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EDUCATIONAL INSIGHTS

UNITED GRAIN GROWERS: ENTERPRISE RISK MANAGEMENT AND WEATHER RISK

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ABSTRACT

In August of 1999, Mike McAndless, the risk manager of United Grain Growers (UGG), was preparing for a meeting with the firm's chief financial officer, Peter Cox. Mike and Peter had spent considerable time over the past three years with representatives of the Willis Group Ltd., a large international insurance broker, identifying and measuring UGG's major sources of risk. The risk assessment process indicated that, although UGG hedged most of its currency and commodity price risk and purchased insurance against property and liability losses, the firm's earnings still exhibited substantial volatility. This volatility was, in large part, due to the weather. Mike and Peter had to decide whether to retain the risk or shift it to another party using one of two innovative contractual arrangements: weather derivatives or a new type of insurance contract.

INTRODUCTION

This is a case study designed to be used in a risk management class to illustrate enterprise risk management. This case does not reveal United Grain Grower's (UGG) decisions. Instead, the case ends with seven questions for students to answer.

COMPANY BACKGROUND

Based in Winnipeg, Manitoba, UGG provides commercial services to farmers and markets agricultural products worldwide. It was founded in 1906 as a farmer-owned cooperative, and became a publicly traded company on the Toronto and Winnipeg stock exchanges in 1993. Figure 1 provides information on UGG's stock price since going public.

Although UGG is a public company, it retains some of its farmer cooperative roots. The company has both members and shareholders. At the time of the initial public offering,

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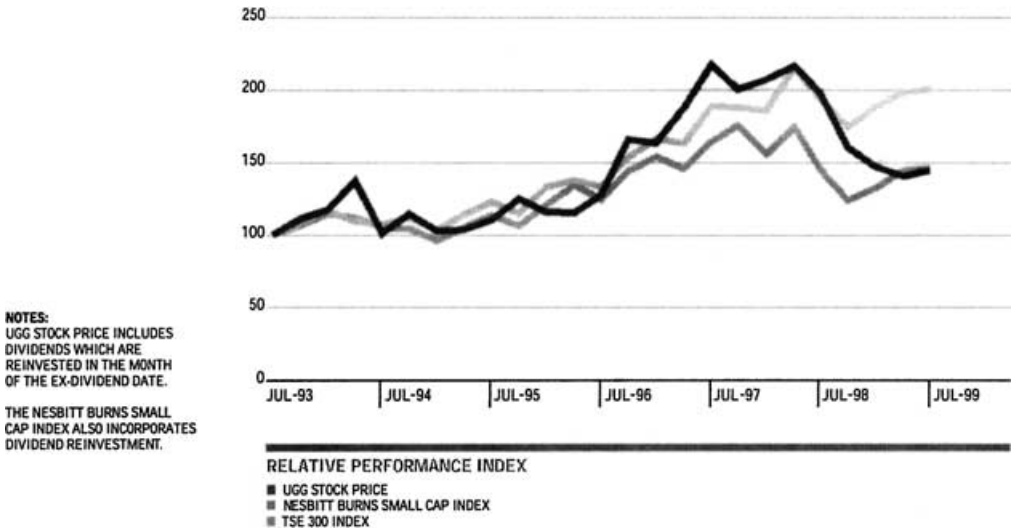
FIGURE 1
United Grain Growers Stock Price Index Compared to Other Indices



Note: Documents provided to the authors by UGG.

the members of the cooperative (farmers) automatically became members of the new organization, and they also received limited voting common shares (thus making them both members and shareholders of the new organization). An individual, who is not currently a member, can apply for membership if the individual does a minimum amount of business with the company. The initial public offering, as well as subsequent equity offerings, allowed nonmembers to become shareholders.

Although a member is not entitled to share in any profit or distribution by the company (unless the member is also a shareholder), members have control rights. Of the 15 people on UGG's board of directors, 12 must be "members" who are elected by delegates representing members from various geographical regions.

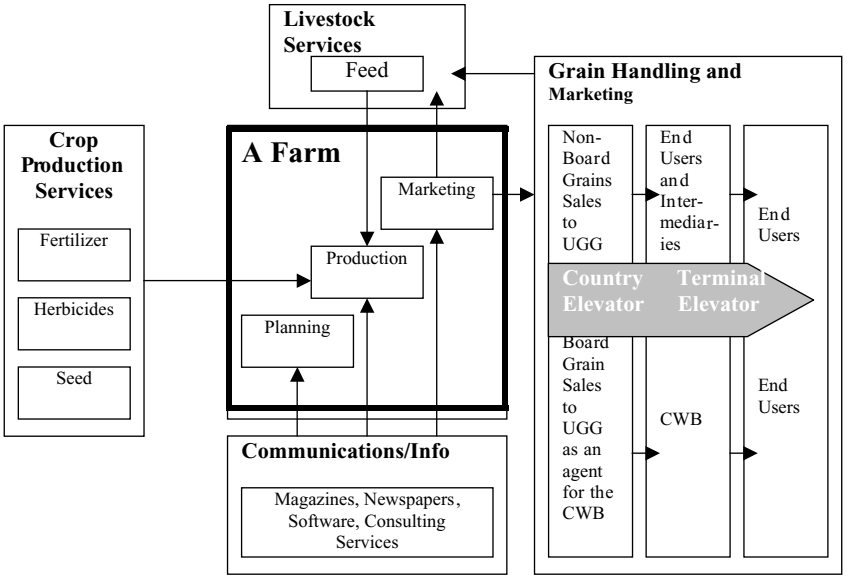
Business Segments

UGG is comprised of four main business segments: Grain Handling Services, Crop Production Services, Livestock Services, and Business Communications. As illustrated in Figure 2 and discussed below, UGG's four business units help farmers plan, produce, and market their products.

Western Canada is a major producer and exporter of wheat, barley, canola, and other grains and oilseeds. The role of UGG's Grain Handling Services unit (comprised of Farm Sales and Services, Marketing and Transportation Services, and Terminal Services divisions) is to identify sources of grain and oilseeds and deliver them to exporters and to domestic end users, such as food processors. A farmer's production of grain and oilseeds usually is transported to a country elevator, where the product is weighed, graded, blended, purchased, and stored. From the elevator, the product is shipped to a domestic consumer (e.g., a mill) or to an export terminal.

UGG historically owned hundreds of relatively small "country" elevators, which the firm has been replacing with a smaller number of large, high throughput, more efficient

FIGURE 2
Overview of United Grain Growers (UGG) Business



Note: Diagram illustrates UGG's four business segments: Crop Production Services, Livestock Services, Grain Handling and Marketing, and Communications/Information and the planning, production, and marketing services that each of the segments provide to farmers. Documents provided to the authors by UGG.

elevators. The map of western Canada in Figure 3 identifies the locations of UGG's main elevators and export terminals.

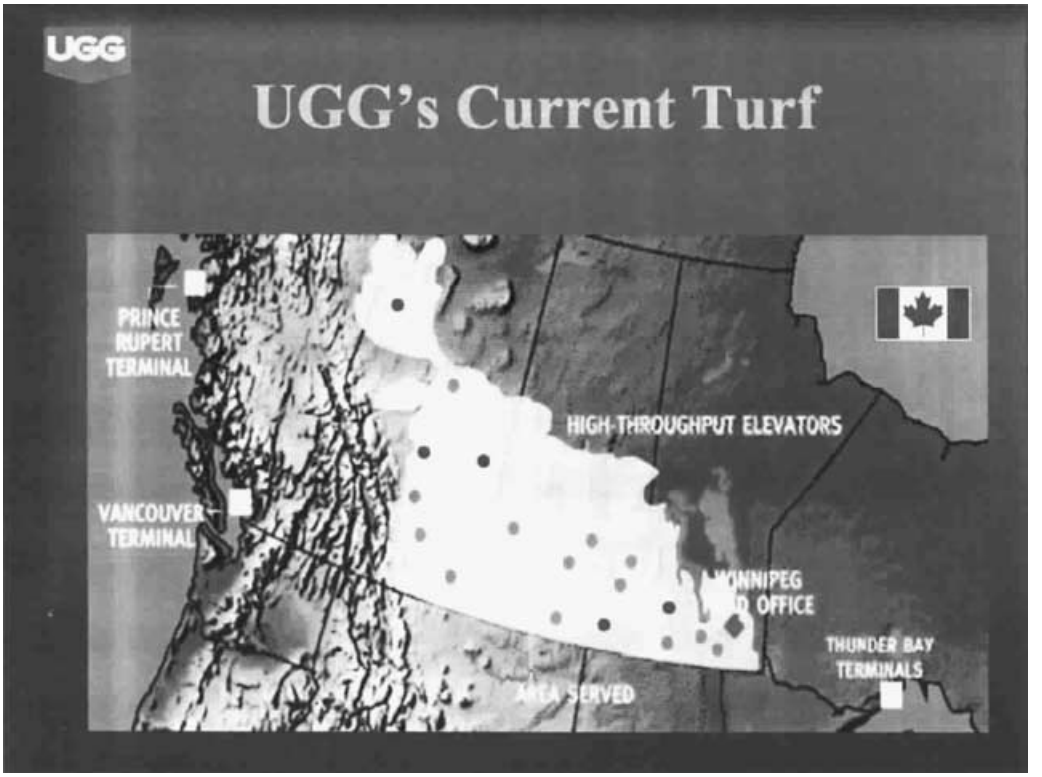
The farming industry in Canada is regulated by several government agencies. The Canadian Wheat Board (CWB) markets human consumable grains on behalf of farmers. About 85 percent of the wheat and 45 percent of the barley produced in Canada is sold through the CWB. The CWB must ensure that the sales it has arranged are available to customers at the agreed upon site and date. Thus, the CWB contracts with companies like UGG to collect, store, and deliver grains. About 60 percent of UGG's grain handling unit's business is on behalf of the CWB. The prices paid to farmers and the prices for storage and transportation of "board grains" are determined by the CWB.

The Canadian Grain Commission regulates grain handling and maintains quality standards for Canadian grain. Firms like UGG must obtain an operating license from the Commission. The Commission also maintains extensive records of the grain that is shipped from country elevators and from export terminals. Table 1 provides data on grain shipments and deliveries for the industry and for UGG from 1981 through 1999.

UGG's competitors in the grain handling business are listed in Table 2 along with approximate market shares in 1999. UGG's market share of approximately 15 percent makes it the third largest provider of grain handling services in western Canada.

Table 3 provides information on the volume of grain shipped by UGG, as well as UGG's gross margin and earnings on grain shipments. The table also provides information on gross margin and earnings per tonne of grain shipments.

Figure 3
Area Served by United Grain Growers (UGG) and the Location of Its Elevators



Note: White area indicates the area served by UGG, dots indicate the location of high throughput grain elevators, and the squares indicate the location of export terminals. Documents provided to the authors by UGG.

The Crop Production Services unit provides inputs (e.g., seed, fertilizer, and crop protection products) to farmers. In addition, through its Farm Sales and Services division, it provides a range of consulting, agronomic, and financial services to farmers. UGG tries to differentiate itself from its many competitors by developing distinctive products sold under brand names and by the provision of superior services to farmers.

UGG's third largest unit is Livestock Services, which provides inputs to producers of cattle, hogs, and poultry. This unit also faces competition from a number of other grain and feed companies. UGG's smallest business unit is Farm Business Communications, which provides information needed to run a profitable agribusiness. In addition to publishing periodicals (*Farm Investor Newsletter* and *Disease, Weeds & Insects*), this unit has developed Web-based information on weather, market prices, and agribusiness news.

Figure 4 illustrates earnings before interest and taxes (EBIT) for each of UGG's business units over time. The two largest lines of business, Grain Handling Services and Crop Production Services, account for over 80 percent of UGG's earnings in most years. The figure also illustrates the substantial earnings volatility in these main business segments.

TABLE 1
Data on Industry Grain Volume and UGG's Grain Volume (in tonnes) and the Weighted Average Crop Yields (bushels per acre)

Year	Industry Shipments	UGG Shipments	Weighted Average Crop Yields in Previous Year
1981	26,871	4,298	30.9
1982	30,392	4,842	34.7
1983	33,142	5,367	37.4
1984	33,905	5,320	33.3
1985	27,183	4,020	28.6
1986	27,443	4,394	32.5
1987	33,322	5,368	40.0
1988	33,435	5,072	36.3
1989	23,364	3,928	26.3
1990	29,682	4,954	31.3
1991	33,376	5,498	38.4
1992	34,374	5,720	37.3
1993	30,989	5,125	37.0
1994	33,489	5,503	na[a]
1995	35,898	6,059	na
1996	29,877	4,937	na
1997	35,663	5,591	na
1998	33,921	5,170	na
1999	29,729	4,328	na

[a] "na" indicates data are not available.
Note: Documents provided to the authors by UGG.

TABLE 2
UGG's Competitors in Western Canada for Grain Handling Business

Organization	Market Share in 1999 (%)
Saskatchewan Wheat Pool	25
Agricore	25
UGG	15
James Richardson Int'l	10
Cargill Ltd	10
Others	16

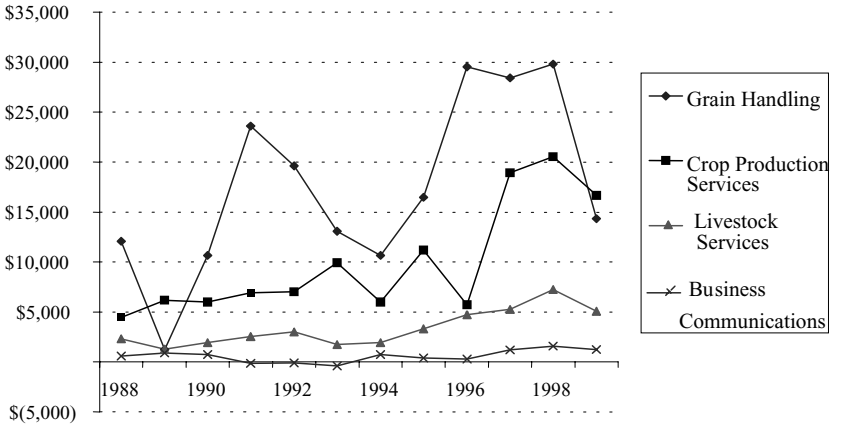
Note: Documents provided to the authors by UGG.

TABLE 3
Earnings for Grain Handling Segment (all numbers except shipments are in Canadian dollars)

For Years Ended July 31	1997	1998	1999
Grain shipments (tonnes)	5,591	5,170	4,328
Revenue (thousands of C$)	186,121	185,345	162,682
Expenses excluding depreciation	73,108	72,886	69,140
Gross margin	113,013	112,459	93,542
Depreciation	11,502	9,763	10,082
EBIT	28,403	29,810	14,320
Per tonne of grain shipped			
Gross margin	20.2	21.8	21.6
EBIT	5.1	5.8	3.3

Note: Documents provided to the authors by UGG.

FIGURE 4
Earnings Before Interest and Taxes (EBIT) for United Grain Growers' Four Main Business Segments (in Canadian dollars)



Note: Documents provided to the authors by UGG.

Financial Results

Table 4 contains information from UGG's balance sheet, income, and cash flow statements. Earnings before interest, taxes, depreciation, and amortization (EBITDA) declined substantially in 1999 relative to the prior years. UGG increased capital expenditures substantially in 1998 and then again in 1999. Most of these expenditures were for large high throughput grain elevators. As a result of the low EBITDA in 1999, UGG's return on equity (defined as net earnings to book value of equity) was just 1.17 percent. Note as well that in 1999, the percentage of the firm's total assets financed with debt increased to about 37 percent with the issuance of another 50 million Canadian dollars in long-term debt.

TABLE 4
Consolidated Financial Highlights (in Canadian dollars)

For the Years Ended July 31 (in thousands except per share amounts)	Restated					
	1994	1995	1996	1997	1998	**1999**
Operating						
Gross profit and revenue from services	$156,030	$185,637	$198,749	$216,260	$224,953	**$209,227**
Earnings before interest, taxes and depreciation	25,538	30,573	40,198	54,788	60,577	**42,423**
Operating income	12,612	15,151	24,090	38,452	43,335	**21,636**
Earnings before income taxes and unusual items	3,772	282	8,065	24,744	31,926	**8,067**
Net earnings	153	−$7,385	5,851	9,059	16,332	**3,575**
Cash flow provided by operations	12,533	16,177	21,322	32,770	35,871	**29,853**
Capital expenditures and business acquisitions	27,725	43,894	26,826	21,904	53,760	**91,002**
Financial						
Working capital	$75,028	$44,573	$71,557	$101,790	$136,155	**$119,249**
Net investment in capital assets	153,228	182,079	190,308	193,323	226,304	**287,442**
Total assets	564,043	544,284	531,416	489,214	515,209	**554,322**
Shareholders' equity	140,516	130,620	133,694	161,290	234,611	**233,182**
Ratios						
Total debt to net assets	59.11%	57.72%	55.36%	36.01%	26.24%	**36.76%**
Return on average common equity, before unusual items	0.06%	−2.20%	4.30%	8.51%	8.69%	**1.17%**
Per share						
Earnings (loss), before unusual items (net of taxes)	$0.01	−$0.24	$0.45	$0.89	$0.91	**$0.15**
Cash flow from operations	1.30	1.47	1.94	2.66	2.08	**1.72**

Note: UGG's 1999 Annual Report.

CORPORATE RISK MANAGEMENT

Background

For many corporate risk managers, "risk management" refers to the management of so-called "pure risks," e.g., losses from property damage, liability suits, and worker injuries. These risks typically are managed through a combination of loss control (efforts to reduce the likelihood or magnitude of losses) and loss financing through internal retentions or the purchase of insurance.

In the 1980s and 1990s, a different type of risk management—financial risk management—grew in importance at many corporations. Financial risk management typically refers to the management of price risks, e.g., losses from changes in prices, such as exchange rates, interest rates, commodity prices, and credit exposures. These risks usually are managed through derivatives contracts, such as options, forwards, futures, and swaps. In most corporations, financial risks were managed separately from pure risks, and the terminology and methods used by managers of financial risk differed from those used by managers of pure risk.

Enterprise Risk Management

During the latter part of the 1990s, some managers started to question the desirability of managing pure risk and financial risk separately. They also began to consider risk exposures that were not handled by pure risk or financial risk managers. For example, a firm might have operational risks that were being ignored by the risk managers because there was not an established contract (insurance or derivative) that could be used to shift the risk to another party. The idea that a firm should examine all of its risk exposures and deal with them using a consistent framework came to be known as enterprise risk management (ERM). To facilitate communication among different areas within a firm and the adoption of a consistent risk management framework, some firms even established a new position—the chief risk officer.

ENTERPRISE RISK MANAGEMENT AT UGG

Several factors led UGG to investigate enterprise risk management. One factor was that the Toronto Stock Exchange directs the board of directors of all listed corporations to identify the corporation's principal risks and to implement appropriate systems to manage these risks. Other factors included increased requirements for disclosure of risk exposures, increased emphasis on risk management by credit rating agencies, and UGG's perception that equity analysts recommendations were sensitive to earnings results that deviated from forecasts.

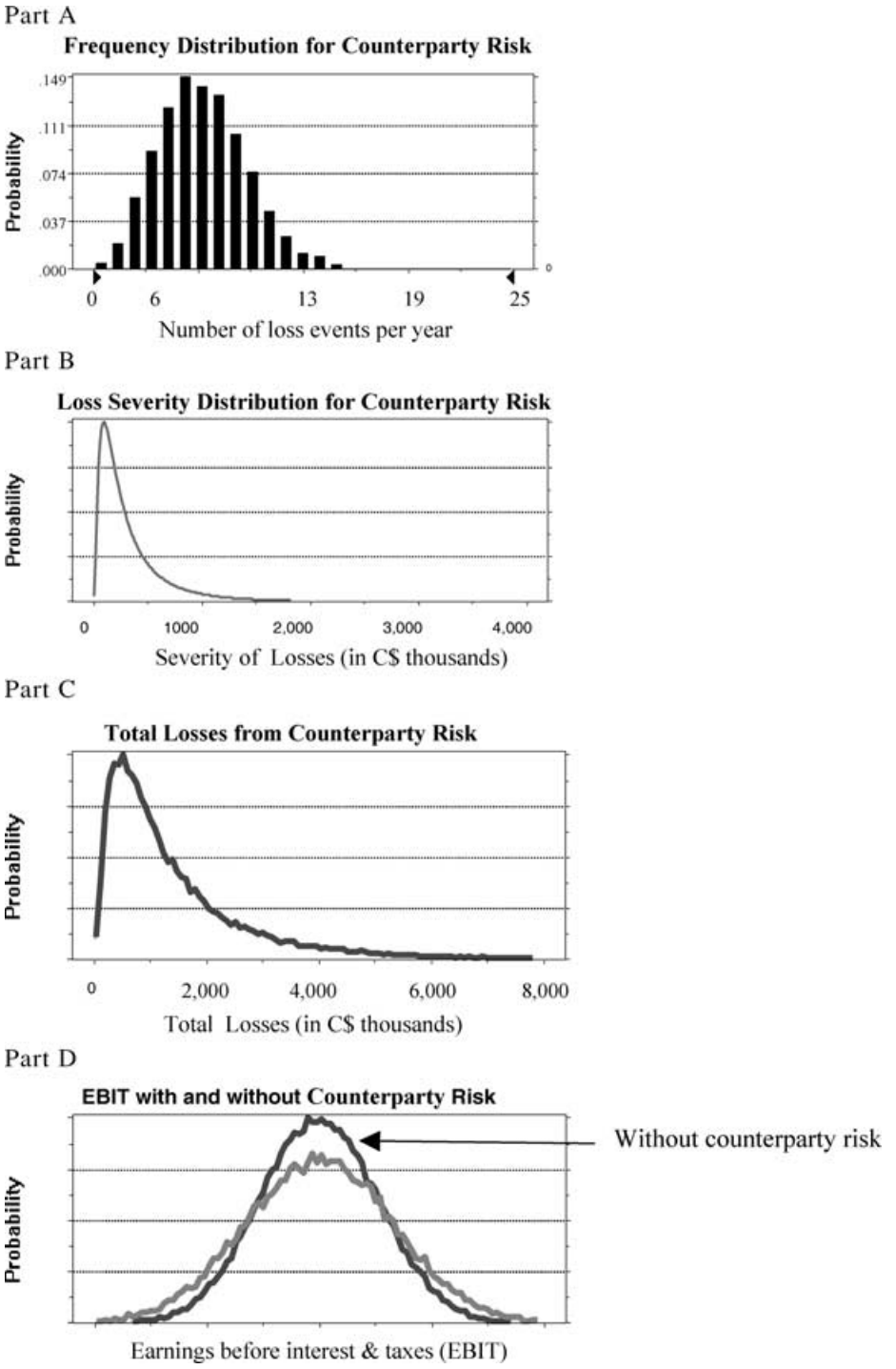
Identifying and Quantifying Risk Exposures

UGG started by forming a risk management committee, consisting of the CEO, CFO, risk manager, treasurer, compliance manager (for commodity trading), and manager of corporate audit services. This committee, along with a number of UGG employees, then met with a representative from Willis for a brainstorming session to identify the firm's major risks. This process identified 47 exposure areas, from which six were chosen for further investigation and quantification. The six risks were (1) environmental liability, (2) the effect of weather on grain volume, (3) counterparty risk (suppliers or customers not fulfilling contracts), (4) credit risk, (5) commodity price and basis risk, and (6) inventory risk (damage to products in inventory).

Willis Risk Solutions, a unit of the Willis Group Ltd., took on the task of gathering data and estimating the probability distribution of losses from each of the six risk exposures. These probability distributions were then used to quantify the impact of each source of risk on several measures of UGG's performance, including return on equity, economic value added, and earnings before interest and taxes (EBIT).

Figure 5 provides an example of the type of analysis conducted by Willis Risk Solutions. The example is based on UGG's counterparty risk. Based on data provided by UGG and

FIGURE 5
Analysis of Counterparty Risk



Note: Analysis performed by the authors.

discussions with UGG employees, Willis estimated that the number of counterparty losses per year could be described by a Poisson distribution (see Part A in Figure 5) and that the loss severity on any given loss could be described by a lognormal distribution (see Part B). Given the probability distributions for the number of losses and for the loss per event, an annual loss distribution from counterparty risk could be estimated (see Part C). Finally, the impact of counterparty risk on the probability distributions of various performance measures (e.g., EBIT) could be estimated under the assumption that all other risk factors took on a specific value (see Part D).[1]

The analysis conducted by Willis Risk Solutions led to the conclusion that, of the six risks originally identified, UGG's main source of unmanaged risk was from the weather. The parties therefore focused their energies on understanding how weather affected UGG's performance. Ken Risko and Michelle Bradley, a statistician and an actuary, respectively, for Willis Risk Solutions, conducted an in-depth regression analysis of how crop yields in each province of western Canada were influenced by temperature and precipitation.

Examples of the regression analysis conducted by Ken and Michelle are presented in Table 5. The table provides the results of estimating a regression equation where the dependent variable is the crop yield (bushels per acre) for either wheat or oats, and the explanatory variables are a time trend (to capture productivity increases over time), the average June temperature, and the average July precipitation. A large number of different combinations of weather variables were tried and these two variables provided a good parsimonious model for explaining crop yields. The analysis was conducted using data from 1960 to 1992 for the provinces of Alberta, Manitoba, and Saskatchewan. Similar analysis was also conducted for other grains and seeds.

To illustrate the results, consider the first row of Table 5. The positive and statistically significant coefficient on the time trend variable indicates that Alberta wheat yields have increased over time. The negative and statistically significant coefficient on the average June temperature variable indicates that wheat yields in Alberta are negatively related to the average June temperature. Finally, the positive coefficient on the average July precipitation variable indicates that crop yields increase on average with rainfall in July. The *R*-squared indicates that about 68 percent of the annual variation in Alberta wheat yields is explained by these three variables.

The remainder of Table 5 indicates that, in general, crop yields for wheat and oats have increased over time, are negatively related to average June temperature and positively related to average July precipitation. There are, however, some exceptions to these generalizations. The exhibit also indicates that the three variables in the regression equation explain a substantial proportion of the variability in yields in all of the provinces, i.e., the *R*-squareds generally are high.

The regression results can be used to assess how expected crop yields would be affected by deviations from normal weather conditions. For example, if temperature and

[1] Although not presented here, all of the risk factors could be incorporated simultaneously into the analysis of the performance measures if the correlations between the risk factors were estimated.

TABLE 5
Results of Regression Analysis of Crop Yields (bushel per acre) and Weather Conditions in Two Canadian Provinces Using Data From 1960 to 1992; Temperature Is Measured in Degrees Fahrenheit and Precipitation in Inches. The Time Trend Variable Equals (Year-1960); Thus, for the Year 2000 the Time Trend Equals 40

Dependent Variable: Crop Yield for			Explanatory Variables				
Province	Crop		Intercept	Time Trend	Avg. June Temp.	Avg. July Precip.	R^2
Alberta	Wheat	Coef:	59.88	0.33	−0.76	2.70	0.68
		t-stat:	4.49	6.19	−3.19	2.63	
Manitoba	Wheat	Coef:	79.34	0.42	−0.98	1.00	0.65
		t-stat:	5.70	5.94	−4.38	0.95	
Saskatchewan	Wheat	Coef:	55.6	0.19	−0.69	4.80	0.61
		t-stat:	4.02	2.65	−3.01	4.44	
Alberta	Oats	Coef:	43.53	0.69	−0.17	4.70	0.72
		t-stat:	1.89	7.59	−0.41	2.71	
Manitoba	Oats	Coef:	121.02	0.65	−1.50	5.30	0.64
		t-stat:	4.89	5.16	−3.77	2.96	
Saskatchewan	Oats	Coef:	74.07	0.24	−0.76	9.30	0.56
		t-stat:	2.93	1.91	−1.82	4.70	

Note: Analysis performed by the authors using data provided by Willis.

precipitation were expected to take on their historical average values (presented in Table 6), then the predicted Alberta wheat crop yield for 2000 would be

$$\text{Yield} = 59.88 + .33(40) - 0.76(56.6) + 2.7(2.06) = 35.6 \text{ bushels per acre.}$$

If instead the average June temperature was higher than the mean value by one standard deviation (2.2 degrees from Table 6), the Alberta wheat crop yield would be predicted to be

$$\text{Yield} = 59.88 + .33(40) - 0.76(58.8) + 2.7(2.06) = 34.0 \text{ bushels per acre.}$$

Having established a relationship between crop yields and weather, Ken and Michelle then estimated the relationship between crop yields and UGG's grain volume. They first calculated a weighted average crop yield for western Canada using crop yields by grain/seed and by province and the proportions of total production of each grain/seed in each province. The values for this weighted average crop yield are reported in Table 1. They found that UGG's grain volume in year t was highly correlated with overall crop yields in year $t - 1$.

TABLE 6
Descriptive Statistics for Variables Used in Regression Analysis

	Mean Value for Avg. June Temp. (°F) 1960–1992	Std. Dev. for Avg. June Temp. (°F) 1960–1992	Mean Value for Avg. July Precipitation (inches) 1960–1992	Std. Dev. for Avg. July Precipitation (inches) 1960–1992
Alberta	56.6	2.2	2.06	0.51
Manitoba	61.7	3.0	1.83	0.67
Saskatchewan	60.4	2.8	1.55	0.61

	Correlation Coefficients for Avg. June Temperature		
	Alberta	Manitoba	Saskatchewan
Alberta	1.00	0.41	0.69
Manitoba		1.00	0.87
Saskatchewan			1.00

	Correlation Coefficients for Avg. July Precipitation		
	Alberta	Manitoba	Saskatchewan
Alberta	1.00	0.51	0.74
Manitoba		1.00	0.55
Saskatchewan			1.00

Note: Analysis performed by the authors using data provided by Willis.

The next step in Ken and Michelle's analysis was to relate UGG's grain volume to UGG's financial results using the information in Table 3. For each tonne of shipments, UGG had gross profit of 21.2 Canadian dollars on average from the 1997 through 1999.

To summarize, Ken and Michelle established a relationship between weather and UGG's gross profit using the following steps and information:

$$\underset{\text{Table 5}}{\text{Weather}} \rightarrow \underset{\text{Table 1}}{\text{Crop Yields}} \rightarrow \underset{\text{Table 3}}{\text{UGG's Grain Volume}} \rightarrow \text{UGG's Profit}$$

They illustrated their results by graphing UGG's actual gross profit and what gross profit would have been if the effects of weather were removed. Their graph is reproduced as Figure 6.

ALTERNATIVE RISK MANAGEMENT APPROACHES

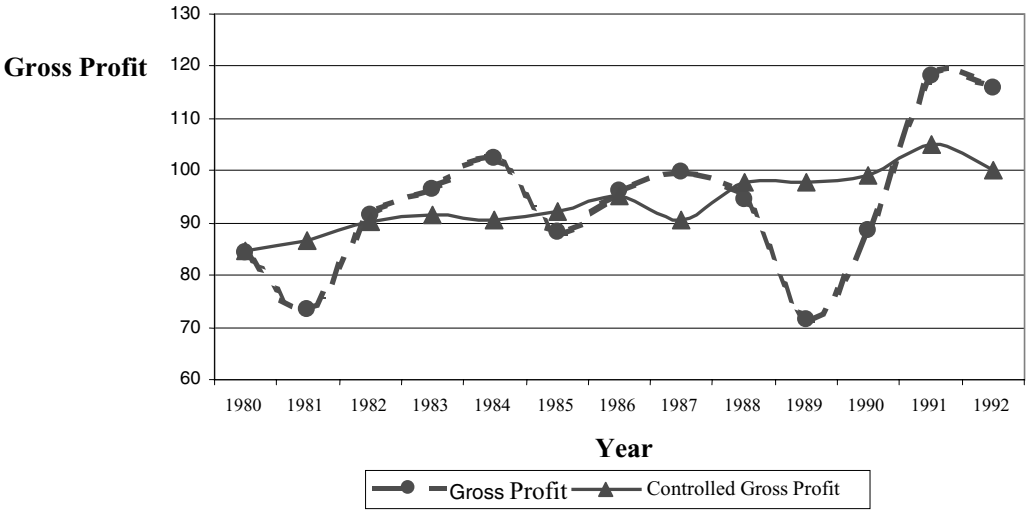
Having quantified their exposure to weather risk, UGG had to decide what to do about it. They explored several options.

Retention

One approach was to continue operating as they had been and not try to reduce their weather exposure. As previously discussed, this approach exposed their profitability to large swings due to weather variation. There were several disadvantages of such volatility.

First, UGG had been and planned to continue making large investments in storage facilities (grain elevators). The ability to finance these capital expenditures from internally

FIGURE 6
Actual Gross Profit Compared to Controlled Gross Profit (Weather Risk Removed) in Thousands of Canadian Dollars



Note: Documents provided to the authors by Willis.

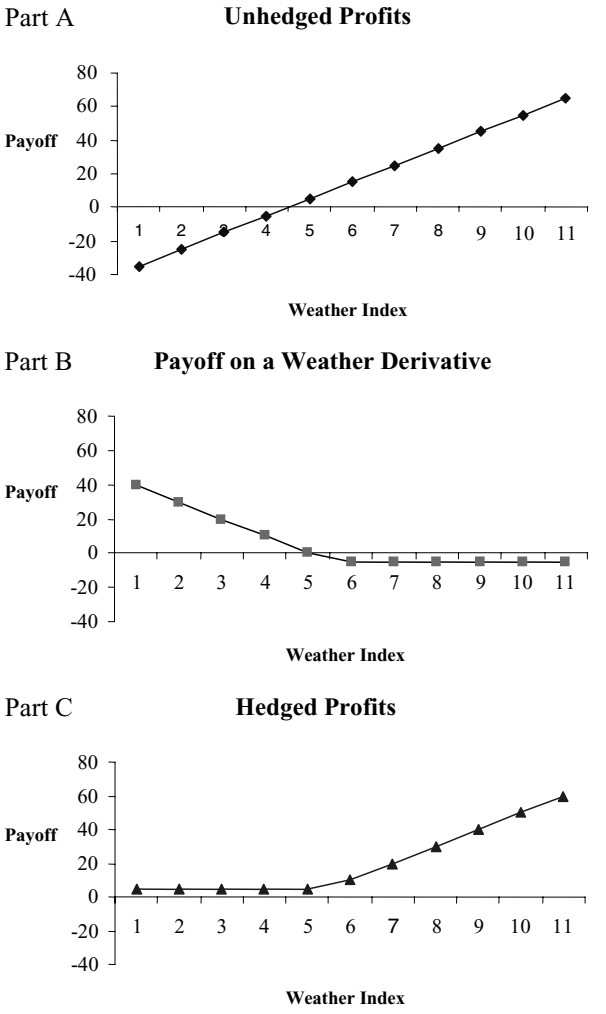
generated funds would allow the firm to avoid the costs associated with raising external capital. And, to the extent that external capital would be needed, the rate that the firm would have to pay on borrowed funds would likely be higher if they retained the weather risk.

Second, the variability in its cash flows caused UGG to use equity capital as a cushion against unexpected low cash flows in any given year. If the firm could reduce its weather risk, it could increase the proportion of the firm financed with debt without paying higher yields, which in turn would allow it to gain additional interest tax shields.

Third, although much of UGG's current business could be characterized as a commodity business, UGG tried to distinguish itself from competitors by creating products with brand names and by providing on-going services to customers. Stability in the firm's cash flows would help the firm characterize itself as a company that suppliers and customers could rely on for service and high quality products for many years. Moreover, the importance of supplier and customer relationships was likely to increase in the coming years as the marketplace for agricultural products adjusted to scientific advances. Analysts predicted that over the next decade, food producers would demand specific genetically engineered crops, which in turn would require farmers to plant specific seeds. The coordination of these activities between farmers and food producers would require an information, storage, and transportation network. UGG saw itself as a provider of these intermediary services.

The main advantage of retaining the weather risk was the cost associated with shifting it to someone else. In addition, Mike and Peter were not sure that the capital markets really would reward the firm for eliminating weather risk, given that this was a risk that most investors could easily diversify on their own.

FIGURE 7
Illustration of a Weather Derivative



Note: No source data used.

Weather Derivatives

In the late 1990s, weather derivatives were a relatively new risk management tool. These contracts were sold in the over-the-counter (OTC) market by firms such as Enron. A contract could be tailored on a number of dimensions to meet the specific needs of the buyer. For example, the underlying variable determining the payoffs could be one or a combination of weather variables, such as average temperature, rainfall, snowfall, a heat index, or the number of heating or cooling degree days. The payoff structure could resemble a put option, a call option, a swap, or combinations of these structures.

Figure 7 provides an example of how UGG could potentially use a weather derivative. Suppose that, based on Willis's analysis of the sensitivity of crop yields to weather and

the sensitivity of gross profit to crop yields, UGG's *expected* gross profit exhibited a pattern depicted in Part A of Figure 7. The vertical axis measures expected gross profit and the horizontal axis measures a weather index, which equals a weighted average of various temperature and precipitation measures in western Canada. As the index increases, expected gross profit increases (because crops' yields increase, which in turn increases UGG's shipments of grains and seeds). For simplicity, the illustration assumes that the relationship between gross profit and the weather index is linear. Since low values of the weather index correspond to low expected profits for UGG, a derivative contract that would pay UGG money when the index is low would provide a hedge. For example, the put option structure illustrated in Part B in Figure 7 would help to hedge UGG's risk. When the put option payoff from Part B is added to expected gross profit from Part A, UGG's expected gross profit would vary with the weather index as depicted in Part C.

Hedging their weather risk with derivatives was feasible, but it suffered from several difficulties. Although Willis had performed a sophisticated analysis of the effect of weather on UGG's gross profit, the results of this analysis had to be converted into a desired contract structure. That is, the underlying weather index that determined the derivative contract's payoff would need to be specified. Next, the effectiveness of the derivative contract in hedging UGG's risk would have to be assessed. UGG then would have to obtain price quotes in a marketplace that had relatively few participants.

The Insurance Contract Idea

When discussing the weather analysis, Mike McAndless and Peter Cox thought of an alternative way of dealing with the firm's weather risk. They knew that the primary reason weather was important was because weather affected UGG's grain shipments. They therefore wondered whether they could construct an insurance contract that would pay UGG when its grain shipments were abnormally low. The obvious problem with such a contract is moral hazard—UGG's pricing and service also influences its grain shipments. One solution to this problem was to use industry-wide grain shipments as the variable that would trigger payments to UGG. Industry shipments would likely be highly correlated with UGG's shipments, which would imply that the basis risk would be minimal. In addition, because of its relatively low market share, UGG would have minimal effect on the value of industry-wide shipments, which would significantly reduce the moral hazard problem.

Mike and Peter also considered the possibility of integrating grain volume coverage with UGG's other insurance coverage. Currently, UGG purchased a number of different insurance policies for various traditional risk exposures. For example, they purchased a variety of policies to cover their property exposures (e.g., a boiler and machinery policy to cover losses on machinery and equipment) and liability policies to cover their exposure to tort liability (e.g., environmental impairment liability). Each policy had its own retention level and its own coverage limit. By integrating its various coverages under one policy, UGG could replace the individual deductibles and limits with an overall annual aggregate deductible and limit that would apply to all or a subset of losses, including grain volume losses.

Mike called Willis and asked them to investigate the possibility of structuring an insurance contract on industry grain shipments. Willis then contacted several major commer-

cial insurers, including a division of the large reinsurer Swiss Re, called Swiss Re New Markets. Located in New York, this group structured innovative risk financing deals for commercial entities.

In preparation for a meeting with a group from Swiss Re New Markets, Mike and Peter wanted to answer the following questions:

(1) Given that any method of reducing the weather risk exposure will be costly, what are the benefits to UGG's diversified owners from reducing the weather risk? (Hint: What characteristics of UGG's operations and strategy would make risk reduction potentially beneficial?)

(2) Should UGG's rather unique ownership structure influence the decision to reduce the weather risk exposure?

(3) How could the parties structure a weather derivative to cover the exposure? More specifically, what would be the underlying index? Would they need a separate contract for each crop and each province? (Hints: In constructing an underlying index use the regression analysis in Table 5. In discussing whether they would need a separate contract for each crop and province, consider basis risk and also transaction costs.)

(4) How could the parties structure an insurance contract to cover the grain volume exposure? More specifically, how would a loss be defined? And, what would be the payment to UGG conditional on a loss? (Hint: Use information in Tables 1, 2, and 3.)

(5) What are the advantages and disadvantages of integrating the grain volume coverage with the firm's other insurance coverages? That is, instead of having separate policies with separate deductibles and limits for the various exposures (including the grain volume exposure), what are the advantages and disadvantages of bundling all of the firm's exposures in one policy with one deductible and one limit?

(6) Ignoring cost differences, are there any advantages of the insurance contract approach versus the use of weather derivatives? (Hint: Comment on basis risk and moral hazard.)

(7) Are there any loss control measures that could be used to manage UGG's weather risk?

TEACHING NOTE FOR UNITED GRAIN GROWERS (UGG) CASE

INTRODUCTION

This teaching note on the United Grain Growers' case provides an overview of the case, suggested answers to the questions at the end of the case, and a brief summary of UGG's decisions.

The UGG case can be used to facilitate discussion of the following concepts, tools, and issues:

- Enterprise risk management
- How risk management can increase shareholder wealth
- Risk identification
- Risk measurement
- Interpretation of regression analysis
- Basis risk
- Moral hazard
- Weather derivatives
- Insuring operational risk
- Bundling insurance coverages
- Insurance policy design
- Determinants of insurance premiums
- Role of brokers

OVERVIEW OF THE CASE

The case presents background material on enterprise risk management and describes the enterprise risk management process followed by UGG. Although UGG provides numerous services to farmers in western Canada, its main source of revenue is grain shipments. Despite insuring traditional pure risk exposures and hedging currency and commodity price risk, UGG's earnings exhibit considerable volatility. After an extensive risk identification and measurement process, UGG finds that the main source of this volatility is annual variation in the amount of grain that it ships (its grain volume). The case ends with a description of the risk management choices considered by UGG, but the case does not reveal what UGG actually did. The main issue facing UGG is whether to retain their grain volume exposure, hedge the exposure with weather derivatives, or insure it using an innovative insurance contract. UGG chose the insurance contract alternative.

PEDAGOGICAL POINTS

There is value in just having students read the case, without answering any of the questions at the end. Reading the case will illustrate to students the sophistication of modern risk management and expose them to ideas of enterprise risk management, which suggests that firms should evaluate all of their risk exposures (pure risks, price risks, and operational risks) using a common framework.

We have written the case to give the instructor flexibility in choosing the topics and analysis that will be covered. Not all of the bullet points listed above need to be covered. There are seven questions at the end of the case. By selecting specific questions for students to answer, you can tailor the case to your specific needs and desires.

DISCUSSION OF THE SEVEN QUESTIONS

Question 1: Given that any method of reducing the weather risk exposure will be costly, what are the potential benefits to UGG's diversified owners from reducing the weather risk?

There are at least three reasons why reducing risk might benefit UGG's diversified shareholders. First, by reducing the volatility in its cash flows due to variability in grain volume, UGG can increase the likelihood that it will have the internal funds available to fund its planned capital expenditures on grain elevators and thereby avoid the costs associated with raising external capital (Froot et al., 1993).

Second, by reducing the volatility in its cash flows due to variability in grain volume, UGG can reduce the likelihood of going into financial distress. From debt holders' perspective, this will reduce expected bankruptcy costs and expected financial distress costs due to underinvestment problems (Myers, 1977) and overinvestment in risky assets (Jensen and Meckling, 1976). Lenders should therefore be willing to lend to UGG at better terms. Table 4 indicates that UGG just increased its debt ratio, which makes financial distress costs more of a concern.

As noted in the case, UGG has tried to create brand names for its products and to provide superior service to customers. The returns on these investments will accrue to UGG over time, but only if it survives. Thus, reducing the likelihood of financial distress can benefit UGG's shareholders by increasing the likelihood that they will receive a return on their past investments.

Also, reducing the likelihood of financial distress might benefit UGG by improving the terms at which UGG contracts with suppliers, employees (especially top managers), and customers. As a result of advances in genetics, agricultural markets could become less of a commodity business and rely more on relationships. For example, some analysts have forecasted that farmers will be employed to plant specific seeds that are demanded by a particular user. As an intermediary between end-users and farmers, UGG could develop a valuable information, supply, and transportation network that would facilitate specific transactions between end-users and farmers. A lower likelihood of financial distress could increase the willingness of end-users and farmers to contract with UGG as an intermediary compared to a competitor with a higher likelihood of financial distress.

Third, by reducing the volatility in its cash flows due to variability in grain volume, UGG can increase the proportion of debt in its capital structure without incurring additional financial distress costs and thereby gain additional interest tax shields (Modigliani and Miller, 1963). The income tax rate in Canada is approximately 50 percent, which makes the value of interest tax shields greater than in countries like the United States with lower tax rates.

Question 2: Should UGG's rather unique ownership structure influence the decision to reduce the weather risk exposure?

This question forces students to think about how the ownership and governance structure of a corporation can influence risk management. UGG has members and shareholders. Farmers who do business with UGG can become members. Since 12 of UGG's 15 board members are elected by UGG's members, the members have considerable control rights (but no cash flow rights, unless they are also shareholders). Since members are UGG's customers and since customers probably are not as diversified as nonmember shareholders, the members might prefer that UGG have lower risk than nonmember shareholders. Consequently, compared to a traditional stock company, UGG's governance structure might lead to more risk reduction.

Question 3: How could the parties structure a weather derivative to cover the exposure? More specifically, what would be the underlying index? Would they need a separate contract for each crop and each province?

For most students, the design of a weather derivative contract to meet UGG's needs will be an advanced topic, requiring interpretation of the multiple regression analysis reported in Table 5. The instructor therefore might have to review a number of concepts related to regression analysis, such as the meaning of coefficient estimates, *t*-statistics, *R*-squared, and forecasting.[2]

For UGG to hedge its risk using weather derivatives, it must construct an index that can be used for the "underlying" of the derivative contract. The regression analysis of crop yields indicates that average June temperature in a province typically is negatively related to crop yields and average July precipitation in the province is positively related to crop yields. Thus, for a given crop and province, a weather index can be constructed using the coefficients in the regression results. For example, the index for the year 2002 for Alberta wheat could equal the coefficient on the June temperature variable, −0.76 times the actual average June temperature observed in 2002 plus the coefficient on the July precipitation variable, 2.70 times the actual average July precipitation observed in 2002. As this index increases, Alberta wheat crop yields are expected to increase, which would result in greater grain volume for UGG.

The question also asks what type of a derivative would hedge UGG's exposure. If the index were constructed as described above, then a put option with this index as the underlying would help UGG hedge its wheat volume exposure in Alberta. The dollar payoff on the put option would have to be specified based on the impact of crop yields

[2] The actual regression analysis performed by Willis included additional explanatory variables. The authors chose to report less complicated results for pedagogical purposes.

on UGG's gross profit. Of course, other derivative contracts would also hedge UGG's exposure. A short forward or swap position would hedge the downside exposure by giving up the upside exposure. Also, a put option could be combined with a short call option position with a higher exercise price. A more advanced question is to ask students to actually construct the dollar payoffs on a weather derivative contract.

A useful regression exercise is to have students calculate predicted values for crop yields based on the regression model. An example of calculating predicted values is provided in the case. Additional motivation for this analysis relates to the choice of the strike (exercise "price") on the weather derivative contract. If the strike were set equal to the expected or predicted value of the underlying index, then the weather derivative would provide protection against crop yields that are lower than expected.

Note that since the regression coefficients vary across crops within a given province and across provinces, UGG might need a separate contract for each crop and each province. Alternatively, the different crop yields for a given province could be aggregated (by calculating a weighted average based on the percentage of UGG's business that comes from each crop) and a separate contract for each province could be constructed. Another possibility is to aggregate across provinces and crops and have a derivative contract based on average June temperature and another weather derivative contract based on average July precipitation. Students can be asked to think about the trade-offs between using separate contracts for each crop and province versus using fewer contracts based on aggregate crop yields. The correlations between the weather variables in the different provinces in Table 6 provide some information about the trade-offs, but an in-depth analysis is not possible given the information provided in the case. Transaction costs are likely to increase with a greater number of contracts, but basis risk is likely to decrease.

Question 4: How could the parties structure an insurance contract to cover the grain volume exposure? More specifically, how would a loss be defined? And, what would be the payment to UGG conditional on a loss?

The case indicates that an insurance contract based on UGG's actual grain volume is problematic because of moral hazard. The case also states that a solution to the moral hazard problem is to base the insurance contract payoff on industry grain volume. Although the case suggests that industry grain volume and UGG's grain volume are highly correlated, students should check the correlation. The data are presented in Table 1. Students then need to identify a specific contract structure that can be used for the coverage.

The policy purchased by UGG from Swiss Re was a multiyear contract in which the grain volume exposure was bundled with a number of other pure risk exposures. A grain volume "loss" occurs when industry grain volume is lower than the average industry grain volume over the previous five-year period. To specify the grain volume loss to UGG, the difference between the actual industry grain volume in year t and the average industry grain volume is multiplied by 15 percent, which is UGG's market share.[3] To translate the volume number into a dollar figure, the volume differential is then multiplied by

[3] The contract allows for an adjustment in the 15 percent market share parameter if UGG's market share changes over time.

UGG's gross margin per ton of grain shipments, which can be found in Table 3. Ignoring deductibles and limits, the algebraic formula for the payoff in year t equals

$$\text{Max}[0, 0.15\ (\text{gross margin})\ (\text{Avg Ind Vol} - \text{Ind Vol}_t)],$$

where

$$\begin{aligned}\text{Avg Ind Vol} &= \text{Average Industry Volume in years } t-6 \text{ to } t-1,\\ \text{Ind Vol}_t &= \text{Industry Volume in year } t.\end{aligned}$$

Incorporating a deductible equal to D and a limit equal to L, the payoff formula becomes

$$\text{Max}\{0, \text{Min}[0.15(\text{gross margin})\ (\text{Avg Ind Vol} - \text{Ind Vol})_t - D,\ L]\}$$

Some students might suggest using revenue per ton as opposed to gross margin per ton. However, it is probably better to hedge gross profit than revenue, because some costs are variable.

Question 5: What are the advantages and disadvantages of integrating the grain volume coverage with the firm's other insurance coverages? That is, instead of having separate policies with separate deductibles and limits for the various exposures (including the grain volume exposure), what are the advantages and disadvantages of bundling all of the firm's exposures in one policy with one deductible and one limit?

Most of the arguments for why risk management can increase shareholder wealth do not specify the source of a loss as being important; instead, the aggregate loss is important. For example, the arguments related to the costs of raising external capital and related to financial distress focus attention on large losses; it does not matter whether the large loss is the result of a major loss from one exposure or an accumulation of losses from different exposures that individually are relatively small. When ignoring other issues (see below), this reasoning suggests that it would make sense to have one deductible and one limit for the firm's aggregate loss.

A firm's aggregate loss distribution depends on the probability distributions of the individual component losses and the correlations between the component losses. Since different loss exposures are not perfectly correlated, the aggregate loss will have less variability than a weighted average of the individual component losses; i.e., diversification of risk takes place. Although diversification often is identified as an advantage of bundling, the logic for why it is an advantage is not always very precise.

Note that the insurer obtains the same diversification by selling individual policies on all of the firm's exposures as it does by selling a bundled policy. Perhaps more importantly, the insurer obtains much greater diversification by insuring exposures of thousands of different entities. Thus, bundling does not give the insurer any greater diversification opportunities.

The advantage of diversification of loss exposures at the firm level is that the firm is able to obtain its desired coverage at a lower cost because bundling reduces the probability that losses exceed some threshold. An analogy which is useful for students with a finance

TABLE 7

Loss From Exposure 1	Loss From Exposure 2	Probability of Occurrence	Total Loss	Cost Imposed on Shareholders
0	0	0.8464	0	0
5	0	0.0460	5	5
10	0	0.0184	10	10
15	0	0.0092	15	15
0	5	0.0460	5	5
5	5	0.0025	10	10
10	5	0.0010	15	15
15	5	0.0005	20	25
0	10	0.0184	10	10
5	10	0.0010	15	15
10	10	0.0004	20	25
15	10	0.0002	25	35
0	15	0.0092	15	15
5	15	0.0005	20	25
10	15	0.0002	25	35
15	15	0.0001	30	45
Expected values			1,200,000	1,212,500

Note: No source data used.

background is to note that insurance is just like a put option and an option on a portfolio is less costly than a portfolio of options. The option on a portfolio is less costly because the volatility is lower, which decreases the expected payoff.

An example also will help illustrate the point and also highlight the assumptions needed for bundling to be beneficial. Suppose that a firm has two independent, identically distributed exposures, and that each exposure has the following loss distribution:

$$\text{Loss} = \begin{cases} \$15 \text{ million}, & \text{with probability } 0.01 \\ \$10 \text{ million}, & \text{with probability } 0.02 \\ \$5 \text{ million}, & \text{with probability } 0.05. \end{cases}$$

Also, assume for simplicity that the firm has determined that retained losses less than or equal to $15 million impose a cost on shareholders equal to the actual loss, but that retained losses above $15 million impose a cost on shareholders equal to the actual loss plus an amount equal to the difference between the loss and $15 million. For example, a loss of $20 million will impose a cost on shareholders equal to $20 million plus $5 million for a total cost of $25 million. This simple assumption captures the idea that large losses are the ones that are costly for firms.

TABLE 8

Coverage for Exposure 1 →	No Coverage	Ded. = $5 M Limit = $10 M	Bundled Policy Ded. = $15 M Limit = $15 M
Coverage for Exposure 2 →	No Coverage	Ded. = $5 M Limit = $10 M	
Expected retained losses	1,200,000	800,000	1,187,500
Expected cost of retained losses imposed on shareholders	1,212,500	800,000	1,187,500
Expected insured losses	0	400,000	12,500
Insurance premium	0	480,000	15,000
Expected total cost to Shareholders = Premium + Expected cost of retained losses	1,212,500	1,280,000	1,202,500

Note: No source data used.

Table 7 presents all of the possible combinations for the firm's two loss exposures, as well as the total loss and the cost imposed on shareholders if the firm retains all of the losses. The highlighted rows in the table indicate the outcomes for which the cost imposed on shareholders exceeds the total loss. The expected total loss equals $1,200,000, but the expected cost imposed on shareholders equals $1,212,500.

Suppose that the premium for insurance coverage equals expected claim costs plus a 20 percent proportional loading. This premium loading assumption along with the assumption that retained losses below $15 million impose costs to shareholders equal to the actual loss imply that insurance coverage for losses below $15 million is detrimental to shareholders. This is because the expected cost to shareholders of paying these losses is the expected loss, but the expected cost to shareholders of having the insurer pay these losses is greater than the expected loss due to the 20 percent loading. Insuring losses above $15 million, however, might be beneficial to shareholders, because losses above $15 million impose costs on shareholders beyond the actual loss.

Table 8 describes several alternative policy combinations, along with the expected retained loss, expected insured losses, the insurance premium, and the expected cost imposed on shareholders.

If the firm buys no insurance coverage (see column 1), then the expected total cost to shareholders equals $1,212,500, even though expected retained losses equal $1,200,000. The firm can avoid the cost of allowing retained losses to potentially exceed $15 million by purchasing $10 million of coverage above a $5 million deductible on both exposures (see column 2). With these policies, the firm is protected from large retained losses (losses never exceed $15 million). However, these policies are costly to shareholders, because of the premium loading, which equals $80,000. In this case, the firm is better off not purchasing separate insurance policies, because the premium associated with insuring relatively small losses exceeds the benefit from avoiding high retained losses. The problem with

the separate policies is that they provide coverage for losses for which the company does not need coverage and this coverage is costly.

Now consider the bundled policy with an aggregate deductible of $15 million and an aggregate limit of $15 million (see the last column). This policy would avoid the possibility of retained losses exceeding $15 million, but the policy does not provide coverage for small losses, which reduces the premium loading that the firm has to pay. Consequently, the firm is better off purchasing the bundled policy than retaining all losses.

Another potential benefit of bundling is administrative costs and loading costs would be reduced if there are fixed costs for either the insurer or the insured associated with negotiating each individual policy. By bundling, fewer policies are negotiated and therefore these fixed costs are reduced. A counterargument is presented below.

There are also several potential disadvantages of bundling coverages. To price a bundled policy, an insurer needs to have some understanding all of a firm's risk exposures and their correlations. The cost of associated with performing this analysis can increase the premium loading on a policy relative to the loading that would be incurred on separate policies. Also, since the number of insurers that will have the expertise to price a complicated bundled policy might be limited, the lack of competition could increase the loading. Finally, because of the modeling expertise needed to price a complicated bundled policy, some specialized insurers with expertise in loss control and claims processing might be excluded, which in turn could reduce the quality of services provided.

A completely bundled policy would not make distinctions among the source losses. Consequently, moral hazard problems could arise. For example, once a firm's aggregate deductible was reached during a year, any additional loss (up to the aggregate limit) would be covered by the insurer under a completely bundled policy. Such a scenario would greatly reduce the insured's incentive to prevent and reduce additional losses. To reduce these problems, per occurrence deductibles and limits for each type of loss exposure would likely be included in a bundled policy. This was the case with UGG's bundled policy.

Question 6: Ignoring cost differences, are there any advantages of the insurance contract approach versus the use of weather derivatives?

A potentially important advantage of the insurance approach is that, even though it was based on industry grain volume, the basis risk would be less than that with weather derivatives. The lower basis risk is likely to arise from two sources. First, factors other than weather affect grain volume. For example, grain volume will be influenced by government policies, general economic conditions, and worldwide competition. The insurance contract captures annual variation in these factors, but a weather derivative approach would not. Second, the weather derivative approach relies on statistical analysis of how weather influences crop yields and then how crop yields influence grain volume. The estimated relationships between these variables seem reliable, but there is still sampling error in the process, which could cause the actual results in a given year to deviate from the expected results.

Question 7: Are there loss control measures that could be used to manage UGG's weather risk?

One possible loss control measure is for UGG to develop and then market seeds that are more weather resistant. The resulting reduction in the variance in crop yields would lower the volatility in UGG's cash flows and thereby reduce expected indirect losses (see question 1).

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