¹At the most basic level, literacy entails the skills of (1) recording information of some kind in some code understood by the person making the record and possibly by other persons in some more or less permanent form; and (2) decoding the information so recorded. Similarly, numeracy is defined as “the skill of using and recording numbers and numerical operations for a variety of purposes” (Oxenham, et al., 2002).

²Abadzi notes that during the 1970s, literacy programs surveyed had success rates of 12.5 percent, though in the 1980s these rose to a median of about 60 percent of adults acquiring basic literacy skills.

disappointing gains may be partly due to the lack of reading materials in local languages: once an adult learns how to read or write in his or her local language, there are few opportunities to use this newly acquired skill on a daily or even weekly basis. Even if reading material is available, there may remain an important disconnect between the information available and the information required for livelihood pursuits. Herein lies a fundamental challenge of adult literacy efforts: Whereas children can become functionally literate based simply on innate curiosity and some instruction, illiterate adults may need to see a direct livelihood benefit from literacy to muster the motivation to obtain and maintain literacy skills (Oxenham, et al., 2002). Mobile phones and Short Message Service (SMS) provide a unique opportunity to address these constraints to literacy adoption.

SMS – more commonly known as text messaging - allows adults to practice their reading and writing skills in local languages, either by contacting family or friends or by requesting information. In addition, the pricing scheme of mobile phone services in Niger provides a financial incentive to use mobile phones as a natural platform for literacy. The original motivation for this project was based precisely on this SMS-based literacy incentive, which was observed in action by one of the authors: the large cost difference between sending simple text messages and calling encouraged some previously illiterate grain traders to teach themselves how to read and write SMS.

We estimate the impact of a mobile phone-based literacy program for adult women and men in Niger, known as Project Alphonbétisation de Base par Cellulaire (ABC). Similar to many of the poorest countries in the world, mobile phone coverage and adoption have spread throughout Niger since 2001; it is currently estimated that over 40 percent of the population has access to mobile phone coverage and that there are over one million subscribers in the country, representing 10 percent of the population. Niger is a compelling setting for testing the potential literacy and numeracy impacts of these growing mobile phone networks as Niger's education

indicators are among the worst in the world, with over 71.3 percent of the population over 15 classified as illiterate (DHS 2006). Yet Niger is not unique in these indicators. Other countries in West Africa have similar educational indicators and mobile phone coverage rates, suggesting that the current results could be adapted to other contexts.

Project ABC was designed to provide a randomized evaluation of this potential impact by integrating mobile phone-based literacy modules into conventional adult literacy training. Project ABC was conducted in two districts of Niger, each with separate randomizations into treatment and control groups to enable separate analysis by district. Program villages were randomly selected from among a group of candidate villages, allowing differences in educational outcomes between the program and comparison villages to be attributed to the mobile phone-based literacy curriculum.

After one year of the program, we find evidence for positive program impacts on academic performance. Adults in ABC villages had higher math test scores than comparison villages immediately after the courses, a result that is statistically significant at the 10 percent level. In the somewhat more densely populated region (Dosso), test scores gains in math were large, but we cannot reject the hypothesis that there was no program effect in the Zinder region. Math results are stronger and statistically significant at the 10 percent level for women. Both literacy and numeracy tests scores are stronger for students younger than 45 years of age. Finally, test score gains acquired during two months of using mobile phones remained positive and statistically significant in the six months following the end of classes, suggesting that test score improvements reflect real learning. Students were not aware that there would be a second test six months after the end of the program, and so these tests capture active knowledge.

The remainder of the paper is organized as follows. In the next section, we situate our analysis relative to other work on literacy and technology. Section 3 provides the background on

the setting of the research, as well the randomized intervention. Section 4 describes some key features of the data. Section 5 outlines our estimation strategy. Section 6 contains the preliminary results and discussion. In Section 7, we conclude by summarizing our results and offering a discussion of the relevance of these findings for policymakers and mobile service providers in the burgeoning cell phone sector of the world's poorest countries.

2. Information Technology and Education

Partly due to their rapid spread throughout the developing world, mobile phones have drawn substantial attention for their potential impacts on economic development and poverty (Bhavnani et al., 2008, Castells and et al., 2007, Corbett 2008, Donner 2008, Aker and Mbiti 2010). One of the demonstrated channels through which mobile phones improve the welfare of the poor is improved market efficiency and spatial integration (Aker 2010, Jensen 2007, Labonne and Chase). Jensen (2007) concludes by speculating that, “not only can [information] technologies increase earnings, but those increased earnings...can be expected to lead to improvements in health and education.” While these kinds of wealth effects are certainly important, mobile phones may have an even more direct effect on education in settings with low educational outcomes.

Mobile phones – and in particular SMS – serve as a potential educational tool by allowing adults to practice their reading, writing or math skills via communications with family, friends and commercial contacts. While such communication could occur by voice, the dominant pricing scheme makes SMS substantially cheaper than voice to mobile phone users in developing countries, particularly in sub-Saharan Africa. The sensitivity of consumer demand to the relative

pricing of SMS and voice is key to the marketing of mobile services worldwide,³ but this same price gap may have important unintended benefits among illiterate populations for whom cheap SMS rates provide a powerful financial incentive to learn to read and write text messages. Indeed, one of the authors observed anecdotally that relatively cheap SMS rates encouraged some previously illiterate grain traders in Niger to teach themselves how to read and write simple SMS.

This paper speaks to the large literature on the education production functions and the debate on the value of educational inputs (Hanushek 1995, Kremer 2003, Glewwe et al 2004, Kremer, Miguel and Thornton, 2009). More specifically, we show that skill acquisition can be facilitated and strengthened through modern information technology (Linden, et al., 2003). We explore three potential channels through which SMS-based training might produce functional literacy gains. First, when used effectively, technology can directly improve teaching efficacy. In this sense, mobile phones might provide a pedagogical platform for teaching literacy, and this analysis contributes to the broader discussion of educational inputs.

Second, technology and skills are often complementary. Thus, having access to mobile phones can increase the private returns to literacy by making it possible to communicate easily via (relatively cheap) SMS. Since the degree of complementarity between literacy and technology is heterogeneous, the value of SMS communication will differ based on individuals' livelihood and resource differences. This paper is therefore also related to the literature on heterogeneous returns to skills and on endogenous skill acquisition. Whereas a simple correlation between owning a mobile phone and being literate cannot tell us whether the availability of mobile phones encourages people to learn to read and write or whether more literate people choose to

³ The cross-price elasticity of demand for SMS and voice is the subject of a recent structural econometric model (Kim, Telang, Vogt, and Krishnan 2010), which finds evidence that SMS and voice are (weak) substitutes.

buy mobile phones, the randomized design of Project ABC allows us to test the causal relationship between mobile phones and literacy.

Third, in the presence of communication technologies, complementarities exist not just between technology and the skills of an individual but also between individuals. Mobile phones may produce and sustain literacy gains via the potent network externalities that are inherent in information and communication technologies generally and in mobile phones with SMS capabilities in particular. The value of SMS to a mobile phone owner (or one who has access to a mobile phone) is an increasing function of the number of others in her social or livelihood network who also have access to SMS. Furthermore, the profitability of SMS-based services – including relevant local information about weather forecasts and market prices and financial services such as banking or insurance – similarly increases as the network of SMS users grows. These network effects increase the returns to functional literacy and thereby magnify the incentive to obtain and retain these skills.⁴

3. Project ABC

3.1 Literacy in Niger

Niger is one of the poorest countries in the world, and the lowest-ranked country on the UN's Human Development Index (HDI). The country's education indicators are particularly low, with over 71.3 percent of the population over 15 classified as illiterate (DHS 2006). As is the case in many other sub-Saharan African countries, women are disproportionately affected; the gender parity index (GPI) for literacy in Niger is below 0.50. The problem is more pronounced in our

⁴Our paper also relates to the literature on skills depreciation, most of which is centered around skills lost during unemployment. Our paper highlights the fact that unused skills are lost more easily when they cannot be used on a regular basis (De Grip and Van Loo, 2002).

study regions: over 80 percent of adults in the rural communities of the two regions are illiterate, and male and female literacy rates are estimated to be 15 and 7.5 percent, respectively.

3.2 Project Description and Timeline

Project ABC is implemented by Catholic Relief Services (CRS) in two rural regions of Niger, Dosso and Zinder. CRS is an international non-governmental organization (NGO) with a presence in over 80 countries, and has been operating in Niger since the 1990s. Dosso is primarily populated by the Zarma and Hausa ethnic groups, with income-generating activities focused on agricultural production and small ruminants. Zinder is primarily populated by the Hausa and Kanuri ethnic group, with agro-pastoral traditions. The main focus of CRS' program is agricultural marketing and adult literacy, the latter of which is implemented in two classes (men and women) in each village. In collaboration with CRS, the authors developed a curriculum to incorporate a mobile phone module into the adult literacy curriculum.

There were 140 intervention villages across the two regions. The randomization first stratified villages by region, and then by administrative divisions within each region. Randomization into program and comparison groups was then carried out within each stratum using a computer random number generator. Half of the villages were selected to participate in the first year of classes (2009), and half of these were selected to participate in the ABC program.⁵ The same approach was followed for the 2010 villages. In line with the initial stratification, we often present tests for equality of means and the results separately by region. Figure 1 shows the location of the intervention villages by year of intervention (2009 and 2010) and ABC and non-ABC status within both regions.

⁵ These 60 villages are one half of the total number of villages, in which the program will be implemented.

Starting in January 2009, CRS implemented an adult literacy program in 59 villages across the two regions.⁶ Within the village, 25 males and 25 females were randomly selected from among all eligible participants, using a public lottery. Eligible applicants had to be members of existing or newly formed producers' associations and unable to read or write in any language. Among the fifty slots in each village, approximately 10 percent were reserved for members of the village development committee (VDC) with whom CRS works. The remainder were randomly chosen among the eligible volunteers.

A full adult literacy cycle in indigenous languages in Niger covers 12 months of literacy and numeracy classes over a two-year period. Courses start in February of each year and continue until June, with a six-month break between June and December due to the agricultural planting and harvesting season. Thus, classes that started in February 2009 will finish in June 2010. All classes focus on basic literacy and numeracy in local languages (Zarma and Hausa) during the first year and functional literacy topics (agroenterprise and health) during the second year. Participants in ABC villages followed the same literacy and numeracy training as those in the comparison villages, but with two modifications: 1) participants are trained in how to use a simple mobile phone, learn where numbers and letters can be found on the mobile phone handset and send and receive calls and SMS; and 2) the project provided subsidized mobile phones to groups of literacy participants (ie, one mobile phone per group of five people). The mobile phone module in the curriculum began three months after the literacy courses started, and neither students, teachers nor project staff were informed which villages were selected for ABC activities until two weeks prior to the start of mobile phone activities.⁷

⁶ In comparison with other countries in West Africa, the number of indigenous languages in Niger is fairly limited, with less than 10 local languages (as compared to over 60 in Ghana and 100 in Nigeria). The primary languages spoken in Niger are Hausa, Zarma, Fulani, Kanuri and French. The primary local languages spoken in the Dosso and Zinder regions of Niger are Hausa, Zarma and Kanuri.

⁷ In 2009, students in ABC villages had less than 6 weeks to practice using mobile phones. Mobile phones were therefore introduced at the same time in the 2010 villages. Students in ABC villages did not have any extra class

4. Data

4.1 Household Survey and Test Score Data

In this section we provide information about the dataset used in this paper and compare characteristics of program and comparison group villages. We do not yet examine the implications of sample attrition across program and comparison villages, although attrition does not appear to have been a major problem.⁸

A baseline survey was conducted prior to the start of literacy classes in January 2009. In each village, 11 respondents were sampled from among all literacy participants, with a balance between men and women. A total of 1,038 individuals were surveyed across 100 villages. The baseline survey covered information on household demographics, assets, production and sales activities, access to price information, migration and mobile phone ownership and usage. Average household size was 8.2, half of whom were children under 15. Among adult survey respondents, only 4 percent have ever attended primary school, with approximately 20 percent having studied in Koranic school. Children's educational achievements were similarly low: only 60 percent of children aged 7-15 have ever attended primary school.

Literacy and numeracy tests were also conducted with all class participants during the baseline, providing a baseline sample of over 4,750 literacy participants for the 2009 and 2010 cohorts. We conducted follow-up literacy tests in June 2009 (immediately after the end of the course) and again January 2010 (six months later, prior to the start of the second year of

time. Literacy courses are held for five days per week from 2-3 hours per day. One day per week is often allocated to revision of previous material.

⁸Attrition in literacy classes typically occurs within the first month of courses. As mobile phone activities did not begin until two months after the start of the course, and project staff, literacy teachers and students were not informed of the ABC program or their "treatment" status in advance, the decision to drop out of the literacy course could not have been based upon the ABC program. Similarly, once a student misses several weeks' of classes, the literacy teacher will typically not allow him or her to continue, as they have fallen behind in the curriculum.

courses). Prior to the June 2009 tests, participants in ABC villages had the opportunity to work with mobile phones for less than two months. Any literacy or numeracy gains based on such limited exposure to mobile phones would provide compelling evidence of potential mobile phone effects. The comparison of the June 2009 and January 2010 test results enables us to detect the persistence of any initial gains and further gains due to continued mobile phone use.

The literacy and numeracy tests were developed with the Ministry of Non-Formal Education, and were identical in structure and difficulty for all survey rounds and between the two regions. For writing, each student was asked to participate in a dictation exercise, and the Ministry of Non-Formal Education staff then assigned scores into six categories : Level 0 (or “beginner”), which corresponds to not being able to write down any letters of the alphabet correctly; Level 1, which corresponds to correctly writing seven letters of the local language alphabet and syllables; Level 2, which means that the student can correctly write simple two-syllable words; Level 3, which means that a student can write more complicated two-syllable words; Level 4, which requires that the student write two complete short sentences; and Levels 5 and 6, which require that the student correctly write two complete sentences with more complex word patterns. The levels are similar for the numeracy test, ranging from Level 1 (simple number recognition) to Level 6 ((math word problems involving addition, subtraction, multiplication and division).⁹ Examples of the literacy and numeracy tests are provided in Figure 1.

4.2 Pre-Program Characteristics of ABC and Non-ABC Literacy Centers

We utilize the 2009 household baseline survey data to compare ABC and non-ABC students.

Table 1 provides this comparison and suggests that the randomization was largely successful in

⁹ During the June 2009 literacy tests, the Ministry of Non-Formal education assigned grades based upon having a perfect score for a particular level. Therefore, a student could have correctly spelled all words in the two sentences of level 4 except for one, and been given a score of 3. The same is true with math. For this reason, the current estimates are lower bounds on the treatment effect.

creating groups comparable along observable dimensions. Controlling for stratified sampling, we find no significant differences in the age of respondents, their occupation, household size, assets owned (including mobile phone ownership) or whether the individual used a mobile phone prior to the program across ABC and non-ABC villages in the Dosso region (Table 1, Panel A).

Household characteristics are also broadly similar across program and comparison villages in the Zinder sample (Table 1, Panel B). The one exception is the percentage of children under the age of 15 having ever attended primary school in the Dosso region; a higher percentage of children in non-ABC villages attended primary school, and this difference is statistically significant at the 5 percent level. To the extent that this is indicative of adults' attitudes towards education, and hence their performance in literacy classes, this could potentially bias our results. Nevertheless, as this percentage is higher in the comparison households, we would expect that this would put a downward bias on our literacy results.

Baseline test score distributions provide further evidence on the comparability of the program and comparison groups (Table 2). We cannot reject the equality of means for pre-program writing and math test scores in both regions. Literacy and numeracy scores for both program and comparison villages were close to zero, suggesting that selected participants were illiterate prior to the start of the program.

5. Empirical Strategy and Results

We focus on reduced form estimates of the impact of mobile phones on both literacy and numeracy test scores. To better understand possible mechanisms underlying test score impacts, we also estimate program impacts on several channels, including measures of teacher and student effort. The main estimation equation is:

$$(1) \quad test_{iv,t} = \alpha + \beta_1 ABC_v + \beta_2 year_t + \beta_3 ABC_v * year_t + X'_{iv} \beta + \mu_{cv} + \varepsilon_{ivt}$$

$test_{iv,t}$ is the literacy or numeracy test score attained by student i in class c in village v in the year of the literacy class (i.e., 2009 for cohort 1 villages, the current sample).¹⁰ ABC_v is the program village indicator, $year_t$ is the time period (January 2009, June 2009 or January 2010) and $ABC_v * year_t$ is the interaction between the two. The coefficient β_3 captures the average program impact on the population targeted for program incentives. X'_{iv} is a vector of student-level baseline covariates. The error term consists of μ_{cv} , a common class-level error component perhaps capturing common local or teacher characteristics, and ε_{ivt} , which captures unobserved student ability or idiosyncratic shocks. We cluster the error term at the class level and include region- and randomization-level fixed effects in the regressions pooling Dosso and Zinder. We also test for heterogeneity of the results by including indicator variables for gender, age and distance from a market.

5.1 Average Test Score Impacts in the Short-Term

Our sample includes all students who were in the program and comparison villages in 2009, and who had test scores in January and June 2009. Figure 2 summarizes the key results of this paper. The graph shows the difference in means in literacy (Panel A) and numeracy (Panel B) test scores prior to the program, immediately after the program and six months after the end of the first year classes. Literacy classes are associated with a positive and strongly statistically significant increase in participants' math and literacy scores immediately after the program. Literacy and math scores are higher in ABC villages immediately after the program, with a relatively stronger impact on math scores as compared with writing. Both groups experience depreciation in literacy and numeracy skills during the six months when classes are not held, but

¹⁰ It is common practice in many other education studies to use the normalized test score (Glewwe et al 2004, Kremer, Miguel and Thornton 2009). A normalized test score is not appropriate in our context, given the limited range of values. We also use a Poisson regression to test for the robustness of our results.

this depreciation is relatively less in the ABC villages. This suggests that the ABC program could not only improve skills acquisition in the short-term, but also mitigate skills depreciation after the end of the program.

Table 3 shows the simple difference-in-differences (DD) estimates for the pooled sample without region-level or gender fixed effects. Overall, the literacy program strongly improved literacy in both the ABC (Panel A, Column 1) and non-ABC group (Panel A, Column 2) after 4.5 months of courses. The literacy program was successful in teaching basic writing skills, as most students moved from a “beginner” level (i.e., not being able to recognize and write letters) to an average score of 1.94 and 1.72, respectively, suggesting that participants could recognize letters, syllables and two-syllable words. While literacy test scores were 0.22 points higher in ABC villages, this effect is not statistically significant at conventional levels.

Table 3 (Panel B) shows similar evidence for the participants’ numeracy skills. On average, math test scores increased considerably in both ABC and non-ABC villages. Math scores were 0.30 points higher in ABC villages, and the effect is statistically significant at the 10 percent level. This means that 1 of 4 students were able to attain a higher level of numeracy due to mobile phones. More concretely, they were able to transition from an inability to recognize any numbers to successfully completing addition and subtraction problems. The results for both sets of results are similar when including the pre-program literacy and numeracy levels.

Table 4 disaggregates these DD results by region, controlling for individual baseline characteristics. Consistent with the previous results, we do not find significant differences in literacy test scores across program and comparison villages in Dosso or Zinder. These results do not change after controlling for randomization fixed effects (Column 2), village-level fixed effects (Column 3) or gender (Column 4). Similar to the full sample results, the results are quite different for math scores. We find that participation in the ABC program leads to a 0.45-point

higher test score in the Dosso region, and this difference is statistically significant at the 5 percent level. These results are robust to the inclusion of a variety of randomization, village and individual-level controls. Nevertheless, the difference in math and literacy scores between ABC and non-ABC villages in Zinder is not statistically significant at conventional levels.

The short-term impact of the ABC program on math scores are aligned with the methodology of the mobile phone literacy program. First, the ABC curriculum in the 2009 villages only began 6 weeks prior to the end of classes, meaning that participants had limited opportunities with the mobile phone curriculum. For this reason, most ABC villages only had time to cover a limited number of topics in the mobile phone curriculum, namely, turning on and off the mobile phone, learning how to recognize numbers on the phone and making and receiving phone calls. Certain villages were able to reach the level of identifying the letters on the mobile phone, and even fewer were able to teach the SMS component of the program. Second, writing SMS via mobile phones is based upon the numeric system, which means that literacy participants must convert numbers into letters – thereby strengthening their practice of using numbers.

5.2. Heterogeneous Program Effects

The short-term effects of the program suggest that mobile phones are more useful for math skills in one region. It is reasonable to assume that the program could also have heterogeneous effects based upon the respondent's gender and age. Table 5 presents these results by gender for the entire sample and by region, controlling for ABC villages, a time trend and randomized fixed effects. Overall, the results are consistent with prior results in terms of literacy and numeracy; the ABC program does not have a short-term effect on literacy scores for neither men nor women in the overall sample or in each region. However, the ABC program has a positive and statistically significant impact on math scores for women in the overall sample (Column 2) and in

the Dosso region (Column 4), with a statistically significant difference between men and women. The magnitude of the effect is quantitatively larger; the ABC program increases math scores by .4-.5 points, suggesting a $\frac{1}{2}$ level increase in math test scores for women.

Table 6 disentangles the same effects by age. Most empirical specifications of education production impose a quadratic age relationship based upon the assumption that educational achievement increases with age but at a decreasing marginal rate. The average age of literacy participants is 36 years, ranging from 13 to 70 years. While there is no statistically significant difference in the ages of participants across program and comparison villages, literacy participants are six years younger in Zinder as compared to Dosso, with a statistically significant difference at the 1 percent level. The results in Table 6 suggest that the ABC program is relatively more useful for younger participants, with the cutoff point at 45 years of age. Using the entire sample (Column 1, Panels A and B), younger participants have higher math and literacy scores, but there is not a statistically significant difference between the two. This effect also remains in Dosso for literacy scores (Column 3), but there is not a statistically significant difference of the impact of ABC on older and younger participants in terms of math scores. Similar to previous results, there is no statistically significant impact of the ABC program by age in the Zinder region for either math or literacy.

5.3. Dynamic Program Effects

One of the key assumptions of the ABC program is that information technology can not only reinforce skills acquisition in the short-term, but also mitigate skills depreciation when students are no longer in classes. Consequently, Table 7 contains longer run effects for both regions, using literacy data from January 2010 (six months' after the end of the first cycle of classes and prior to the second year). The tests conducted during this period were unannounced, so neither literacy students nor teachers were able to prepare for the tests in advance. For this

reason, the sample size is considerably smaller than the June 2009 sample; the number of adult participants who took the test was 1,846, less than 1/3 of the original sample. If the people who took the test in January 2010 were the best-performing participants, then this could overestimate our results. If, however, those who were absent were the best-performing students, then the results in Table 7 would underestimate our results. As a majority of those absent in January 2010 were seasonal migrants – therefore younger men – we posit that the results in Table 7 serve as a lower bound on the long-term effect.

To deal with this attrition problem, we could either bound the treatment effect or use the inverse Mills' ratio. Table 7 shows the results of the regression in equation (1) using the long-term data and a Heckman two-stage selection procedure to account for possible selection bias.¹¹ In the entire sample, neither the point estimates of the effect on literacy (Panel A) nor math (Panel B) are statistically significant at conventional levels. Consistent with the previous results, we find a strong heterogeneous effect by region: math scores in ABC villages are 0.17 points higher than non-ABC villages at least six months after the end of classes and the effect is statistically significant at the 5 percent level. This suggests that the impact on numeracy skills is persistent, and that the mobile phone-based curriculum could mitigate skills depreciation after the end of classes. Nevertheless, there are no statistically significant effects in Zinder.

6. Mechanisms

There are a variety of mechanisms through which the ABC program could affect learning the short- and long-term. First, the presence of a mobile phone curriculum – including the additional two-day training that teachers received -- could potentially lead to increased teacher participation and motivation, thereby improving the effectiveness of the overall literacy

¹¹ In the first stage we regress a student's presence at the January 2010 literacy tests on a variety of determinants to calculate the inverse Mills' ratio. In the second stage, we include the inverse Mills' ratio as an additional regressor in the OLS regression.

curriculum. Second, the presence of mobile phones can increase students' motivation, reflected by increased participation (attendance) in the classes. And finally, the mobile phone can be used as a tool for learning outside of the classroom – both during the course and after the end of courses --- thereby serving as a dynamic learning incentive.

One principle concern with respect to the previous results is a difference in teacher quality. If the Ministry of Non-Formal Education or CRS chose better-quality teachers for ABC villages, or better-quality teacher self-selected into those villages, then any differences that we observe in test scores between villages might be due to observable differences in teachers' quality, rather than the presence of the ABC program. While this concern is highly unlikely due to the randomized nature of the intervention – and the fact that literacy teachers were chosen prior to the ABC village selection process – we test for the equality of means in teacher characteristics across program and comparison villages (not shown) and do not find a statistically significant difference in teacher characteristics or attendance.

The presence of the ABC program could also encourage greater student attendance during classes. Using daily attendance data in the literacy classes, we do not find a statistically significant difference between ABC and non-ABC villages. Average monthly attendance was 18 days (out of a total of 22 days per month), with slightly higher attendance in Douthi as compared with Zinder.

These results suggest that the primary mechanism through which ABC affects learning outcomes is the opportunity to practice the newly acquired skills outside of the classroom. We will attempt to address this mechanism in future research.

7. Conclusion

Adult literacy programs are an important part of the educational system in many countries, though their successes have been mixed, in part because reading materials in local languages are not available. We present evidence that cell phones can be used as cost-effective teaching tool, providing students with 20% higher outcomes in math in one region of Niger, after little more than two months of usage. The effects on math are persistent. Being able to read and write SMS, presumes that students have a higher level of knowledge that they could have acquired in such a short period of time. We think that the main impact on literacy will occur during the second part of the literacy course, which is taking place from January to June 2010. The larger (though not significant effect) on literacy skills 12 months after the beginning of the program points into that direction. The program effects are heterogeneous. While one region seems to be benefitting substantially, we cannot reject that the second region is not.

Figure 1. Map of Intervention Villages by Cohort (2009 and 2010) and ABC and Non-ABC Status

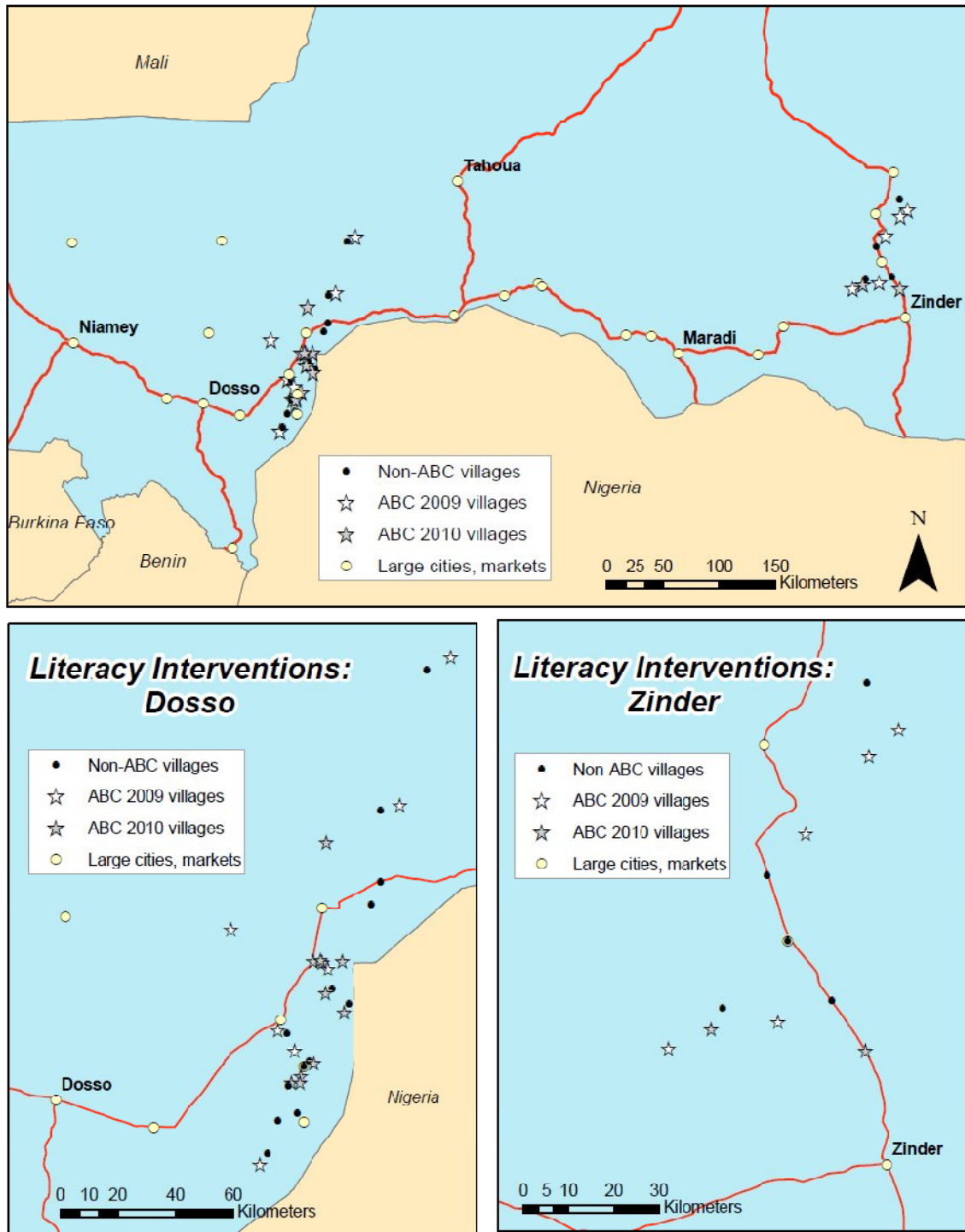


Figure 2: Year 1 (2009) Test Score Impacts by between ABC and non-ABC Literacy Centers for Cohort 1

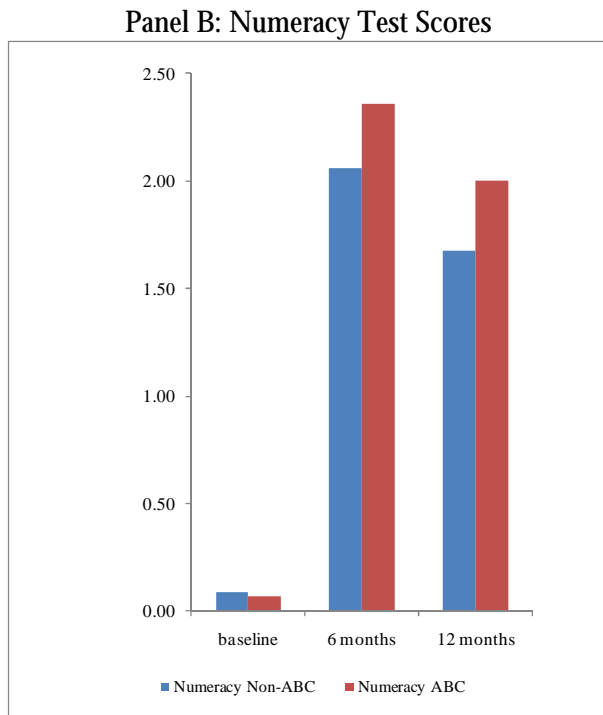
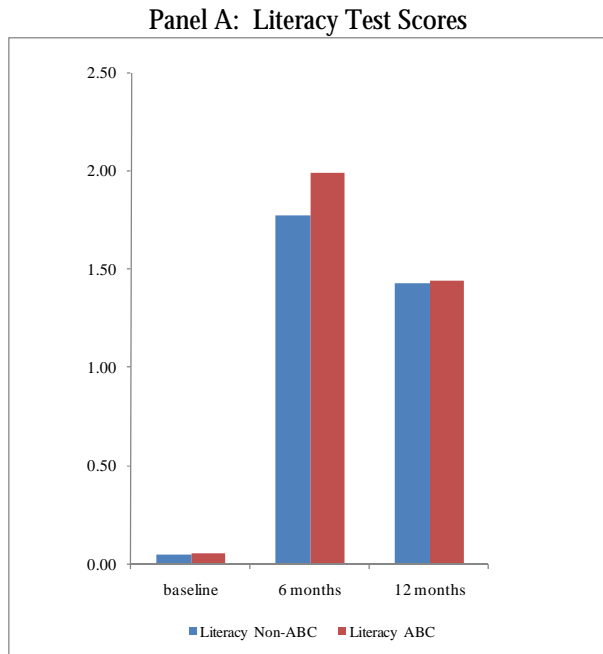


Table 1: Baseline Household Descriptive Statistics (by Treatment Status)

	Non-ABC	ABC	Difference	
Panel A: Dosso				
Age	41.84	41.13	0.71	
Head of Household	0.54	0.49	0.05	
Farming is respondent's main occupation	0.75	0.78	-0.03	
Household chores are respondent's main occupation	0.23	0.21	0.01	
Number of household members	9.17	8.92	0.25	
Percentage of Children <15 with at least some primary education	0.71	0.60	0.12	**
Number of assets owned	10.07	9.67	0.39	
Number of houses owned	3.36	3.03	0.33	
Respondent has used mobile phone since harvest	0.65	0.63	0.01	
Access to a market in the village	0.23	0.32	0.09	
Panel B: Zinder				
Age	34.53	34.18	0.35	
Head of Household	0.47	0.50	-0.03	
Farming is respondent's main occupation	0.83	0.85	-0.02	
Household chores are respondent's main occupation	0.15	0.14	0.01	
Number of household members	7.68	7.23	0.45	
Percentage of Children <15 with at least some primary education	0.55	0.54	0.02	
Number of assets owned	9.24	8.40	0.84	
Number of houses owned	3.10	2.92	0.19	
Respondent has used mobile phone since harvest	0.50	0.44	0.05	
Access to a market in the village	0.40	0.22	0.18	

Notes: Table displays summary statistics for treatment (Column 1) and control group (Column 2). Column 3 reports the difference. ***, **, * denote statistical significance at 1, 5, 10 percent, respectively. Summary statistics are for respondents with non-missing information

Table 2: Baseline Literacy Test Outcomes (by Treatment Status)

	Non-ABC	ABC	Diff(s.e)
Panel A: Dosso			
Baseline literacy test scores	0.05	0.06	.01(.02)
Baseline math test scores	0.11	0.09	-.02(.03)
Panel B: Zinder			
Baseline literacy test scores	0.06	0.04	-.02(.03)
Baseline math test scores	0.07	0.04	-.03(.02)

Notes: Table displays summary statistics for ABC (Column 1) and non-ABC (Column 2). Column 3 reports the difference. Standard errors in parenthesis, adjusted for stratified sampling. ***, **, * denote statistically significance at 1, 5, 10 percent, respectively. Summary statistics are for respondents with non-missing information

Table 3: Effects of Mobile Phone Literacy Program: DD Results

Panel A: Literacy			
	(a) ABC	(b) Non-ABC	(c) ABC-Control
1 6-month results	1.99	1.77	.22 (0.20)
2 Baseline	.05	.05	0.00 (0.02)
3 6-month results - baseline	1.94*** (0.08)	1.72*** (0.08)	.22 (0.20)

Panel B: Numeracy			
	(a) ABC	(b) Non-ABC	(c) ABC-Control
1 6-month results	2.43	2.15	.28* (0.17)
2 Baseline	.067	.093	-.026 (0.02)
3 6-month results - baseline	2.36*** (0.07)	2.06*** (0.06)	0.30* (0.17)

Notes: ABC villages are the villages in which traditional literacy training was complemented by cell phone based literacy training. 6-month results are the results after 6 months of training. Panel A: contains results for literacy. Panel B: contains results for numeracy. ***, **, * denote statistical significance at 1, 5, 10 percent, respectively. Robust standard errors clustered at the class.

Table 4: Program Effects by Region

Panel A: Effects on Literacy	Dosso				Zinder			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	ABC*year	.162 (.206)	.158 (.205)	.151 (.207)	.136 (.207)	.293 (.284)	.296 (.285)	.277 (.287)
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Randomization fixed effects	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Village fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
Gender	No	No	No	Yes	No	No	No	Yes
N	2962	2962	2962	2962	2421	2421	2421	2421
R-squared	.2624	.2894	.3094	.3401	.4794	.4794	0.5351	0.543
Panel A: Effects on Numeracy	Dosso				Zinder			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
ABC*year	.457** (.209)	.433** (.208)	.430** (.208)	.421** (.210)	.112 (.286)	.119 (.287)	.105 (.289)	.102 (.289)
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Randomization fixed effects	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Village fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
Gender	No	No	No	Yes	No	No	No	Yes
N	2974	2974	2974	2974	2424	2424	2424	2424
R-squared	.5283	.5290	0.5768	0.5939	.5186	.5376	0.5836	0.5851

Notes: ABC villages are the villages in which traditional literacy training was complemented by mobile-phone based literacy training. 5-month results are the results after 5 months of training. Panel A: contains results for literacy. Panel B: contains results for numeracy. ***, **, * denote statistical significance at 1, 5, 10 percent, respectively. Robust standard errors clustered at the class.

Table 5: Program Effects by Gender

Panel A: Effects on Literacy	Whole Sample		Dosso		Zinder	
	Men	Women	Men	Women	Men	Women
	(1)	(2)	(3)	(4)	(5)	(6)
ABC*year	.042 (.252)	.340 (.270)	-.125 (.257)	.341 (.237)	.258 (.372)	.318 (.397)
N	2644	2739	1439	1523	1205	1216
R-squared	.4357	.3031	.3665	0.1991	0.5169	.4542
Panel B: Effects on Numeracy	(1)	(2)	(3)	(4)	(5)	(6)
ABC*year	.134 (.241)	.417* (.244)	.345 (.245)	.511* (.304)	-.095 (.421)	.311 (.387)
N	2652	.2746	1446	1528	1206	1218
R-squared	.5560	.5035	.5907	.4970	.5243	.5197

Notes: ABC villages are the villages in which traditional literacy training was complemented by mobile-phone based literacy training. 5-month results are the results after 5 months of training. Panel A: contains results for literacy. Panel B: contains results for numeracy. ***, **, * denote statistical significance at 1, 5, 10 percent, respectively. Robust standard errors clustered at the class.

Table 6: Program Effects by Age

Panel A: Effects on Literacy	Whole Sample		Dosso		Zinder	
	Younger than 45	Older than 45	Younger than 45	Older than 45	Younger than 45	Older than 45
	(1)	(2)	(3)	(4)	(5)	(6)
ABC*year	.314 (.239)	-.017 (.235)	.404* (.251)	.006 (.262)	.098 (.317)	-.064 (.354)
N	2862	2726	1153	1809	1709	917
R-squared	.3613	.3379	.2568	.2723	0.4359	.4644
Panel B: Effects on Numeracy	(1)	(2)	(3)	(4)	(5)	(6)
ABC*year	.294 (.212)	.242 (.21)	.433* (.229)	.481* (.266)	.204 (.317)	-.331 (.313)
N	2867	2736	1156	1818	1711	918
R-squared	.5075	.5191	.5582	.5120	.4831	.5494

Notes: ABC villages are the villages in which traditional literacy training was complemented by mobile-phone based literacy training. 5-month results are the results after 5 months of training. Panel A: contains results for literacy. Panel B: contains results for numeracy. ***, **, * denote statistical significance at 1, 5, 10 percent, respectively. Robust standard errors clustered at the class.

Table 7: Six-Month Effects of ABC on Literacy and Numeracy

Panel A: Effects on literacy			
	Whole Sample (1)	Dosso (2)	Zinder (3)
ABC village * 10 month scores	-.018 (0.88)	0.078 (0.128)	-.080 (0.120)
N	4653	2355	2298
R-squared	0.23	.2372	.3503
Panel B: Effects on numeracy			
	Whole Sample (1)	Dosso (2)	Zinder (3)
ABC village * 10 month scores	.041 (0.064)	.167** (.080)	-.084 (.010)
N	4878	2581	2297
R-squared	.5333	.5756	.5068

Notes: ABC villages are the villages in which traditional literacy training was complemented by cell phone based literacy training. OLS regressions that control for ABC village, time, region (except columns (4) and (5)), sex (except columns (2) and (3)), and columns (1) and (6) also for sex*region. Panel A: contains results for literacy. Panel B: contains results for numeracy. ***, **, * denote statistical significance at 1, 5, 10 percent, respectively. Robust standard errors clustered at the class.

REFERENCES

- Acemoglu, D. 1996. "A Microfoundation for Social Increasing Returns in Human Capital Accumulation." *The Quarterly Journal of Economics* 111(3):779-804.
- Aker, J. 2008. "Does Digital Divide or Provide? The Impact of Cell Phones on Grain Markets in Niger." Department of Agricultural and Resource Economics, University of California, Berkeley.
<http://papers.ssrn.com/sol3/papers.cfm>.
- Akerlof, G., and R. Kranton. 2002. "Identity and Schooling: Some Lessons for the Economics of Education." *Journal of Economic Literature* 40(4):1167-1201.
- Becker, G. 1962. "Investment in Human Capital: A Theoretical Analysis." *The Journal of Political Economy* 70(S5).
- Bhavnani, A., R. Chiu, S. Janakiram, P. Silarszky, and D. Bhatia. 2008. "The Role of Mobile Phones in Sustainable Rural Poverty Reduction." Retrieved November 22:2008.
- Castells, M., and et al. 2007. *Mobile Communication and Society: A Global Perspective*: Mit Press.
- Corbett, S. 2008. "Can the Cellphone Help End Global Poverty." *The New York Times* 13.
- De Grip, A., and J. Van Loo (2002) *The Economics of Skills Obsolescence: A Review*, ed. J. Van Loo, and K. Mayhew, vol. 21, pp. 1-25.
- Donner, J. 2008. "Research Approaches to Mobile Use in the Developing World: A Review of the Literature." *The Information Society* 24(3):140-159.
- Foster, A., and M. Rosenzweig. 1996. "Technical Change and Human-Capital Returns and Investments: Evidence from the Green Revolution." *The American Economic Review* 86(4):931-953.
- Galor, O., and O. Moav. 2004. "From Physical to Human Capital Accumulation: Inequality and the Process of Development." *Review of Economic Studies*:1001-1026.
- Glewwe, P., M. Kremer, S. Moulin, and E. Zitzewitz. 2004. "Retrospective Vs. Prospective Analyses of School Inputs: The Case of Flip Charts in Kenya." *Journal of Development Economics* 74(1):251-268.
- Hanushek, E. 1995. "Interpreting Recent Research on Schooling in Developing Countries." *The World Bank Research Observer* 10(2):227.
- Hanushek, E., and L. Woessmann. 2008. "The Role of Cognitive Skills in Economic Development." *Journal of Economic Literature* 46(3):607-668.
- Jensen, R. 2007. "The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector*." *The Quarterly Journal of Economics* 122(3):879-924.
- Kim, Y., R. Telang, W. Vogt, and R. Krishnan. 2010. "An Empirical Analysis of Mobile Voice Service and Sms: A Structural Model." *Management Science* 56(2):234-252.
- Kremer, M. 2003. "Randomized Evaluations of Educational Programs in Developing Countries: Some Lessons." *American Economic Review* 93(2):102-106.
- Kremer, M., E. Miguel, and R. Thornton. 2009. "Incentives to Learn." *The Review of Economics and Statistics* 91(3):437-456.

- Krueger, A., and M. Lindahl. 2001. "Education for Growth: Why and for Whom?" *Journal of Economic Literature* 39(4):1101-1136.
- Labonne, J., and R. Chase. "The Power of Information: The Impact of Mobile Phones on Farmers' Welfare in the Philippines."
- Linden, L., A. Banerjee, and E. Duflo. 2003. "Computer-Assisted Learning: Evidence from a Randomized Experiment." *Poverty Action Lab Paper* 5.
- Oxenham, J., A. Diallo, A. Katahoire, A. Petkova-Mwangi, and O. Sall. 2002. *Skills and Literacy Training for Better Livelihoods: A Review of Approaches and Experiences*. Washington D.C.: World Bank.
- Schultz, T. 1961. "Investment in Human Capital." *The American Economic Review* 51(1):1-17.
- . 1975. "The Value of the Ability to Deal with Disequilibria." *Journal of Economic Literature* 13(3):827-846.