COOPERATIVES AND CAPITAL MARKETS: THE CASE OF MINNESOTA-DAKOTA SUGAR COOPERATIVES

J. ROY BLACK, BARRY J. BARNETT, AND YINGYAO HU

This case study describes the potential use of new risk-sharing instruments (Skees, Skees and Barnett) by three closed sugar-beet-processing cooperatives in Minnesota and North Dakota. These instruments are discussed in the context of members'crop yield risk. Zeuli, in a companion paper, develops the background for applying new risk-sharing instruments to mitigating the business-risk of cooperatives.

The first two sections of this article describe the beet sugar cooperatives, the risks faced by the cooperatives and their members, and currently available risk-management tools. The following two sections present members' stated risk-management objectives and various alternatives that are under consideration as means for achieving those objectives. An important point raised here is that although members are not pleased with some features of currently available federal crop insurance products, they are unwilling to forego the premium subsidies contained in those federal products. The remainder of the article considers an important implementation issue related to one of the alternatives being considered by the cooperatives. Segmenting of yield risk into systemic (spatially correlated) and independent components—a concept discussed in the Skees and Zeuli companion papers—is demonstrated. This example draws on information from focus groups with cooperative members and processing plant managers, yield data maintained by the coopera-

tives, and analyses of selected issues raised by the focus groups (Black, Black and Hu).

Description of the Beet Sugar Cooperatives

Three closed, new-generation cooperatives process sugar beets produced in the Red River Valley of eastern North Dakota and southwestern Minnesota. American Crystal processes beets raised in a fourteen-county area in the mid and northern valley and has six processing plants. Min-Dak draws beets from a five-county area in the southern valley and has one processing plant. Southern Minn draws beets from a six-county area in southwestern Minnesota and has one plant. All three cooperatives have been expanding, targeting new members and production areas as well as selling additional shares to existing members.

The cooperatives are the only firms in the region that process sugar beets. Contracts between the grower members and their cooperative are for the right and obligation to deliver beets grown on a specified number of acres. The three cooperatives produce over 30% of the beet sugar produced in the United States.

There are about 2,000 members in the cooperatives (including some joint ventures), but there is substantial variation in the size of members' farms. Contracts between the cooperatives and their members require that sugar beets be grown in rotation with other crops, typically requiring that beets cannot be raised on the same parcel more frequently than every third year. Some members raise sugar beets in an area as small as a section while other members have farm units in both North Dakota and Minnesota. The largest member controls about 12,000 acres. For many members,

spatial diversification is an important method of mitigating exposure to yield risk.

Risk Exposure and Existing Risk-Management Products

Production risks are similar to those faced by farmers raising most crops and are very much weather related. The relationship may be direct, such as prevented planting or replanting due to excess moisture. It may also be indirect, such as weather-influenced plant disease and/or weed-control problems. Weather-related production losses can be either spatially correlated with losses occurring throughout the region (e.g., drought), or localized and largely independent (e.g., hail). Further, farm-level factors such as soil types and management practices affect both the incidence and severity of production loss.

On average, members of the three sugar beet processing cooperatives are more prone than growers of other commodities to purchase federally subsidized Actual Production History (APH) plan insurance (for information on APH insurance, see Barnett and Coble, Knight and Coble). Buy-up policies, which offer protection above the minimum catastrophic level, are purchased on about 85% of members' eligible sugar beet acres. Premiums for members' sugar beet APH insurance, exclusive of delivery and service costs, were about $15 million in 1998. Total APH plan premiums for member farms were even greater since farms grow sugar beets in rotation with other crops. Some private-sector crop insurance products are also sold either alone or in a package with APH plan yield insurance. These include insurance contracts to protect against hail, low recoverable sugar (farmer revenue is based on recoverable sugar not gross sugar), and replanting costs.

Members' overall risk exposure extends beyond just production risk and includes risks related to storage, processing, and marketing and thus should be analyzed from a systems perspective. For example, members are very concerned about the risk of storage loss after beets leave the field (Black and Hu) and processing throughput risk. These risks are beyond the scope of the current APH plan, where coverage ceases after the crop is harvested.

Members' Objectives

The processing cooperatives jointly market their sugar through United Sugars Corporation, a cooperative they created in partnership with U.S. Sugar Corporation, a cane sugar processor. The sugar beet processing cooperatives also created an additional cooperative to handle their members' workers' compensation insurance. This experience compelled them to investigate other insurance provision issues, including alternative approaches to insure members' yields. Yield insurance could be provided through a new cooperative or by expanding the role of the existing workers' compensation insurance cooperative.

Three objectives motivated the cooperatives to consider alternative insurance designs and delivery systems (Black and Hu). First, the cooperatives believe they can deliver and service insurance products with lower transaction costs than those assumed in the current APH structure. They would like to capture this cost savings and pass it on to their members. Second, the risks members face are often difficult to insure under traditional insurance arrangements because of the typical problems associated with asymmetric information. The processing cooperatives, however, have proprietary information on each member. This information is likely superior both in quantity and quality to that used for underwriting and rating the current APH product. Third, the cooperatives would like to develop tailored insurance products that better reflect the unique needs of farmer members in an integrated production, storage, processing, and marketing system.

Members have engaged in many lively, and sometimes heated, discussions about alternative crop insurance designs and delivery systems. Members' risk-management needs are diverse. Moreover, some members have insurance agency interests. If the cooperatives are successful in developing and delivering alternatives that reduce asymmetric information problems and/or transaction costs, these members would be adversely affected. Finally, it is important to note that members want to address these objectives within the context of the federally subsidized and reinsured crop insurance program. Although aspects of the current APH product are deemed inadequate, the federal premium subsidies are considered too significant to relinquish.

Objective 1: Capture Benefits of Reduced Transaction Costs

The USDA provides a "service contract" to insurance companies to market and service APH crop yield insurance. Under this contract, the USDA reimburses insurance companies for administrative and operating (A&O) expenses. The amount of reimbursement is currently fixed at 24.5% of gross premium (the premium the farmer pays plus the federal premium subsidy). From this federal A&O reimbursement, insurance companies pay commissions to independent insurance agents. The share of A&O reimbursement that is passed on in commissions is negotiated between the company and the agency but is generally between 50% and 70%.

Based, in part, on their previous experience with workers' compensation insurance, the processing cooperatives believe that they can deliver and service APH-type crop insurance policies at a cost that is well below—some have suggested as much as 50% below—the current federal A&O reimbursement. Cost savings are anticipated for at least three reasons. First, the cooperative would provide only limited services to insurance purchasers—much like a discount broker provides only limited services to financial investors. Second, much of the paperwork required for underwriting an APH-type insurance policy could be generated out of existing data bases maintained by the cooperatives. Third, the cooperatives already document planted acreage, and they have accurate measures of actual production due to their exclusive processing contracts with members. Insurance loss adjustment could be conducted using these existing data-collection systems.

Objective 2: Use Superior Proprietary Information

Asymmetry of information regarding soils and management practices contributes to adverse selection and moral hazard. These problems are exacerbated by the APH plan provision that allows subdividing of farms into smaller insurable units. An analysis conducted by the authors reveals the extent of asymmetric information problems. Actual aggregate APH loss ratios in recent years were compared to corresponding aggregate loss ratios simulated from members' farm yield data. In each year, the actual loss ratios are at least 33% higher than what would be indicated by the members' yield records.

In addition to the yield data mentioned earlier, the processing cooperatives also maintain data bases on factors such as soil types and specific agronomic practices employed on each farm unit. The cooperatives could use this information to better address both adverse selection and moral hazard problems. Further, the cooperatives hope to create an incentive for internal monitoring of moral hazard problems by passing any underwriting gains back to farmer members.

Objective 3: Develop Tailored Products

The need for tailored crop insurance products—as opposed to the generic APH federal crop insurance product—is based primarily on two concerns. In an integrated production, storage, processing, and marketing system, grower members have unique risk-management needs (Zeuli). Although members are concerned about the entire system, currently available risk-management tools focus only on one element (e.g., an individual member's production risk). This sometimes creates incentive-incompatibility problems that are further compounded by the spatially correlated nature of weather-related production risk.

Consider the following example. In 1998, sugar beet yields in the Red River Valley were substantially above the long-run average. The cooperatives knew they would be unable to process all the beets in a timely manner. Significant losses could (and did) occur due to deterioration while the beets were stored. From a systems perspective, it would probably have been more efficient to harvest only some portion of the total crop. Yet, all the beets were harvested because APH crop insurance provisions will not compensate policyholders for voluntarily choosing not to harvest. The current APH product is simply not designed to account for the risk interrelationships in a vertically integrated system.

At least some members are interested in tailored crop insurance products for another reason. Members with large and/or spatially diversified production perceive that the current APH crop insurance product does not provide them with premium discounts that fully reflect the risk reductions gained through spatial diversification.

Alternatives Under Consideration

Members have discussed four alternatives for crop insurance design and delivery. The first would maintain the status quo, with members purchasing federally subsidized APH crop insurance from insurance agents. Members would likely ask the Risk Management Agency (RMA) to change APH policy provisions so that they are more advantageous for spatially diversified farmers. They would likely also ask that the Group Risk Plan (GRP) crop insurance product be made available for sugar beets. GRP indemnities are triggered by a shortfall in area (county) crop yield as contrasted to individual farm/insurance unit crop yield (Skees, Black, and Barnett). This could be helpful to new growers with no yield history.

Second, the cooperatives could form an independent crop insurance agency that sells federal crop insurance policies written by a federally reinsured crop insurance company. Just like existing independent insurance agents, the agency would negotiate with reinsured crop insurance companies for the best commission structure. One of the hybrid seed production companies has already done this. By using proprietary information and existing data systems, the company believes it can lower the transaction costs of selling crop insurance polices. The company also negotiated with RMA for APH policy features that the company believes will better meet the needs of seed producers.

Third, the cooperatives could create an insurance company that would write federally reinsured crop insurance policies. Over the last twenty years, the members' sugar beet crop insurance policies generated net underwriting gains (total premiums in excess of liabilities). An insurance company would capture these underwriting gains and pass them on to cooperative members. Moral hazard may be reduced since each member would have an incentive to monitor the activities of other members. In addition, the proprietary information possessed by the cooperative could be used to optimally allocate policies across the various federal reinsurance pools (Skees and Barnett). Finally, an insurance company could better address the incentive incompatibility problems created by risk interrelationships in a vertically integrated system. Considering the example described earlier, during years with unusually high yields, insurance company underwriting gains could be used to compensate farmers who agree not to harvest their beets.

Fourth, many members are seeking changes in authorizing legislation that would allow RMA to offer subsidized GRP policies directly to farmer-owned cooperatives. The cooperatives would sell private individualized crop insurance policies uniquely tailored to members' needs. They would purchase a GRP policy as parametric reinsurance (Skees, Skees and Barnett). The GRP policy would allow the cooperatives to shed most of the systemic risk contained in the individualized policies.

While the cooperatives continue to discuss all of these alternatives, the Southern Minn cooperative is currently pilot-testing a variant of the second alternative. The pilot test provides opportunities for negotiating with federally reinsured crop insurance companies. It may also provide empirical evidence regarding potential transaction costs savings.

The cooperatives have expressed a great deal of interest in the fourth alternative. To effectively implement this alternative, the cooperatives would need to segment their loss risk exposure into systemic and independent components. This would allow the cooperatives to use an "optimal hedge ratio" approach to determine the appropriate GRP coverage level and the optimal amount of GRP protection to purchase. The remainder of the article addresses these issues.

Distribution of Losses

From 1980 to 1998, the Minnesota-Dakota sugar beet area experienced catastrophic yield shortfalls in 1980, 1988, and 1993. The 1980 and 1988 droughts caused losses that were both deep and widespread throughout the region. In 1993, excess moisture caused large losses primarily in southern Minnesota. For members of the three processing cooperatives, the federal APH plan aggregate average loss ratio for sugar policies over the period was 0.88 (exclusive of delivery and servicing costs). A loss ratio is equal to indemnities paid divided by premiums received. The coefficient of variation on the loss ratio was 100%. The spread and substantial positive skewness of the loss ratio distribution are typical of risks that are characterized by a high degree of spatial correlation (Miranda and Glauber). If the loss risks had been independent across ex-

posure units, the coefficient of variation would have been less than 3%.

Loss experience can be even more variable for members of a given cooperative. Between 1988 and 1998, members of the Southern Minn cooperative had a combined loss ratio that averaged 1.1. Seventy-five percent of the time the loss ratio was less than 1.0. But the coefficient of variation on the loss ratio over this period was 300%. This is due almost entirely to large indemnities paid for excess moisture in 1993.

An aggregate loss ratio in excess of 4.0 across all members is within the range of events that could occur. This reveals the extent of systemic risk exposure (Skees and Barnett). Given current acreages and grower choices of insurance coverage, a year with a loss ratio of 4.0 would generate indemnities of $60 million. Members of the Southern Minn cooperative had an estimated combined loss ratio for 1993 equal to 8.22. Members of the other cooperatives are wondering when their "1993 event" will occur. A loss event of this magnitude that affected the whole region (not just southern Minnesota) would generate indemnities in excess of $130 million. In summary, for traditional insurance markets the average loss ratio for the book of business contained in these policies would be acceptable, but the large coefficient of variation caused by systemic risk exposure would create significant problems (Miranda and Glauber, Skees and Barnett).

Measuring Systemic versus Farm Specific Risk

We explore the potential for the sugar beet cooperatives to purchase GRP policies and, in turn, sell individual farm APH-like crop insurance policies to their members. The purchase of GRP policies should greatly reduce the variability in loss exposure by offsetting much of the cooperatives' exposure to systemic risk. The residual risk will be that portion of total risk not offset by the purchase of GRP policies. Cash flows into the cooperatives are the indemnity payments received on the GRP policies. Cash outflows are indemnity payments made to members on their APH policies.

The financial economics and futures and options literatures provide a standard approach to partitioning risk into systemic and independent (or residual) components (Do-

herty, Leunberger, Stoll and Whaley). Following these literatures, we partition farm yield risk into a component that is positively correlated with area yield risk and a component that is farm-specific and independent of the area yield. This is analogous to models that decompose the variability in a firm's return on assets into one component that captures market return on assets and another residual component that is independent of the market as a whole. Miranda applied this approach to a grower's optimal choice of GRP coverage for a sample of western Kentucky soybean farms.

What follows is a brief discussion of how optimal hedge concepts can be used for the situation where the sugar beet cooperatives purchase GRP policies and, in turn, sell individual farm APH-like crop insurance policies to their members. The focus is on finding the optimal choice of GRP coverage, *GRP(cov)*, and purchase level. A more detailed discussion is contained in Black, Barnett, and Hu. Key measures include

$$coop\_loss_t^{APH(cov)}$$

= weighted average indemnity per planted acre on individual farm APH policies across acres insured by members; for simplicity, we assume all members purchase the same level of APH coverage, *APH(cov)*;

$$coop\_loss_t^{GRP(cov)}$$

= weighted average indemnity per planted acre on GRP policies for a given coverage level; indemnities for each county are weighted by the percentage of the cooperative's APH insured acres in that county;

h^{GRP} = hedge ratio, measured as acres the cooperative insures under GRP per APH acre.

The objective is to find optimal values of h^{GRP} and *GRP(cov)* for a given level of *APH(cov)*. The optimal values will be those that minimize the variance of the residual risk. The first step is to estimate the regression equation

$$coop\_loss_t^{APH(cov)}$$

$$= \beta_0 + \beta_1 coop\_loss_t^{GRP(cov)} + \epsilon_t.$$

By construction, the residual risk estimated by ordinary least squares, var(ϵ), will be independent of $coop\_loss_t^{GRP(cov)}$. For given levels of $GRP(cov)$ and $APH(cov)$, β_1 will be the variance minimizing value of h^{GRP}. Searching across possible levels of $GRP(cov)$, the optimum level is that which minimizes var(ϵ) for the given level of $APH(cov)$. This process yields the optimum combination of h^{GRP} and $GRP(cov)$ for a given level of $APH(cov)$.

Data on farm-level sugar yields per planted acre were obtained from the three processing cooperatives. The length of the data series is different for each cooperative but ranges from nine to seventeen years. A regression equation was estimated where the data points are annual observations on $coop\_loss_t^{APH(cov)}$ and $coop\_loss_t^{GRP(cov)}$ for each of the three processing cooperatives. $APH(cov)$ was fixed at 65%. The estimated equation is

$$coop\_loss_t^{APH(65)}$$

$$= \underset{(0.0047)}{0.0128} + \underset{(0.024)}{0.343}\ coop\_loss_t^{GRP(90)}$$

$$R^2 = 0.86\ (36\ obs.)$$

The 90% level of $GRP(cov)$ minimized var(ϵ). The h^{GRP} value of 0.343 indicates that for every acre of 65% coverage APH insurance sold, the cooperatives should purchase 0.343 acres of 90% coverage GRP policies. Eighty-six percent of the variation in aggregate individual APH losses was associated with GRP losses while 14% of the variation was independent of GRP losses.

The variance of the residual, ϵ, is 14% of the variance of $coop\_loss_t^{APH(cov)}$. Nevertheless, significant year-to-year variability remains in the residual. While GRP effectively eliminated the APH policy-loss risk associated with the 1993 excess moisture event, it was less effective in eliminating the loss risk associated with the 1980 and 1988 droughts. For these years, GRP reduced the APH policy-loss risk substantially but did not eliminate it. The probability distribution of ϵ is still positively skewed but, relative to the probability distribution of $coop\_loss_t^{APH(cov)}$, the length of the upside tail is significantly shortened.

Conclusion

This article illustrates that the level of systemic yield risk facing the Minnesota-Dakota sugar beet industry is significant, making it difficult to transfer these risks using traditional private markets. This is not a major problem for the private insurance companies that sell and service federal crop insurance, because the federal government provides reinsurance. Still, there is potential for the cooperatives to act as an insurance company providing tailored individual crop yield insurance. If they were allowed to purchase GRP policies the cooperatives could offset most of their systemic risk exposure while gaining access to both the direct premium subsidy and the 24.5% A&O cost reimbursement. Any transaction cost savings and/or underwriting gains could be passed on to members.

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