THE COOPERATIVE FIRM AS MONITORED CREDIT? EVIDENCE FROM U.S. AGRICULTURAL MARKETS

BRENT HUETH AND PHILIPPE MARCOUL

Abstract. We test a simple financial-contracting theory of the cooperative firm using data on historical variation in cooperative activity across 12 agricultural commodity sectors during the period 1946-2002. We treat cooperation as a particular implementation of "monitored credit" (or "informed intermediation") in the spirit of Holmström and Tirole (1997). In this view, cooperation is a costly means of access to intensive monitoring, and only arises in equilibrium when private investment is not forthcoming. This can occur, for example, in a declining industry with capital flight, or when investment opportunities in unrelated sectors are particularly good. We provide case study and descriptive evidence that offers some support for this view. We provide further support with a statistically significant relationship between cooperative market share and real annual lending rates for 8 of 12 commodity sectors. In all but two of these cases, the direction of influence goes in the direction predicted by our theory.

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Brent Hueth and Philippe Marcoul are Associate and Assistant Professors, respectively, in the Department of Economics, Iowa State University, Ames, Iowa 50011. Contact author: Brent Hueth, `bhueth@iastate.edu`.
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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 regarding the core set of motivations for choosing between these two organizational modes (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. Among the most important of these constraints include requirements that most of the firm's capital be provided by the firm's employees (or input providers in the case of the agricultural marketing cooperative),[2] 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

[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).

[2]Dow and Putterman (2000) make a distinction among labor-managed firms and "firms controlled by input suppliers (e.g., agricultural cooperatives), by customers (consumer cooperatives), or by others (for instance, non-profit organizations)." While we agree that consumer cooperatives and non-profit organizations are fundamentally different from labor-managed firms, making a distinction relative to firms controlled by input suppliers seems artificial. Any input that is supplied by such a firm is a transformation of labor effort, and the relevant set of incentive and organizational design issues differ only by degree (e.g., in relation to the separability of each individual workers' contribution to total output, and possibly with respect to the financial resources of workers).

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. Adding 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) results in a theory of the cooperative firm where 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 alluded 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.[3] Instead, our main contribution is to address the second objection. In particular, we have collected data regarding historical variation in the market share of agricultural cooperatives across 12 commodity sectors during the period 1946-2002. With these data, we test our "monitored credit" 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, at least for most commodities, and that the direction of this influence is in large part 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 are devoted to empirics, discussion, and concluding comments.

2. Cooperative Activity in Agriculture: Theory and Evidence

We begin our discussion in this section by summarizing a qualitative, though well-documented, observation regarding the genesis for cooperative formation in agricultural markets. While descriptive in nature, this evidence complements our subsequent econometric 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.[4] Perhaps surprisingly, many of the cooperative firms engaged in this activity were at one time *not* cooperatives, but rather non-farm investor-owned firms that were subsequently purchased

[3]Legislation that governs the formation and ongoing administration of cooperatives typically restricts the degree of 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. . . "

[4]Cook (1993) provides an informative overview of this and other forms of cooperative activity in agriculture.

by farmers in response to announced plant closings or scaling back of processing activities.[5] 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, 2005). 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, 2005). Still more examples are provided by Hetherington (1991, pp. 182-186) who notes how past growth in cooperative activity in California's fruit and vegetable canning industry can be mostly explained by farmers purchasing abandoned investor-owned capacity. While examples of cooperatives that have emerged *de novo* certainly exist, perhaps outnumbering those that have emerged in response to private firm exit, one is hard pressed to find an example of a private firm that has rescued the operations of an abandoned cooperative.

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

[5] In their work on cooperative behavior in the plywood industry, Craig and Pencavel (pg. 1086, 1992) similarly note that many of the cooperatives in this industry were formed to preserve employment in unprofitable private plants.

investors. If so, then it is possible for growers to operate in a market environment that cannot support private-firm activity. However, for this to be the case, one would have to explain why the firm cannot simply negotiate a lower payment to growers. Staatz (1987) suggests that private information and associated bargaining frictions may be important in this context.

Ben-Ner and Jun (1996) consider one such bargaining friction. In the context of non-agricultural labor markets, these authors 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 workers provides a means of eliciting information from firm managers, it remains to be explained why *workers* (or farmers) should provide the capital to purchase the firm? Why not finance the purchase with the assistance of external investors, perhaps using the firm's assets as collateral?

The work so far cited concerns cooperative formation and is somewhat anecdotal in nature. The U.S. Department of Agriculture (2004) provides a more systematic historical summary of cooperative activity measured not only by formations, but also by dissolutions, value of sales, and annual membership across 12 agricultural commodity sectors in the United States. Later in our analysis, we will focus on the value of cooperative sales in relation to total farm marketings as a measure of cooperative activity. Figure 1 displays the full time series that is available on value of sales across all 12 commodity sectors. To facilitate cross commodity comparison in variation across years, we have normalized each year of revenue by average revenue across all years for which data is available in the relevant commodity sector. The variation observed in Figure 1 can be decomposed into variation attributable to commodity and time specific factors that should have a similar impact on the gross sales of private firms (the total quantity of farm output produced, and the price of final output), and to variation in the relative share of total farm output handled by cooperative and private firms. Our empirical strategy will be to evaluate the predictive content of our theory in explaining some of this latter variation.

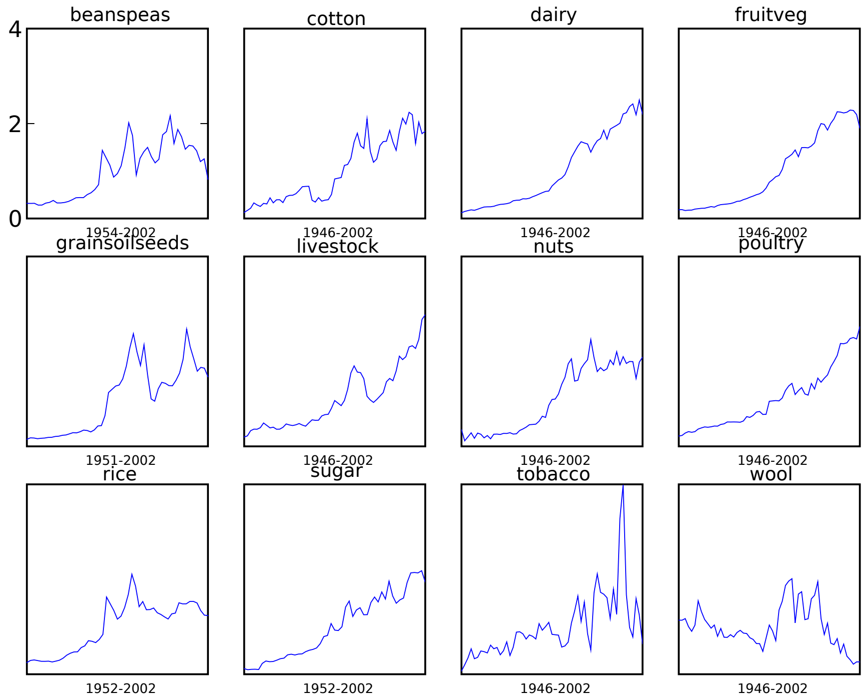

Figure 1. Cooperative market volume as a fraction of average cooperative volume over the entire period for which data is available (indicated in the relevant axis label).

3. The Cooperative Firm as "Monitored Credit"

We propose a theory of the cooperative firm that attempts to account for the fact that cooperatives often emerge in response to "hard times," or in declining industries, and that can explain a some 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 their 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).[6] 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. We also assume that asset pledging generates an expected deadweight loss. This will be the case, for example, when there is a transaction cost associated with asset seizure, or

[6]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, "vertical integration" in our analysis involves an exchange of an organizational deadweight loss for improved incentives.

alternatively (but equivalently for our purposes) when farmers have human capital specific to their assets. We model both forms of deadweight cost, though either would suffice to achieve the main qualitative predictions that we test.

We treat these two sources of deadweight loss, together with the assumption that there is moral hazard in farm production, as maintained hypotheses in our analysis.[7] As we will demonstrate below, these assumptions generate the prediction that the "cooperative structure" (defined by an organizational deadweight loss and asset pledging by farmers) can be an efficient response to high lending rates or low market returns from processing.

Briefly, we present a model where we obtain two equilibrium organizational regimes, depending on the level of lending rates and market returns 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 surplus between private owners and farmers 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.[8]

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 (i.e., the surplus that must be transferred to farmers to ensure efficient provision of effort) 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

[7]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).

[8]The results of this regime are a simple version of those in Sexton and Sexton (1987), where cooperative activity provides a pro-competitive effect in an oligopoly market. However, in our model farmers induce competition with the *threat* of entry; there is no equilibrium cooperative formation.

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."[9] We characterize a region of market returns and lending rates in which a cooperative of this sort is the only viable organizational structure. This will only be possible when the cost incurred from forming a cooperative is no larger than associated reductions in information rents.

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 of these two organizational structures as a function of the exogenous lending rate, and expected market returns from processing.

3.1. **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.[10] 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.

[9]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.

[10]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.

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.[11] Institutional investors are passive risk-neutral investors, with no managerial skills. There exists a competitive fringe of such investors who will lend only if they expect to recoup at least the initial cost of the investment plus interest, rI, where $r > 1$ is one plus the exogenously given real lending rate.

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.[12] 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 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 it is always efficient to induce diligence by the farmer.

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,

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

[12]The term "quality" here is used for expositional ease. Output quantity, various measured quality attributes, 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.

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' choice.
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.

3.2. **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

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

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

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

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. 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.

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 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*

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

and

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

with expected surplus to the processor given by

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

The farmer derives an expected informational rent of $P_h B/\Delta P$ 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, $V(R,r)$, 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 his farm assets.

3.3. **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. Additionally, Craig and Pencavel (1992) document real behavioral differences between cooperative and private firms that plausibly reflect a departure from profit-maximizing behavior. Thus, we assume that organizing a cooperative 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, and consequent behavioral departures from profit maximization, necessarily entail 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 values these assets at F monetary units. However, when the assets are transferred to someone else, they are only worth f units, with $F \geq f > 0$. Several interpretations can be given to this discrepancy in valuation. 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 the change of ownership. 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. The deadweight cost $F - f$ plays an analogous role in our model to the organizational deadweight cost K. However, the magnitude of F determines the effective assets farmers have available to pledge, and therefore plays an independent role.

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 denote the farmers' share of income in case of success, where lenders receive the residual $R - R_f$, and let s denote the probability that the farmer will have his farm seized (or equivalently, the fraction of total assets that the farmer will give up) in case of failure.[13]

The program of the farmer can be stated as

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

[13]Given our earlier assumption that farmers have an outside option (different from cooperative formation) that offers zero expected utility, there is no loss of generality in ruling out the possibility of asset seizure contingent on project success.

subject to

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

$$P_h(R - R_f) + (1 - P_h)sf \geq r(I + K), \tag{7}$$

and

$$0 \leq s \leq 1. \tag{8}$$

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 as in the previous program, we assume is efficient. The loan contract must also meet the individual rationality constraint (7) of the lenders; that is, the lenders must at least recoup the initial cost plus interest of their investment, $r(I + K)$, on average. Finally, the probability of asset seizure must be between 0 and 1.

The following lemma establishes that in the farmer's optimal loan contract, the lender exactly breaks even.

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

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

Lemma 1 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.

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

Proposition 2 (Financial Contract)**.** *As the return R of the processing activity decreases, the financial contract passed with lenders will have three regimes:*

1. (Cooperative with no pledging) *When*

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

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

$$U(R,r) = P_h R - r(I+K)$$

2. (Cooperative with pledging) *When*

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

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

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

and with equilibrium surplus for the farmer given by

$$U(R,r) = P_h R - r(I+K) - (1-P_h) s^* (F - f).$$

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

Using Lemma 1, it is clear from (5) that s should be zero unless it is needed for incentive reasons. Thus, if $s > 0$, 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

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

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 s^* is strictly between zero and one, it is a strictly decreasing function of R.

The relative magnitude of information rents and expected project surplus 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 ($s^* = 1$) to induce diligence by farmers.

3.4. **Comparison of Investor and Cooperative Financing.** The aim of this section is to characterize situations where we expect to observe private firms or cooperatives. However, before proceeding, it is useful to summarize the key qualitative differences between our private investor and cooperative financing regimes. Our treatment of the "cooperative firm" is somewhat unconventional. Typically, the key distinguishing feature of any model of cooperative behavior, relative to a model of private firm behavior, is the form of the objective function, or possibly the explicit modeling of democratic decision making. The two distinguishing features of our model are a deadweight organizational cost, and stronger incentives.[14]

[14]We could further strengthen cooperative incentives in our model through a reduction in the magnitude of B. This would be a natural way of modeling, for example, the effect of peer monitoring that is often associated with cooperative organizations. Accommodating this possibility is a straightforward extension of our analysis that does not alter the qualitative properties of our solution.

At a purely formal level, one can therefore view our cooperative firm as a particular implementation of a generic costly monitor. It is natural to ask why a private firm cannot implement this sort monitoring in some other way. For example, the private firm could ask growers to pledge their assets with a third party against project failure. While recognizing this possibility, we also note that introducing a third party (or dealing with the perverse incentives that arise if farmers' assets go to the firm in the event of project failure), is costly. We therefore regard the form that monitoring takes as an empirical issue.[15]

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 1 (Cooperative activity)**.**

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

We can rewrite the first inequality as $rK + (1-P_h)(F-f) < F$, which says that the maximum expected deadweight cost of the cooperative organization must be no greater than the associated reduction in information rents (from $B/\Delta P$ to $B/\Delta P - F$). 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 $s^* = 1$ yields

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

Imposing the condition $U(\underline{R}) > 0$ yields the desired result. 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"

[15] Martinez (2001) notes that private processors in the 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, and specific to a processor's activity, 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 (or costly monitoring of some other sort).

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

Proposition 3 (Equilibrium organization)**.** *Under Assumption 1, as R increases, we observe the following exclusive sequence of processing organizations:*

1. *If $R < \underline{R}$, no organization is formed; farmers sell their product on the "spot market" and earn zero expected utility.*
2. *If*
$$\underline{R} \leq R < R_p \equiv \frac{rI}{P_h} + \frac{B}{\Delta P},$$
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.
3. *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.*
4. *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 1. In Proposition 2, we have already shown that the cooperative is not sustainable when $R < \underline{R}$. Rearranging this inequality slightly yields
$$P_h\left(R - \frac{B}{\Delta P}\right) - rI < rK - (P_hF + (1 - P_h)f) < 0,$$
by Assumption 1, which verifies that a private firm is also not sustainable.

Next, note that Assumption 1 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 1, by direct substitution into the expressions for $U(R, r)$ and $V(R, r)$.

For R between R_p and $\overline{R}$, the private processor earns strictly positive returns, while the farmer receives $P_h B/\Delta P > U(R, r)$, so that he does better with the processor than by forming a cooperative. For R sufficiently large, the private processor earns $rK > 0$, while the farmer earns expected project surplus $P_h R - r(I + K)$, 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 ($s \in \{0, 1\}$), and that $R < R_p$ so that $T_\ell = 0$ in the firm's procurement problem. Under project success in this case, the farmer must be paid at least the information rents $B/\Delta P$, while the private investor must receive at least rI/P_h so that expected project surplus is positive. Thus, project revenue R must be at least as large as $B/\Delta P + rI/P_h$. In Figure 2, we have drawn the relevant constraint set for the private investor so that the project is just feasible at point A. In the cooperative problem, the farmer must earn at least $B/\Delta P - F$, while investors must earn at least $r(I + K)/P_h - f(1 - P_h)/P_h$. Adding up these earnings and comparing with the total earnings requirement in the private firm problem, there is a region of feasibility for the cooperative that is outside the feasible region for a private firm (the shaded region in Figure 2), provided that $r(I + K)/P_h - f(1 - P_h)/P_h < rI/P_h + F$. Rearranging this inequality yields the first inequality in Assumption 1.

Figure 3 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

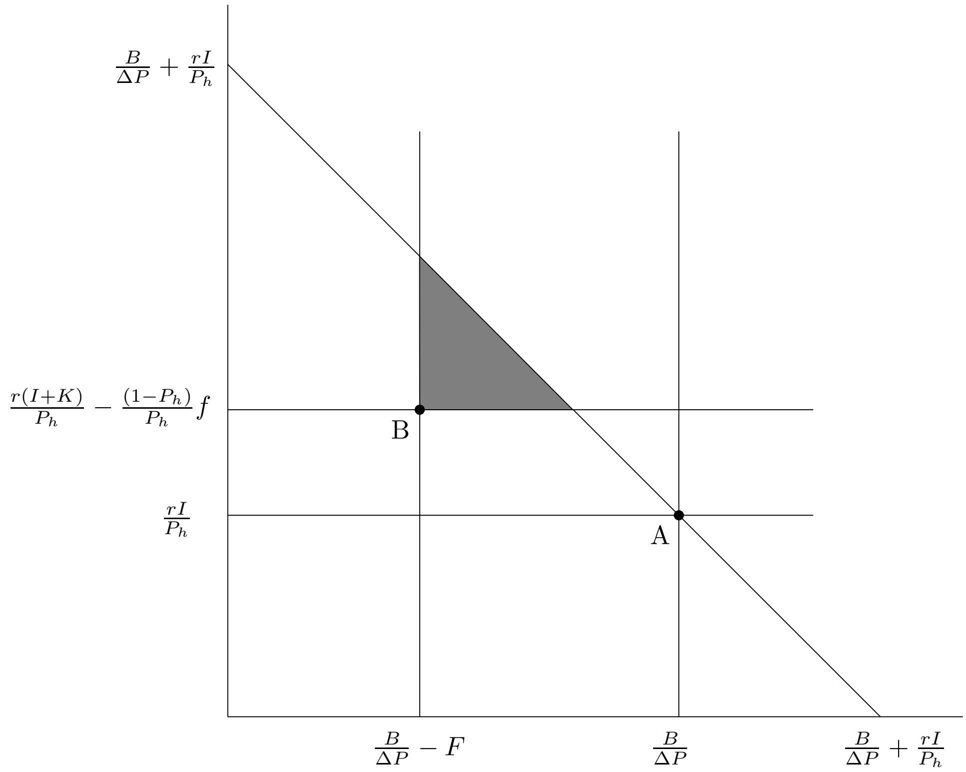

FIGURE 2. Project feasibility with and without pledging by the farmer. Axes represent payoffs under project success, with the farmer on the horizontal axis and the investor on the vertical axis.

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.

So far, we have presented our results on equilibrium organizational structure in terms of variation in market returns R. We have adopted this form of exposition to facilitate interpretation of our model in light of the empirical observations discussed in Section 2. Our model has a number of other empirical predictions. At least three of these seem promising as potential direction for empirical efforts to explain variation in cooperative activity across different agricultural commodity markets, and perhaps across geographical regions for a given commodity. First, the size of F, and the difference between F and f both have predictive content. When farmers have valuable collaterizable assets, and when those assets are not too specific, the range of feasibility for the cooperative organization expands. Second, though not

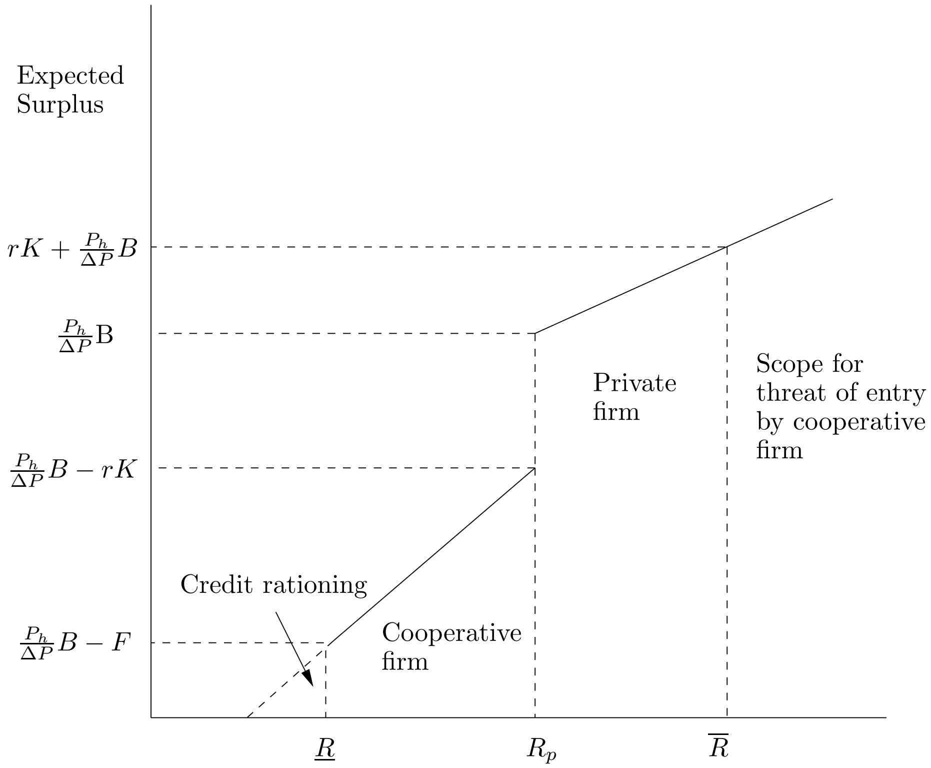

FIGURE 3. Expected social surplus and equilibrium organizational structure as a function of market returns, R.

formally considered in our model, it seems reasonable to expect some degree of nonlinearity in real borrowing rates, particularly for farmers. The loans that farmers receive to establish a cooperative typically come from local lenders who have existing relationships with farmers. For I sufficiently large it may be necessary to seek external (more costly) funds as well. This idea could be accommodated in our model with, for example, a convex borrowing cost $C(I)$. Such an extension could be used to generate predictions relating the size of I (which should vary considerably across commodity sectors), the density of local lending opportunities, and equilibrium cooperative activity.

Lastly, a third prediction of our model relates the exogenous real cost of borrowing, r, to equilibrium cooperative activity. This topic is the focus of our next section. To formally summarize this relationship in our model, we state the following straightforward corollary to Proposition 3:

Corollary 1 (Lending Rates)**.** *Under Assumption 1, as r decreases, we observe the following exclusive sequence of processing organizations:*

1. *If*
$$r > \overline{r} \equiv \frac{P_h}{I+K}\left(R - \frac{B}{\Delta P} + F + \frac{(1-P_h)f}{P_h}\right),$$
no organization is formed; farmers sell their product on the "spot market" and earn zero expected utility.

2. *If*
$$r_p \equiv \frac{P_h}{I}\left(R - \frac{B}{\Delta P}\right) \le r < \overline{r},$$
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.

3. *If*
$$\underline{r} \equiv \frac{P_h}{I+K}\left(R - \frac{B}{\Delta P}\right) < r < r_p,$$
then processing activities are exclusively performed by the private firm. Its procurement contract with the farmer is described in Proposition 1.

4. *If $r < \underline{r}$, 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. Verifying the cutoff values for r in regimes 3 and 4 is a matter of rearranging the analogous expressions for $\overline{R}$ and R_p in Proposition 3. To verify that $\overline{r} > r_p$, note that violation of this inequality would imply that the private firm is viable when the cooperative firm is not, or in other words that there exists an (R, r) pair such that

$$P_h(R - B/\Delta P) - rI > 0,$$

and

$$P_h(R - B/\Delta P) - r(I+K) + P_hF + (1-P_h)f < 0.$$

It is straightforward to verify that satisfying this pair of inequalities requires violation of Assumption 1. □

4. 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). Although this prediction is most naturally interpreted in terms of the entry and exit decision of firms, it can also be used to consider the expansion (or contraction) of cooperative activity for a fixed number of firms in any given period. For example, an existing cooperative might taken on new members who previously delivered to a private firm. By focusing empirically only on entry and exit, we may miss much of the important year-to-year variation in cooperative activity.

We regard the description in Section 2 as informal evidence on entry and exit behavior that is consistent with our theory. To allow for more precise inferences, we have constructed a panel data set of cooperative activity that draws from two additional sources. These include U.S. Department of Agriculture (2004) and various years of the USDA's Agricultural Statistics series (see appendix for details). Our main motivation for combining these two sources of data is to develop a measure of cooperative activity that accounts for variation in *total* sectoral activity in any given year. For this purpose, we choose gross cooperative sales relative to total farm marketings. In addition to measuring the relative importance of cooperative and private firm activity, this measure of activity has the additional advantage of being a more comprehensive measure of activity than entry and exit behavior.[16]

[16]Cooperative "formations" and "dissolutions" are also included in our data set, thus raising the possibility of using other measures of activity. However, the USDA classifies the purchase of one cooperative by another as a dissolution. Measured dissolutions therefore overestimate actual reductions in the extent of cooperative activity, and we have no way to gauge the magnitude of this bias. This still leaves open the possibility of looking at the formations data alone. Unfortunately, we have no information on the entry and exit decisions of noncooperative firms, and thus have no way to identify behavioral differences across cooperative and investor owned firms without further data collection.

Of course, having in hand a reasonable measure of cooperative activity is only half the story. We would also like to observe variation in some other features of our model that can be regarded as exogenous to cooperative formation and expansion (or contraction). Of the measurables in our model, lending rates are perhaps the best source of such variation. Lending rates can plausibly be viewed as exogenous to each individual agricultural sector, and they are relatively easily measured.[17] Other candidates include some measure of sector profitability, the financial and physical asset portfolios of growers in a given sector, and (with a slight extension of our model) possibly the magnitude of the investment required for cooperative formation. Relative to each of these candidates, one clear advantage of lending rates (in addition to their ready availability) is relative lack of measurement error. All remaining variables mentioned above are sector specific with considerable variation within sectors across different commodities. While collecting such data (and perhaps working with less aggregate sectoral definitions for cooperative activity) seems at least feasible, it would no doubt introduce measurement error and require considerable additional data collection effort. We thus consider immediate examination of the relationship between cooperative activity and lending rates a worthwhile empirical endeavor.

In what follows, we develop an econometric model for our measure of cooperative activity and present estimation results.

4.1. **Estimation.** Ideally, we would like to observe total farm output accounted for by cooperative firms in any given period, relative to output handled by all firms. Such a measure would simultaneously account for the entry and exit of firms, and migration of farmers from one firm type to another. Unfortunately, U.S. Department of Agriculture

[17]One obvious problem with using a variable that is constant across all commodity sectors for every time period is endogeneity between this measure and other time specific effects. That is, if we believe that there are other macro variables that effect cooperative activity in all sectors the same way in each time period, and that these variables are correlated with annual lending rates, then we cannot identify the influence of lending rates on cooperative activity without knowing what these variables are and explicitly controlling for such correlation. We regard this potential endogeneity as the most important caveat to our empirical results presented below. Having said this, we know of no model of cooperative activity that would lead us to expect such variables to exist.

(2004) only contains information on cooperative gross revenue, and there is no analogous time series information on the total value of marketings by all processing firms. Instead, we have constructed a times series on the *farm value* of production for each of the commodity sectors defined in U.S. Department of Agriculture (2004) using the USDA's Agricultural Statistics publication from various years.[18]

These two data sources provide us information on the sectoral revenue of cooperative firms *after processing* (or at wholesale), and total farm revenues at the *farm gate*. Assuming competition in the processing sector, we can write wholesale revenues as the sum of farm wages w and processing costs c. While ideally we would like to observe the aggregate sector outputs of cooperative and all firms, Q_c and Q_a, instead we observe $(w+c)Q_c$ and wQ_a. Thus, the ratio of our observed measures of cooperative and total activity, $y \equiv (w+c)Q_c/wQ_q$, differs from $y^* \equiv Q_c/Q_a$ by the term $(w+c)/w$, or the inverse of the farm share of wholesale revenue.

Consider the following regression model for the conditional mean of $\log(y^*_{it})$ in commodity sector i and period t:

$$\log(y^*_{it}) = \mu^*_i + \sum_{k=1}^{3} \gamma^*_{ik} t^k + \sum_{k=0}^{2} \beta^*_{ik} \text{rate}_{t-k} + u^*_{it}. \tag{10}$$

for $i = 1, \ldots, 12,\ t = 1, \ldots, T_i$, where $rate_t$ is the real *ex post* federal prime rate in period t. Equation (10) incorporates a commodity fixed effect, a smooth cubic trend, plus current and lagged lending rates.[19] We wish to preserve maximum flexibility in allowing for unobserved commodity and time specific effects. Thus, for each variable, we allow the relevant effects to vary across commodity sectors. Of course, absent a generalized least squares estimation approach, equation (10) amounts to 12 individual regressions. In our effort to maximize flexibility and reduce the possibility of bias in estimating the influence of lending rates on

[18]See our data appendix for details on the construction of these series.
[19]The number of lags to include for the lending rate is somewhat arbitrary, but it does seem reasonable to expect a lagged effect. We have experimented with a single lag and no lag, without much qualitative difference in results.

cooperative activity, we are sacrificing some precision in these estimates under the hypothesis that they can be treated as constant across commodity sectors. Thus, we will also report results from a version of equation (10) where we restrict $\beta^*_{ik} = \beta^*_k$ for all i.

As indicated above, we do not observe y^*, but rather y. To accommodate this measurement error, we specify a slightly modified version of equation (10) as

$$\log(y_{it}) = \mu_i + \sum_{k=1}^{3} \gamma_{ik} t^k + \sum_{k=0}^{2} \beta_{ik} \mathrm{rate}_{t-k} + \gamma_i \log(\mathrm{winvshare}_{it}) + u_{it}. \tag{11}$$

where our left-hand side variable is now the one we actually observe, and where we have added the log of the inverse farm share of wholesale revenue in period t for commodity sector i to the right-hand side. For $\gamma_i = 1$, this equation is of course equivalent to (10). In other words, if we could observe $winvshare_{it}$, we could make the appropriate adjustment to y and estimate equation (10). Unfortunately this data does not exist, though there is a good proxy measure available. Figure 4 plots the farm level share of *retail* revenue for a market basket of farm commodities (also obtained from the USDA's Agricultural Statistics publication). Clearly, this measure has been on a steady downward trend during the period of our data. This is not a problem if, as is the case here, our only interest in estimating equation (11) is to get consistent estimates of β^*_{ik}. For this purpose, our main concern is with the possible correlation between $\log(winvshare_{it})$ and current and past lending rates. So long as $\log(winvshare_{it})$ and lending rates are orthogonal, we can safely place $\log(winvshare_{it})$ in the error term of (11).

Alternatively, we can use the series displayed in Figure 4 as a proxy. This series is reported at a more disaggregate level, but unfortunately not for commodity definitions that match up well with those used to report cooperative activity (dairy and poultry are the only matches), and only for the years 1946-2002 (our data on cooperative activity date from 1930). Thus, we would be inclined to treat $\log(winvshare_{it})$ as unobserved error, if we could be confident of its exogeneity. Table 1 reports the results of projecting the log inverse farm share of retail revenue for the market-basket, dairy, and poultry commodity groups, on a constant, $rate_t$,

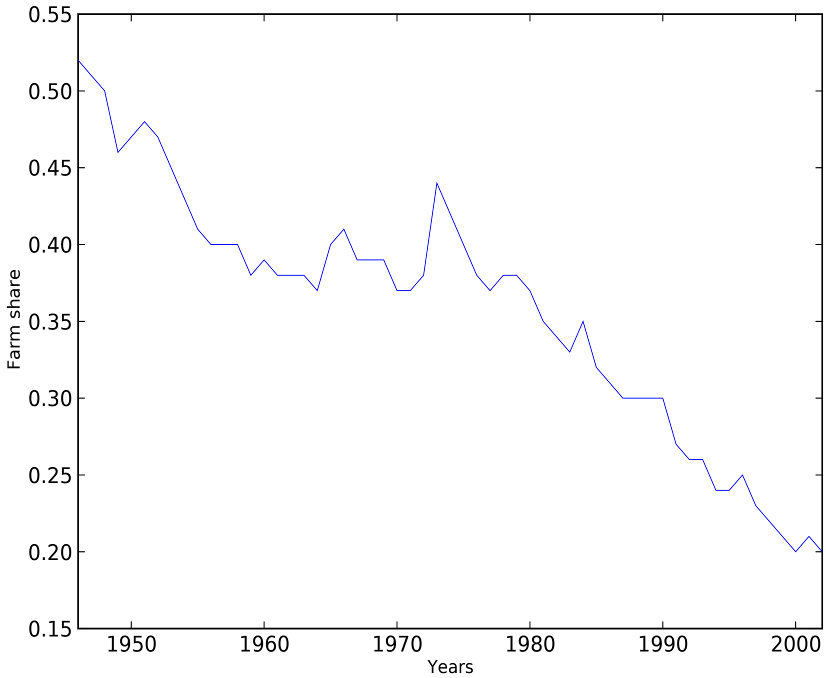

FIGURE 4. Farm share of retail revenue, 1946-2002.

$rate_{t-1}$, and $rate_{t-2}$.[20] Unquestionably, there is a strong degree of correlation between each of these proxies and annual lending rates. We take this as evidence of the potential endogeneity of r_t (including lagged values) in (11), and use the proxy variable $\log(rinvshare_{it})$ (the log inverse farm share of retail revenue) in our estimation. We use the market basket measure for all commodities except dairy and poultry.

Let D_i be the $T_i \times 12$ dummy-variable matrix for commodity i with ones in the i'th column and zero everywhere else; let time_i be the T_i-vector of time indices for commodity i; and let $Z_i = [D_i, \text{time}_i D_i, \text{time}_i^2 D_i, \text{time}_i^3 D_i]$ be the $T_i \times 48$ matrix of commodity dummies and (commodity specific) time trend variables. Stacking the observations in (11) across all t for each i, and applying the projection matrix $M_i = I_i - Z_i(Z_i'Z_i)^{-1}Z_i'$ to each side, yields the

[20]The P values reported in this table, and all subsequent P values (and other regression statistics) that are reported for estimation of pure time series regressions are computed using the Kiefer et al. (2000) robust estimator of the relevant covariance matrix. This estimator consistently estimates the true covariance matrix under arbitrary forms of conditional heteroskedasticity and serial correlation. Computation is carried out using the code provided by James MacKinnon at `http://www.econ.queensu.ca/pub/faculty/mackinnon` and described in MacKinnon (2000).

Table 1. Relationship between regressors and proxy variable for log(*winvshare*).

Dependent variable	constant	rate_t	rate_{t-1}	rate_{t-2}
dairy	-3.8783	0.0179	-0.0008	0.0168
	(0.0000)	(0.0683)	(0.8661)	(0.2660)
poultry	-4.1045	0.0194	-0.0023	0.0223
	(0.0000)	(0.0392)	(0.6757)	(0.0681)
market basket	-3.7581	0.0329	-0.0032	0.0304
	(0.0000)	(0.0000)	(0.0277)	(0.0000)

P values are reported in parenthesis.

estimating equation

$$M_i y_i = \sum_{k=0}^{2} \beta_{ik} M_i \text{rate}_{ik} + \gamma_i M_i \log(\text{rinvshare}_i) + M_i u_i, \tag{12}$$

composed of the residuals from regressing each variable in (11) (other than the commodity fixed effects and trend terms) on Z_i, and where (with a slight abuse of notation) $rate_{ik}$ denotes the T_i-vector of the k'th lag of the lending rate. Assuming strict exogeneity of the regressors in (10), estimation of (12) with ordinary least squares provides consistent estimates of β_{ik}. Similarly, imposing $\beta_{ik} = \beta_k$ and $\gamma_i = \gamma$ for all i, we can apply ordinary least squares to (12) stacked across all i to obtain consistent estimates of the restricted parameters. As noted earlier, the principal caveat in both cases is the possibility that u^*_{it} contains a time effect that is correlated with $rate_t$(or with lags of $rate_t$).

4.2. **Results.** Results are reported in Table 2. First note that we expect a coefficient close to 1 on our proxy variable log(*rinvshare*). In all but 4 cases (*dairy*, *fruitveg*, *nuts*, and *livestock*), we cannot reject this hypothesis at the .1 level of significance. In two of the cases where we do reject, the estimated coefficients are nevertheless quite close to 1 (.64 for *dairy* and .59 for *fruitveg*). These results suggest that (12) is a close approximation to (11).

Focusing on the results for individual commodities, there are two regressions (*dairy*, and *sugar*) with P values less than .0005. In each case, the direction of influence on statistically significant coefficients are positive. Higher lending rates are associated with higher levels of aggregate sectoral cooperative activity. For the *dairy* sector, current-period lending rates

Table 2. Estimation results

					Regression Statistics		
Commodity	**rate**$_t$	**rate**$_{t-1}$	**rate**$_{t-2}$	**log(rinvshare)**	R^2	F	P value
beanspeas	-0.0245	0.0338	-0.0198	1.6317	0.1300	14.51	0.4176
	(0.2431)	(0.2680)	(0.2906)	(0.4155)			
cotton	0.0345	-0.0004	0.0157	-0.7056	0.1326	33.51	0.1512
	(0.1539)	(0.9538)	(0.4787)	(0.1948)			
dairy	0.0075	0.0002	0.0001	0.6414	0.6365	399.71	0.0000
	(0.0225)	(0.9450)	(0.9523)	(0.0510)			
fruitveg	-0.0044	0.0024	-0.0040	0.5914	0.2484	74.10	0.0269
	(0.1742)	(0.4399)	(0.0445)	(0.0563)			
grainsoilseeds	0.0272	-0.0055	-0.0068	-0.4041	0.0983	6.12	0.7025
	(0.3146)	(0.5487)	(0.3838)	(0.2325)			
livestock	0.0200	-0.0016	-0.0211	-0.2791	0.3162	81.21	0.0206
	(0.0611)	(0.8128)	(0.2804)	(0.0101)			
nuts	0.0213	-0.0158	0.0126	-1.6513	0.1136	24.95	0.2333
	(0.4006)	(0.2665)	(0.2158)	(0.0135)			
poultry	-0.0029	-0.0016	-0.0085	0.7308	0.2298	70.96	0.0303
	(0.3807)	(0.7391)	(0.0092)	(0.5365)			
rice	-0.0052	-0.0026	0.0433	0.8501	0.1852	28.63	0.1928
	(0.7117)	(0.8720)	(0.0296)	(0.8630)			
sugar	0.0112	-0.0166	0.0387	1.7252	0.2810	214.45	0.0004
	(0.6549)	(0.2853)	(0.0777)	(0.1199)			
tobacco	0.0522	-0.0370	-0.0044	1.1007	0.1429	43.82	0.0933
	(0.0118)	(0.3254)	(0.7554)	(0.8784)			
wool	0.0143	-0.0256	0.0095	-0.5981	0.0586	49.75	0.0718
	(0.5590)	(0.1969)	(0.2826)	(0.2486)			
pooled	0.0081	-0.0080	-0.0032	0.9797	0.0816	2.19	0.7014
	(0.5578)	(0.0790)	(0.6494)	(0.9876)			

P values are reported in parenthesis. For coefficients on each of the *rate* variables, the null hypothesis is a coefficient of zero; for coefficients on the log(*rinvshare*) variable, the null hypothesis is a coefficient of 1.

have the most explanatory power, while 1-period and 2-period lags have the most explanatory power for *sugar*. Next, there are three regressions (*fruitveg*, *livestock*, and *poultry* with P values less than .1. Here the results are mixed. There is a positive and statistically significant coefficient in the livestock equation (at the .1 level of significance), however the direction of influence on the coefficients with the greatest explanatory power in each of the other pair of equations (*poultry* and *fruitveg*) is negative.

There are four additional regressions (*cotton*, *rice*, *tobacco*, and *wool*) that have an overall level of significance of at least .2, and in each case (arguably with the exception of the *wool* equation, where there is no single coefficient that is significant), the sets of coefficients with the greatest explanatory power are positive. In the *cotton* equation, the one negative coefficient is highly insignificant. Similarly, in the *rice* and *tobacco* equations, there are two negative coefficients, but both are highly insignificant in each case. In the *sugar* equation all three *rate* coefficients have roughly the same magnitude and level of precision; one of these is negative, the other two are positive. There are only two equations (*beanspease* and *grainsoilseeds*) where lending rates seem to have very little explanatory power. Figure 5 plots actual and predicted values from each of the six most significant regressions.

The last row of Table 2 reports results for the pooled fixed effects regression where coefficients on lending rates and the log inverse farm share of retail sales are assumed to be the same across all commodities (though we still allow for commodity fixed effects and commodity-specific cubic time trends).[21] Here, there is a statistically significant (at the .1 level) negative coefficient on the one period lagged lending rate, but the restrictions implied by this regression are strongly rejected (P value $< .000001$).

Overall, the results in 6 of 12 commodities support our main hypothesis linking lending rates and aggregate cooperative activity. In two commodities, results run counter to what our theory predicts, and in four cases we are unable to draw any conclusive inferences. We

[21]Because here we are estimating a true panel regression model, standard errors are computed using the Arellano (1987) robust covariance matrix estimator. Hansen (2005) shows that for fixed N and large T panels, and when the data are iid across i, the limiting distribution of this estimator is proportional to the actual covariance matrix.

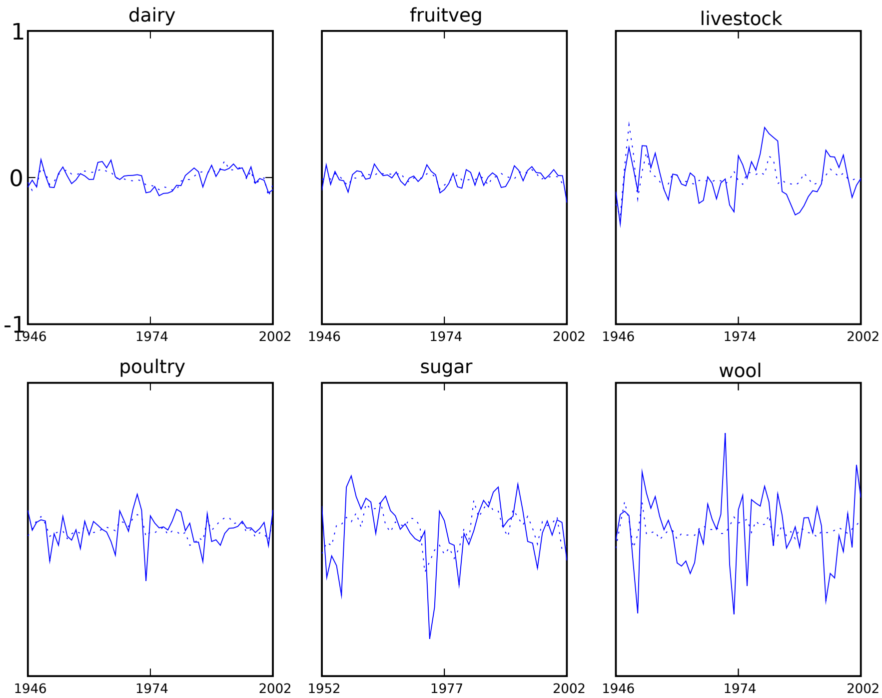

FIGURE 5. Actual and predicted values from (12) for highly significant regressions from Table 2.

are not surprised with the regressions that are not significant; we must confess to being initially rather skeptical regarding possibilities for explaining aggregate cooperative activity with real annual lending rates. It seemed likely to us that the magnitude of variation in idiosyncratic factors across commodities would overwhelm any possible effect that lending rates might have.

We are more hard pressed to explain why things might run counter to our theory. One possibility is to attribute the "failure" of our model to measurement error in our proxy variable. However, one of the equations where results are not as expected (*poultry*) is where we have a match between commodity sector definitions in the cooperative-activity and farm-share data. We believe we have a good proxy for the farm share of wholesale revenue even when using the aggregate "market basket" commodity proxy; in the case of the *poultry* commodity sector, we have even greater confidence in our proxy. Evidently, there are other important channels through which annual lending rates influence aggregate cooperative activity

Consider, for example, the traditional "pro-competitive" motivation for cooperative activity. Possibly this rationale is important in relatively high return (or loose credit) environments where our model has little to say. That is, perhaps cooperatives emerge both when credit is tight *and* when farmers stand to gain a lot by inducing competition in the processing activity. One reduced-form way to represent this idea in our model is to suppose that there is some threshold share of total surplus earned by growers that, when crossed, spurs cooperative activity. Although mostly outside the scope of our model, this sort of intuition would be consistent with cooperative activity occurring during high surplus (or loose credit) states in commodity sectors where payoffs to farmers under the private processor regime are relatively low (and therefore where the threshold is most easily crossed).[22] Under this interpretation, finding a negative relationship between interest rates and cooperative activity is not inconsistent with our model; it is merely evidence that cooperative activity is motivated by multiple forces.

5. Conclusion

We test a "monitored credit" theory of the cooperative firm using historical data on cooperative activity in agricultural markets. We rely on two key maintained hypotheses in developing our theory. First, we assume that there is an agency problem between farmers and firm management, and that farmers who deliver to a cooperative firm earn fewer informational rents than their counterparts who deliver to an investor-owned firm. Second, we assume that the governance structure of a cooperative firm generates a deadweight loss relative to the governance structure of an investor-owned firm.

[22]Poultry, where growers act essentially as paid labor on company managed farms (e.g., Martinez, 2001; Tsoulouhas and Vukina, 2001), is arguably one such sector. In the context of our model, we can think of the poultry sector being characterized by a relatively low B or large ΔP—that is, a sector where workers earn low informational rents, and therefore receive a relatively small share of total surplus.

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 form of financing is as a mechanism for relaxing a limited liability constraint (if the firm fails, farmers lose their assets), with a resulting decrease in informational rents.

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 friction that is not present in an investor-owned firm. Assuming there is a deadweight loss that must be incurred by a cooperative organization is one simple way of modeling the consequence of this friction. Alternatively (and analogously 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 use this pair of assumptions to build a simple financial contracting model of the cooperative firm based on the work of Holmström and Tirole (1997). With this model, we show that a cooperative firm (which we equate with asset pledging by farmers and a deadweight organizational cost) can be the equilibrium organizational structure when market returns are relatively low, or alternatively when lending rates are relatively high. Intuitively, when market returns are sufficiently high or capital costs sufficiently low, there is enough surplus to compensate investors and to pay farmers their informational rents. However, in "hard times" (low market returns or high lending rates), it is necessary to squeeze information rents. This can be accomplished with a more highly powered incentive instrument (more intensive monitoring), though of course not without a price. If this price is a deadweight cost, and is smaller than associated reductions in information rents, then a cooperative is only an equilibrium organizational structure in hard times.

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, controlling for commodity fixed effects, and a commodity-specific flexible time trend, we demonstrate a positive relationship between annual real lending rates and the level of cooperative activity across 6 of 12 commodity sectors during the years 1946-2002. In four cases, there is no discernible effect, and in two other cases the relationship runs counter to our hypothesis. Despite these two exceptions, the evidence we provide does seem at least consistent with the notion 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. However, we are not aware of other research that pulls these two pieces together as the key ingredients in a model of cooperative activity. 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.

Lastly, we note that our theory is rather loose in the sense of not imposing much structure on the data generating process for the joint distribution of "cooperative activity" and annual lending rates. Without more structure, it is difficult to distinguish our model from other possible explanations for an observed correlation between cooperative activity and lending rates. Our model is of an equilibrium organizational structure, and arguably the best empirical counterpart for such a model is observation on the entry and exit decisions of individual firms. With such data, one might (for example) be able to more carefully model the nature of the incentive problem across firms, and to generate predictions regarding the *magnitude* (as opposed to just the direction) of the relation between market returns, lending rates, and cooperative activity. A firm-level analysis of organizational choice is thus a natural next step for further modeling and empirics.

6. Appendix: Data Construction

This appendix contains a brief description of our data sources. In all cases, data regarding cooperative activity was obtained from the USDA RBS publication, "Farm Marketing, Supply and Service Cooperative Historical Statistics," Coopertive Information Report 1, Section 26. This document can be obtained on the net at the following url (last accessed, Jan. 25, 2005):

`http://www.rurdev.usda.gov/rbs/pub/cir1s26.pdf`

Data on the nominal prime interest rate and on the rate of inflation (percent change in the CPI) were taken from the from US Federal Reserve series published at

`http://woodrow.mpls.frb.fed.us/research/data/us/`.

Data regarding the gross value of farm output (and farm share of retail value) were obtained from the USDA National Agricultural Statistical Service publication, "Agricultural Statistics" at `http://www.usda.gov/nass/pubs/agstats.htm`. The specific tables are summarized below. For brevity, we indicate table numbers and titles for the 1994 publication. There is slight variation in table numbers and titles across years. Further details of the data construction, and the data files used in our analysis, are available from the authors upon request.

- *rinvshare*: Table 9-29: Price components: Market basked of farm-originated food products by food group, United States 1933-2002.

- *fruitveg*: Is the sum of the cash receipts from Vegetables and Fruits Table 9-38. Values for tree nuts, beans, and peas are removed.
- *dairy*: Milk value information Table 8-15.
- *allgrains*: Initially (1930-1951) reported as an aggregate of: sum of the value of production of barley, corn, oats, wheat, rye, sorghum, flaxseed, canola, mustard, peanuts, rapeseed, safflower, soybeans, sunflower, rice, beans and peas subsequently broken up into
  - *grainsoilseeds*: sum of the value of production of barley, corn, oats, wheat, rye, sorghum, flaxseed, canola, mustard, peanuts, rapeseed, safflower, soybeans, and sunflower
  - *rice*
  - *beanspeas*.
- *tobacco*: Table 2-44.Tobacco: Area, yield, production, and value, United States, 1994-2003.
- *poultry*: The sum of the value of sales of mature chicken and the value of production of broilers, eggs and turkey. Chicken information Table 8-49. Broilers information Table 8-50. Turkey information Table 8-58. Eggs information Table 8-63.
- *nuts*: 1930-1968: almonds, pecans, walnuts, filberts. 1969-2002: also macadamia. Almonds: Table 5-82. Hazelnuts: Table 5-84. Macadamia: Table 5-86. Pecans: Table 5-87. Pistachios: Table 5-90. Walnuts: Table 5-91. Filberts: Agricultural Statistics 1984 Table 346.
- *special*: Sugar, rice, dry edible beans, and peas. After 1951, this series is split out into two series; sugar and "other" (rice, beans, and peas).
- *sugar*: Multiplied the receipts quantity of refined sugar by the price of refined sugar. The quantity of refined sugar was taken from Table 2-30. Sugar, cane and beet (refined): Stocks, production or receipts, and deliveries, continental United States, 1994-2003.

The price of refined sugar was taken from: Table 2-31. Sugar (raw and refined): Average price per pound at specified markets, 1994-2003.

- *livestock*: Sum of cattle, hogs, and sheep (wool not included). Information on Cattle and calves Table 7-10. Cattle and calves: Production, disposition, cash receipts, and gross income, United States, 1993-2002. Hogs Table 7-32. Hogs: Production, disposition, cash receipts, and gross income, United States, 1993-2002. Sheep Table 7-47. Sheep and lambs: Production, disposition, cash receipts, and gross income, United States, 1993-2002.
- *wool*: Sum of wool and mohair. Wool information Table 7-55. Wool: Number of sheep shorn, weight per fleece, production, average price per pound received by farmers, value of production, exports, imports, total new supply of apparel wool, and imports of carpet wool, United States, 1993-2002. Mohair Table 7-64. Goats and mohair: Number of goats clipped, mohair production, average price per pound received by farmers, and value of production, Texas, 1994-2003.
- *cotton*: Cotton: Sum of cotton lint and cotton seed value of production. Table 2.1-Cotton: Area, yield, production, market year average price, and value, United States, 1994-2003.

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