IMPACT OF INVESTMENT IN INFORMATION AND COMMUNICATION TECHNOLOGY ON PERFORMANCE AND GROWTH OF MICROFINANCE INSTITUTIONS IN UGANDA

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Abstract
This study assesses the impact of investment in information and communication technology on performance and growth of microfinance institution in Uganda. Performance is measured as a change in total factor productivity and growth as change in scale of operation. Two level growth models were used to determine the impact of investment in information and communication technologies on total factor productivity and scale change trajectories of individual microfinance firms. Results indicate that about 18% variation in performance and 19% variation in growth across firms were due to investment in information and communication technologies. The shrinking customer base, decreasing marginal returns, and increased competition are necessitating selecting optimal input-mix and investment in information and communication technology by microfinance institutions in Uganda. This will ensure providing service at lower cost and sustainability and microfinance institutions in Uganda.
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1. Introduction

Microfinance is defined as the provision of financial services to lower income people, especially the poor people. Waterfield and Duval (1996) defines microfinance as the provision of both savings and credit financial services to micro enterprises. Ledgerwood (2000) definition emphasize the evolution of microfinance as an economic development tool intended to benefit low income women and men, with savings, credit, insurance and money deposit services. Social intermediation is another service offered by microfinance institutions. This service includes group formation and capacity building, developing community leadership and training in financial literacy. In this aspect,

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microfinance is therefore viewed as a development tool. Christen et al. (2003) shows that clients of microfinance institutions are not just microentrepreneurs seeking to finance their businesses. They are poor clients who also use microfinance to manage emergencies, acquire household assets, improve their homes, smooth consumption and fund social obligations. Investment in ICT allows offering these services more efficiently and at lower cost.

In addition, the growing attention on the importance of microfinance institutions in economic development is attracting participation of formal and other commercial financial institutions. These firms are expanding outreach programs and scaling up operations in rural area where the poor people reside. This is increasing competition in the microfinance sector in Uganda. Increased competition has impact on mission drift. Mission drift arise when microfinance institutions increasingly cater to customers who are better-off than their intended original customers, the poor people. It also affects client behavior such as multiple loan-taking that affect repayment capacity and level of savings deposit. This necessitates information sharing between microfinance and other lending institutions through investment in ICT that will enhance monitoring the credit of customers and loan evaluation activities.

The microfinance institutions in Uganda can take advantage of various policies, statutes, laws, acts and regulations that have been passed and enacted in the last two decades to attract investment in ICT. Uganda's National Policy emphasize that ICT is a basic resource for development, a mechanisms for accessing information, and an independent industry to support e-business, software development and service and manufacturing sectors. The policy supports various categories of ICTs that cater for different sectors of the economy (including health, education, agriculture, energy, environment, business, and science & technology). The aim is empowering people to improve their living conditions (ICT_NPU, 2010).

For microfinance firms, investment in ICT is essential in terms of overall performance by improving productivity and reducing business costs. Productivity is defined as maximizing the use of available resources to achieve the desired impact. It compares results or outputs with the cost of producing them. Increase in productivity is achieved either through a reduction of marginal costs (costs per unit of output) or through an increase in marginal revenue (revenue per unit of output) or both. Waterfield and Duval (1996) suggest that operating cost ratio is the most important productivity measure for credit programs. The ratio tells the institution how much result or portfolio is being produced for every unit cost or resources spent. It is represented as a percentage of total operating costs to net outstanding portfolio. The operating cost ratio is the interest a microfinance institution would have to charge to break even. The lower the operating cost ratio, the more efficient the program. However, this measure is more useful for commercial microfinance institutions.

Jansson et al. (2002) suggest that productivity of the credit department or credit caseload uniquely defines efficiency of microfinance institutions. The argument is that to be sustainable and efficient, microfinance institutions must be able to handle very large numbers of customers with least administrative costs and without allowing portfolio quality to deteriorate. Ledgerwood (2000) recommends using the average portfolio outstanding per credit officer as a measure of productivity. This is based on the fact that the number of active loans and clients per credit officer varies depending on the method of credit delivery and whether or not loans are made to individuals, individuals as group members, or to groups. One limitation of this measure is that salary costs may appear lower when the case load is higher but too many clients may result into higher loan defaults, which offsets lower administrative costs. These ratios are also unsuitable in terms of measuring general performance and growth.

The purpose of this study was to estimate the impact of investment in ICT on performance and growth of microfinance institutions in Uganda. Performance is measured as changes in total factor productivity, which was estimated using an input-oriented Malmquist productivity index. The index was decomposed further into technological change, technical efficiency change, and scale efficiency change. The basic idea is that a microfinance firms could increase productivity by changing the scale such that it operates at a technically optimal scale. We use scale efficiency change as measure of growth.

The rationale is that, while the focus of most microfinance institutions is on poverty reduction; financial self-sustainability is increasingly becoming important. Increasing competition among microfinance institutions and other commercial banks have conditioned microfinance institutions to concentrate more on expanding their customer base and increasing productive efficiency (Hermes et al., 2008; Rhyne and Otero, 2006). In order to increase the customer base, Uganda's microfinance institutions are increasingly investing in ICT. However, there is no empirical evidence indicating that ICT investment leads to better performance and growth (Kateeba, 2001). This paper adds to existing literature about the impact of ICT capital on firm's performance and growth. We also demonstrate the use of individual growth model in assessing the impact of ICT among microfinance institutions in Uganda.

M**icrofinance institutions and ICT:** Brynjolfsson and Yang (1996) categorize ICT into office, computing and accounting machinery, consisting primarily of computers. Kateeba, (2001) defines ICT as the use of computers, micro electronics and telecommunications to produce, store and send information in form of pictures, words or numbers, more reliably, quickly and economically. It is both software and hardware. Investment in ICT is regarded as the most important innovation in providing quick and efficient services. Evangelista (2000) points out that the information-based characteristics of services offered by microfinance institutions make ICT very compatible. The generation and use of ICT play a vital role in service innovation activities and therefore boosting performance. Koson (2007) shows that the presence and intensity of ICT may be used to explain the higher growth experienced by the service industries in the last two decades.

In general, while growth can be achieved from capital investment, performance gains stem from the role that ICT plays as input in the production process of the firm. Sircar et al. (1998, 2000) indicated that investment in ICT has a positive effect on revenues and companies that spend more on technology tend to have higher revenues. In their study, Koch, Mayper and Wilner (2009) indicated that that billions invested in ICT have not yielded significant gains in worker productivity. They argue that ICT created the need for human to be smarter and exceedingly well paid to make the new and complex ICT to run correctly. Therefore, capital investment in ICT did not lead to lower labor costs and improved productivity. Totolo (2005) contends that it is inappropriate to blame the investment in ICT for productivity failures. Many problems of ICT relate to the systems' integration that needs trained personal to manage the new investment. Major investment in ICT (especially in developing countries) tends to forget investment in human capital that enhances ICT penetration within the firm. Therefore, investment in ICT includes investment in human capital that compliments efficient management and operation of new technologies. Various techniques are used to assess the impact of ICT on growth and performance. Previous studies use a variety of growth accounting methods and econometric models to examine the impact of ICT on industry or firm level performance. Gretton, Gali and Parham (2002) used firm-level data from the Australian Business Longitudinal Survey and econometric model to analyze the impact of ICT on growth. Results indicated positive and statistically significant relationship between the use of ICT and growth in both manufacturing and service sector. Using econometric model, Brynjolfsson and Hitt (2003) showed that ICT has a solid impact on productivity on most firms. Hempell, Leeuwen and Wiel (2004) analyzed comparable panel data of the Dutch and German firms in the service industries and found that ICT capital deepening and innovation have complementary impact on productivity. For service oriented firms, evidences from prior researches suggest that investment in ICT has a positive impact on growth and performance. However, specific research on how ICT particularly affects the service industries at the firm-level is still scarce, especially for developing countries in Africa. In addition, previous studies used linear regression techniques that tend to estimate average impact and not the impact of ICT on individual growth or performance trajectories. The individual growth model is a relatively new statistical technique now widely used to examine the unique trajectories of individuals and groups in panel data. The method overcomes some of the limitations of panel data and offers additional benefits and information. The models allow researchers to measure change over time in a phenomenon of interest (impact of ICT) at both the aggregate (sector) and individual (firm) levels.

2. Empirical methodology

Malmquist Productivity index: Performance and growth measures were estimated by decomposing the Malmquist Productivity index (Malmquist, 1953) that was estimated using Data envelopment analysis. Data envelopment analysis (DEA) is a standard techniques used to compute the Malmquist Productivity Index. The use of the DEA does not require any specification of the functional form of the production relationship. This non-parametric technique allows the evaluation of the relative efficiency of economic decision making units based on multiple inputs used and multiple outputs produced. The efficiency score is calculated as the ratio of a weighted composite of outputs to a weighted composite of inputs. The weight of each input and output is estimated relative to other firm's inputs and outputs in reference to an efficient technology. Given the reference technology or production frontier, the objective of DEA is to determine how a firm can scale-up output using the same inputs or producing the same output using less inputs. The DEA techniques used to estimate efficiency are outlined in Färe, Grosskoff and Lovell (1985). The Malmquist Index is a bilateral index that can be used to compare the production technology across firms. The index is based on the concept of the production function that determines the maximum possible output, with respect to a set of inputs and reference technology. In that respect, DEA-based Malmquist productivity index approach has been applied by several authors to determine changes in productivity over time across disciplines including agriculture, education and several specific industries. The index is defined using Shephard's (1953) distance functions that describe multi-input and multi-output production technology. The distance functions are then estimated using DEA techniques. Apart from the practical work of Färe et al.

(1989); the algebraic representation of Malmquist Index models can be found in many papers, therefore not replicated here. Methods for estimating the input-oriented Malmquist productivity index using DEA are illustrated in Charnes, Cooper and Rhodes (1978) and in many other papers; likewise not replicated here. For practical application using panel data see Tulkens and Eeckaut (1995), Becchetti,Bedoya and Paganetto (2004) and Coelli et al. (2005). For this paper and as indicated before, performance is measured as changes in total factor productivity, which is estimated using an input-oriented Malmquist productivity index that measure performance. The index is further decomposed to capture the scale efficiency change, which is a measure of growth. By definition, total factor productivity changes determine whether a microfinance institution is serving as many people as possible at the lowest possible cost. Scale efficiency change depends upon the choice of an output vector and also the reference technology. It measures the degree of movement in terms of coming closer to the point of optimal scale. Generally, the Malmquist factor productivity index is a product of technical efficiency change (catching up to the frontier) and technological progress (shifting the production function). Technical change is further decomposed into pure technical efficiency change and scale efficiency change. Technological change is associated with increase in output for any given input and causes an upward shift of the production frontier. The concept of technical efficiency is based on the input-output relationship. Technical efficiency change occurs when the observed output is produced by less input when compared to the past period. Scale efficiency change depends upon the choice of an output vector and also the reference technology. It measures the degree of movement in terms of coming closer to the point of optimal scale.

Individual Growth Models: Individual growth models are usually used for exploring longitudinal data on individual firms over time (Goldstein,1979; Singer and Willett, 2003). Combined with multilevel modeling, the model allows for investigating within and between variability of the response variable (in this case performance and growth) (Raudenbush and Bryk, 2002). The model also allows estimating the covariance matrix to test for variability as well as the average growth parameters. The basic assumption is that observations taken over time are nested within subjects (in this case individual microfinance institutions) drawn from some population of interest giving a two-level hierarchical structure. The variation of responses within subjects (or within the microfinance sector) over time is at the lowest level (level one) and the variation of the underlying mean responses between institutions is at level two. This means that measurements made on the same institution are correlated and it is this dependency that leads to the inadequacy of simple estimation procedures based on ordinary least squares (Moskowitz and Hershberger, 2002). Following Singer (1998) a simple unconditional individual growth has two levels. The level-1 model is a linear individual growth model and the level-2 model expresses variation in parameters from the growth model as random effects unrelated to any firm level characteristics. This model can be presented as:

$$Level-1: Y_{tj} = \pi_{0j} + \pi_{1j}T_{tj} + r_{tj} \qquad \text{where} \quad r_{tj} \sim N(0,\sigma^2), \tag{1}$$

$$\begin{aligned} Level-2: \pi_{0j} &= \beta_{00} + u_{0j}, \\ \pi_{10} &= \beta_{10} + u_{1j}, \end{aligned} \qquad \text{where} \quad \begin{pmatrix} u_{0j} \\ u_{1j} \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \tau_{00}, \tau_{01} \\ \tau_{10}, \tau_{11} \end{pmatrix}\right].$$

In equation (1), Y_{tj} is the estimated total factor productivity or scale efficiency changes for microfinance institution *j*, which is tracked overtime time T and the π's are parameters for level-1 (within microfinance institution) model. The intercept of the Level-1 model (π_{0j}) estimates the expected measure of performance or growth (average total factor productivity or average scale efficiency change for each firm) at the first year (T=0), also called initial status. The slope (π_{1j}) is the performance or growth rates for the *j*th microfinance institution. The variable T represents the time of measurement and is coded as (T=0,1,…,T), and r_{tj} are microfinance firms random errors (within-firm residuals), which varies by time. The residuals are normally distributed with a zero mean and homogenous or constant variance. This implies that source of variability in performance and growths are the same across all microfinance institutions, which is reasonable for firms operating in the same market.

In Level-2 model, the fixed parameters β_{00} and β_{10} represents, respectively, the samples averages (performance or growth) and average growth rate in performance or scale change. The random variation by individual microfinance institutions from the sample means are captured by the random variables u_{0j} and $u_{1j,}$ respectively. Combining level (1) and level (2) models results in a following equation:

$$Y_{tj} = [\beta_{00} + \beta_{10}T_{tj}] + [\mu_{0j} + u_{ij}T_{tj} + r_{ij}]. \qquad (2)$$

Equation 2 is the sum of two parts: a fixed part and a random part. The fixed part account for the impact of time on sample average performance or growth and the random part contains three random effects that account for sample, time, and individual effects.

Note that Equation (2) can be expanded to explore weather individual variation in the expected performance measures and growth is related to investment in ICT. While level-1 model remains the same, the objective of level-2 (between- microfinance institutions) model is changed so as to quantify the impact of investment on ICT on performance and growth measures. Equation (1) is modified as follows:

$$Y_{tj} = \pi_{0j} + \pi_{1j}T_{tj} + r_{tj} \qquad \text{where} \quad r_{tj} \sim N(0,\sigma^2), \qquad (3)$$

$$\pi_{0j} = \beta_{00} + \beta_{01}(IT_{tj} - \overline{IT}) + u^*_{0j}, \qquad \text{where} \quad \begin{pmatrix} u^*_{0j} \\ u^*_{1j} \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \tau^*_{00}, \tau^*_{01} \\ \tau^*_{10}, \tau^*_{11} \end{pmatrix}\right].$$

$$\pi_{1j} = \beta_{10} + \beta_{11}(IT_{tj} - \overline{IT}) + u^*_{1j},$$

The combined model is therefore:

$$Y_{tj} = \beta_{00} + \beta_{10}T_{tj} + \beta_{01}(IT_j - \overline{IT}) + \beta_{11}(IT_j - \overline{IT})T_{ij} + u^*_{0j} + u^*_{1j}T_{ij} + r_{tj}, \qquad (4)$$

In Equations (3) and (4) , IT_j is investment in ICT by firm *j* in year *t*, which is centered at its grand mean. The parameter β_{01} captures the impact of investment in ICT on sample's average measure of performance or growth (shift intercept of the production function) and parameter β_{11} captures the impact of investment in ICT on performance and growth rates (slope of the production function). Notice that Equation (4) has four fixed effects (an intercept (β_{00}) and three slopes (β_{01}, β_{10} andβ_{11}) and three random effects: for the intercept (μ_{0j}^*), for the slope (μ_{1j}^*) and for the firm random residuals (r_{tj}). These random variables define individual growth trajectories after controlling for the impact of investment in ICT. Also, the variance-covariance matrix in Equation (3) can be compared with the variance-covariance matrix in Equation (1) to determine the influence of the investment in ICT on explaining variation in performance and growth of all microfinance institutions.

3. Source of data and data description

The study uses data from six firms; members of the Association of Microfinance Institutions of (AMFIU) in Kampala, Uganda. The association is an umbrella organization of microfinance institutions (MFIs) in Uganda. The association was established to allow Uganda's microfinance institutions to have a common voice when advocating for favorable policies; to enhance information and experiences sharing; and to linkup and network with both local and international organizations. Members of AMFIU dominate in terms of serving the poor and cover all regions of Uganda. In 2007, the network served over 900,000 customers with saving accounts and over 350,000 customers with line of credit. In 2007, savings and loans portfolios for AMFIU members were, respectively, over 170 and 180 billion Ugandan Shillings. About 48% and 60% of the saving account holders and borrowers were female (AMFIU, 2008). Data were collected by reviewing annual progress reports, audited financial reports and portfolio performance reports. The latter is a standardized performance-monitoring tool for the micro finance industry produced on a quarterly basis by AMFIU members. The numbers of firms were based on willingness to access their financial information and availability of needed data from 2000 to 2006. However, the firms involved in this study account for over 80% of the services offered by microfinance institutions in Uganda. The data from these documents were verified by the firm's executives or finance managers. The data collected included number of clients, the book value of all assets (physical capital), operation and management cost and investment in ICT. The investment in ICT include value of capital injected in ICT infrastructures such as computers, internet, computing and accounting machinery and all electronic and telecommunication equipments and infrastructures used to produce, store and send information. This was in addition to investment in human capital. As stated before, performance was measured as changes in total factor productivity and growth was measured as changes in scale of operation. The data are summarized in Table 1. The inputs are total capital, operations and management costs and investment in ICT. The output is the number of clients served. The assumption is that the major objective of microfinance institutions is to serve as many poor people as possible at lower cost. All six institutions have all required records for 2000-2006.

4. Results and discussion

Summary statistics of estimated Malmquist factor productivity index and associated components are presented in Table 2. On average, for 2000 to 2006, factor productivity grew by 9%. In the same period, scale efficiency change was 86%. The major source of efficiency change was scale efficiency change, which changed by 76% on averaged. Technical efficiency associated with optimal input choices was a major drag on factor productivity growth. Firm 1 performed better in both performance and growth measures and has the highest investment in ICT. The least performers were firm's 2 and 6 that registered no growth in performance and regressivennes in total factor productivity growth. This can be attributed to poor choices of input mix or technical inefficiency.

Results of the unconditional growth models are presented in Table 3. The likelihood ratio tests for unconditional growth models were both statistically significant at 1%. The likelihood ratio test statistic was 55.16 for productivity model (performance) and 47.87 for the scale change model (growth). Both test statistics are distributed Chi-squared with 3 degree of freedom. The tested null hypothesis was that the only intercept model is the true model. The test statistic indicates that the null hypothesis is false. The estimated model (Equation 2) fit the data significantly better than the more restrictive model without time variable or the time variable has influence on productivity growth and scale change.

For both models, the intercepts (β_{00}) represents the average performance and growth for the six firms. Over the 2000 to 2006 time period, the average productivity growth was approximately 55.6%. In the same period, for each microfinance institution, the scale of operation increased by 39.2%. For the productivity growth model, based on the sign of the time variable parameter (β_{10}), which is negative; productivity growth has been increasing at a decreasing rate by an average of 18.5% year. However, on average, the scale of operation has been increasing at an increasing rate of 14.6% year. The inverse relationship can be related to the law of diminishing marginal returns. In all productive processes, adding more of one factor of production, while holding all others constant, will at some point yield lower per-unit returns. Based on 5% level of significance, we reject the null hypotheses that either the intercept or time variable parameter are zero in the sample. In both models the estimate variances for intercept (τ_{00}), time variable parameter (τ_{11}) and residuals (σ^2) are statistically significant at 5% level of significance. This tells us that there is variation in both intercept and slope that potentially could be explained by level 2 covariates and there is variation in both performance and growth among the six microfinance institutions.

The results of conditional model (Equation4) are presented in Table 4. Again, the likelihood ratio tests that tested the null hypotheses that the only intercept models are true for productivity and scale change models were rejected at 1% level of significance. The likelihood ratio test statistic was 78.61 for productivity model and 45.34 for the scale change model. Both test statistics are distributed Chi-squared with 5 degree of freedom. The models with time and ICT capital variables fit the data better than models with intercepts only.

In addition, the likelihood ratio test was used to test the goodness of fit for unconditional and conditional growth models. The hypothesis is that the unconditional growth models (Equation 2) fit the data better than conditional growth model (Equation 4). For both models (performance and growth models), this hypothesis was rejected at 1% level of significance. The likelihood ratio test statistic was 28.98 for productivity growth (performance) model and 36.76 for the scale change (growth) model. Both test statistics are distributed Chi-squared with 2 degree of freedom. Because investment in ICT variable was centered at its grand mean, the intercepts (β_{00}) and time variable parameters (β_{10}) are similar for both unconditional and conditional growth models and have same meanings. These two parameters in Table 4 are better estimated when compared to the same parameters in Table 3 as indicated by corresponding smaller standard errors.

In Table 4, the ICT capital parameter (β_{01}) captures the relationship between investment in ICT on average productivity growth (for performance model) and on average scale change (for growth models). Likewise, the parameter on the interaction between time and ICT capital variables (β_{11}) captures the relationship between time and investment in ICT on average productivity growth (for performance model) and on scale change overtime (for growth models). Both parameters are statistically significant at 1% level of significance. These results imply that for every Million Ugandan Shillings invested in ICT, increase average productivity by 5.7% and productivity growth rate by 2.3%. The same amount increases the average scale of operation by 18.7%; with higher annual growth rate of 1.3%. In other words, a microfinance institution that invest more one million Ugandan shillings in ICT; on average, the size of operation (number of customers) are 18.7% higher than its counterpart and the annual growth rate is 1.3% higher.

Again, we reject the null hypotheses that β_{01}=0 or β_{11}=0. In addition, the estimated variance for intercept and slope are different from zero. Hence, there is a variation in both the intercepts and slopes that potentially could be explained by other variables not include in both models. A thing to note is that for both unconditional and conditional growth models, the estimated residual variances remain unchanged. But the estimates for the variance-covariance matrix for the slopes have changed. The variance-covariance matrices for unconditional and conditional productivity growth (performance) models are, respectively:

$$\begin{pmatrix} \hat{\tau}_{00} & \hat{\tau}_{01} \\ \hat{\tau}_{10} & \hat{\tau}_{11} \end{pmatrix} = \begin{pmatrix} 0.956 & -0.238 \\ -0.238 & 0.062 \end{pmatrix} \quad \text{and} \quad \begin{pmatrix} 0.965 & -0.246 \\ -0.246 & 0.051 \end{pmatrix}.$$

Comparing these estimates, including the investment variable did not improve estimating the intercept of the conditional growth model. This result means that the ICT capital variable did not reduce the variance of the average growth in productivity for all six microfinance firms. Due to centering, this result is as expected result. The variance component of productivity growth rate decreased from 0.062 (unconditional growth model) to 0.051 (conditional growth model), which is a 17.7% change. It can be therefore concluded that, for these six firms, investment in ICT accounted for 17.7% in productivity growth rate. The variance-covariance matrices for unconditional and conditional scale change (growth) models are, respectively:

$$\begin{pmatrix} \hat{\tau}_{00} & \hat{\tau}_{01} \\ \hat{\tau}_{10} & \hat{\tau}_{11} \end{pmatrix} = \begin{pmatrix} 0.561 & -0.005 \\ -0.005 & 0.031 \end{pmatrix} \quad \text{and} \quad \begin{pmatrix} 0.565 & -0.006 \\ -0.006 & 0.025 \end{pmatrix}.$$

Similarly, including the investment variable did not improve estimating the intercept of the conditional growth model. The variance components of scale efficiency change (growth model) decreased from 0.031 (unconditional growth model) to 0.025 (conditional growth model), which is a 19.4% change. Therefore, investment in ICT accounted for 19.4% of the increase in the size of operation of these microfinance firms. From these results, it is obvious that investment in ICT is needed for both productivity growth and increase in the size of operation.

Individual performance and growth rate trajectories (including individual effects) are shown in Figure 1. On average, productivity growth rate is decreasing. This means that almost all microfinance institutions are operating on the second part of the production function and are facing diminishing marginal returns; therefore, approaching optimal size. The approach is accelerated by investment in ICT as shown in the second part of the graph. In both graphs, spikes are due to one-time abrupt increase in level of ICT investment, particularly by firm 5 in 2000 and firm 1 in 2003. These firms have two choices: maintain current size and concentrate on optimizing input-mix to increase technical efficiency; and or increase the current size by increasing investment in all inputs.

5. Summary and conclusion

In summary, despite the large body of firm-level analyses devoted to the impact of investment in ICT on growth and performance, a robust evidence for developing countries is still needed. The ICT provides the opportunity to reduce transaction costs and improve coordination of various activities, inside and outside firms. Innovative ICT improves the efficiency of all inputs by improving the production processes and organisational structures of the firm. However, the mere accumulation of ICT capital is not enough to increase productivity. The impact lies in the way firms integrate and use these technologies. Skilled staff training, adjustments in organizational structure and complementary investments are needed if potential gains are to be realized. Other factors related to the firm environment such as the regulatory framework, the availability of electricity and the extent and use of networks, are also important in determining the impact of ICT investment. In this study we use individual growth models to access the impact of investment in Information and Communication Technology on growth and performance of microfinance institutions based in Kampala, Uganda. We deviate from other studies and use individual linear growth models to assess the impact of investment in Information and Communication Technology on growth and performance. Individual growth models have advantage of tracing out firm-level growth trajectories and estimating individual growth rather than average growth. Results from this study indicate that investment in ICT accelerated growth and improved performance of microfinance institutions in Uganda.

Growth or firm expansion was defined scale efficiency change and performance was defined factor productivity growth. However, these microfinance firms were facing diminishing marginal returns. There is a need to improve technical efficiency by choosing input-mix that is optimal or investing in other inputs (e.g., physical capital) that complement ICT performance. In general, success of microfinance in countries like Bangladesh, Bolivia and Indonesia has demonstrated the potential micro-lending to poor households. Microfinance institutions have ability to reach the poor without collaterals required by commercial banks. In Uganda, micro-financing is viewed as a new rural development paradigm aimed at helping poor households to take advantage of available economic opportunities and increase household's income hence reduce income poverty and poverty vulnerability. Micro-financing also smoothen household consumption and therefore improve food security and also improve households' socioeconomic empowerment by engaging them in community development and decision processes that affect their social and economic live. However, most of poor households reside in remote locations characterized by low population density. Investment in Information Communication Technological may reduce transaction costs and expand access. Microfinance institutions in Uganda should take advantage of existing conducive laws and incentive that promote investment in Information and Communication Technology in the Country. Future studies can focus on the identifying innovations and best practices that generate highest impact.

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Annex

Table 1: Summary Statistics of Input and Output Variables for 2000-2006					
Firm	**Variable**	**Mean**	**Std Dev**	**Min**	**Max**
Sample	Total Capital (M U.shs)	37.50	47.52	0.22	151.99
	O & M cost (M U.shs)	75.80	71.69	0.09	241.88
	Investment in ICT (M U.shs)	2.30	3.56	0.00	17.27
	Number of clients	13,784	6,158	4,928	31,670
	Average total cost (U.shs/client)	71,579	76456	63.72	328,489
Firm 1	Total Capital (M U.shs)	14.69	8.21	3.38	26.57
	O & M cost (M U.shs)	224.69	19.68	186.93	241.88
	Investment in ICT (Million U.shs)	7.44	6.02	2.23	17.27
	Number of clients	8,975	1,672	7,196	11,658
	Average total cost (U.shs/client)	252,223	47,274	200,362	328,489
Firm 2	Total Capital (M U.shs)	114.91	23.79	78.09	151.99
	O & M cost (M U.shs)	59.40	51.93	12.05	151.99
	Investment in ICT (Million U.shs)	2.16	1.19	0.93	4.56
	Number of clients	13,241	2,700	9,890	16,811
	Average total cost (U.shs/client)	45,452	28,606	18,071	92,611
Firm 3	Total Capital (Million U.shs)	11.18	8.23	4.00	28.80
	O & M cost (M U.shs)	84.66	29.22	50.37	137.00
	Investment in ICT (M U.shs)	0.64	0.60	0.14	1.87
	Number of clients	12,460	1,642	10,333	14,588
	Average total cost (U.shs/client)	66,518	14,975	48,747	95,040
Firm 4	Total Capital (M U.shs)	90.49	4.12	83.58	95.56
	O & M cost (M U.shs)	52.13	18.68	16.42	69.43
	Investment in ICT (M U.shs)	1.65	1.08	0.89	3.74
	Number of clients	16,727	7,936	9,311	31,670
	Average total cost (U.shs/client)	39,283	21,528	5,186	65,143
Firm 5	Total Capital (Million U.shs)	4.50	4.84	0.40	13.70
	O & M cost (M U.shs)	66.02	19.93	39.40	101.10
	Investment in ICT (Million U.shs)	3.60	4.57	0.28	13.43
	Number of clients	7,995	1,867	4,928	10,959
	Average total cost (U.shs/client)	81,619	6,622	7,2386	92,253
Firm 6	Total Capital (Million U.shs)	0.30	0.04	0.22	0.37
	O & M cost (M U.shs)	0.33	0.19	0.09	0.70
	Investment in ICT (Million U.shs)	0.02	0.01	0.00	0.03
	Number of clients	22,005	4,066	13,393	26,635
	Average total cost (U.shs/client)	147.08	86.74	62.72	333.60
Monetary values are in nominal terms; O &M is operation and management; M U.Shs is Million Uganda Shillings. In 2006, the average exchange rate was 1873 U.shs per US $.					

Figure 1: Change in Productivity and Scale of Operation Overtime

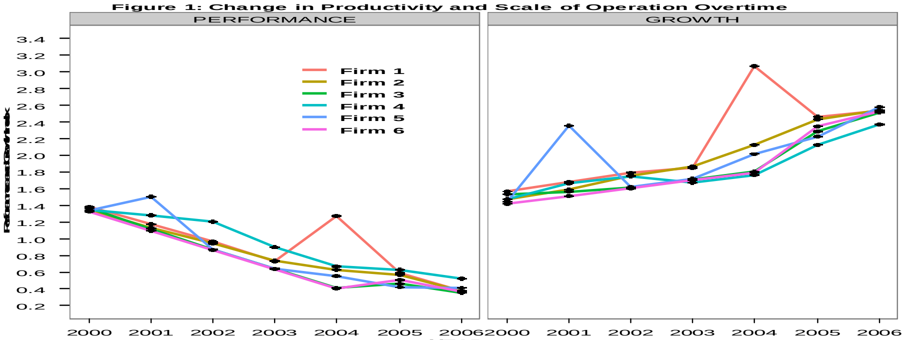

Table 2: Estimated Total Factor Productivity Measures

Firm	Year	EFFCH	PEFFCH	SCCH	TECHCH	MALMQ
1	2000	1.54	1.03	1.49	1.57	2.41
1	2001	0.74	0.95	0.78	0.92	0.68
1	2002	2.99	0.77	3.91	0.97	2.89
1	2003	0.1	1.03	0.09	1.18	0.11
1	2004	2.78	2.58	5.21	0	0.99
1	2005	1.14	1.11	1.02	0.86	0.98
Average		1.55	1.25	2.08	0.92	1.34
Standard deviation		1.14	0.66	2.01	0.52	1.07
2	2000	1.85	1.27	1.46	0.44	0.81
2	2001	0.89	1.21	0.73	0.88	0.78
2	2002	0.93	1.43	0.65	0.84	0.78
2	2003	0.95	1.13	0.84	0.54	0.52
2	2004	1.98	1.18	3.99	0	0.64
2	2005	1.24	1.05	1.17	0.86	1.07
Average		1.31	1.21	1.47	0.59	0.77
Standard deviation		0.49	0.13	1.27	0.34	0.19
3	2000	1.89	0.97	1.94	1.51	2.86
3	2001	6.21	1.1	5.65	0.92	5.75
3	2002	0.68	1.31	0.52	1.13	0.77
3	2003	2.18	1.14	1.91	0.54	1.18
3	2004	8.93	1.45	6.17	0	0.04
3	2005	1	1	1	0.82	0.82
Average		3.48	1.16	2.87	0.82	1.9
Standard deviation		3.33	0.19	2.43	0.52	2.11
4	2000	0.25	0.5	0.51	0.67	0.17
4	2001	1.13	1.14	1	0.93	1.05
4	2002	2.05	0.69	3	0.98	2.01
4	2003	2.43	1.35	1.79	0.54	1.32
4	2004	5.34	1.91	3.53	0	0.25
4	2005	1	1	1	0.79	0.79
Average		2.03	1.1	1.81	0.65	0.93
Standard deviation		1.8	0.5	1.21	0.36	0.69
5	2000	0.04	0.96	0.05	1.57	0.07
5	2001	4.2	1	1.17	0.92	1.12
5	2002	3.53	1.37	2.57	0.97	3.41
5	2003	0.04	1.27	0.03	1.18	0.05
5	2004	2.12	1.91	3.1	0	0.31
5	2005	1	1	1	0.78	0.78
Average		1.82	1.25	1.32	0.9	0.96
Standard deviation		1.77	0.36	1.28	0.52	1.27
6	2000	1	1	1	0.59	0.59
6	2001	1	1	1	0.88	0.88
6	2002	1	1	1	0.84	0.84
6	2003	1	1	1	0.8	0.8
6	2004	0.98	1	0.98	0	0
6	2005	0.99	0.99	1.01	0.87	0.86
Average		1	1	1	0.66	0.66
Standard deviation		0.01	0	0.01	0.34	0.34
Sample average		1.86	1.16	1.76	0.76	1.09
Sample standard deviation		1.83	0.37	1.57	0.43	1.14

EFFCH is efficiency change; PEFFCH is purce efficiency change; SCCH is scale change; TECHCH is technical efficiency change; and MALMQ is Malmquist total factor productivity

Table 3: Results of unconditional growth models

Variable	Parameter Estimate	Standard Error	Probability
Productivity Growth (Growth)			
Intercept (β_{00})	1.556	0.593	0.002***
Time (β_{10})	-0.185	0.112	0.040**
Variance estimate for intercept ($\tau_{00)}$)	0.956	0.093	0.030**
Variance estimate for slope ($\tau_{11)}$)	0.062	0.067	0.038**
Covariance estimate for intercept and slope ($\tau_{10)}$)	-0.238	0.344	0.148
Variance of residuals (σ^2)	0.96	0.252	0.001***
Scale Change (Growth)			
Intercept	1.392	0.471	0.003***
Time	0.146	0.0153	0.002***
Variance estimate for intercept ($\tau_{00)}$)	0.501	0.451	0.059**
Variance estimate for slope($\tau_{11)}$)	0.003	0.005	0.061*
Covariance estimate for intercept and slope ($\tau_{10)}$)	-0.005	0.041	0.120
Variance of residuals (σ^2)	2.442	0.941	0.001***
Three asterisks, two asterisks and one asterisk mean statistically significant at 1% and 5% level, respectively.			

Table 4: Results of the conditional growth models				
Variable	Parameter Estimat	Standard Error	Probability	
Productivity Growth (Performance)				
Intercept (β_{00})	1.559	0.569	0.006	***
Time (β_{10})	-0.185	0.108	0.069	**
ICT capital (β_{01})	0.057	0.025	0.023	***
Time*ICT capital (β_{11})	0.023	0.011	0.037	***
Variance estimate for intercept ($\tau_{00)}$)	0.965	0.264	0.0131	**
Variance estimate for slope($\tau_{11)}$)	0.051	0.023	0.017	**
Covariance estimate for intercept and slope ($\tau_{10)}$)	-0.246	0.325	0.449	
Variance of residuals (σ^2)	0.96	0.132	0.002	***
Scale Change (Growth)				
Intercept (β_{00})	1.326	0.622	0.033	**
Time (β_{10})	0.093	0.043	0.031	**
ICT capital (β_{01})	0.187	0.062	0.003	***
Time*ICT capital (β_{11})	0.013	0.007	0.063	**
Variance estimate for intercept ($\tau_{00)}$)	0.565	0.033	0.001	***
Variance estimate for slope($\tau_{11)}$)	0.025	0.021	0.046	**
Covariance estimate for intercept and slope ($\tau_{10)}$)	-0.006	0.004	0.171	
Variance of residuals (σ^2)	2.442	0.679	0.010	***
Asterisks: 3, 2 and 1 asterisk imply statistically significant at 1%, 5% and 10% level, respectively.				