

A COMMODITY MARKET SIMULATION GAME FOR TEACHING MARKET RISK MANAGEMENT

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Abstract

The Market Risk Game is a computerized simulation game available for IBM PC and Apple II microcomputers that is designed to give realistic practice in making decisions in a risky market environment. It illustrates the use of hedging and put options to reduce risk in livestock and grain markets. It is best suited for individuals who have a basic understanding of commodity trading, but who need experience to solidify their knowledge to a functional level. Through the game, this is done without facing the risk of an actual investment or requiring the time involved in watching a market over an extended period.

Key words: risk, hedging, options, simulation, game, marketing.

Coping with market risk is a fact of life for livestock and grain producers. The Market Risk Game is a computerized simulation game designed to give its players realistic practice in making decisions in a risky market environment. It focuses on the use of hedging and commodity put options as risk-reducing marketing alternatives for livestock and grain producers. It is likely best suited for players who have a basic understanding of hedging and put options trading, but who need experience and practice to solidify their knowledge and confidence to a functional level. The game is designed to allow players to develop a "feel" for the usefulness and limitations of outlook information, futures market contracts, and commodity options. Through the game, this can be done without facing the risk of actual dollar investments or requiring the time involved in watching the actual market over extended periods. It, of course, cannot be a substitute for actual market experience. But experience has shown that producers need some type of realistic learning ex-

ercise before they actually use the futures market. The Market Risk Game is designed to provide a useful learning tool for this stage of the process of learning to cope with market risk.

TRADITIONAL VS. COMPUTER SIMULATION TEACHING OF HEDGING

A terse review of marketing textbooks (Kohls and Uhl, Tomek and Robinson, Dahl and Hammond, and Purcell) reveals that most use the same general approach to teaching the principles and mechanics of hedging. They first present the perfect hedge by showing the cash and futures prices on the day of the cash purchase. They then show the cash and futures prices on the day of the cash sales. Given this information, they calculate the profits or losses in the futures market and cash market and discuss the fact that a perfect hedge requires the basis to remain unchanged between the two periods. Following this, they generally proceed to discuss the reasons why the basis may change over time, basis risk, the role of the speculator, etc. This traditional presentation of hedging is necessary to provide an initial concept of what hedging is. But it provides a very limited and artificial view of the dynamics involved in placing a hedge and the market risk that is eliminated by a hedge. A strength of the Market Risk Game is its ability to simulate both the uncertainty and time dynamics involved in using the futures market. Change in basis, options premiums, market outlook, etc. are simulated.

The stark contrast between the above textbook explanation of hedging and reality has led many university classroom instructors to develop "paper trading games." These games generally function based upon actual commodity market prices over the course of a semester. The instructor acts as a broker in

these games and takes paper orders to transact commodity market activities. This approach has the advantage of confronting the student with realistic situations. But it also has the drawback of providing a very limited set of market experiences (i.e., only about 10 to 15 weeks' worth). Compared to a "paper trading game" approach, the Market Risk Game allows the player to see many market situations in a very short period of time. Within hours the equivalent of years of paper trading experience can be simulated. The main disadvantage of the simulation game approach is some loss of realism relative to the paper game. But in the earlier stages of learning the mechanics and strategy of using futures contracts and options, this is believed to be more than compensated for by the varied experiences given to the player by computer simulation.

A number of microcomputer programs have been developed to analyze the futures market for commodities. An extensive listing of these programs can be found in the publication compiled by the North Central Computer Institute entitled "Agricultural Software Inventory." Most existing computer software programs dealing with the futures market are not learning-oriented programs. They generally assume the user has a working knowledge of the futures market and needs computational help in developing and evaluating alternative risk management strategies that make use of the futures market. For example, there are dozens of programs that aid in chart construction and technical analysis of the futures market. Several programs also exist which specifically evaluate commodity options. They include "Ag Option Systems" and "OP-MASTER" (Brugler) among others. Most of these programs focus on calculating the option's premium rather than the use of options in a marketing plan (i.e., they consider the influence of market volatility, time, and strike prices upon the premium). Two microcomputer programs which do focus upon risk analysis and marketing are the "Whole Farm Risk-Rated Microcomputer Model" by Anderson and Ikerd and the "Agricultural Risk Management Simulator" (ARMS) by King and Black. These models consider both production and market risk, but focus much more heavily on production risk than market risk. Thus a void appears to exist in microcomputer programs to teach the use of hedging and options as a market risk management tool.

GAME OVERVIEW

The game functions by simulating daily market prices through random processes designed to reflect realistic market variability. These random processes ensure that no two rounds of the game will be the same. However, care is taken to ensure that current and expected cash market prices, futures prices, and options prices are all simulated with realistic interrelationships. The simulated daily cash and futures prices are graphically displayed on the computer screen. Players have the choice on each trading day of taking an action in the cash market, placing a hedge, or using a put option. Choices that involve speculating on the futures market, such as attempting to hedge when you do not own the cash commodity, are overridden and an explanation of their irrationality as a hedging strategy is given. To aid the players in making their market action decisions, a number of evaluation and information summary displays are available for viewing through a "Trading Alternatives Menu." Various alternatives on the menu display the standard calculations one would undertake to evaluate a hedge or a put option. In each case, the calculations show how cash prices, futures prices, commissions, basis, premiums, etc. are related to determine the expected profit consequences of a selected action. The calculations made are displayed in enough detail to enable the players to repeat them by themselves using paper and pencil. Once a player has taken a position in the market, the consequences of taking this position are updated daily and are available for display. Also the consequences of alternative actions the player could have taken are maintained (i.e., if a player hedged grain, the consequences of having used a put option or remaining unhedged are also shown as the game progresses).

The basic purpose of the Market Risk Game is to serve as a mechanism to provide players with a set of "learning experiences." Through these learning experiences, the fundamentals of hedging and using put options as market risk management tools can be extended and enhanced. The game provides realistic experience in analyzing a market situation, taking an action, and then evaluating the consequences of that action as they evolve. Misconceptions about the market situation or the mechanics of hedging and using put options will lead to unexpected game results. Through repeated play of the game, these misconceptions can be resolved. But this is not the teaching strength

of the game. Its strength lies in that through repeated play of the game the stochastic properties present in the game give the player a perspective of the amount of risk present in the cash market versus the risk remaining after a hedge or put option has been used. An intuitive understanding also evolves with regard to the differences in the opportunities and risks remaining when a hedge versus a put option is used to reduce market risk. Also the random variation present in the game drives home the point that even the best formed risk management plans and expectations are subject to some unexpected variation. Hence, well formulated risk management plans may not always be the best given perfect hindsight. Through repeated play of the game, these dilemmas and an appreciation for their nature are brought out. The player learns to distinguish between poor results due to bad planning versus "bad luck" from market variation not controlled even with good risk management. Perhaps most importantly, players learn to understand and accept the consequences of their decisions, knowing that what they seek and what they achieve may not always be the same, but also knowing that even though their goals are not always fully realized, certain benefits can nevertheless be achieved through the use of options and hedging. This type of maturity and depth of understanding is highly desirable before committing actual resources to the "real" futures market. Classroom presentations and written material do not readily give this kind and depth of understanding. They are not time dynamic, stochastic, or personal with regard to the fact that it was uniquely the player's decision, his/her game, and his/her set of consequences. The Market Risk Game is dynamic, stochastic, and personal.

TARGET AUDIENCES AND INPUT REQUIREMENTS

The program is targeted for use by producers and students (university or high school) with a limited knowledge of the concepts of hedging and options. More specifically, the game is designed to be used as a follow-up application exercise after an introductory short course or series of class lectures on the fundamentals of using the futures market for risk management. By playing the game, players can place the principles they have learned into action and see them work. A secondary use of the game is as a self-tutorial. A User's Manual is available with the game

(Ikerd) which explains the use of the game and the fundamental principles of using hedging and put options for market risk management. After the principles discussed in the User's Manual (and perhaps other supporting literature) have been studied, the game can be used as a device to test one's understanding of these principles. Continued play and experimentation with the game will enhance the player's understanding of the dynamic and stochastic nature of market risk management, whether he/she is self-instructed or has the benefit of formal instruction in the fundamentals of hedging and options use.

Playing the game requires no input data. Likewise it requires no microcomputer expertise. The game is "self-booting" and is entirely menu driven. The game requires anywhere from five to 25 minutes to play. The primary factor affecting the time required to play the game is the market strategy being pursued by the player. Strategies that require specific timing or searching for selected market conditions will take longer. Length of play is also affected by the player's familiarity with the program and by the particular random sequence of market conditions dealt. Players who are unfamiliar with options available and who wish to study the options before each decision will take longer. As players become familiar with the game, most games will require approximately 10 minutes or less to complete.

SEQUENCE OF PLAY AND UNDERLYING SIMULATION FEATURES

Game Orientation and Alternatives Selection

Upon "booting" the program, players are given a choice of playing either a beef cattle or wheat simulation game. The games are similar in concept but incorporate the different decision frameworks and market dynamics of grain versus livestock markets.

After either the cattle or wheat game is selected, the market/asset situation and rules of the game are explained through several screens of text. Differences between the cattle and wheat game become apparent in these discussions. Basically, in the cattle game, players are assumed to own a feedlot which has fixed cost of operation per day whether cattle are being fed or not. Players do not initially own any cattle but may buy cattle at any time. They may hedge their cattle upon purchase with either a futures or options con-

tract, or they may choose not to hedge. Hedging can be done at any time after the purchase date, but once a hedge is placed it cannot be removed until the cattle are sold. Sale of the cattle is not permitted until the last 10 days of the game. This restriction is intended to reflect the fact that cattle cannot be sold until they reach slaughter weight. An 85-day trading period is simulated. A longer period may have been more realistic, but the graphic display capabilities of the microcomputer used limited the simulation length to 85 periods.

In the wheat game, players are assumed to initially have 5,000 bushels of wheat in storage that is unhedged. They may sell the wheat any time during the 85 days of simulated market activity. They also may hedge the wheat any time during the 85 days using either a futures contract or a put option. As in the case of cattle, the hedge cannot be lifted until the wheat is sold. Players are assumed to own their own storage facilities. Hence a \$5-per-day fixed cost exists for storage whether wheat is in storage or not. Interest cost is charged against unsold wheat.

In both the cattle and wheat game, players are told that they will be given a daily score based upon their current profit situation. Penalty points will be deducted if their losses exceed 10 percent of their gross value. Additional penalty points will be assessed when losses exceed 20 percent of the gross value.

Presentation of the Initial Market Situation

Action in the game is started by simulating seven days of futures and cash prices. A forecast of future price expectations is then presented. This forecast is given in a report form such as one might read in a paper or magazine. The effective result of the forecast is to give the player a positive, negative, or neutral price outlook. The computational result of the forecast is to alter or "bias" the way the forthcoming sequence of market prices are simulated. Day-to-day price changes are simulated by drawing a random price change and adding it to the previous day's price. For a neutral price forecast, changes in the futures market prices are drawn from a discrete approximation of a normal distribution with a mean of zero and standard deviation of roughly one-half of the value of a limit move for the contract price in question. The distribution is truncated at a limit move. For a favorable/unfavorable forecast, the distribution is shifted upward/downward by about one-fifth of a standard deviation.

This procedure generally results in prices trending in the direction they were forecasted to move. However, in some cases the randomness of the process will lead to trends opposite of that forecasted. This occasional discrepancy between the forecasted and simulated trend was sought in the design of the game. To further add to the realism of the uncertainty about future price trends, the forecast is updated halfway through the game. The trend inferred in the update is random and independent of the initial forecast. Hence a positive price trend may be reversed and vice versa.

Simulation of the Market Period

The basic screen displayed to players during the simulation is a bar chart showing the futures prices and cash prices for each of the 85 simulated days. An example of this chart as it would appear midway through the game is given in Figure 1. The futures price series, which is denoted by an "F" at the beginning of the charted price series, shows the high, low, and closing price for each day. The cash price series, denoted by a "C," shows only one price. In the upper left-hand corner of the chart, a number is continually displayed which represents the player's current game score.

Beneath the price chart, quotes of the current futures price, cash price, and the premium of two different put options are shown. A prompting statement indicating the possible entries a player can make to proceed with the game is also shown. To proceed, players must enter a number between zero and nine. Entering a value of zero will cause a "Trading Alternatives Menu" to appear on the screen. This menu allows the player to make marketing decisions. The nature of these decisions will be discussed presently. Entering a value from one to nine will cause the corresponding number of days of market activity to be simulated. As these days are simulated the information at the bottom of the chart is updated and the chart is plotted. The options premiums displayed are calculated using an adapted version of the Black/Sholes model presented by Labuszewski. The two option strike prices selected are set at the beginning of the game. One is selected to be "in the money" and the other is selected to be "out of the money."

Day-to-day changes in futures prices are generated randomly as discussed previously. Daily cash prices are determined from the futures prices. This structure should not be

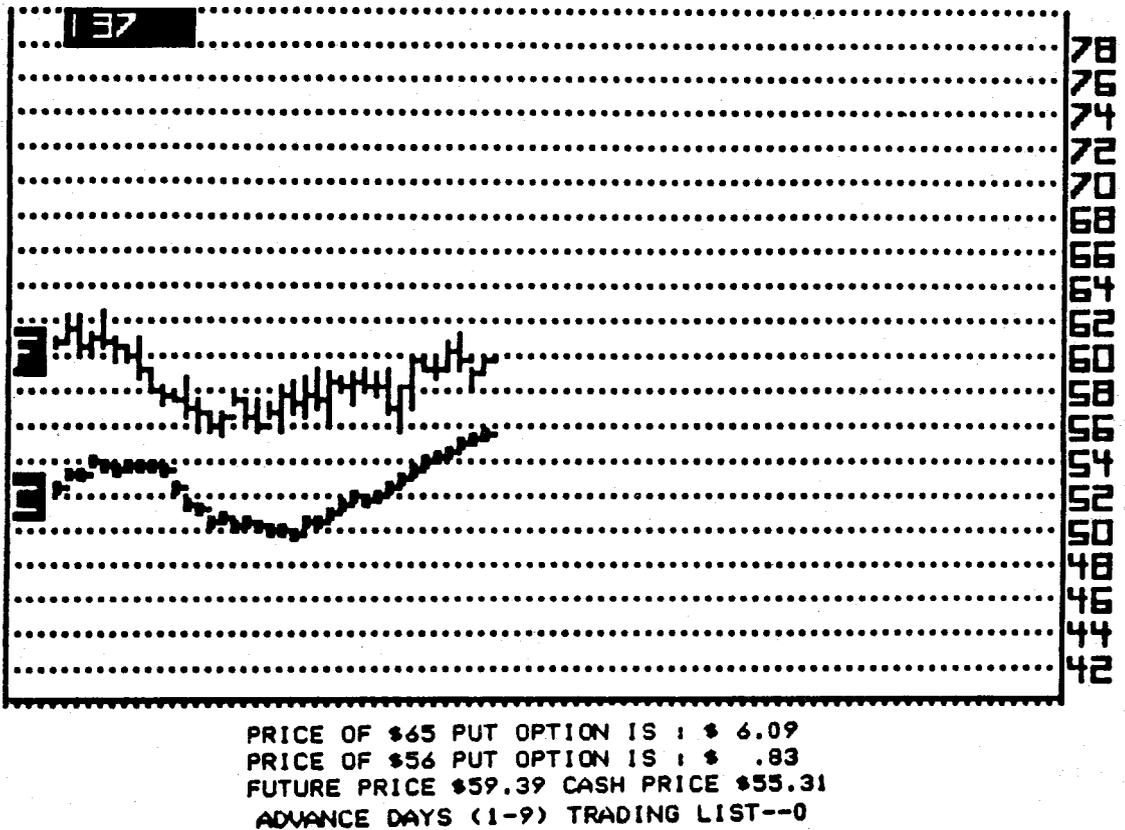


Figure 1. Graphic Display of the Simulated Cash and Futures Prices.

construed as meaning this is the game's interpretation of reality. In fact, the manner in which the cash prices are determined is not evident to the player. The approach used was taken because it was computationally convenient. The cash price is calculated as a moving average of the futures price, plus or minus a basis. The basis used contains both an expected value and a random component. This simulation process results in a more stable cash price than futures price. This is generally the case in the actual markets.

The basis (cash price minus futures price) is generated randomly but with a definite expected pattern. Both wheat and cattle have been assigned an expected basis at the end of the simulation period. Players can use an information menu to find out what these basis values are. The initial simulation period basis is randomly selected. In the case of wheat, it is constrained to roughly reflect storage cost and is, therefore, always negative. In the case of cattle, the initial basis may be either negative or positive. The difference between the initial basis and expected closing basis is

used to calculate the daily rate of change needed to make the initial basis close to the expected closing basis. A daily expected basis is then calculated by adjusting by this amount each day. A random component is added to the daily expected basis in figuring the cash price relative to the moving average futures price. The magnitude of this randomness is reduced over the simulation period. Hence in the early phases of the game, the cash and futures prices are less correlated than in the later phases.

Hedging and Marketing Decisions

A "Trading Alternatives Menu" can be accessed by entering a zero value for days to simulate. This menu allows players to make a marketing decision or to obtain a more detailed analysis of the current situation. Figure 2 presents the respective menus for cattle and wheat. They are slightly different due to the uniqueness of the decision framework for each commodity. Selection of each menu item results in the display of another screen of information. By selecting various menu items,

Cattle Trading Alternatives

- 1) Make cash commitment
- 2) Sell futures
- 3) Buy put option
- 4) Current cash market situation
- 5) Current futures market situation
- 6) Current options market situation
- 7) Summary of current situation -- cash, futures and options
- 8) Return to market action screen
- 9) End game

Press number to choose desired option.

Wheat Trading Alternatives

- 1) Place hedge by selling futures
- 2) Buy put option
- 3) Look at current cash situation
- 4) Look at current hedging situation
- 5) Look at current options situation
- 6) Look at summary of current position
- 7) Return to market action screen
- 8) End game -- sell cash wheat and close out all contracts

Press number to choose desired option.

Figure 2. Trading Alternatives Menu

players can make purchasing, selling, and hedging decisions. But perhaps more importantly from a learning standpoint, they can access analyses of the current situation (i.e., what minimum price could be guaranteed with a put option, what price can be "locked in" with a hedge, what is the current expected breakeven price, etc.). A description of each of these analysis options cannot be presented in detail here. Each was designed to show players all the values used in making the calculations (except in the case of the breakeven price) so they could repeat them with paper and pencil in actual application. Estimated breakeven prices are determined at the time of cash purchase of the commodity in question and are known to players before they make their cash purchase. In the case of wheat, which is owned at the outset of the game, the breakeven price is established automatically at the beginning of the game. Computationally, the breakeven prices are drawn from a random distribution with an expected value about five percent above the cur-

rent futures price. This fact is unknown to the player. The net result is that unless a favorable price trend emerges or a well-timed hedge is placed, the player will generally lose money. Again this was the reality deemed appropriate in the design of the game.

From an educational viewpoint, the most informative of the menu items available is the one titled "Look at Summary of Current Position." This option shows players their current profit situation and game points. But it also shows them what their net profit situation would have been if they had followed several other marketing alternatives available to them. The summary screen simultaneously shows the net profit position of three marketing alternatives. The first alternative displayed shows the consequences of the buying and selling decisions made assuming no hedging is done. The second and third alternatives show the consequences of any futures or options hedging done. For the sake of comparison whenever an options or futures hedge is implemented, the other is also assumed to have been implemented. Thus, for example, a futures hedger can see what would have happened if an options hedge had been used instead or what would have happened if no hedge had been used.

Termination of the Game

Termination of the game is either automatic at the end of the 85 day trading period or at the player's choice. In the case of cattle, the player cannot choose to sell cattle and terminate the game until the last 10 days of simulation. As previously stated, this is intended to represent the fact that cattle cannot be sold until they have reached slaughter weight. Wheat in storage on the other hand can be sold at any time. The purpose of allowing players to terminate play on their own choice is to teach them to use the available basis and outlook information to select a favorable time to sell and lift their hedge. Again information to aid in this decision is available in the alternatives menu.

In many games, players will have made all of their marketing decisions with regard to hedging, buying a put option, etc. in the first few days of the game. At this point all that remains is to wait for the appropriate date to closeout their position. In the case of the cattle game, players cannot closeout their position until the last 10 trading days when cattle have hypothetically reached market weight. Players may proceed through the game in one-

to nine-day intervals and watch the success or failure of their strategy develop by referring to various summary screens accessible through the Trading Alternatives Menu. This process can be an informative learning experience and simulates the reality of having to wait to see the results of one's decisions. But it does take time. An option exists under the "End Game" alternative of the Trading Alternatives Menu to allow the game to automatically proceed to the last 10 days of trading. At this point, control is returned to the player to allow him/her to choose a specific closeout date. This option is available in both the grain and livestock game. Use of this option will speed up the game for experienced players.

Upon terminating the game, the player has the choice of continuing to play the same game with his/her score being carried cumulatively from game to game, starting over with the same commodity and a new score, or switching to the other commodity. The purpose of keeping a cumulative score is to provide an equitable evaluation of the player's marketing skills. The player who consistently chooses better marketing strategies is likely to win a multi-round game while losing one or more individual rounds of the game.

REVIEW AND USE

The program was continually reviewed by several faculty and graduate students during its development. Since its release, informal review of the program has been received from four groups who have used the program. The first consisted of more than 100 university extension personnel and other participants attending an Options Teaching Workshop sponsored by the Chicago Board of Trade. Each person at the workshop was given a demonstration of the program and a copy of it. The second group was formed by a local state agricultural area specialist who used the program in conducting hedging workshops for county extension personnel and producers. Thirdly, the program has been used in several university classes to assist in presenting futures market concepts. It has then been made available to students to use independently for further study. The fourth source of review came from Colorado State University, which has used the program in its Extension Division. Evaluation and feedback from all of the users has been informal, positive, and constructive.

As previously stated, the Market Risk Game is primarily designed to supplement lec-

tures and short courses. A useful way to introduce the game, if possible, is to operate it in a live classroom demonstration using a big-screen T.V. or projection device. One or two games can be simulated with all decisions discussed as they are made and the results critiqued as they evolve. The focus of the demonstration game should not be on the game's computer operational procedures (these are relatively self-explanatory), but instead should be on getting the players to start thinking about how to use the game to learn. A rather distinct learning pattern exists in using the game. Initially players focus upon confirming that the mechanics of hedging and using put options are functioning as they perceive they should. Misconceptions are frequent. In a number of cases, the misconceptions can be self-corrected by the player through the information menus contained within the game. However, it is also useful to have personnel available to answer questions as the game is played. The most frequent questions deal with whether undesired results occurred because of improper use of the futures market or unexpected actions in the market.

After the game has been played three to four times, the players begin to shift their focus from the mechanics of hedging and options toward analyzing which tools/strategies work best under what conditions and why. It is at this point that the game's comparative advantage as a teaching tool is believed to exist. The comparative analyses provided by the game are used to study alternative market situations and to evaluate after-the-fact the success or failure of given decisions. The game's challenge of making a profit is strived for. With experience, players achieve the ability to make profits more frequently than losses. Most find this rewarding and reassuring.

A final and more subtle set of learning experiences is achieved by a number of players. Players learn to accept the fact that in a stochastic world one cannot always "win" even though good decisions are made. They realize that with stochasticness comes imperfect knowledge and the chance that hindsight will reveal that good decisions were made, but they nevertheless turned out to be less than optimal. Players also begin to evaluate exactly what their objectives are and what "winning" means in the context of the game as well as in an actual risk management situation. Trade-offs between remaining unhedged, hedging, or using put options begin

to be intuitively definable in the player's mind. A realization evolves that while there are guidelines and principles to risk management, there are not absolute rules that will always work. Assimilation of these types of understanding generally require several hours of play. Many players are self-motivated to pursue play to this level. Some are not. In a classroom setting, motivation to achieve this level of experience can be enhanced by asking students to report their experiences and answer specific questions about when and why various risk management strategies were and should be used.

AVAILABILITY AND HARDWARE AND SOFTWARE REQUIREMENTS

The program is available for both Apple and IBM microcomputers. The program loads and runs automatically. No supplemental software is required. The Apple version is written in Applesoft BASIC and will run on Apple II+, IIe, and IIc machines with 64K of memory. Only one disk drive is required, and the program is designed for non-color monitors. The IBM version of the program is written in IBM BASIC and uses IBMDOS. It is designed for IBM Personal Computers with at least 256K of memory and requires a Color Graphics Adapter (CGA) card as well as a color graphics monitor. The programs and a User's Manual are available from the author for a handling and processing fee of \$15.

SUMMARY

The Market Risk Game provides a teaching tool capable of complementing and extending the knowledge transmitted through traditional lectures and written material dealing with commodity market risk management. The game provides applied, individualized learning experiences through which the principles and objectives of hedging and options use can be studied in a simulated realistic environment that captures both the dynamic and stochastic nature of risk management. Through the game, a number of key learning experiences can be provided that are not

easily developed by lectures and/or written material. Some of the major concepts, perspectives, and abilities enhanced through these experiences are: a) a perspective of the amount of risk present in the cash market versus the risk remaining after a hedge or put option is used; b) an understanding of the differences in the nature of the risk and opportunities remaining after a hedge is placed versus after a put option is bought; c) the ability to distinguish between bad planning and misconception versus the consequences of uncontrolled risk which may be present even after using hedging or put options; and d) the ability to evaluate a market situation, make a decision, and, most critically, accept the consequences of that decision despite the fact that the results of the decision cannot be predicted with complete accuracy, and knowing that even though the decision may have been the best action at the time it was made, it may not turn out to be the best action given perfect hindsight. The latter point is critical to sustained use of hedging and options.

The above-listed skills go well beyond simply understanding the mechanics of hedging and using options. They address the heart of risk management. Lectures and written material are well suited for introducing the mechanics of using risk management tools, but they do not provide the depth of understanding and experience necessary to impart the type of concepts listed above. In many cases, lectures and written material do not provide the confidence and experience needed to enter the real market with actual money at stake. The Market Risk Game is designed to provide the learning experiences necessary to enhance traditional introductory lectures and written material about market risk management to a level that will permit successful use of hedging and options as risk management tools. The game does not teach one all there is to know about risk management with hedging and options, but it is capable of teaching one to become a confident and functional user of basic risk management strategies using hedging and options.

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