INTERLINKED CREDIT AND FARM INTENSIFICATION: EVIDENCE FROM KENYA

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ABSTRACT

This paper addresses the potential for interlinked credit/input/output marketing arrangements for particular cash crops to promote food crop intensification. Using panel survey data from Kenya, we estimate a household fixed-effects model of fertilizer use per hectare of food crops, using an instrumental variables approach for addressing the endogeneity of participation in interlinked credit arrangements. Results indicate that households engaging in interlinked marketing programs for selected cash crops applied considerably greater fertilizer on other crops (primarily cereals) not directly purchased by the cash crop trading firm. These findings suggest that, in addition to the direct stimulus that interlinked cash crop marketing arrangements can have on small farmer incomes, these institutional arrangements may provide spillover benefits for the productivity of the farmers' other activities such as food cropping.

INTRODUCTION

Meeting the challenge of raising rural incomes in Africa will require some form of transformation out of the semi-subsistence, low-input, low-productivity farming systems that currently characterize much of rural Africa. High-valued cash crops represent one potential avenue of crop intensification. Evidence indicates that, where agro-ecological and infrastructural conditions are favorable, smallholders can raise their agricultural productivity and incomes by engaging in commercialized crops with coordinated input, credit, and output marketing systems (von Braun and Kennedy 1994; Little and Watts, 1994; Kelly *et al.,* 1996; Dorward, Kydd, and Poulton 1998). However, staple food crops continue to account for the bulk of area cultivated in most African countries, and increasing the productivity of these food crops remains a major development priority.

A major research question concerns the effect of engaging in commercialized cash crops on households' food crop productivity. Concerns are often expressed that cash crops compete with food crops for scarce land and may jeopardize households' ability to feed themselves particular when markets fail. However, there is some evidence indicating that participation in cash crop schemes can improve households' access to crop inputs and training that provide "spillover" benefits to their food crops (Goetz, 1993; Govereh and Jayne, 2003). Thus, in addition to the direct effect of cash cropping on household incomes, there may be important indirect effects of cash cropping on the productivity of other household activities such as food cropping. These potential synergies between cash crops and food crops have been generally neglected in food crop research and extension programs, although they may have important implications for programs designed to promote smallholder food crop productivity growth.

This paper measures the potential synergies between interlinked cash cropping schemes and intensification of fertilizer use on food crops. Interlinked schemes are programs where farmers receive inputs on loan from farmers and pay back the loan through sale of the crop at harvest. Credit, input supply, and output sale are "interlinked" in one transaction (Gangopadhyay and Sengupta, 1987; Hayami and Otsuka, 1993). Our analysis focuses on the case of interlinked smallholder crop marketing programs for sugarcane, coffee, and tea in Kenya.

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Findings suggest that participation in interlinked cash crop schemes has enabled small farmers in Kenya to acquire key inputs that allow them to substantially increase the level of fertilizer on crops other than the ones featured in commercialized marketing schemes. A better understanding of why and how these synergies occur can help in the design of policy strategies to intensify food crop production in Africa.

DATA

Analysis is based on a two-year panel of rural household surveys in 1997 and 2000.[1] In April 1997, a total of 1,540 households were randomly selected within the eight provinces of the country, using a sampling frame derived from the Central Bureau of Statistics. In May 2000, 1,422 of these households were located and surveyed (attrition rate was 5.2%).

In Kenya, interlinked credit (ILC) is provided to small farmers mainly by firms purchasing and processing commercialized crops, e.g., coffee, tea, sugarcane, and horticulture. Because of large variations in agro-ecological environments across regions, we restrict our analysis to areas where ILC is available. We selected villages where at least one household received interlinked credit in either survey year. As a result of this procedure, 61 villages containing 825 households were selected.

SPILLOVER EFFECTS OF INTERLINKED CREDIT ON FERTILIZER USE ON OTHER CROPS

An important feature of many interlinked credit programs is that the buying firm provides input on credit not just for the cash crop, but for food crops as well. The rationale is that participating farmers may increase their area to cash crops if they can satisfy their basic food requirements by using less land (Nyoro 2001).

To examine potential spillover effects of fertilizer use on non-ILC crops, we stratified the sample into four groups based on credit status in 1997 and 2000. The first group received credit neither in 1997 or 2000 (n=370). The second group received ILC in 2000 only (n=140), while the third group received credit in 1997 only (n=69). The last group received credit both in 1997 and 2000 (n=246). We name these four groups "Neither," "Enter", "Exit" and "Both", respectively. Changes in households' use of ILC between the two periods provide an opportunity to estimate the effects of credit.

Table 1. Changes in Fertilizer Nutrient Use on Non-ILC Crops, by Household Category with Respect to Use of Interlinked Credit (1997 and 2000 Pooled Data).

Household category regarding use of ILC	**ILC received in**		**Number of households (C)**	**Fertilizer Nutrient use on Non-ILC Crops**		
	1997 (A)	**2000 (B)**		**1997 (D)**	**2000 (E)**	**Changes (D) - (E)**
				Kgs (s.d.)	*Kgs (s.d.)*	*Kgs [t-ratio]*
Never	**NO**	**NO**	370	15.53 (25.89)	20.14 (32.17)	+4.61** [2.14]
Enter	**NO**	**YES**	140	20.60 (25.44)	32.24 (36.80)	+11.64** [3.09]
Exit	**YES**	**NO**	69	15.31 (19.74)	23.01 (27.90)	+7.70* [1.89]
Both	**YES**	**YES**	246	20.69 (28.87)	31.72 (43.10)	+11.03** [3.33]
All			825	17.91 (26.37)	25.89 (36.60)	+7.98** [5.08]

Note: Total number of households is 1,650 (825 households *2 rounds). Numbers in parentheses are standard deviations. Numbers in brackets are standard errors. * indicates 10% significance. ** indicates 5% significance.

[1] These surveys were designed and implemented under the Kenya Agricultural Marketing and Policy Analysis Project (KAMPAP), implemented primarily by Egerton University/Tegemeo Institute.

Table 1 shows in bivariate terms how these four groups of farmers used fertilizer on crops other than those for which interlinked credit was given. We measure fertilizer use as kilograms of nutrients. Nutrient use is a better indicator of soil enhancement than the quantity of fertilizer because nutrient-to-weight ratios differ between fertilizer types. For the entire sample, fertilizer nutrient use on non-ILC crops increased from 17.91 to 25.89 kgs (+44.6%) from 1997 to 2000 (Table 1). However, this increase was smallest among the "never" category. The increase in fertilizer nutrient use was largest among the "Enter" households. Because they did not receive interlinked credit in 1997, their increase in fertilizer use should be compared with that of Never-households. The difference between the two groups is 7.03 kgs. This can be considered as a naive estimation of interlinked credit's spillover benefit to non-ILC crops. The naive estimate, however, could be biased. For instance, it will be overestimated if interlinked credit is given to households having more resources or better husbandry skills in both ILC and Non-ILC crop productions. The remainder of this paper describes the model and estimation strategy used to avoid such selection problems.

ESTIMATION STRATEGIES AND VARIABLES

The main purpose of this paper is to measure the effects of interlinked credit on fertilizer use on other crops (non-ILC crops) that are not part of interlinked credit contracts.[2] The main problem of estimating the effects of interlinked credit is the selection problem at household and village level. Households who are provided interlinked credit by traders and who agree to participate in such arrangements may have unobservable characteristics that are correlated with fertilizer use on Non-ILC crops. Or villages in which traders operate may have good soil quality or infrastructure that encourage high fertilizer use on Non-ILC crops. This selection problem can be written as an omitted variables problem.

The conditional demand equation for fertilizer use on Non-ILC crops is

$$Y_{ijt} = Z_{ijt}\beta + X_{ijt}\chi + \mu_{ij} + v_j + e_{ijt} \quad (1)$$

where Y_{ijt} is the fertilizer nutrient use on Non-ILC crops of household i in village j at time t; Z_{ijt} is a dummy variable which is one if household i has received interlinked credit at time t; X_{ijt} is a vector of household and village characteristics. The time-invariant unobservable household characteristics is μ_{ij}, while the time-invariant village characteristics is v_j. The participation of interlinked credit, Z_{ijt}, is most likely to be correlated with some of unobservable household and village characteristics that are also correlated with the fertilizer use on Non-ILC crops.

By taking an advantage of panel data, we take the first difference of equation (1)

$$Y_{ijt+1} - Y_{ijt} = (Z_{ijt+1} - Z_{ijt})\beta + (X_{ijt+1} - X_{ijt})\chi + e_{ijt+1} - e_{ijt}. \quad (2)$$

The time-invariant unobservable household and village characteristics are now purged from this model. However, the selection problem of interlinked credit may still exist. The change in the interlinked credit, $Z_{ijt+1} - Z_{ijt}$, may be correlated with the error term, which include time-variant household and village characteristics. An improvement in village infrastructure, for instance, may attract traders offering interlinked credit and also may give incentives to farmers to use more fertilizer on Non-ILC crops.

To avoid biased estimations, we estimate the equation (2) with instrumental variables. We use the mean village-level prices received for ILC crops in the previous year and their interaction terms with ILC village dummies as instruments. High ILC-crop prices tend to be positively associated with traders' profits and the availability of credit to farmers. Traders use past production information of individual producers to select borrowers and determine maximum credit limits. The ILC-crop prices, however, are germane only in villages where that specific crop is grown and marketed. Thus we create an interaction term, for instance, between the coffee price of the previous year and the coffee-ILC village dummy (=1 if interlinked credit for coffee inputs is disbursed to at least one farmer in that village; zero otherwise). We have similar interaction terms for tea and sugarcane.

[2] Feder, et al. (1990) and Kochar (1997) have studied on effects of credit on farm productivity in general. They did not study a potential spillover from interlinked credit to non-interlinked credit crops (or food crops).

Variables
Two groups of household level variables are included in estimations. The first group represents households' human resources: the maximum years of schooling of male and female non-student adults, a dummy for female headed households, and demographic attributes. The second group represents households' financial resources: a dummy for households with land title deed, land owned in acres, value of productive agricultural and non-agricultural assets (e.g., ploughs, ox-carts, bicycles), and value of animal assets. Land owned is defined as the sum of land that a household claims its ownership with or without title deed.

ILC Village Variables
We use four village-level dummies to capture commodity specific effects in the interlinked credit. The first dummy is for villages where interlined credit is received only for tea (Tea-ILC Villages). Analogous village dummies are constructed for villages where coffee and sugarcane are the only source of interlinked credit. The last dummy is for villages where interlinked credit is provided both for tea and coffee (Coffee&Tea ILC Villages). The dropped villages are those where at least one sampled farmer received ILC from other kinds of traders.

We also collected data on prices of ILC crops in the years previous to the 1997 and 2000 surveys. For 1996, village-level prices are derived from household recall information. The 1998/99 price information is taken from a smaller survey in 1998, in which roughly half of the original households in the 1997 survey were revisited and surveyed. Although we do not use this survey in our analysis because of a small number of observations, we use this survey to obtain the 1998-99 price information.

RESULTS

This section reports results of the reduced-form interlinked credit model in which the dependent variable is whether a household receives interlined credit in a year or not, by pooling the two years of survey data.

Interlinked Credit Reception
Results in Table 2 indicate that village characteristics are important determinants of interlinked credit reception. The joint significance test indicates that ILC-village dummies and their interaction terms with the year 2000 dummy has a large Wald test statistic (χ^2=135.7) compared to others. In villages where tea ILC is available (tea-ILC villages), the probability of receiving interlinked credit is 64.6 percent higher than in the reference villages, where only non-specific commodity traders are available to provide interlinked credit. In sugarcane dominant villages, the probability of receiving interlinked credit is also 70.9 percent higher than in the reference villages. In contrast, in coffee dominant villages the probability is not significantly higher than in the reference villages.

In 2000, the probability of receiving interlinked credit increased by 27.7 percent in the reference villages. In tea-ILC dominant villages, however, the estimated coefficient of the interaction term between the second survey dummy and tea-ILC village dummies is almost the same size but has a negative sign, indicating that in tea-ILC dominant villages, the probability of receiving credit did not change significantly. In coffee dominant villages, the results indicate that the probabilities of receiving credit has declined by about 12 percent. The probabilities have increased in sugarcane dominant villages by about 8.7 percent in 2000.

As discussed earlier, the value of farmers' sales in the previous year has been used by cash crop marketing firms to set credit constraints. This implies that the previous year's prices of ILC-crops are positively related to maximum credit limits and the probabilities of households receiving credit in the current year.

The results support this hypothesis. An increased tea price in the previous year, for instance, increases the probability of receiving interlinked credit in tea-ILC villages. An increase in coffee price in the previous year has a much larger coefficient than tea price. A simple simulation indicates that a 20 percent increase in coffee price in the previous year increases the probability of receiving interlinked credit by 6.8 percent. On the other hand, a 20 percent decrease in coffee price in the previous year decreases the probability by 5.0 percent.

Table 2. Interlinked Credit Reception.

	Descriptive Statistics		ILC Received (0/1) (Probit) [a]	
	mean	*s.d.*	*Coefficient*	*|z-score|*
Household Human Resources				
Male Max Schooling Years	7.037	4.848	0.002	0.55
Female Max Schooling Years	6.864	4.098	-0.011	3.13**
Female Headed Household (0/1)	0.099	0.299	-0.094	2.08**
Number of Children under 6	0.867	1.100	-0.012	0.92
Number of Boys age 7-14	0.961	1.107	-0.021	1.65*
Number of Girls age 7-14	0.971	1.075	0.014	1.10
Number of male adults	1.879	1.294	0.010	0.79
Number of female adults	1.884	1.138	0.012	0.93
Household Resources				
Land Tenure (0/1)	0.522	0.500	0.004	0.12
Land Owned (acres)	5.453	9.600	0.026	1.64
Land Owned splined at 3 acres	—	—	0.001	0.58
Value of assets (‘000 Ksh)	48.44	317.8	0.004	1.85*
Value of assets splined at 20,000 Ksh	—	—	9.4 e-5	2.08*
Value of animals (‘000 Ksh)	46.47	117.0	0.007	4.32**
Value of animals splined at 25,000 Ksh	—	—	-6.4 e-5	0.28
ILC Villages a * Year2000				
Tea-ILC villages	0.208	0.406	0.646	5.35**
Coffee-ILC villages	0.190	0.393	0.028	0.17
Coffee&Tea ILC villages	0.198	0.398	-0.265	1.26
Sugarcane-ILC villages	0.225	0.418	0.709	6.78**
Year 2000 (0/1)	0.500	0.500	0.277	2.72**
Tea-villages * Year 2000	—	—	-0.286	2.95**
Coffee-villages * Year 2000	—	—	-0.397	4.45**
Coffee&Tea-villages * Year 2000	—	—	-0.367	3.67**
Sugarcane-villages * Year 2000	—	—	-0.190	1.65*
ILC Crop prices at t-1				
Tea price at t-1 (Kenyan shillings/kg)	*12.48*	*4.409*	*0.009*	*1.16*
Coffee price at t-1 (Shillings/kg)	*14.27*	*3.507*	*-0.007*	*1.26*
Sugarcane price at t-1 (Shillings/kg)	*4.777*	*2.642*	*0.004*	*0.54*
Tea price (t-1)*(Tea-vil or Coffee &Tea-vil dummy)	—	—	*0.021*	*2.06***
Coffee price (t-1)*(Coffe-vil or Coffee &Tea-vil dummy)	—	—	*0.062*	*5.28***
Sugarcane price (t-1)*Sugarcane-village dummy	—	—	*-0.075*	*2.74***
Joint Significance Test (χ^2)				
Household Human Resources			22.0 [0.00]	
Household Resources			46.8 [0.00]	
ILC Villages* Year2000			135.7 [0.00]	
ILC Crop prices at t-1			66.2 [0.00]	
Log Likelihood			-890.3	
# of observations	1,650 (825 households * 2)			

Note: *a*) Coefficients are changes in marginal probability. *b*) Dropped villages are those where ILC arrangements are primarily for horticultural crops.

In contrast, the sugarcane price in the previous year has a negative coefficient on the probability of receiving interlinked credit. This may indicate that households are choosing to limit their reliance on sugar companies, perhaps because they have enough working capital from the previous year’s harvest. This may happen when credit from sugar companies is expensive and self financing is preferable when it is possible.

Female headed households have a 9.4 percent lower probability of receiving interlinked credit than male headed households.

Female education has a negative impact on the probability of receiving interlinked credit also. This suggests that either female headed households have less access to interlinked credit and/or that women are seeking credit and other income generating activities outside ILC-crop production.

Spillover Effects

Table 3 shows results from the first difference models. The dependent variable is changes in fertilizer nutrient use on non-ILC crops between 2000 and 1997. Household use of interlinked credit is instrumented as described in Section 4. The results indicate that the ILC positively affects fertilizer use on Non-ILC crops. Farmers receiving ILC used 15.05 kgs more fertilizer nutrient on non-ILC crops than similar households receiving no credit, but this effect is significant only at the 10% significance level (Table 3). The average level of fertilizer use on non-ILC crops is 18.6 kgs among non-borrowers. Thus the estimated coefficient suggests a 81 percent increase in the fertilizer nutrient use on non-ILC crops. The contribution of ILC to fertilizer use on non-ILC crops is also twice as large as the naive estimate from Table 1.

Table 3. The Spillover Effects of Interlinked Credit on Fertilizer Use per Acre on non-ILC Crops.

	Fertilizer Nutrient Use (kgs per acre) (First Difference-Instrumental Variables Estimation)	
	coefficient	| *t-stat*|
ILC Credit		
. ILC Received (1/0) a	15.05	1.673*
Household Human Resources		
. Male Max Schooling Years	-0.960	1.467
. Female Max Schooling Years	0.085	0.147
. Female Headed Household (0/1)	5.205	1.309
. Number of Children under 6	0.277	0.235
. Number of Boys age 7-14	-0.295	0.238
. Number of Girls age 7-14	-0.725	0.578
. Number of male adults	-1.045	1.019
. Number of female adults	1.398	1.297
Household Resources		
. Land Tenure (0/1)	1.529	0.637
. Land Owned (acres)	-0.010	0.080
. Value of assets (‘000 Ksh)	0.004	0.383
. Value of animals (‘000 Ksh)	-1.8 e-4	0.018
ILC Villages[a] * Year2000		
Tea-village dummy * Year 2000	4.737	1.061
Coffee-village dummy * Year 2000	5.768	1.243
Coffee and tea-village dummy * Year 2000	18.71	4.166**
Sugarcane village dummy * Year 2000	1.664	0.368
Year 2000	-0.242	0.068
R-squared	0.016	
# of observations	825 households	

Note: *a*) Endogenous variables. Instrumental variables are ILC crop prices from the previous years and their interaction terms with ILC villages.

Although the main focus of this paper is on the effects of interlinked credit on non-ILC crops through household level credit reception, interlinked credit and other associated factors may have impacts on fertilizer use on Non-ILC crops.

For instance, Dione (1991) found that the introduction of cotton to Southern Mali increased the demand for fertilizer, which subsequently stimulated private investment from input manufacturers, distributors, and retailers.

These investments made fertilizer and other inputs more accessible and profitable not only for use on cotton (which was the primary impetus for the expansion of input supply in these areas) but also for farmers who only produced staple food crops. This description is consistent with our finding in Table 3 that the estimated coefficient of the interaction term between the ILC-village dummy for coffee & tea villages and the 2000 year dummy is significantly positive. The interpretation of this coefficient is that fertilizer use on Non-ILC crops increased by 18.7 kgs from 29.6 kgs in 1997 in villages well-served by both the Kenya Tea Development Authority and coffee cooperatives (these are the agents providing ILC for these two crops in Kenya).

CONCLUSIONS

This paper addresses the potential for interlinked credit/input/output marketing arrangements for cash crops to promote food crop productivity. Findings from Kenya suggest that, in addition to the direct stimulus that such institutional arrangements can have on household incomes, interlinked input/credit/marketing arrangements may have spillover benefits on the productivity of other household activities such as food cropping. Specifically, our econometric panel model results indicate that households engaging in interlinked marketing programs for selected cash crops tended to apply considerably greater fertilizer on other crops (primarily cereals) not directly purchased by the trading firm providing the ILC. Especially where there are market failures in credit and input markets (which frequently occur in many areas of Africa where credit repayment is hindered by firms' inability to control the output market), farmers' ability to obtain inputs on credit from food crop traders is very constrained. Participation in cash cropping programs may, at least in some cases, allow farmers to overcome such market failures facing food crop input and credit supply. However, whether these complementarities actually materialize depends on whether cash cropping firms are able to continue to recoup their up-front costs and support farmers through purchase of the cash crop. A useful analysis of the strategic interactions between smallholders and cash crop trading firms is contained in Dorward, Kydd, and Poulton (1998). Along these lines, there is a need for future research to help identify policies and strategic partnerships between cash crop firms and governments that might better exploit the potential for high-valued cash crops to serve as vehicles to promote food crop productivity.

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