COOPERATIVE FORMATION AND FINANCIAL CONTRACTING IN AGRICULTURAL MARKETS

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Abstract. We use historical variation in the market share of agricultural cooperatives to examine the nature of the cooperative firm. Our data include the share of sectoral output accounted for by cooperative firms across 15 commodity sectors during the period 1930-2002. We test a simple financial contracting model where the cooperative firm is viewed as a particular implementation of "monitored credit" (or "informed intermediation"). Controlling for sectoral and year effects, we find support for the main prediction of our model with a positive and statistically significant relationship between cooperative market share and real annual lending rates.

1. Introduction

The cooperative firm is somewhat of an enigma for economists. Although considerable research effort has been directed at understanding the relative merits of investor-owned and cooperative firms, little consensus has emerged (Dow and Putterman, 2000).[1] There is arguably a better understanding of the relative disadvantages of the cooperative firm than of its advantages. This is not surprising given that one can view a cooperative firm as essentially an additional layer of constraints imposed on an investor-owned firm. The most important of these constraints include requirements that most of the firm's

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[1]The relevant literature is vast, and we do not attempt a comprehensive review here. The interested reader can consult Bonin et al. (1993) and Dow (2003) regarding the labor-managed firm. Parallel developments in the literature on agricultural cooperatives (which, early on, proceeded many of the developments in the labor-managed-firm literature) are nicely discussed in Sexton (1984).

capital be provided by the firm's employees (or input providers in the case of the agricultural marketing cooperative), and that firm decision making be democratic. Thus, for example, one can point to wealth and credit constraints faced by workers, and to consequent difficulties in funding the firm's capital requirements, as a source of relative disadvantage. Similarly, preference heterogeneity among cooperative members, and a lack of liquidity in membership markets, together generate internal decision making frictions that are not present in a publicly traded firm (Dow, 2001; Holmström, 1999). Much of the theorizing along these (and other) lines has been motivated by the observation that the cooperative firm is observed less frequently than its investor-owned counterpart.

The genesis for our work comes from the complementary observation that cooperative firms are often formed in declining industries. Or put another way, cooperative firms seem to be sustainable in relatively low-return economic environments that do not support private or investor-owned activity. This observation suggests an apparent *advantage* of the cooperative firm. One natural place to look for the source of this advantage is in the incentives that can be provided to workers. For example, as Dow and Putterman (2000) point out, "mutual monitoring, reductions in supervisory expenses, and strong work incentives, are widely accepted stylized characteristics of worker-owned firms." Certainly, if a cooperative firm can provide incentives to its workers that cannot be replicated in a private firm, then the cooperative firm can be sustainable in otherwise unsustainable environments. Add to that logic a deadweight cost associated with the cooperative governance structure (which is a reduced-form way of thinking about the points raised in our previous paragraph), and we have a theory of the cooperative firm in which its emergence occurs mostly as a response to "hard times." Later in the paper, we will develop this idea more fully, but in essence this is our hypothesis.

There are two potential objections to this theory. The first is a violation of what Dow (2003) refers to as the "symmetry principle." On what grounds should we treat a cooperative and investor-owned firm differently in terms of the incentives that can be provided to workers? Without being more specific about the nature of such an asymmetry, this is really just an ad-hoc assumption. The second potential objection regards the empirical evidence on which the theory rests. The evidence regarding worker and grower buyouts that we allude to above (and that we document more carefully in the next section) is to some extent anecdotal in nature. Thus, one might argue that although the theory is reasonably sound conceptually (ignoring objection 1 for the moment), there is not strong empirical support one way or the other.

In this paper, we to some extent pass on the first potential objection by arguing that the cooperative firm is just one possible institutional response to

hard times (or in the context of our model, to a binding financial constraint). We discuss other mechanisms that can implement identical incentives, and argue that it is just a matter of comparing the relative cost of these alternatives. Lacking information on such cost, but observing that cooperatives often emerge in response to hard times, we conclude that apparently the cooperative option is relatively low cost. However, we do not contribute any new theory on the essential nature of this cost.[2] Instead, our main contribution is to address the second objection. In particular, we have collected an extensive data set regarding historical variation in the market share of agricultural cooperatives across 15 commodity sectors during the period 1930-2002. With these data, we test our "hard times" theory of cooperative activity by looking at variation in market share in response to real lending rates. It turns out that a significant fraction of this variation can indeed be explained by the cost of borrowing, and that the direction of this influence is consistent with our theory.

In the next section we briefly summarize and critique existing theory and evidence regarding the motivation for cooperative activity in agricultural markets. We then present our model of cooperative formation. Subsequent sections of our paper are devoted to empirics, and concluding comments, respectively.

2. Cooperative Activity in Agriculture: Theory and Evidence

Although there are many forms of cooperative activity in agriculture, among the most prominent are those that involve the processing and marketing of farmers' output. Perhaps surprisingly, many of the cooperative firms engaged in this activity were at one time *not* cooperatives, but rather were non-farm investor-owned firms that were subsequently purchased by farmers in response to announced plant closings or scaling back of processing activities. For example, American Crystal Sugar, the largest U.S. producer of refined beet sugar, is a producer cooperative that was formed in 1973 with the purchase of the combined assets of the investor-owned firm with the same name (American Crystal Sugar Company, 2003). Similarly, the recent purchase of an Oscar Meyer meat processing plant by a group of Iowa turkey growers occurred in response to an announced plant closing (West Liberty Foods, 2003). Still more examples are provided by Hetherington (1991, pp. 182-186) who notes how past growth in

[2]An apparently little recognized point which seems relevant for further thinking on this issue is that cooperative legislation explicitly restricts outside ownership. One interpretation of such a constraint is that it represents a (socially beneficial) commitment device that facilitates member participation. Thus, we echo Dow (2003, pg. 13) who suggests that "problems of intertemporal credibility are therefore a prime hunting ground in looking for behavioral asymmetries...".

cooperative activity in California's fruit and vegetable canning industry can be mostly explained by farmers purchasing abandoned investor-owned capacity.

The closing or scaling back of operations by a private firm is presumably an indication of poor profitability. What rationale can be provided for growers to invest equity capital in such a venture? Hansmann (2000, p. 124) argues that growers may choose to invest equity in a marginally valuable processing facility if the alternative is one or a small number of oligopsony buyers. That is, the return on investment in such a facility is made up of firm-level profits *plus* any benefit associated with inducing competitive pricing by other buyers. However, in many of the examples where growers have taken over the activities of a private firm, it has been the threat of *no* buyer that has motivated growers, rather than the threat of a small number of oligopsony buyers. Moreover, if growers can induce competitive pricing with cooperative activity, why should we not also expect to see cooperative activity in settings with relatively high market returns?

Alternatively, Staatz (1987) suggests that perhaps growers have fewer opportunities to invest their capital and are willing to accept a lower return on investment than are non-farm investors. However, for this to be the case, one would have to explain why the firm cannot simply negotiate a slightly lower payment to growers as market conditions deteriorate.

In the context of non-agricultural labor markets, Ben-Ner and Jun (1996) argue that "worker buyouts" act as a screening mechanism with respect to the private information of firm managers. Management will never accept a low price for the firm when future prospects are good, but may be willing to pay relatively higher wages. Similarly, when future prospects are poor, management will never pay higher wages, but may be willing to accept a relatively low sale price. This argument has considerable intuitive appeal, but ignores changes in the financial and organizational makeup of the firm pre and post buyout. That is, while it may be true that a buyout offer by growers provides a means of eliciting information from firm managers, it remains to be explained why growers should use their *farm* equity in the purchase? Why cannot *firm* assets be used as collateral?

In addition to observations regarding the formation of individual cooperative firms, the U.S. Department of Agriculture annually collects information on aggregate cooperative activity across 15 different commodity sectors. Figure 1 is a graphical representation of this data. The measure of activity of gross sales of cooperative firms, and to facilitate cross commodity comparisons in variation across years, we have normalized each year of revenue by the the average reported revenue across all years for which data is available in the relevant commodity sector. Perhaps the most striking feature of these data is the degree to which there *is* substantial year-to-year variation. All though one

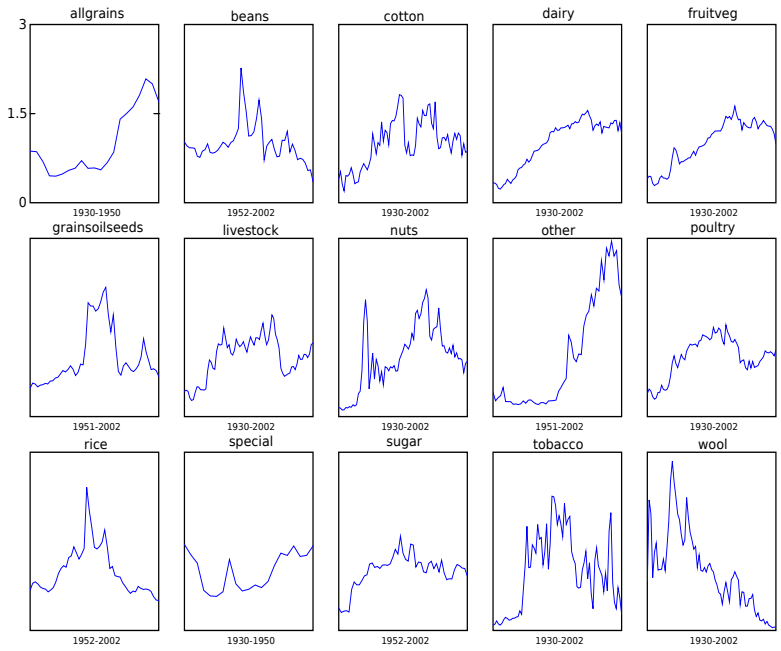

FIGURE 1. Cooperative market volume as a fraction of average volume over the entire period for which data is available (indicated in axis label).

might expect a significant degree of institutional inertia, there is apparently quite a substantial amount of resource reallocation across cooperative and noncooperative firms from one year to the next. Some of this reallocation sure includes the formation and dissolution of cooperative firms, but is probably also do to the scaling up or down of production with and across firm types. In any case, we are unaware of any previous attempt to explain this observed variation.

3. A "HARD TIMES" THEORY OF COOPERATIVE FORMATION

In this paper, we propose a theory of cooperative formation that can explain why cooperative firms sometimes emerge in response to "hard times," and that can explain a significant portion of the year-to-year variation in cooperative activity observed in Figure 1. As briefly noted in our introduction, we argue that cooperative formation is a costly mechanism for increasing the power of incentives farmers face. In addition to the "mutual monitoring, and reduction

in supervisory expenses" referenced by Dow and Putterman (2000), by pledging farm assets to acquire processing facilities, farmers increase their collective private cost of business failure, and this effectively increases the combined "pledgeable income" (i.e., the amount available to pay lenders, after deducting the transfer that is needed to provide efficient incentives to farmers) of the farming *cum* processing operation. However, if risking the forfeiture of farm assets entails a deadweight cost, or if the cooperative governance structure is inherently less efficient than other forms of governance, then we should only expect cooperative formation when there is otherwise insufficient pledgeable income. This can happen, for example, when expected market returns are sufficiently low, or when lending rates are sufficiently high.

Thus, the key ingredients in our explanation are an incentive problem between the processing firm and farmers, and a deadweight cost associated with forming a cooperative or with pledging farm assets. Several contributions have already argued that informational asymmetries at the level of the farm can explain the emergence of stronger vertical relationships in the agricultural sector (e.g. Hennessy, 1996; Bogetoft and Olesen, 2003).[3] Our analysis differs from these by focusing on the importance of farm-level assets in financial contracts between liquidity-constrained farmers and competitive lenders.

The notion that cooperative formation involves a deadweight cost, relative to non-farm investor ownership, is meant to capture the idea noted by Hansmann (2000) and others (e.g. Fulton, 1999; Holmström, 1999; Rey and Tirole, 2001) that the restriction on passive ownership within a cooperative results in a relatively illiquid market for ownership shares, and hence creates internal decision-making frictions that are not present in an investor-owned firm. Similarly, we assume that asset seizure involves a deadweight loss to capture the idea that there is a cost associated with the necessary legal transaction, or alternatively (but equivalently for our purposes), because farmers have human capital specific to these assets. We treat these two assumptions, together with the assumption that there is moral hazard in farm production, as maintained hypotheses in our analysis.[4] As we will demonstrate below, these assumptions generate the prediction that the cooperative structure (involving asset pledging by farmers) can be an efficient response to high lending rates or low market returns from processing.

[3]The general trade-off between vertical integration and separate ownership has been emphasized by Williamson (1985), who argues that vertical integration tends to weaken incentives but improve the quality of information available for decision making. In contrast, as we will show, "vertical integration" in our analysis involves an exchange of an organizational deadweight loss for improved incentives.

[4]For evidence of moral hazard in settings with both private and cooperative agricultural processing firms, see Hueth and Melkonyan 2004; Hueth and Ligon 1999; and Knoeber and Thurman 1985.

Briefly, we present a model in which we obtain two equilibrium organizational regimes, depending on the level of lending rates and market returns and from the processing activity. When returns are relatively high or lending rates are relatively low, both the private investor-owned firm and cooperative are viable in the sense that both generate a positive expected social surplus. However, because cooperative ownership involves a deadweight loss, the non-farm investor-owned structure is Pareto dominant. Though we are agnostic about the exact distribution of gains from private versus cooperative ownership in this regime, there is scope for the threat of cooperative formation to provide some degree of rent transfer from the private owners to farmers.[5]

When returns are relatively low or lending rates are relatively high, the non-farm investor-owned firm exits the market because its returns no longer exceed informational rents plus investment costs. When information rents are strictly positive, there is thus some degree of credit rationing in that the project can generate positive expected social surplus and yet not be implementable. As a response, farmers can acquire the processing facility to continue production. However, farmers are liquidity constrained and must find a loan agreement that both preserves incentives and allows the lender to recoup its investment. When returns to the processing activity are sufficiently low or lending rates are sufficiently high, the equilibrium loan agreement has farmers pledging farm assets against the possibility of business failure, and we interpret the resulting financial contract as a "cooperative."[6] We characterize a region of market returns and lending rates in which a cooperative of this sort is the only viable organizational structure.

In what follows, we make these arguments more precise. We first present a simple model with complete separation between farm-level production and processing. The processing firm contracts for delivery of a raw agricultural input from farmers. There is moral hazard and limited liability by farmers. Using an approach inspired by Holmström and Tirole (1997), we then introduce a third party, the "outside investor," who can provide capital to farmers wishing to form a cooperative to buy the firm. We then compare the viability

[5]The results of this regime are a simple version of those in Sexton and Sexton 1987, where cooperative activity provides a degree of yardstick competition in an oligopoly market.

[6]According to Zeuli and Cropp (2004), "the three primary cooperative principles include: user ownership, user control, and proportional distribution of benefit." Our representation of a cooperative captures the first of these principles, though we have little to say about the second and third. In effect, we *assume* that growers will control decision making when they invest their farm equity in the purchase of processing and intermediation assets. State and federal statues that govern cooperative activity formally restrict the degree of passive ownership. Although costly in terms of access to financing, such a restriction may help to encourage investment by users if, for example, there is imperfect commitment in contracts between between passive and active (i.e., "users") owners.

of these these two organizational structures as a function of expected market returns from processing, and present our main result that the cooperative structure is the only viable organizational when market returns are sufficiently low.

4. Model

Our economy is composed of three types of agents: farmers, non-farm or "private" investors, and institutional investors. For simplicity, we assume that individuals within each group of agent types are perfectly homogeneous, so we can think of their being a single representative member of each type.[7] The representative farmer grows an essential input used in producing some processed agricultural product. The farmer does not have the managerial skills to run a processing facility but can acquire them at a cost.

The private investor possesses the ability to run a processing facility and is not wealth-constrained. We assume, however, that private investors are mobile and can operate in several markets; they can eventually exit the food processing activity if the returns in this market are sufficiently low. A private investor who wants to be active in the processing business must invest an amount $I > 0$ to acquire the physical capital needed to process the agricultural product. He then procures this input from the farmer. Production lasts for one period and we assume that, at the end of the period, the residual value of the processing plant is 0.[8] Institutional investors are passive risk-neutral investors, with no managerial skills. We assume that there exists a competitive fringe of such investors who will lend only if they expect to recoup their initial loan.

We assume that there is moral hazard in agricultural production. The quality of the final output is uncertain and depends in part on unobservable (to both private and institutional investors) actions of growers.[9] For simplicity, we assume there are only two possible outcomes. When the farmer is "diligent," farm output is high-quality with probability P_h, whereas when the farmer "shirks," output is high-quality with probability $P_\ell < P_h$. We let

[7]Farmer heterogeneity is clearly a source of friction within the cooperative governance structure and potentially a source of inefficiency relative to a non-farm investor-owned firm. In order to focus our analysis on the potential benefits, rather than the costs, of the cooperative structure, and to keep our model tractable, we do not model this heterogeneity explicitly.

[8]This assumption is made for simplicity; the extension to the case in which the processing facility has some salvage value is immediate.

[9]The term "quality" here is used for expositional ease. Output quantity and possibly delivery timing are other attributes of farmers' output which may be stochastic and influenced by unobserved actions of the farmer. The important point is simply that there is an incentive problem, and that farmers must be rewarded for performance.

the strictly positive difference between these two probabilities be denoted by $\Delta P = P_h - P_\ell$. The farmer enjoys a private benefit $B > 0$ in monetary units from shirking (or equivalently, incurs a cost $-B < 0$ from being diligent). Revenue of the processor is R when the output is high-quality and is normalized to 0 when the output is low-quality.

These revenues are verifiable, and to make our problem interesting, we assume that that it is always efficient to induce diligence by the farmer:

Assumption 1 (Diligence is optimal)**.**

$$R > \frac{P_h B}{(\Delta P)^2}$$

We model cooperative formation as a Stackelberg game in which the leader is a private investor who contemplates the opportunity to create a processing facility. The investor must, however, take into account the ability of the farmers to take collective action to create and operate their own processing cooperative.

The timing of activities is as follows:

(1) The private investor decides whether to establish a processing facility. He then makes a take-it-or-leave-it procurement offer to the farmer, who decides whether to accept or reject the offer. If the offer is rejected, the private investor exits the market and obtains his reservation utility.
(2) If the offer of the private investor has been turned down, the farmers decide whether or not to acquire and run a processing facility by eventually borrowing money from institutional investors. The institutional investors decide whether or not to lend money. If the loan is refused, farmers produce for the "spot market" and earn zero net expected utility.
(3) Production takes place and the farmers decide to be diligent or careless. Neither the private investor nor the institutional investor observes the farmers' choices.
(4) Processing is performed and outcomes are realized. Payments are made according to the contracts signed either in step 2 or 3. The game ends.

We now turn to the situation in which private investors decide to be present in the processing market.

4.1. **Investor Financing.** The problem of the private investor consists in finding a pair of transfers (T_h, T_ℓ) made to the farmer contingent on the processor's revenue. The objective can be stated as

$$V(R) \equiv \max_{(T_h, T_\ell)} P_h(R - T_h) - (1 - P_h)T_\ell \tag{1}$$

subject to the following constraints:

$$P_h T_h + (1 - P_h) T_\ell \geq \underline{U} \tag{2}$$

$$P_h T_h + (1 - P_h) T_\ell \geq P_\ell T_h + (1 - P_\ell) T_\ell + B \tag{3}$$

and

$$T_h \geq 0, \;\; T_\ell \geq 0. \tag{4}$$

The objective function of the processing firm states that the firm obtains net revenue $R - T_h$ with probability P_h and $-T_\ell$ with probability $1 - P_h$. The first constraint states that the farmer's reward has to be greater than expected utility in his outside option given by $\underline{U}$. Later we will take account of the fact that the farmer's outside option is cooperative formation, but for now we treat expected utility under the private investor regime as a parameter. The incentive constraint (3) states that the farmer is induced to be diligent and thus produces a high-quality input with probability P_h. The last pair of constraints (4) characterize the farmer's limited liability; the private firm cannot use unlimited punishments to induce the farmer to behave.

Note that we can rewrite the constraint set as $T_\ell \geq \max\{0, \underline{U} - BP_h/\Delta P\}$ and $T_h \geq B/\Delta P + T_\ell > 0$. Thus, when the farmer's expected utility in his outside option is sufficiently high, the processor must pay the farmer a strictly positive amount even when the project fails. Otherwise, it is possible to set $T_\ell = 0$, and pay the farmer just enough under project success to ensure that the expected (public) payment from working is at least as large as the private payoff from shirking. Note that when the farmer's incentive compatibility and participation constraints are satisfied, the limited liability constraint under project success never binds. Moreover, given that the processor wishes to minimize expected transfers to the farmer, it is straightforward to verify the following proposition:

Proposition 1 (Procurement Contract)**.** *One solution of the program (1)-(4) is given by the following transfers*

$$T_\ell = \max\{0, \underline{U} - \frac{P_h B}{\Delta P}\},$$

and

$$T_h = \frac{B}{\Delta P} + T_\ell > 0,$$

with expected surplus to the processor given by

$$V(R) = P_h R - I - \max\{\frac{P_h B}{\Delta P}, \underline{U}\}.$$

The farmer derives an expected informational rent of $P_h \frac{B}{\Delta P}$ from his farming activities. When these information rents exceed the farmer's outside option expected utility $\underline{U}$, it is possible to set $T_\ell = 0$; otherwise the farmer must be paid a positive amount in both outcome states and earns exactly his outside option expected utility. The processor will undertake the processing activity when expected returns, $V(R)$, are positive, and no processing activity is undertaken by a private firm otherwise.

We now study the farmer's decision to launch a cooperative, possibly by pledging their farm assets.

4.2. **Cooperative Financing or "Pledging the Farm".** Arguably, the "cost of democracy" that underlies the cooperative governance mechanism is the fundamental difference between a cooperative and a private investor owned firm. Thus, we assume that cooperative formation necessarily entails a monetary cost, $K > 0$, borne by our representative farmer during the life of the cooperative, and that this cost is independent of the cost of the assets of the food processing plant, I. This assumption is the simplest possible way to capture the idea that majority participation in firm-level decision making necessarily entails a deadweight loss, relative to private-investor governance.

The farmer does not have sufficient cash to cover the investment and organizational cost, $I+K$, associated with the processing activity but does have some illiquid assets like machines and acreages. These assets can be used as collateral by the farmer in any loan that the institutional investors issue. The farmer derives some utility from possession of these assets, and we assume that this utility is equivalent for him to F monetary units. However, when these assets are transferred to someone else, they are only worth f units, with $F > f > 0$. Several interpretations can be given to this discrepancy in valuation. For example, the farmer may have knowledge needed for efficient operation of the collateralized assets that is both asset specific and costly to transfer. Alternatively, a discrepancy may arise because farmers have a sentimental attachment to their farms, or possibly because there is a deadweight transaction cost associated with asset seizure itself. For the purposes of our model, a discrepancy in asset valuation represents a strictly positive deadweight loss of $F - f$ if the asset is seized.[10]

The farmers have to invest an amount $I+K$ to form a processing cooperative. There exist several prospective lenders, with no managerial skills, who compete in a Bertrand fashion in issuing a loan to the farmers. The loan contract specifies how the two parties will share the revenue, R, in case of success, as well as possible contingent rights for the lenders to seize the assets. Let R_f

[10]See Chan and Kanatas 1985 who also study financial contracting with discrepancy in valuation between lender and borrower.

denote the farmers' share of income in case of success, where lenders receive the residual $R - R_f$, and let y_s and y_f denote the probabilities that the farmer will have his farm seized (or equivalently, the fraction of total assets that the farmer will give up) in case of success or failure, respectively .

The program of the farmer can be stated as

$$U(R) \equiv \max_{(R_f, y_s, y_f)} P_h(R_f - y_s F) - (1 - P_h) y_f F \tag{5}$$

subject to

$$P_h(R_f - y_s F) - (1 - P_h) y_f F \geq P_\ell(R_f - y_s F) - (1 - P_\ell) y_f F + B, \tag{6}$$

$$P_h(R - R_f + y_s f) + (1 - P_h) y_f f \geq I + K, \tag{7}$$

and

$$0 \geq y_s \leq 1; \quad 0 \geq y_f \leq 1. \tag{8}$$

The farmer undertakes the processing venture with borrowed cash. The incentive constraint (6) states that the loan contract is structured in such a way that farmers are induced to produce high-quality input with probability P_h, which from Assumption 1 we know is efficient. The loan contract must also meet the individual rationality constraint (7) of the lenders; that is, the lenders must at least recoup their investment, $I + K$, on average. Finally, the probabilities of asset seizure must be between 0 and 1.

The following lemma establishes that in the farmer's optimal loan contract, it is never efficient to seize assets when the project succeeds, and that the lender exactly breaks even.

Lemma 1. *Any solution (R_f^*, y_s^*, y_f^*) to the loan contract that solves the farmer's program (5)-(8) satisfies $y_s^* = 0$, and*

$$R_f^* = R - \frac{I + K}{P_h} + \frac{(1 - P_h) y_f f}{P_h}. \tag{9}$$

That the lender's rationality constraint is fully saturated can be easily verified by noting that R_f must be strictly positive to ensure that farmers earn positive expected surplus, and moreover that for any solution in which the constraint is slack, it is possible to increase R_f slightly without violating any constraint, thus increasing expected surplus to the farmer.

Although it seems intuitively plausible that farm assets should not be seized when the project succeeds, it is somewhat less straightforward to verify. To see that this is indeed the case, first use the fact that the lender's rationality constraint binds to rewrite the farmer's objective function in (5) as $P_h R - I - K - q(F - f)$, where $q = y_f - P_h(y_f - y_s)$ represents the total probability of asset seizure. Thus, the farmer wishes to maximize expected social surplus,

where seizing assets with probability q reduces expected surplus by $q(F-f)$. Clearly, q should be made as small as possible from this perspective. Making the same substitution in the incentive constraint (6) and rearranging yields,

$$P_h R - I - K + (y_f - y_s)P_h(F-f) + y_f f \geq \frac{P_h B}{\Delta P}.$$

From this expression, it is clear that in any solution where $y_s > 0$, it is possible to reduce y_s slightly without violating any constraint. Doing so reduces q, and thus increases expected payoff to the farmer. Intuitively, it is never efficient to use a transfer of assets as a means of transferring surplus from the farmer to the lender. Any transfer of surplus from the farmer to the lender that is needed to satisfy the lender's rationality constraint can be achieved at lower cost by reducing R_f. Asset seizure is a costly incentive instrument and is most effective when $y_s = 0$.

Lemma 1 provides the solution of program (5) for any given probability of asset seizure when the project fails, y_f. The next result characterizes the optimal y_f when project revenues, R, decrease gradually.

Proposition 2 (Financial Contract)**.** *As the return R of the processing activity decreases (equivalently, as $I+K$ increases), the financial contract passed with lenders will have two regimes:*

(1) *(*Cooperative with no pledging*) When*

$$R \geq \overline{R} \equiv \frac{I+K}{P_h} + \frac{B}{\Delta P},$$

farmers are able to pledge cash for repayment without pledging any physical assets in any state of the world; that is, $y_f^* = 0$. Equilibrium surplus for the farmer is given by

$$U(R) = P_h R - I - K$$

(2) (Cooperative with pledging) *When*

$$\underline{R} \equiv \frac{I+K}{P_h} + \frac{B}{\Delta P} - F - \frac{(1-P_h)}{P_h} f < R < \overline{R},$$

then farmers will lose a fraction of their assets in case of failure, with

$$y_f^* = \frac{I + K - P_h(R - B/\Delta P)}{P_h F + (1-P_h)f},$$

with equilibrium surplus for the farmer given by

$$U(R) = P_h R - I - K - (1-P_h)y_f^*(F-f).$$

For lower values of R, farmers do not obtain a loan (although the cooperative project may still have a strictly positive net value).

Using Lemma 1, it is clear from (5) that y_f should be zero unless it is needed for incentive reasons. Thus, if $y_f > 0$, we can find its value from the farmer's incentive constraint (6), which must be binding. If the value we find here is strictly greater than one, then

$$P_h R - I - K - (1 - P_h)(F - f) < \frac{P_h B}{\Delta P} - F,$$

and the problem is infeasible: project revenues, combined with the collaterized value of farm assets, are insufficient to cover project costs and pay the farmer's information rents. Proposition 2 is thus simply a matter of evaluating the farmer's incentive constraint as a function of R. For future reference, note that when y_f^* is strictly between zero and one, it is a strictly decreasing function of R.

The relative magnitude of information rents and expected project surplus (ignoring the deadweight loss from asset seizure) plays an important role in the structure of the loan agreement. When the informational rent attached to the farm product is smaller than expected project surplus (ignoring the deadweight loss from asset seizure), there is sufficient cash to repay lenders and no need to collaterize the farm asset. In contrast, when informational rents are sufficiently high, full contingent asset seizing may be necessary ($y_f^* = 1$) to induce diligence by farmers.

Interestingly, these two cooperative regimes have characteristics resembling organizational features found in some actual cooperatives. For instance, to participate in a so-called "new generation cooperative," a farmer must contribute significant up-front equity to become a member.[11] Harris et al. (1996) note that these minimum up-front capital requirements are sometimes too high for young equity-poor farmers, who are thus indirectly restricted access. Although not universally the case, these new generation cooperatives have tended to concentrate on "niche products" in which branding and organizational reputation are important. It seems reasonable that, relative to the marketing of a generic commodity, incentive provision is relatively important in such a venture, or that, in the context of our model, information rents are relatively high. Thus, our model seems to describe well the combination of significant equity investment coinciding with large information rents.

[11]New generation cooperatives have several other organizational features in addition to the requirement of significant equity contribution by farmers. Perhaps the most important of these is that members have tradable (and appreciable) delivery rights associated with their equity participation. The tradeability of delivery rights seems to play an important role in addressing conflicts among members with heterogeneous organizational tenure (i.e., the "horizon problem"). For a recent formal treatment of the horizon problem in cooperatives, see Rey and Tirole 2001.

Proposition 2 also has some policy implications. When returns are sufficiently low, farmers are credit rationed and cannot create their cooperative. This occurs when

$$(1-P_h)(F-f) < P_hR - I - K < P_h(\frac{B}{\Delta P} - F) - (1-P_h)f,$$

so that the project is not feasible but is socially valuable. In this case, expected project returns plus the expected value of farm assets that are seized in the case of failure are insufficient to cover expected project costs which include both the investment and organizational costs, and the information rents of farmers. Note that this outcome implies that $P_hB/\Delta P > F$, or that expected information rents are large in comparison with the farmer's asset valuation. In this case, providing secured loans or subsidies to farmers can enable cooperative activity that generates positive expected social surplus (ignoring the cost of government funds) but that would be otherwise infeasible. In our model, a secured loan or subsidy to farmers would act like an increase in R or a decrease in $I + K$. However, for incentive purposes, it is important to let the farmers bear the project risk.

5. Comparison of Investor and Cooperative Financing

The aim of this section is to characterize situations in which we expect to observe private firms or cooperatives. The next results, which are the main results of the paper, discuss the existence, as an equilibrium outcome, of each type of processing organization.

We first state an assumption that provides a pair of necessary conditions for the equilibrium emergence of cooperative activity.

Assumption 2 (Cooperative activity)**.**

$$\frac{K}{P_h} - \frac{(1-P_h)}{P_h}f < F < \frac{P_hB}{\Delta P}.$$

The first inequality, which we can rewrite as $K < P_hF + (1-P_h)f$ says that the expected value of the farm asset, given that it is pledged, is larger than the cost of cooperative organization. Viewing the expected value of the farm asset as a component of the "project" value, this assumption says that the amount that the farmer contributes to the project must be at least as large as the additional cost which is incurred to accommodate farmer participation in management. Alternatively, this inequality can be viewed as simply a restriction on the magnitude of K. There is no scope for cooperative activity when the necessary organizational costs are sufficiently high.

The second inequality ensures that the farmer always receives positive expected surplus from cooperative activity. To see this, note that $U(\underline{R})$ evaluated

at $y_f^* = 1$ yields

$$U(\underline{R}) = P_h(\frac{B}{\Delta P} - F) - (1 - P_h)F.$$

Imposing the condition $U(\underline{R}) > 0$ yields the second inequality in Assumption 2. Thus, if the farmer is to be made at least as well off as in his outside option (which, recall, we assume is the "spot market" yielding a net expected utility of zero), then information rents from the cooperative venture must be relatively large in comparison with the value of assets that are pledged.

Using Assumption 2, we now present a proposition that summarizes equilibrium organizational structure as a function of project returns, R.

Proposition 3 (Equilibrium organization)**.** *Under Assumption 2, as R increases, we observe the following exclusive sequence of processing organizations:*

- *If $R < \underline{R}$, no organization is formed; farmers sell their product on the "spot market" and earn zero expected utility.*
- *If*

$$\underline{R} \leq R < R_p \equiv \frac{I}{P_h} + \frac{B}{\Delta P},$$

  then a cooperative with asset collateralization is the unique equilibrium organization. The structure of its financial contract with the lender is described in Proposition 2.
- *If $R_p \leq R \leq \overline{R}$, then processing activities are exclusively performed by the private firm. Its procurement contract with the farmer is described in Proposition 1.*
- *If $R \geq \overline{R}$, then processing activities are performed by a private firm, but against threat of entry by a cooperative firm. The farmer's procurement contract is as described in Proposition 1.*

Proof. The proof of this proposition is a straightforward comparison of the various regimes characterized in Propositions 1 and 2, under Assumption 2. In Proposition 2, we have already shown that the cooperative is not sustainable when $R < \underline{R}$. Rearranging this inequality slightly yields

$$P_h(R - \frac{B}{\Delta P}) - I < K - (P_h F + (1 - P_h)f) < 0,$$

which, using Assumption 2, demonstrates that a private firm is also not feasible.

Next, note that Assumption 2 ensures $\underline{R} < R_p$. Thus, there is an interval where the farmer's incentive compatibility constraint can be satisfied in the cooperative organization. However, we still need to ensure that the cooperative members earn positive expected surplus in the interval between $\underline{R}$ and R_p while

the private processor does not. This is easily verified, again using Assumption 2, by direct substitution into the expressions for $U(R)$ and $V(R)$.

For R between R_p and $\overline{R}$, the private processor earns strictly positive returns, while the farmer receives $P_h B/\Delta P > U(R)$, so that he does better with the processor than by forming a cooperative. For R sufficiently large, the private processor earns $K > 0$, while the farmer earns expected project surplus $P_h R - I$ minus K, which makes him exactly indifferent between producing for the processor and forming a cooperative. □

These arguments can be presented graphically by assuming that farmers must pledge all or none of their assets to the cooperative venture, or that $y_f \in \{0, 1\}$, and that $R < R_p$ so that $T_\ell = 0$ in the firm's procurement problem. In the firm problem, when the project succeeds, the farmer must be paid at least the information rents $B/\Delta P$, while the private investor must receive at least I/P_h so that expected project surplus is positive. Thus, the project revenue R must be at least as large as $B/\Delta P + I/P_h$. In Figure 1, we have drawn the relevant constraint set for the private investor so that the project is just feasible. In the cooperative problem, the farmer must earn at least $B/\Delta P - F$, while investors must earn at least $(I+K)/P_h - f(1-P_h)/P_h$. Thus, there is a region of feasibility for the cooperative that is outside the feasible region for a private firm, provided that $(I+K)/P_h - f(1-P_h)/P_h < I/P_h + F$ as indicated in the figure. This inequality is the first part of Assumption 2.

Figure 2 summarizes the results of Proposition 3 in terms of expected social surplus. Under the assumptions of our analysis, a cooperative is less profitable than a private investor-owned firm when the returns of the processing activity are relatively high. Thus, at R_p there is a discrete jump in social surplus as project returns are reduced slightly, and the only feasible organizational structure is the cooperative. Moreover, as returns fall still further, the rate of decrease in expected social surplus is greater in the cooperative organization than in a private firm (at higher R); this is because in addition to the loss in social surplus resulting from a reduction in R, farmers must pledge additional assets which generate a further deadweight loss. When returns are sufficiently low, some credit rationing can appear as farmers cannot credibly commit to repaying loans to lenders.

The results of Proposition 3 suggest that cooperatives with asset pledging tend to emerge not because farmers choose to develop a product with high returns (i.e., a high R) but rather because they are the only feasible organizational structure. One possible implication is that cooperatives be relatively preponderant in low-return segments of the agricultural sector. Parliement et al. (1990) provide some evidence that seems consistent with this prediction.

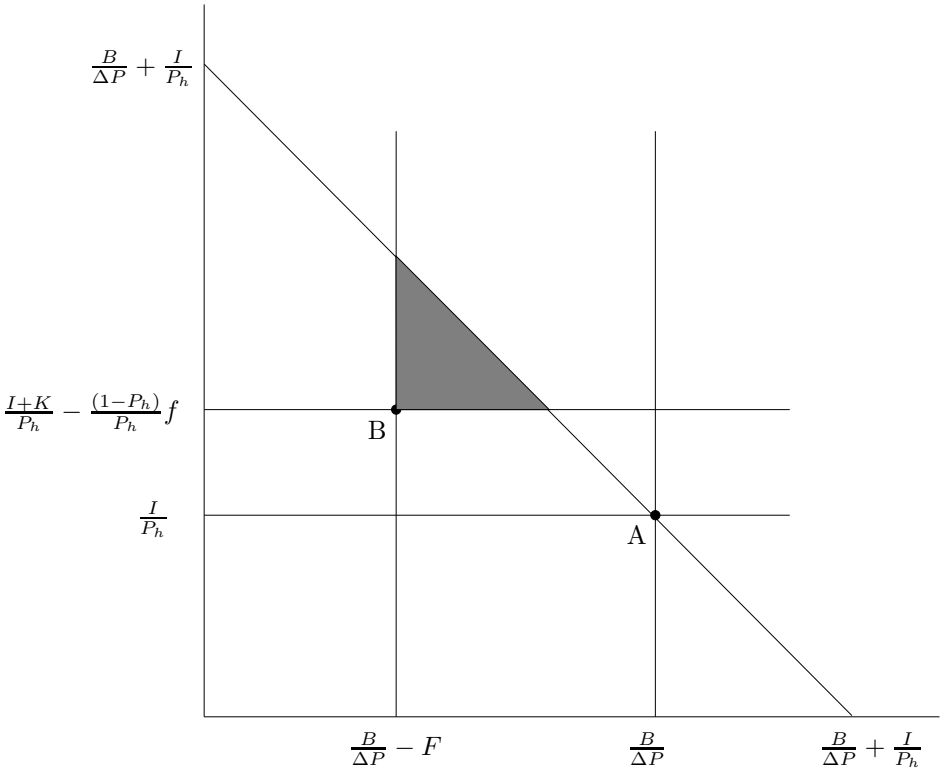

FIGURE 2. Project feasibility with and without pledging by the farmer. Axes represent payoffs under project success, with the farmer on the horizontal axis and the investor on the vertical axis.

In particular, they note that dairy cooperatives tend to concentrate their activity in the low-value fluid milk segment of the industry. Stafford and Roof (1984) make a similar observation.

The cost of collective decision making plays an important role in our analysis. If a cooperative organization is to be feasible, it must choose a venture in which these costs are relatively low. Empirical observations by Zusman (1982) and Fulton (1990) show that New generation cooperatives (NGCs) are usually devoted to one commodity and therefore tend to have less conflict of interest than private, investor-owned firms, which tend to be involved in multiple commodity segments.

Interestingly, the farmer-specific valuation also matters in our analysis. Indeed, a higher F relaxes the incentive constraint even if the pledged assets have a small tradable value. Thus, these assets are likely to be included in the loan agreement. Cook and Iliopoulos (1999) suggest that most of the recent

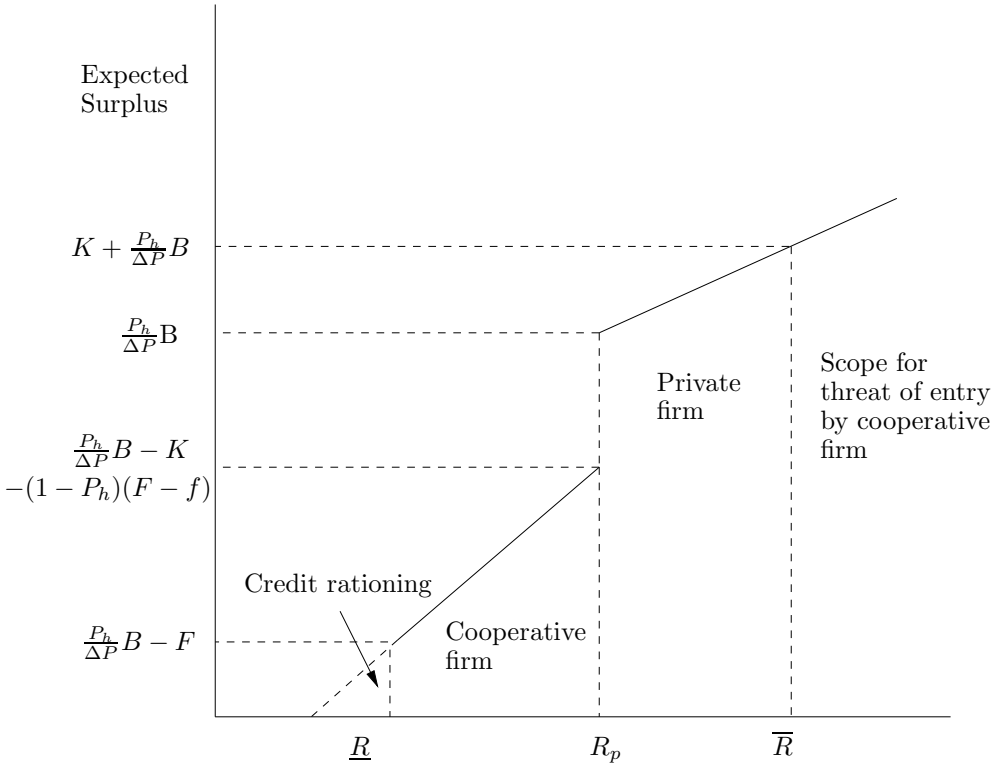

FIGURE 3. Expected social surplus and equilibrium organizational structure as a function of market returns, R.

cooperative formation in the Upper Midwest have adopted NGC-like organizational characteristics. One of the most recurrent characteristics is a minimum up-front investment. Increases in the financial value of the collateral, f, and the level of informational rent also favor existence of the cooperatives with asset pledging. An increase in information rents makes the provision of incentives through asset pledging more important, and increases in f reduce the deadweight cost of using these incentives.

Finally, Proposition 3 emphasizes that cooperatives can only be viable when the extra organizational costs associated with the cooperative activity, $K + (1 - P_h)(F - f)$, are small relative to information rents that must be paid to the private investor, $BP_h/\Delta P$. The existence of cooperatives thus relies on the ability of farmers to internalize information rents as a source of revenue for the processing firm. Processing cooperatives as such represent a means by which farmers perform vertical integration. The cost of this form of vertical integration is the deadweight loss of collective decision making and the cost of exposing farm assets that have a specific value to the possibility of seizure by a third party.

6. Empirics

Our model predicts that a cooperative firm is financially feasible in a larger class of economic environments than a private investor-owned firm (but that a private firm dominates when both are feasible). To test this prediction, it is necessary to observe variation in the relevant economic environments and corresponding variation in the formation and dissolution of firms. Of the measurables in our model, variation in lending rates offer perhaps the best opportunity for such a test. Lending rates can plausibly be viewed as exogenous to each individual agricultural sector, and they are relatively easily measured. Unfortunately, we do not observe the formation and dissolution decisions of individual firms. However, if cooperative activity is in large part a response to the exit of financially distressed private firms, then the aggregate market share of cooperative firms should rise in response to the price of credit. Figure 6 is a simple scatter plot of the relevant comparative static where we have used one period lags of the real the interest rate. With the exception of two commodity sectors ("nuts" and "other"), there appears, at least visually, to be a fairly strong positive relationship. In the rest of this section we develop an empirical model to test this apparent regularity more carefully and discuss various caveats regarding the construction of our data.

Consider a population model for the average market share y_{it} of cooperative firms in sector i and period t,

$$y_{it} = \alpha + \beta r_{t-1} + b_i + u_{it}, \tag{10}$$

where $r_{i,t-1}$ is the lagged real interest rate, b_i is a sectoral fixed effect, and u_{it} is a disturbance term which we assume has conditional expectation $\mathrm{E}[u_{it}|r_t, b_i] = 0$ for all t.

The data for our empirics come from two sources. Information on aggregate cooperative activity come from U.S. Department of Agriculture (2004), while information on aggregate total market activity come from various years of U.S. Department of Agriculture (2000). The first of these publications measures sectoral revenues of cooperative firms *after processing*, while the latter measures sectoral revenues of all farms at *the farm gate*. Assuming competition in the processing sector, we can write revenues at the level of the firm as the sum of farm wages w and processing costs c. Thus, while we would like to observe $y = q_c/q_T$, where q_c and q_T are the aggregate sectoral outputs of cooperative and all firms, respectively, we instead observe $\tilde{y} = sq_c/q_T$, which differs from y by the term $s = (w+c)/w$, or the inverse of the farm level share of retail cost.

One way to deal with our mismeasured y is to instead model the population distribution for the $\log \tilde{y} = \log y + \log s$. In this case, we can accommodate time and sectoral variation in s in equation (10) by including a time effect, so

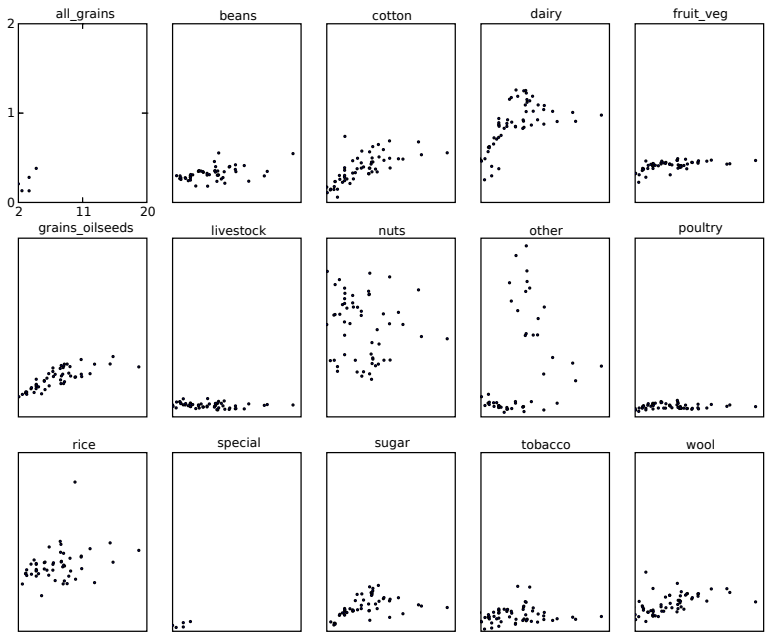

FIGURE 4. Cooperative market share versus federal prime rate, 1930-2002.

that our estimating equation becomes,

$$\log y_{it} = \alpha_t + \beta r_{t-1} + \tilde{b}_i + u_{it}, \tag{11}$$

where $\alpha_t = \alpha + s_t$, and $\tilde{b}_i = b_i + s_i$. For this correction to be valid, we must assume that s_{it} can be written as the additive sum of an aggregate year affect plus a sectoral effect.[12]

Table 1 reports regression results from the specifications in equations (10) and (11), where we suppress reporting individual sectoral and time effects. In all cases, the interest rate has a statistically significant and positive effect on cooperative market share. At this point, our results are preliminary, as we would like to explore a dynamic specification for our model that allows from

[12]Alternatively, we could use USDA data on the aggregate farm level share of retail cost across all sectors to adjust our observed $\tilde{y}$. The USDA reports this measure across individual commodity sectors, but for sectoral definitions that do not match those used in our data on cooperative activity, and only for the years 1946-2002 (see U.S. Department of Agriculture, 2000, Chapter 9, Table 9-29). As a result, making this correction would force us to drop 16 years of data from our sample, and all but two commodity sectors.

TABLE 1. Estimation Results

	Model	
	Base	Semilog
coefficient	.0463	.1823
t-stat	3.5l	7.75
ρ	0.5	0.5
t-stat	1.53	1.57
R^2	.1333	0.3230
sample size	930	930

some degree of institutional inertia (for example, by including lagged y in our estimating equations). It seems reasonable to expect that the the year t level of cooperative activity should influence activity in $t-1$. The row labeled "ρ" in Table 1 is the parameter obtained from regressing $\hat{u}_t$ on $\hat{u}_{t-1}$ and should not be significantly different from zero under a no-serial-correlation hypothesis. The outcome of this test indicates marginal support for some degree of positive serial correlation and thus warrants further testing.

7. Conclusion

This paper tests a "hard times" theory of cooperative formation using historical data on cooperative activity in agricultural markets. We rely on two key maintained hypotheses in developing our theory. First, there is an agency problem between workers and firm management, and workers in a cooperative firm earn fewer informational rents than their counterparts in an investor-owned firm. And second, the governance structure used in a cooperative firm entails a deadweight loss relative to that used in an investor-owned firm.

The justification for our first assumption is based partly on the common sense notion that there are economies of scale in supervisory activities. In addition (though this is somewhat specific to the context of agricultural markets), there is also the fact that cooperative members typically leverage some portion of their physical assets to satisfy the firm's capital requirements. One way to interpret this observations is that it represents a mechanism for relaxing a limited liability constraint (if the firm fails, farmers lose their assets), with a resulting decrease in informational rents.[13]

[13]We do not explain why similar outcomes cannot be achieved in a private firm by having farmers pledge their assets to a third party. Even if it seems reasonable to suppose that farmers who pledge assets to finance a risky project will exercise some degree of managerial control over the project (and hence govern "cooperatively"), the reason remains to be explained. One possibility is that a third party introduces opportunities for collusion and this is costly to police. Alternatively, Martinez (1999) notes that private processors in the

Our second maintained assumption is meant to capture the idea noted by Hansmann (2000) and others (e.g. Fulton, 1999; Holmström, 1999; Rey and Tirole, 2001) that the restriction on passive ownership within a cooperative results in a relatively illiquid market for ownership shares, and hence creates internal decision-making frictions that are not present in an investor-owned firm. Or equivalently for our purposes, when farmers pledge their own physical assets against the firm, they risk losing those assets in the event the firm fails. If farmers have human capital that is specific to these assets, then the possibility of asset seizure involves an expected deadweight loss to society.

We present two kinds of data to support our hypothesis. On the one hand, there is anecdotal and case-study evidence that cooperative firms often emerge in response to the exit of private firms, and that cooperative firms in general are sustainable in economic environments that cannot support the activity of a private investor-owned firm. Moreover, we demonstrate an apparent positive causal relationship between annual real lending rates and the level of cooperative activity across 15 commodity sectors during the years 1930-2002. Both sources of evidence support our hypothesis that the cooperative organizational structure facilitates financing that would otherwise not be available.

To some extent, our theory is an amalgam of existing theories. In particular, other authors have argued that cooperatives improve the provision of incentives to workers. A mostly different set of authors has argued that cooperative governance procedures are costly, relative to those used in investor-owned firms. However, to the best of our knowledge, we are not aware of other research that pulls these two pieces together as the key ingredients in a model of cooperative formation. Indeed, our view of the cooperative suggests an alternative to the prevailing view (e.g. Dow and Putterman, 2000; Bonin et al., 1993) that a key disadvantage of the cooperative is its lack of access to external financing. Though not modeled explicitly, our theory suggests that this lack of access may be a necessary requirement to elicit the *internal* financing that comes from cooperative members. In this sense, access to finance is a key advantage of the cooperative firm.

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livestock sector effectively leverage their *own* assets by using procurement contracts with farmers (who purchase or own land and equipment), rather than self-producing the farm input. To the extent that the capital purchases of farmers are debt-financed, this is potentially another way to effectively implement the incentives that occur in our model. If so, then the cooperative organization can be viewed as just one of many possible means of achieving the outcomes that are possible with asset pledging. Although we do not address these questions in in our analysis, they certainly warrant further thought and represent a useful direction for future research.

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