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PRICE UNCERTAINTY AND LOAN REPAYMENT IN-KIND

by

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### Abstract

We show that the Pareto superiority of loan repayment in-kind within a tied credit arrangement to a cash-for-cash scheme under uncertain output price depends crucially on the farmer loan demand elasticity and his risk attitude. When demand is inelastic, risk aversion among farmers is required for Pareto superiority. We show that certain soft credit intervention initiatives may have output effects opposite to those intended.

The linking of credit to other markets confronting the farmer has attracted a good deal of work. Braverman and Stiglitz (1982) have analyzed the linkage between the consumption or production credit and tenancy contract focused on the positive effect of borrowing on tenant effort, which forms the main motivation for the linkage. Mitra's (1983) focus is also on the incentive effect of credit. Kotwal (1985) showed that consumption credit acts like a side-payment that allows risk sharing without dampening effort incentive. Basu (1983) argues that "potential risk" results in "isolation" of tenants as landlords ensure that credit is granted to tenants selected on the basis of minimum default risk. The role of imperfect credit markets has always loomed large over the issue of agrarian credit tying (Braverman and Srinivasan, 1981; Bliss and Stern, 1982; Bell, 1988; Otsuka, Chuma and Hayami, 1989). Besley (1988) has recently used credit market imperfection to show the Pareto superiority of credit tying in a monopoly product market.

Although the focus of the vast interlinked contract literature has been, and properly so, the complex relationship between landlord and tenant encompassing the credit, factor, consumption goods and output markets (Bardhan, 1980; Braverman and Srinivasan, 1981; Braverman and Stiglitz, 1982; Kotwal, 1985; Eswaran and Kotwal, 1985; Bell and Zusman, 1979; Binswanger and Rosenzweig, 1981; Shetty, 1988; Otsuka and Hayami, 1988), it would surprise no one if market linkages characterized relationships between other agents in the same agrarian economy. One such fairly common relationship is between farmers and other credit sources, be they traders or local money lenders. Floro (1987a and 1987b) has already described the broad features of the relationship between farmers and traders in the linked contract framework. This paper focuses on a

particular feature reported by this and other researchers - the widespread presence of "loan repayment in-kind" among farmers and traders. This is a common observation in the LDC rural economy. Farmers receive cash loans from traders at planting time and repay in units of produce (say, in sacks of palay or padi), the number of units being agreed upon at planting time. The main question addressed in this paper is the following: why do farmers and traders in LDC prefer loan payment in-kind within a tied arrangement to straight cash-for-cash scheme?

The tack we embrace here in lieu of the more common credit market imperfection is that the output market is characterized by substantial price uncertainty which can spell disaster for farmers. Note that the common focus of risk analysis in this area is production uncertainty (Otsuka, Chuma, Hayami, 1989). The price uncertainty may be due to supply-and-demand shifts; but in more primitive settings it may be due more to lack of access to markets either infrastructure-and/or information-wise, compounded by such problems as the perishability of the produce. The loan repayment in-kind in a tied arrangement answers this exigency. In effect, part of the farmer's output is insulated from price fluctuations. In return, he may agree to either pay a higher interest on the loan or accept a lower price for his output. The monopolistic trader, on the other hand, maximizes profit from his transaction with the farmer. This clearly depends on the level of farmer output which he can affect via the price at which he makes the crop loan available. This price becomes the decision parameter for the farmer.

In Section II, we define the two competing arrangements available. We show that when he is risk-averse, there is a pricing structure where he prefers the tied arrangement even when he either pays a higher interest on the loan or accepts a lower price for the output. In III, we define the trader's arrangement problem and give conditions for the Pareto superiority of loan repayment in-kind. In Section IV, we show that certain soft-loan initiatives intended to raise output may lower it.

## II. Farmer's Arrangement Choice Problem

The farmer produces one commercial crop  $x$  with a production function  $F(\cdot)$  which is strictly concave, nondecreasing, differentiable and defined over one argument  $B$ , the farmer's total borrowings for production purposes. We assume the farmgate output price,  $\hat{P}$ , to be a random variable with mean  $\bar{P}$  and variance  $\sigma^2$ . The farmer is a price taker. The farmer confronts two types of arrangement. The first is:

- $A_1$ : (Cash-for-Cash) The farmer borrows cash at planting time from the rural financial market or the trader and repays with interest in cash after disposing of his produce at prevailing post-harvest price in the product market.

The profit function under  $A_1$  is

$$\hat{\pi}_1 = \hat{P}F(B) - (1+r)B, \quad (1)$$

where  $r$  is the rural financial market interest rate. In this case, the product and credit markets are independently confronted. The second arrangement confronting the farmer is:

$A_2$ : (Loan Repayment in-Kind) The farmer procures his credit requirement in cash from a trader-lender at planting time and repays in units of produce at harvest time, the number of units being agreed upon at the time the cash loan was secured.

We assume  $A_2$  to be monopolized by a particular trader. There are two considerations of importance: the purchase price per output unit,  $P'$ , and the interest rate,  $r'$ , charged per unit of borrowing. Both of these are agreed upon at planting time. The loan could also be secured in-kind, say, in bags of fertilizer. If  $q$  is the number of units owed (say, in sacks of palsy), we have

$$q = (1+r')B/P'. \tag{2}$$

After the repayment, the farmer is left with  $(F-q)$  which he disposes at post-harvest farmgate market price. In this paper, we assume that the lending trader, in fact, buys the remainder of the output. The farmer profit function for  $A_2$  is

$$\hat{\pi}_2 = \hat{P}\{F(B) - [(1+r')/P']B\}. \tag{3}$$

In  $A_2$ , part of the farmer's output,  $q$ , is insured from price uncertainty which is its attractive feature. This is, of course, not sufficient to tilt the balance in favor of  $A_2$ . Our concern in this section involves the conditions that make the farmer prefer  $A_2$  to  $A_1$ .

We assume that the farmer compares arrangements using a continuous and separable utility function  $U(\cdot)$  which is linear and monotonically increasing in mean profit,  $\bar{\pi}_i$ ,  $i = 1, 2$ , and, when he is risk-averse, linear and monotonically decreasing in profit variance,  $\sigma_i$ ,  $i = 1, 2$ , where  $i$  refers to the type of arrangement and the usual superscript "2" in the variance is omitted. We have

$$U = U(\bar{\pi}_i, \sigma_i), \quad U_{\pi} > 0, \quad U_{\sigma} \leq 0, \quad i = 1, 2. \quad (4)$$

Note that  $U_{\pi} = \partial U / \partial \bar{\pi}_i$ ,  $U_{\sigma} = \partial U / \partial \sigma_i$ . For the sake of convenience and focus, we assume that  $U$  is linear in  $\bar{\pi}_i$  and  $\sigma_i$ . This way we would not be weighed down by higher moments of preference. Let the farmer utility at a particular  $B$ ,  $B^0$ , be written as  $U(\bar{\pi}_1(B^0), \sigma_1(B^0))$ . Let  $B_1^*$  be the optimum borrowing by the farmer in arrangement  $i = 1, 2$ . We write:

$$\max_B [U(\bar{\pi}_i, \sigma_i)] = U(\bar{\pi}_i(B_1^*), \sigma_i(B_1^*)). \quad (5)$$

At maximum,  $B_1^*$  is a function of effective loan rate, say  $R$ , and when we need to be explicit, we write  $U(\bar{\pi}_i(B_1^*(R)), \sigma_i(B_1^*(R))) = V_i(R)$ .

We now assume the farmer to apply the following rule:

Rule: Given  $(r, r', P', \bar{P})$ , the farmer chooses  $A_2$  over

$$A_1 \text{ if } U(\bar{\pi}_2(B_2^*), \sigma_2(B_2^*)) > U(\bar{\pi}_1(B_1^*), \sigma_1(B_1^*)).$$

It is obvious that the rule applies the Pareto principle on choice of arrangements. From (1), the expected profit,  $\bar{\pi}_1$ , in  $A_1$  is

$$\bar{\pi}_1 = \bar{P} F(B) - (1+r)B, \quad (6)$$

and the variance is



$$\sigma_1 = F(B)^2\sigma^2. \quad (7)$$

From (3), the expected profit,  $\bar{\pi}_2$ , in  $A_2$  is

$$\bar{\pi}_2 = \bar{P}[F(B) - ((1+r')/P')B], \quad (8)$$

and the variance for  $A_2$  is

$$\sigma_2 = [F(B) - ((1+r')/P')B]^2\sigma^2. \quad (9)$$

Comparing (7) and (9) and noting that  $[F(B) - ((1+r')/P')B] <$

$F(B)$  for all  $B$  such that  $\bar{\pi}_2 \geq 0$ , we have for all  $B$ ,

$$\sigma_1 > \sigma_2. \quad (10)$$

Thus,  $A_2$  is unambiguously less risky than  $A_1$  for any given  $B$  from the viewpoint of the farmer. Comparing (6) and (8) we have, for every  $B$ ,

$$\bar{\pi}_2 \geq \bar{\pi}_1 \text{ iff } [(1+r')/P'] \leq [(1+r)/\bar{P}]. \quad (11)$$

Now,  $[(1+r')/P']$  is really the effective interest rate on the loan incurred by the farmer in a tied credit and output arrangement while  $[(1+r)/\bar{P}]$  is the average effective rate on the loan in the straight cash transaction. The higher is  $P'$  and/or the lower is  $\bar{P}$ , the more attractive cost-wise is the tie-in arrangement. In the preceding, we have assumed that the composition utility function  $U(\cdot)$  in each arrangement is strictly maximizable in  $B$ . This may not necessarily be the case. We thus spell out the conditions for the concavity in each case of the farmer utility function. Recalling that farmer utility is linear in  $\pi_1$  and  $\sigma_1$ ,  $U(\cdot)$  in  $A_1$  is strictly concave with respect to  $B$  if



$$(i) F'(PU_x + 2U_\sigma F\sigma_1) - U_x(1+r) > 0 \quad (12)$$

$$(ii) F''(\bar{P}U_x + 2U_\sigma F\sigma_1) + U_\sigma(F')^2 + 2F'U_\sigma(d\sigma_1/dB) < 0.$$

Since  $F' > 0$  and  $F'' < 0$ ,  $(\bar{P}U_x + 2U_\sigma F\sigma_1) > 0$  is necessary for (12i) and sufficient for (12ii) since  $(d\sigma_1/dB) > 0$ . If the farmer is risk-neutral, (12i) becomes  $U_x(\bar{P}F' - (1+r)) > 0$  and (12ii)  $U_x\bar{P}F'' < 0$ .  $U(\cdot)$  in  $A_2$  is strictly concave if

$$(i) (F'-R)(\bar{P}U_x + 2U_\sigma[F - RB]\sigma_2) > 0 \quad (13)$$

$$(ii) (\bar{P}U_x + 2U_\sigma[F - RB]\sigma_2)F'' + 2U_\sigma(F'-R)\sigma_2 + 2U_\sigma[F - RB](d\sigma_2/dB) < 0$$

where  $R = (1+r')/P'$ . Now  $d\hat{\tau}_2/dB = (F'-R) \geq 0$  so that  $(-.-) > 0$  in (13i).

(13ii) follows if  $(-.-) > 0$  in (13i) it being clear that  $(d\sigma_2/dB) > 0$ .

If the farmer is risk-neutral, (13i) becomes  $(F'-R)PU_x > 0$  and (13ii) becomes  $U_xPF'' < 0$ . For a risk-neutral farmer, the strict concavity of  $F(\cdot)$  suffices for the strict concavity of  $U(\cdot)$ . Conditions (12) and (13) guarantee the existence of a unique global maximum for each problem.

The following is easily shown:

Claim 1: If the farmer is risk-neutral ( $U_\sigma = 0$ ), he chooses

$A_2$  over  $A_1$  if and only if  $[(1+r')/P'] < [(1+r)/\bar{P}]$ .

Proof: (if) With risk neutrality, the farmer's utility function

is  $U(\bar{\tau}_i)$ ,  $i = 1, 2$ . Since  $U(\cdot)$  is monotonic increasing on

$\bar{\tau}_1$  and (1) being true for all  $B$ ,  $U(\bar{\tau}_2(B_1^*)) > U(\bar{\tau}_1(B_1^*))$ .

Suppose  $B_1^* \neq B_2^*$ , then  $U(\bar{\tau}_2(B_2^*)) > U(\bar{\tau}_2(B_1^*)) > U(\bar{\tau}_1(B_1^*))$ ,

$B_2^*$  being optimum for  $A_2$ . If  $B_1^* = B_2^*$ ,  $U(\bar{\tau}_2(B_2^*)) > U(\bar{\tau}_1(B_1^*))$

and he chooses  $A_2$  over  $A_1$ .

(only if) Suppose, given  $r, r', P'$  and  $\bar{P}$ , the farmer chooses  $A_2$  over  $A_1$ , i.e.,  $U(\bar{\tau}_2(B_2^*)) > U(\bar{\tau}_1(B_1^*))$ . Then  $\bar{\tau}_2(B_2^*) > \bar{\tau}_1(B_1^*)$ . Suppose now  $[(1+r')/P'] = R \geq [(1+r)/\bar{P}]$ . Consider the problem of maximizing  $\bar{\tau}_1$  in (6) with respect to  $((1+r)/\bar{P})$ . By duality, (Varian, 1978), the maximized profit function,  $\bar{\tau}_1(B_1^*)$ , is convex and decreasing in  $((1+r)/\bar{P})$ . Now substitute  $[(1+r')/P']$  for  $[(1+r)/\bar{P}]$  in (6). Let  $\bar{\tau}_1(B_1^{**})$  be the maximum profit after the substitution. Obviously,  $\bar{\tau}_1(B_1^{**}) \leq \bar{\tau}_1(B_1^*)$ . But  $\bar{\tau}_2(B_2^*) = \bar{\tau}_1(B_1^{**})$ . Thus,  $\bar{\tau}_2(B_2^*) \leq \bar{\tau}_1(B_1^*)$ . A contradiction. Q.E.D.

A risk-neutral farmer will thus be induced into  $A_2$  if and only if there is an explicit monetary cost saving to be made, which is what we expect. We now have the main results of this section.

Claim 2: If the farmer is risk-averse ( $U_{\sigma} < 0$ ), there exists a pair  $(r'', P'')$  so that  $[(1+r'')/P''] > [(1+r)/\bar{P}]$  and the farmer chooses  $A_2$  over  $A_1$ .

Proof: Consider the pair  $(r', P')$  so that  $[(1+r')/P'] = R = [(1+r)/\bar{P}]$ . Then for all  $B$ ,  $\bar{\tau}_1 = \bar{\tau}_2$ . Consider  $B_1^*$ . Clearly  $U(\bar{\tau}_2(B_1^*), \sigma_2(B_1^*)) > U(\bar{\tau}_1(B_1^*), \sigma_1(B_1^*))$ , since again  $\sigma_2(B_1^*) < \sigma_1(B_1^*)$ . Clearly, by (5) and (13i) and (13ii),  $U(\bar{\tau}_2(B_2^*), \sigma_2(B_2^*)) > U(\bar{\tau}_1(B_1^*), \sigma_2(B_1^*))$  at this pair  $(r', P')$ . As was previously indicated, we write  $U(\bar{\tau}_2(B_2^*), \sigma_2(B_2^*)) = V_2(R)$  to bring out the dependence of  $B_2^*$  on  $R$ . Consider  $(R+h)$ ,  $h > 0$ . Now,  $[V_2(R) - V_2(R+h)] = V_2'(R+\epsilon)(-h)$  where  $0 \leq \epsilon \leq h$ , by the mean value theorem, and  $V_2' < 0$  is the derivative of  $V_2$  evaluated at  $(R+\epsilon)$ . This difference approaches zero as  $h$  approaches zero. Thus, for

small enough  $h > 0$ ,  $V_2(R+h) > U(\bar{\pi}_1(B_1^*), \sigma_1^2(B_1^*))$ . And the farmer chooses  $A_2$  over  $A_1$  for  $(R+h)$ . Let  $h = (\delta/P')$ , so that  $R+h = [1+r'+\delta]/P'$  and  $r'' = r' + \delta$  while  $P'' = P'$ . Q.E.D.

Thus, when the effective price of the loan is higher than the expected effective price, the farmer's risk aversion is a necessary condition for his preference for  $A_2$  over  $A_1$ .

### III. The Trader's Choice of Arrangement and Price Offers

The monopolistic trader can choose between pure trading or a mixture of trading and lending in a tied credit arrangement. Note that merely providing a crop loan at planting time does not qualify as credit-tying. For example, the trader lends  $B$  at interest rate  $r$  (the market rate) and later on buys the farmer's produce at  $\hat{P}$  after which the farmer pays  $B(1+r)$  to the trader. This, as far as the farmer is concerned, is cash-for-cash. The trader is merely a financial intermediary.

If the trader chooses credit-tying, he confronts two types of the same produce: the loan repayment in-kind,  $q$ , and the residual  $[\Gamma(B^*)-q]$  where  $B^*$  is the farmer's optimum borrowing. Note that the arrangement subscript is dropped since the choice of arrangement will be subsumed in the choice of price offers problem. At harvest time, the trader receives  $q = [(1+P')/P']B^*$  as payment. This he sells at exogenous price  $\hat{P}^s$  (the outlet market is assumed competitive) at a per unit distribution cost of  $c$ . Thus, he realizes  $(\hat{P}^s - c)q$ . The residual output he sells at  $\hat{P}^s$  but he buys it at farmgate price  $\hat{P}$  with the per unit distribution cost of also  $c$ . For

providing the farmer  $B^*$ , the trader now has to pay himself or his creditor  $B^*(1+r)$ . Thus, his (random) profit is

$$\hat{\pi} = (\hat{P}^s - c)q - B^*(1+r) + (\hat{P}^s - \hat{P} - c)[F(B^*) - q] \quad (14)$$

which, after arranging and taking expectations, reduces to

$$\bar{\pi} = \bar{P}q - B^*(1+r) + mF(B^*), \quad (15)$$

where  $m = (\bar{P}^s - \bar{P} - c)$ . We have assumed above that  $\hat{P}$  and  $\hat{P}^s$  are independent random variables. This need not be the case and, in fact,  $\hat{P}$  can be just some linear function of  $\hat{P}^s$ . Assuming that the trader is risk-neutral, then his only concern is maximizing  $\bar{\pi}$ . The feature that is of interest in (15) is the following: Suppose  $P' = \bar{P}$  and  $r' = r$ . Then the first two expressions in (15) which is  $[(\bar{P}/P')(1+r') - (1+r)]B^* = 0$  and  $\bar{\pi} = mF(B^*)$ . This is the average profit of a pure trader who, if he lends at all, operates on a pure cash-for-cash basis. Therefore, if the trader optimum price offers differ from  $(\bar{P}, r)$ , we know that the trader prefers credit-tying. The trader has two instruments in his hands,  $r'$  and  $P'$ . We first show that the trader's maximum profit is the same whether pursued through  $r'$  or  $P'$ .

Claim 3: Suppose  $F(\cdot)$  is characterized by decreasing absolute risk aversion. The trader's maximum profit is invariant with respect to instrument use.

Proof: We first set the partial of (15) with respect to  $r'$  to zero, getting

$$[mF' + \bar{P}R - (1+r)]B^*/P' = (-\bar{P}/P')B^*, \quad (16)$$

where  $B^{*'} = (dB^*/dR)$  and  $R = [(1+r')/P']$ . Setting the partial with respect  $P'$  to zero gives, after factoring out  $(-R/P')$ ,

$$[mF' + (\bar{P}/P')(1+r') - (1+r)]B^{*'}/P' = (-\bar{P}/P')B^*,$$

which is identical to (16). We need to show that (16) indicates a profit maximum. The second order condition for a maximum in both cases is:

$$[mF'' + \bar{P}R - (1+r)]B^{*''} + mB^{*'} F'' B^{*'} + 2\bar{P}B^{*'} < 0,$$

where  $B^{*''} = dB^{*'}/dR$ . Now since  $F'' < 0$  and  $B^{*'} = (dB^*/dR) = (1/F'') < 0$ , the last two expressions are negative. Now  $[mF' + \bar{P}R - (1+r)] = d\bar{\pi}/dR \geq 0$ . A sufficient condition for negativity is that  $B^{*''} \leq 0$ . This is true if  $F(\cdot)$  is characterized by decreasing absolute risk aversion, i.e.,  $F''' \geq 0$ . Since  $B^{*'} = (1/F'')$ ,  $B^{*''} = -[F'''/(F'')^2] \leq 0$  if  $F''' \geq 0$ . Q.E.D.

Thus, the two instruments are perfectly substitutable. Suppressing, for example, interest rate leaving output price free to move will not improve farmer welfare, an interesting though not totally unexpected result. A fall in  $P'$  will see to that. That being the case, we analyze the trader's problem using only  $P'$ . Setting  $r' = r$  in (16) and simplifying, we get

$$P' - \bar{P} = [mF'/R] - [\bar{P}/\epsilon]. \quad (17)$$

The following is obvious from (17):

Claim 4: With  $r' = r$ ,  $P' \geq \bar{P}$  as

$$\epsilon \geq (\bar{P}/mF').$$

Thus, a farmer whose loan demand is very elastic ( $\epsilon$  large enough) will get a higher than average price offer while the farmer with very inelastic demand will get a lower than average price offer. This is because the higher is  $\epsilon$ , the higher is output supply elasticity and vice-versa. This is clearer if we realize that  $B^{**} = 1/F''$  and, thus,  $\epsilon = (-1/F'')(R/B^*)$ . Thus  $\epsilon \rightarrow \infty$  as  $|F''| \rightarrow 0$  or that the production function is approximately linear and is hardly subject to decreasing returns. Lowering the price offer raises output (and thus trader profit) considerably. The opposite is true if  $|F''|$  is very large. We now have the following:

Claim 5:  $A_2$  is always Pareto superior to  $A_1$  if  $\epsilon > (\bar{P}R/mF')$ .

Proof : If the inequality holds then the trader offers  $P' > \bar{P}$ , i.e., chooses  $A_2$  over  $A_1$  voluntarily. Since  $r = r'$ , then  $[(1+r)/P'] < [(1+r)/\bar{P}]$  and the farmer chooses  $A_2$  over  $A_1$  whether he is risk-averse or neutral by Claim 1. Q.E.D.

Claim 6: A necessary condition for  $A_2$  to be Pareto superior to  $A_1$  when  $\epsilon < (\bar{P}R/mF')$  is that the farmer be risk-averse.

Proof : Again when  $\epsilon < (\bar{P}R/mF')$ , then the trader sets  $P' < \bar{P}$ , thereby choosing  $A_2$  voluntarily. Thus,  $[(1+r)/P'] > [(1+r)/\bar{P}]$ . By Claim 2 the farmer can choose  $A_2$  voluntarily under this condition if he is risk-averse. Q.E.D.

Note that risk aversion is necessary but not sufficient for the farmer to improve his lot with  $A_2$  because the price offer may be too low (or the price insurance may be too costly given his risk aversion). But if he chooses  $A_2$  voluntarily, he is risk-averse.



The first policy result of interest in this section is really that intervening in one instrument only may not either decrease the trader's profit or improve the farmer's welfare. The second is the central role played by the loan demand elasticity and its sibling, the output supply elasticity. If these are fairly large, traders may be doing farmers a favor and intervention may be detrimental. If these are fairly small, then the proper approach may be to raise the elasticities (better irrigation, proper and available fertilizer, etc.).

#### IV. Output and Credit Policy

The first order necessary condition for farmer maximum in  $A_2$  is given by setting (13i) equal to zero. We have the following:

Claim 7: At maximum in  $A_2$

$$F' - R = 0. \quad (18)$$

Proof: Suppose that at maximum,  $F' - R > 0$ , so that  $[\bar{P}U_x + 2U_\sigma(F-RB)\sigma_2] = 0$ .

Rearranging and taking the second derivative, we have: or  $[F' - R] = (-PU_x/U_\sigma)(-1/\sigma_2^2)(d\sigma_2/dB) < 0$ , since  $(d\sigma_2/dB) > 0$ , a contradiction.

On the other hand,  $F' - R = d\pi_2/dB \geq 0$  and cannot be negative at the relevant economic range. Q.E.D.

Thus, the risk-averse farmer under  $A_2$  acts like a risk-neutral agent. Compare this with the maximum condition of the farmer under  $A_1$ :

$$F' = [(1+r)/\bar{P}] [U_x / [U_x + 2U_\sigma(F/\bar{P})\sigma_1]]. \quad (19)$$

If the farmer is risk-neutral ( $U_\sigma = 0$ ) we have simply  $F' = (1+r)\bar{P}$ , which is algebraically identical to (18).



The following derives from the strict concavity of  $F(\cdot)$ :

Claim 8: Output under  $A_2$  exceeds that under  $A_1$  iff

$$[(1+r)/\bar{P}]/[(1+r')/P'] > [U_x + 2U_\sigma(F/\bar{P})U]/U_x. \quad (20)$$

Proof: (if) This follows from (18) and (19) where the right hand side of (19) exceeds the right hand side of (18) if the inequality condition (20) holds. (only if) Suppose output under  $A_2$  exceeds that under  $A_1$ . Then  $F'(B_1^*) > F'(B_2^*)$  and (20) follows from (18) and (19). Q.E.D.

Note that  $[U_x + 2U_\sigma(\bar{F}/P)\sigma] > 0$  from the concavity condition (13i) but its absolute value decreases as either of the following rises:  $F$ ,  $\sigma$  and  $|U_\sigma|$ . The larger is  $F$ , the variance and the more risk-averse is the farmer, the more likely that the output under  $A_2$  exceeds the output under  $A_1$ .

This can lead to an intriguing policy possibility. Suppose that in a geographic area, farmers are risk-averse and are effectively purchasing price insurance by paying a higher effective loan rate  $R$  to a lender under  $A_2$ . Assume that (20) holds. Suppose a government agency concerned with increasing output steps in, judges the rate as "usurious", outlaws the lender's activity and offers instead  $A_1$  at a rate  $[(1+r)/\bar{P}] < R$ . The result will be lower output! For the policy to have the desired result, the interest bargain must be substantial enough to reverse (20). There is, thus, a 'threshold' below which the output result is the reverse of the expectation.

If the lender's activity on the other hand is not outlawed, the agency's offer will have no takers but output will not drop. This then argues for government agencies to respect current arrangements and aim

instead to enrich the farmers' menu of options. But the latter case may be incentives incompatible as far as the proponents of the "soft loan" scheme is concerned especially when "loans granted" constitutes the measure of success or failure of the program.

### Conclusion

In this paper, we consider the widespread practice of "loan repayment in-kind" made at harvest time, the units of produce being set at planting time. Part of the farmer's output is thus shielded from price fluctuation which can spell disaster for the farmer. The paper shows that risk-neutral farmers prefer the pure cash-for-cash ( $A_1$ ) to repayment in-kind ( $A_2$ ) if and only if  $A_1$  enjoys a net loan price advantage (Claim 1). A risk-averse farmer may still choose  $A_2$  even if  $A_1$  enjoys a net loan price advantage (Claim 2). In this latter case, the farmer is purchasing a price insurance. The trader's choice of arrangement problem is imbedded in his choice of price offers. We show that the trader's maximum profit is the same whether the instrument used is interest rate or output price (Claim 3). The offer price exceeds (falls short of) the average farmgate price as loan demand elasticity exceeds (falls short of) the ratio  $(\bar{P}R/mF')$  (Claim 4). Thus, the higher elasticity farmer will get a price advantage over the low elasticity farmer.  $A_2$  is always Pareto superior to  $A_1$  for high elasticity farmers (Claim 5). Risk aversion is necessary for the Pareto superiority of  $A_2$  (Claim 6). Finally, we discuss a case where "soft credit intervention" with the banning of the trader in order to raise output may actually decrease it.

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