The effects of a fertilizer loan on dry-season rice cultivated areas in Laos

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Abstract

This study estimates the effects of agricultural credit, especially a fertilizer loan, by utilizing original survey data collected before and after the policy change. We apply the fixed-effects method to account for the endogeneity that occurs when the farmer fs specific unobserved heterogeneity correlates with the amount of loan. The result indicates that the quantitative effects of a fertilizer loan on dry-season rice cultivated areas (DRCAs) are small. This suggests that the elimination of the fertilizer loan may have little effect on DRCAs.

I would like to thank Yoshiaki Omori, Keiichi Yamazaki, Masahito Kobayashi, and Yoichi Tashiro for helpful suggestions and comments. The paper was partially supported by the Japan Society for the Promotion of Science under Grant-in-Aid for Scientific Research (C), 17530164. All remaining errors and omissions in this paper are my own responsibility.
Citation: Channgakham, Phinseng, (2006) "The effects of a fertilizer loan on dry-season rice cultivated areas in Laos." *Economics Bulletin*, Vol. 15, No. 12 pp. 1-8
Submitted: July 31, 2006. **Accepted:** September 29, 2006.
URL: http://economicsbulletin.vanderbilt.edu/2006/volume15/EB-06O10008A.pdf

1. Introduction

The estimation of the effects of agricultural credit becomes an important indicator for evaluating an antipoverty strategy. In many developing countries, including Laos, farm households receive subsidized interest rate loans, one of the direct credit policies to improve the credit access of rural households. However, since the 1970s, this policy has been strongly criticized as not being an appropriate policy to encourage formal financial institutions to provide the needed financial services to poor rural households. Critics argue that it may reduce, rather than improve, the credit access of rural households because of the high transaction costs for supplying a small loan amount to a large number of borrowers (Sial and Carter 1996). Thus, many developing countries, including Laos, have considered adopting financial liberalization by emphasizing savings and the flexibility of interest rates.

The important question is whether the adoption of financial liberalization policies is a significant alternative to correct for the failure of traditional agricultural credit policies, if poor rural households in most developing countries remain too poor to accumulate savings and to pay higher interest rates. For example, in the Philippines, policy-based loan programs continue to be implemented, although there is the adoption of market-oriented finance (Izumida 2001). Therefore, the effects of agricultural credit need to be seriously studied, to understand the problems and feasibility of switching from traditional agricultural finance to market-oriented finance. The adoption of market-oriented finance, which leads to the elimination of subsidized loan programs, may produce a negative effect on poor rural households, if the effects of such loans show a significantly positive effect on households' outcomes or agricultural production.

This paper focuses on the dry-season cultivated area as opposed to the rainy season. The reason for this focus is because through policies of promoting self-sufficiency in rice production and increase in production, the government has encouraged farm households to cultivate rice in the dry season rather than only cultivate in the rainy season. The yield of rice production is higher, about 4–4.5 tons per hectare, in the dry season compared with about 3–3.5 tons per hectare in the rainy season.

Since there are no direct subsidies to farm households, the Agricultural Promotion Bank (APB), the only formal financial institution that provides loans to farm households under government supervision and subsidies, becomes a major supporter to promote dry-season cultivation through the loan programs. APB provides loans in the form of cash and fertilizer. Fertilizer loans are provided in unit bags of 50–60 kg per season and repaid either by cash or rice production after harvesting.

However, because of reductions of government subsidies and financial structural reform of the APB that emphasizes commercial finance, the APB decided in 2004 to end the policy of providing fertilizer loans. Without the fertilizer loans, farm households may be discouraged from cultivating in the dry season and this may lead to a decline in the total dry-season rice cultivated areas. Without fertilizers, dry-season cultivation is impossible as rice yield is only 2.1 to 2.5 t/ha, which creates a financial deficit to farmers. Moreover, most farm households undertake insufficient capital investment to obtain the higher-priced fertilizer from the market. Under this situation, we suspect that the APB's cessation of fertilizer loans may have contributed to the decline in the area of dry-season rice cultivation.

The evidence shows that the aggregate of dry-season cultivated areas has rapidly declined after the policy change from 81.36 thousand ha in 2003 to 61 thousand ha in 2005 (Table I). Therefore, a thorough study of the effects of fertilizer loans on dry-season cultivated areas is necessary to examine the effect of the policy change. Whether the change in such a policy would affect the dry-season cultivated area depends on the magnitude of the effects of fertilizer loans on dry-season cultivated areas.

The main obstacle in estimating such effects is the endogeneity of loans. This identification problem can be solved by applying alternative identification strategies. Previous studies such as Feder et al. (1990), Sial and Carter (1996), Duong and Izumida (2002), and Carter (1989) estimate the effects of agricultural credit by applying an endogenous switching regression model in order to account for the heterogeneity among borrowers and nonborrowers or credit-constrained and nonconstrained households. These studies, with the exception of Carter (1989), found that the credit factor has significantly positive effects on agricultural production in China, Pakistan, and Vietnam. Carter (1989), however, found that the effect of credit support on small farm production is weak in Nicaragua.

The endogenous switching regressions model, however, does not account for farmer-specific unobserved heterogeneity, which is expected to correlate strongly with the loan amount. Therefore, our paper attempts to account for farmer-specific unobserved heterogeneity by using fixed-effects estimation and original survey data collected before and after the policy change. The results show the small quantitative effects of fertilizer loans on dry-season rice cultivated areas.

The remainder of the paper is organized as follows. Section 2 describes the econometric framework; section 3 presents the survey design and data characteristics; section 4 discusses estimate results; and section 5 summarizes and discusses the implications of the results.

2. Econometric Framework

The purpose of the study is to estimate the effects of agricultural credit, especially fertilizer loans, on the dry-season rice cultivated areas (DRCAs) by taking farmer-specific unobserved heterogeneity into account. The simple model of the DRCAs can be written as follows:

$$DRCA_{it} = \beta_0 + \beta_1 FL_{it} + \beta_2 CL_{it} + \beta_3 X_{it} + \alpha_i + \varepsilon_{it}, \quad (1)$$

where $DRCA_{it}$ is the amount of dry-season cultivated areas of farm households i at time period t, FL_{it} is an amount of fertilizer loans made to farm households i at time period t, CL_{it} is the amount of cash loans made to farm households i at time period t, β_1 and β_2 are estimated parameters that measure the effect of the fertilizer loans (FL) and cash loans (CL) respectively, and X_{it} represents other explanatory variables of interest for farm households i at time period t, including family labor, farmer experience, female head of household, and dummy variables for irrigation areas. In the sample area, irrigation areas are classified into three zones: upstream, middle-stream and downstream. These dummy variables estimate the effect of irrigated water used during the dry-season cultivation. α_i is the farmer-specific unobserved heterogeneity affecting the dry-season cultivated area, and ε_{it} is an error term.

Equation (1) is estimated by applying the fixed-effects estimation, and for comparison, the simple OLS is also estimated. OLS relies on the restrictive exogeneity assumption that the compound of error term (ε_{it}) and farmer-specific unobserved heterogeneity (α_i) are not correlated with other explanatory variables, $E[\alpha_i + \varepsilon_{it} \mid FL_{it}, CL_{it}, X_{it}] = 0$. However, this assumption is violated because at least farmer-specific unobserved heterogeneity (α_i) is expected to correlate highly with fertilizer and cash loans. For example, a highly able or productive farmer (high value of α_i) would increase the amount of fertilizer and cash loans made. As a result, OLS suffers from the omitted variable bias.

The alternative method is to use fixed-effects estimation to control for farmer-specific unobserved heterogeneity. The fixed-effects estimation assumes that the error term (ε_{it}) is not correlated with other explanatory variables and the farmer-specific unobserved heterogeneity

(α_i), $E[\varepsilon_{it} \mid FL_{it}, CL_{it}, X_{it}, \alpha_i] = 0$. Rather than taking the difference of equation (1) to eliminate α_i , the method directly controls for α_i by generating a set of dummy variables for each farm household, and each dummy variable indicates the farmer-specific unobserved heterogeneity[1]. Then equation (1) becomes:

$$DRCA_{it} = \beta_0 + \beta_1 FL_{it} + \beta_2 CL_{it} + \beta_3 X_{it} + Dummy_i + \varepsilon_{it} . \quad (1a)$$

The coefficient of the dummy variable for farmer *i* gives the estimation for α_i . The study further assumes that ε_{it} is independent from ε_{it-1}, which means that ε_{it} is uncorrelated over time, with $\text{cov}(\varepsilon_{it}, \varepsilon_{it-1}) = 0$. In other words, last year's positive or negative shock on DRCAs does not affect this year's DRCAs[2].

3. Data

The original data were collected by conducting a two-stage field survey. The first stage was to select, at random, two districts from each Vientiane municipality and Vientiane province in the central region, and one district from the Savannakhet province in the southern region. The basic information was collected from the District Agricultural Offices (DAOs) of sample districts. Then, 21 villages were randomly selected from these sample districts. The heads of villages were interviewed to obtain the basic data such as number of cultivated households, amount of annual cultivated areas, agricultural activity and financial services.

The second stage involved interviews with the sample farm households, which were randomly selected from sample villages[3]. Data for 2003 (before the policy change) and for 2005 (after changing the policy) were collected. Those interviewed included farm households who had applied for fertilizer and cash loans, as well as those who had not. Borrower farm households included households who borrowed from formal and/or semiformal financial institutions, and/or informal financial services. The numbers of farm households interviewed from Vientiane municipality, Vientiane province, and Savannakhet province were 345, 450, and 303, respectively.

4. Estimate Results

Means and standard deviations of some major variables are reported in Table II. For comparison, the statistics before and after the policy change are presented. The mean of the dry-season rice cultivated areas (DRCAs) significantly declined after the change in policy, though the difference is small, only 0.5 rai (0.08 ha) on average. The correlation coefficient between the fertilizer loan and DRCAs is also positive: 0.1903. This suggests that the elimination of fertilizer loans may affect the DRCAs negatively.

Estimating the effects of fertilizer loans on DRCAs is necessary to identify whether the policy change affects DRCAs. For comparison, both the OLS and fixed-effects estimated results are reported in Table III. Although these two methods show a positive effect of fertilizer loans on DRCAs, the quantitative effects of fertilizer loans differ remarkably between the two methods. The OLS estimate of the effect of fertilizer loans is 0.191 (with a

[1] Equation (1a) contains 1,098 dummy variables of farm households.

[2] There are many empirical studies that have tried to solve the problem of last year's positive or negative shock on this year's dependent variable by including the last year Y_{it-1} variable into a model. However, this solution not only is unable to solve the problem from bias estimation but even makes the bias become larger (Nickell 1981).

[3] The survey excludes farm households who could not survive after the policy change. Therefore, although the percentage of these households is small (about 2%), this exclusion may cause sample selection bias.

standard error of 0.023), while this effect decreases to approximately 0.044 (with a standard error of 0.025) in the fixed-effects estimation.

One possible explanation for the overestimation in the OLS is that the OLS estimate not only contains the effect of fertilizer loans but also confounds the effect of farmer-specific unobserved heterogeneity correlating with fertilizer loans. This reflects the omitted variable bias in the OLS estimate. Therefore, after accounting for farmer-specific unobserved heterogeneity, the impact of fertilizer loans becomes small. Although the fixed-effects estimate shows a statistically significant positive effect of the fertilizer loans on the DCAs, the quantitative effect is small. One additional bag of fertilizer loan (about 50–60 kg) would increase the DRCAs only 0.044 rai (0.007 ha or 0.017 acre).

In the case of the cash loans, the OLS estimate shows a significant positive effect of the cash loans on DRCAs, while the fixed-effects estimate is insignificant. The reason may be that cash loans may have no effect on the DRCAs because farm households may not directly spend cash loans on cultivating rice in the dry season. For instance, they may spend the cash loans on food for laborers or other household items during the cultivated season. Another reason is that although the correlation between cash loans and farmer-specific unobserved heterogeneity is accounted for in the fixed-effects estimation, the correlation between cash loans and productive shock may occur, thereby generating an inconsistent estimate.

Other explanatory variables, except family labor stock (the number of adults who work in the field) and the middle-stream zone, are statistically insignificant. Family labor stock has a positive effect on the DRCAs. Generally the family labor stock is the primary labor force for cultivation in rural areas, especially in the sample areas. Adding one more family labor stock would significantly increase the DRCAs by about 1 rai or 0.16 ha (0.395 acre). The dummy variable of irrigated water, middle-stream zone, shows a significant positive effect on the DCA because there is a sufficient amount of irrigated water in this zone.

5. Discussion and Conclusion

This study estimates the effects of fertilizer on the DRCAs by using original data collected before and after the policy change. Our study utilizes the fixed-effects estimation to account for the farmer-specific unobserved heterogeneity. The result shows only a weak support for the hypothesis that the fertilizer loan had a positive effect on the DRCA.

By comparing OLS and fixed-effects estimates, we establish the importance of controlling for farmer-specific unobserved heterogeneity, which affects the amount of the loan. The results of the OLS and fixed-effects estimates are remarkably different. The OLS estimate of the effect of the fertilizer loan on the DRCAs is greater than the fixed-effects estimate. This result indicates that the omitted variable bias may occur in the case of the OLS estimates.

Such evidence reflects the fact that small numbers of productive farm households receive a loan from the formal financial institution, the APB, while a large number of unproductive farm households may be excluded from the formal financial services. Therefore, unlike poor farm households, these productive farm households can obtain the fertilizer input from the market, even without the APB’s fertilizer loan.

Because of the small quantitative effect of fertilizer loans on the DRCAs, which would increase the DRCAs only by 0.007 ha or 0.017 acre, the elimination of fertilizer loans may have little effect on the DRCA. This implies that although the fertilizer loan is provided to farm households, it provides inadequate support for farm households to cultivate rice in the dry season. Therefore, the elimination of the policy of the fertilizer loan to farm households may be a significant way for the APB to introduce market-oriented finance to the agricultural sector gradually rather than completely eliminating all subsidized loan programs.

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Table I: Aggregate dry-season rice cultivated areas, 1976–2005

Year	Aggregate dry-season cultivated area	Year	Aggregate dry-season cultivated area
1976	2,741	1999	87,000
1980	7,708	2000	91,800
1985	10,000	2001	102,000
1990	12,047	2002	84,000
1995	13,593	2003	81,360
1996	18,000	2004	76,840
1997	27,300	2005	61,030
1998	53,100		

Source: Basic Statistics, Ministry of Agriculture and Forestry.

Table II. Mean and standard deviation of the major variables

Variable	All		Before policy change		After policy change	
	Mean	SD	Mean	SD	Mean	SD
Female	0.1835	0.3872	0.1821	0.3861	0.1849	0.3884
Age	45.9403	12.3243	44.9404	12.2865	46.9404	12.2865
Education	5.5075	4.3213	5.5075	4.3224	5.5075	4.3224
Number of family members	5.8215	2.1964	5.8396	2.2019	5.8035	2.1918
Number of dependents	1.8077	1.4774	1.8566	1.5154	1.7589	1.4374
Farmer experience (years)	26.5983	14.1621	25.5974	14.1285	27.5993	14.1313
Number of family laborers	3.2390	1.7855	3.3224	1.7317	3.1557	1.8346
Hired labor	8.6553	13.8736	8.9699	14.5107	8.3406	13.2049
Dry-season cultivated area (rai)[a]	4.0302	3.3129	4.3018	3.3484	3.7589	3.2865
Rainy-season cultivated area (rai)[b]	7.9233	7.3976	7.9689	7.3484	7.8777	7.4497
Total cultivated area (rai)[c]	11.9263	9.1780	12.2444	9.2322	11.6082	9.1205
Amount of rental farmland (rai)	2.7362	6.2554	2.7786	6.4094	2.6937	6.1000
Amount of cash loan (Kip)	291,849	852,160	268,160	784,313	315,537	914,738
Amount of fertilizer loan (bag)	0.8916	2.4621	1.7832	3.2462	0	0
Upstream zone	0.5464	0.4979	0.5464	0.4980	0.5464	0.4980
Middle-stream zone	0.3288	0.4699	0.3288	0.4699	0.3288	0.4699
Downstream zone	0.1248	0.3305	0.1248	0.3306	0.1248	0.3306

Note: 1 ha = 6.25 rai. 1US$ = 10,281 kip (Vientiane Times March 28th, 2006). 1 bag = 50–60 kg

Upstream, middle-stream, and downstream are dummy variables used to control for irrigated water.

a, b, and c are the cultivated areas of rice production.

Table III: Estimation of the effect of a fertilizer loan on dry-season rice cultivated areas

Dependent variable: dry-season rice cultivated areas

Explanatory variables	OLS		Fixed-effects estimator	
Intercept	2.535***	(0.246)	–0.680	(1.474)
Fertilizer loans (bag)	0.191***	(0.023)	0.044*	(0.025)
Cash loans (‘000 Kip)	0.001***	(0.0001)	0.0002	(0.0002)
Family labor	0.313***	(0.038)	0.809***	(0.076)
Farmer’s experience (year)	0.025	(0.017)	0.014	(0.078)
Farmer’s experience_sq	–0.0003	(0.0003)	–0.003*	(0.001)
Female-headed-household	–0.485***	(0.175)	–0.234	(1.638)
Middle-stream zone	–0.553***	(0.150)	14.108***	(4.384)
Downstream zone	–0.188	(0.212)	1.613	(2.728)
Observation	2191		2191	
F-test	F(8, 2182) = 33.45		F(1101, 1089) = 4.47	
R-squared	0.1093		0.8188	
Adjusted R-square	0.1060		0.6356	

Note: 1 ha = 6.25 rai; 1US$ = 10,281 kip (Vientiane Times March 28th, 2006). 1 bag = 50–60 kg.

Upstream zone is dropped from estimation as a reference group. Results of farm household dummies are not reported in the Table. Standard errors are in parentheses.

* ** *** Significance at 10%, 5%, and 1% levels respectively.