Could mobile money applications improve farm productivity? Insights from rural Mozambique

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Abstract:

The productivity levels in rural Mozambique are particularly low compared to neighboring countries. Farmers in these regions have limited access to inputs and banking services; as a result, they use low levels of input. The study utilizes unique data from a survey conducted in rural Mozambique to investigate the effect of the use of mobile money, an innovative and accessible banking service, on the growth of total factor productivity. The results of the estimation show that improved access to input through marketing visits was associated with an increase in Total Factor Productivity, but the mobile money trainings taken separately was not effective in improving farm productivity. Further, the study looks at the effect of various socio-economic variables on productivity growth. Portuguese literacy is associated with a 0.23% change in productivity while cattle ownership increases productivity by 1%. This study is the first to investigate the impact of mobile money use on the growth of total factor productivity, a broader measure of productivity. The results of the study can be used to design better policies to improve the financial inclusion of smallholder farmers and their farm productivity.

Introduction

It is widely recognized that agricultural inputs play a critical role in farm productivity, yet the agricultural productivity literature shows that Sub-Saharan African farmers use low input levels (Adjognon et al., 2017; Christiaensen, 2017; Crawford et al., 2003). The resulting low rates of productivity growth are not surprising. In Mozambique, the levels of productivity are particularly low relative to its neighboring countries, aggravating the threat of food insecurity (IFPRI, 2016). Attempts to increase agricultural productivity in Sub-Saharan Africa through intensification, raising input levels, are hindered by the lack of financing including informal and formal loans.

Recent literature shows that smallholder farmers in Sub-Saharan Africa have insufficient access and use of credit (Sacerdoti, 2005). Banks and other financial institution hardly provide loans to smallholder farmers due to the high transaction costs to reach farmers, but also their high perception and lack of knowledge of the risk involved in small-scale farming. Smallholders can barely provide the guarantee required by financial institutions in terms of collateral but also of credit profiling and other relevant information. Informal loans through relatives and village community members are limited due to community members facing the same capital constraints as borrowers. The main source of credit used by smallholders remains sharecropping contracts between laborers and farmers which rarely include any provision of inputs. As a result, most farmers finance their input needs through cash from farming and non-farm activities (Adjognon et al., 2017), and remittances.

Finding enough cash to finance agricultural inputs is not an easy task for smallholder farmers, most farmers in the region face binding capital constraints. In rural Mozambique, not all farmers can save, and those who do cannot save enough between harvest and growing seasons since no banking service is offered within a reasonable distance from farmers' villages. Nearly all

banking and input marketing services are located in town (IFPRI, 2016). In addition to the inexistence of banking services, farmers face high transaction costs that limit the amounts and the frequency of money transfer by friends and relatives. Finally, few farmers earn non-farm revenue and when present, this revenue is highly constrained by the household needs. Hence, smallholder farmers need an innovative and more adapted solution to finance their input needs.

The large-scale adoption of digital payment in developing countries provides an opportunity to improve the financial inclusion of multiple households living in remote areas (Jack and Suri, 2014; Munyegera and Matsumoto, 2016; Suri and Jack, 2016). Digital payments have three main advantages. First, they provide to the unbanked an accessible method to transfer money at low cost with few investments needed. Second, digital payments allow for savings and credits that can be leveraged by farmers to finance their farm and non-farm operation needs. Finally, they generate transaction data that are valuable information for credit profiling with the ultimate goal of offering banking services that are tailored to rural populations. An improved financial inclusion of smallholder farmers through mobile money could allow them to increase their purchases of inputs and ultimately contribute to improving their productivity.

The objective of the study is to investigate the impact of the use of mobile money on the TFP growth in rural Mozambique.

Methods

- Data

The dataset used in the study is a household level cross-sectional obtained from an experiment conducted in Mozambique by the International Food Policy Research Institute (IFPRI) under the Mozambique cell phone project. The project was evaluated using an encouragement design with randomized control trial clustered at the association level. Household level data were collected in a baseline survey from August to September 2014 within four districts of the Nampula province in Mozambique: Monapo, Meconta, Angoche, and Mogovolas. Farmers in these districts are located far from towns where most inputs markets and formal banks are operating. The endline survey was conducted from October to November 2015 in the same districts. The treatment consisted of two interventions: 1) trainings and incentives to use mobile money and 2) inputs marketing visits. In total 809 households were interviewed in the baseline survey against 689 households in the endline survey, resulting in a 15% attrition rate.

The cross-cutting treatment used in the design of the evaluation ensures a sufficient number of farmers in each of the four subsamples: (1) no treatment, (2) input marketing treatment only, (3) mobile money training only and (4) input marketing treatment and mobile money training. As shown in table 1, the proportion of farmers in each subsample is not altered by the 15% rate of attrition. It is important to mention that only the marketing visit treatment was randomized.

The farmers interviewed at the endline survey reported having produced fewer quantities of Maize and Cassava in year 2 (endline) relative to year 1 (baseline) with a 56% decrease in the maize production. These low levels of production imply a low use of input in year 1 relative to year 2, with the exception of the improved seeds that were more used by the farmers in year 2

than in year 1. The fall in production and input use between the two years is imputable to difficulties in the implementation of the survey. First the marketing visit scheduled after the harvest could not be conducted due to technical issues with the implementing partner. Moreover, several farmers reported a decline in output that could be explained by a flood in the area. They had to purchase additional input for replanting the affected plots (IFPRI, 2017). However, the rise in the use of improved seeds (67%) suggests that the combined interventions consisting of marketing visits and mobile money training have improved the accessibility of inputs by smallholder farmers in the Nampula province.

Table 1: Descriptive statistics

		Baseline	Endline
Demographics			
Household size	Median	5	5
Age (years)*	Mean	39.33	40.31
	Standard deviation	12.92	12.83
Gender*	Male	733	604
	Female	76	66
Education level*	Secondary or higher	135	122
	Less than secondary	674	541
Has non-farm job*	Yes	450	431
	No	359	239
Speak Portuguese*	Yes	507	569
	No	302	100
Mobile money use and agriculture			
Use mobile money	Yes	264	135
	No	204	287
Total maize production (kg)	Mean	163.89	72.28
	Standard deviation	312.94	331.04
Total cassava production (kg)	Mean	345.25	30.42
	Standard deviation	388.15	38.72
Traditional seeds (kg)	Mean	40.69	30.42
	Standard deviation	38.52	38.72
Improved seeds (kg)	Mean	4.68	14.94
	Standard deviation	88.24	92.46

* Age, gender, education level and Speak Portuguese are reported for the head of household.

- Total Factor Productivity

Productivity is measured in the study, using total factor productivity (TFP) which encompasses production efficiency and technological change (Rezek et al., 2011). The use of TFP relies on the assumption that Mozambique farmers exposed to the treatment will update both their quantity of inputs and the technology used to grow their commercial and non-commercial crops. This assumption is supported by the increased use of improved seeds in year 2, after treated farmers were given the opportunity make input purchases through mobile money.

Total factor productivity is measured by computing the ratio of an output index to an input index, which computation procedure vary across practitioners (Christensen, 1975). The computation of the TFP growth in the study is based on the approach to compute international measures of TFP growth developed by the USDA. Because the input prices are not reported in the survey, the method of computation of the input index in the study applies estimates of labor, land and capital shares reported by the USDA for sub-Saharan African countries. Dias Avila and Evenson (2010) used a similar procedure to compute TFP measures for developing countries. The output index is computed for the two main crops produced in the Nampula province: Maize and Cassava. In this region, Maize is the only commercial crop grown by the farmers, suggesting that technological change will mainly originate from Maize plots. However, the lack of output specific input data does not allow for a measure of TFP for only one crop. The output shares in the index are approximated by the average annual retail prices of Maize and Cassava in the Nampula province in 2015, reported by the FAO.

The TFP growth is given by:

$$\ln\left(\frac{TFP_t}{TFP_{t-1}}\right) = \sum_i R_i \ln\left(\frac{Y_{i,t}}{Y_{i,t-1}}\right) - \sum_i S_j \ln\left(\frac{X_{j,t}}{X_{j,t-1}}\right) \quad (1)$$

where R_i denotes the i^{th} output revenue share, S_j the j^{th} input cost share, $Y_{i,t}$ represents the level of output i in year t and $X_{j,t}$ the level of input j used in year t. The subscript i takes the value of 1 for land, 2 for capital and 3 for labor. The cost share of each input is adapted from the USDA estimates of input cost shares restricting the number of inputs to three as opposed to the USDA's six inputs index. The subscript j is 1 for Maize and 2 for Cassava. The revenue share of output j is given by the ratio of the price of output j to the sum of the prices of both outputs.

- Empirical estimation

To estimate the effect of the treatment on total factor productivity, the TFP growth estimates in (1) are regressed on the use of mobile money and a vector of socio-economics characteristics. The socio-economic variables are selected based on the literature on productivity in developing countries (Battese, 1992; Kalirajan, 1991; Mango et al., 2015). The empirical model is estimated by ordinary least square clustered at the association level consistent with the design of the experiment.

A potential problem to the OLS estimation is endogeneity due to reverse causality. Variables such as cattle ownership included in the regression may be impacted by the productivity levels and may, in turn, impact productivity levels. To address this problem, only baseline variables are included in the model such that they are not affected by the growth in productivity in year 2.

Results

The change in total factor productivity was regressed on the treatment and a vector of socio-economic characteristics to estimate the impact of the use of mobile money on productivity. The results of the estimation, reported in table 2 show that the estimate of the input marketing visits is significant at the 10% level. The input marketing visits are associated with a 0.9 percentage point increase in Total Factor Productivity. The mobile money training taken independently was not found to affect Total Factor Productivity. The estimates of the Portuguese literacy and livestock ownership variables were significant at the 5% level while the coefficient estimates of association membership, gender and secondary education were significant at the 10% level.

Table 2: Model estimation

Variables	Change in total factor productivity
Marketing visits	0.932*
	(0.391)
Mobile money training	0.291
	(0.223)
Combined treatments	-0.806
	(0.382)
In Association	0.778*
	(0.284)
Male	-0.703*
	(0.257)
Age	-0.035
	(0.028)
Portuguese literacy	0.230**
	(0.059)
Secondary education	1.245*
	(0.413)
Non-farm employment	0.147
	(0.468)
Livestock ownership	0.982**
	(0.282)
Constant	-0.287
	(1.490)
Observations	559
R-squared	0.048

***, ** and * denote respectively significance at the 5% and 1% and 10% levels

Discussion

The results of the estimation suggest a positive relationship between improved access to input through marketing visits and Total Factor Productivity. In other words, the improved access to input is associated with a better productivity of these inputs. This could be explained by a timely access to seeds and fertilizers that allow for a more effective use of these inputs on the plots. However, no evidence is found regarding the impact of mobile money use on Total Factor Productivity growth. This is not surprising given the issues in the implementation of the project. The model explains only 5% of the variability in the TFP growth. One of the factors that may explain the low fit of the model and the non-significant treatment estimate may be outputs and inputs measurements errors due to recall bias. The underestimation of output is one of the most common constraints to measure productivity in Sub-Saharan Africa (Kelly et al., 1995). Another important point to notice is the input purchases from sources different from the marketing visits, as reported in the survey report. That is, part of the increase in input use is not attributable to the marketing visits, making challenging to capture their effect.

Speaking Portuguese was associated with a 0.23% increase in productivity. However, the coefficient estimate on Portuguese literacy is too low (less than 1%) to be interpreted as a gain in productivity: farmers averaged a production of 72kg of Maize in year 2. Farmers who owned livestock were found to increase their productivity by an additional 1% compared to their non-owner counterparts. The positive effects of this two socio-economic variables on productivity are consistent with previous studies. Made headed households experienced a decline in Total Factor Productivity compared to their female headed counterparts. This could be explained by the higher inputs purchases by male headed households and the additional purchases due do the

potential flood in the area. Attending secondary school was associated with a 1.2 percentage point increase in Total Factor Productivity as expected.

This study is the first that utilize TFP growth to analyze the impact of mobile money on farmer productivity. Given the constraints in implementing the evaluation and their effect on the quality of the data collected, the results of this study could hardly be generalized to other regions in Mozambique or Sub-Saharan Africa.

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