FUTURES MARKETS AND
LOW INCOME COUNTRY RISK MANAGEMENT

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A NOTE ON TERMINOLOGY

Any discussion of futures markets requires the use of specialized vocabulary. The first time a technical term appears in the text, it will be defined. Definitions will not accompany subsequent uses of the term, and the reader should refer to the Glossary at the end of the paper for clarification.

CHAPTER ONE

INTRODUCTION, ORGANIZATION, AND OBJECTIVES

1.1. Introduction

To many people, futures trading is a little understood and rather suspicious activity. The word most often associated with this trading is "speculation", the idea being that most of those involved in futures markets are gamblers in a high stakes game seeking profit at the expense of those outside the game. Any relationship between futures markets and cash markets is generally seen in a negative light - futures trading causing "speculative booms" which distort cash markets and harm many honest traders not directly involved in futures. The idea that futures trading might be a valuable risk management tool for farmers, processors, and other market participants is generally neither understood nor readily accepted.

A quote from a professional futures trader might be helpful in evaluating these ideas:

> The whole purpose of hedging is to remove credit and price risks or minimize them. Hedging is not used to make a profit, either speculative or otherwise, but to insure one already existing or to limit a loss already threatened ... By using the futures market to shift and minimize risk, management is removed from the constant nerve-wracking distractions which are the companions of a speculative (i.e., unhedged) market position, and can concentrate on management decision directed to maximizing profits. (Parrot, pp. 193, 203-204, quoted in Peck, 1978. Parentheses and emphasis added)

In other words, management uses the futures market not primarily to make a profit in its futures transactions, but to create the conditions conducive to making a profit in its primary business activities.

Johnson (1985) supports this contention by indicating that a farmer needing an operating loan would be rational to transact in the futures market, even if he expected a loss on that transaction, if:

1. the transaction locks in an acceptable level of revenues; and

2. this reduced uncertainty allows him to obtain the loan needed to effectively run his primary business - farming.

Far from gambling, such a farmer is making a sound business decision as part of a management strategy which includes the use of futures markets.

Low Income Country (LIC) decision makers might also benefit by incorporating futures trading into their management strategies. For example, the director of a West African parastatal in charge of importing wheat often knows what price he can sell at domestically (possibly a government imposed ceiling), but just as often faces great uncertainty anticipating costs. Futures trading might enable him to establish import prices ahead of time, thereby fixing a margin and allowing him to turn his attention to other planning decisions.

An exporting parastatal often does not know prior to planting what price the export crop (say, maize) will bring after harvest. In response, it may pass its uncertainty on to the country's farmers by not announcing producer prices prior to planting. Farmers faced with this uncertainty often reduce output, and the country as a whole suffers. Futures trading might allow the parastatal to determine price early enough to announce firm producer prices before planting, or even to enter into production contracts with farmers, specifying prices and quantities. The benefits from these actions could include more efficient parastatal management, greater export volume and earnings, and higher producer incomes, with positive repercussions throughout the economy.

The potential benefits of futures trading do not apply only to public sector agencies. Private traders face similar risks, and may obtain similar benefits through informed futures trading.

1.2. Organization and Objectives

This paper is directed toward professionals, economist and non-economist alike, with an interest in the management of import and export risk by LICs. The paper assumes only a basic knowledge of economics, and little or no familiarity with futures markets. It focuses on futures markets while recognizing that they are but one of a number of available risk management tools. The objectives of the paper are:

1. to present a clear description of the theory and techniques of futures trading;
2. to discuss and analyze the potential benefits of futures trading to LIC importers and exporters, and
3. to delineate the conditions under which LIC traders might realize these potential benefits, and how these benefits might be passed on to other market participants.

Chapters Two and Three are general, presenting examples of, but not focusing on LIC use of futures markets. Chapter Two has three parts. The first part illustrates the increased dependence of LIC economies on uncertain international markets, and the resultant need for effective risk management tools. Part two briefly discusses available tools, including futures markets. The final part is a brief initial discussion of the limitations of futures markets. Chapter Three discusses the institutional setting of futures markets, illustrates the mechanics of simple futures trades, and presents basic futures market theory. One should thoroughly understand this chapter before proceeding to chapters four through seven.

Chapter Four begins to focus more on LIC use of the markets. It discusses the potential benefits of such use, both to the traders actually engaged in futures transactions and the producers, consumers, and other market participants affected by their actions.

Chapters Five and Six focus exclusively on LIC use of futures markets. Chapter Five discusses the conditions which must prevail, both within the trading agency and within the relevant cash and futures markets, if LICs are to realize the potential benefits of futures trading. Chapter Six presents a simulation study of a "typical" importing LIC's use of the wheat futures market over the past ten years. Chapter Seven briefly summarizes the conclusions drawn from the previous six chapters, develops recommendations which follow from the conclusions, and suggests areas of further research.

CHAPTER TWO

RISK MANAGEMENT IN THE WORLD ECONOMY

2.1. Introduction

The international economy of the 1970's and 1980's has been a risky arena in which more and more Low Income Countries (LIC's) have had no choice but to compete. The dissolution of the Bretton Woods Agreement in 1972 paved the way for a system of floating exchange rates, adding a previously absent element of uncertainty to the domestic currency value of a country's trade flows. The oil shocks and commodity price explosions of 1973 and 1979 contributed to an LIC export boom, but also increased the uncertainty they faced. Meanwhile, protectionist agricultural policies in industrial countries destabilized international markets, and may have increased the commodity price fluctuations (World Bank, 1986). These policies continue to influence international markets today. Furthermore, rampant inflation in the U.S. and other Industrial market economies, caused in large part by the oil and agricultural commodity price increases,[1] pushed nominal as well as real interest rates to record levels, and greatly increased their variability (Figures 2-1 & 2-2). This followed a period of very low real rates between 1974 and 1978 (IMF, 1984), and increased both the cost and uncertainty associated with LIC borrowing in international capital markets.

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[1] This inflation may have been avoided had these countries not expanded their money supplies. But tight monetary policy would likely have caused pronounced economic contraction. The price boom, then, confronted these countries with a difficult choice they otherwise would not have had to make. They chose inflation instead of economic contraction.

Figure 2–1. U.S. Inflation
1970–1985
(% Change in CPI)

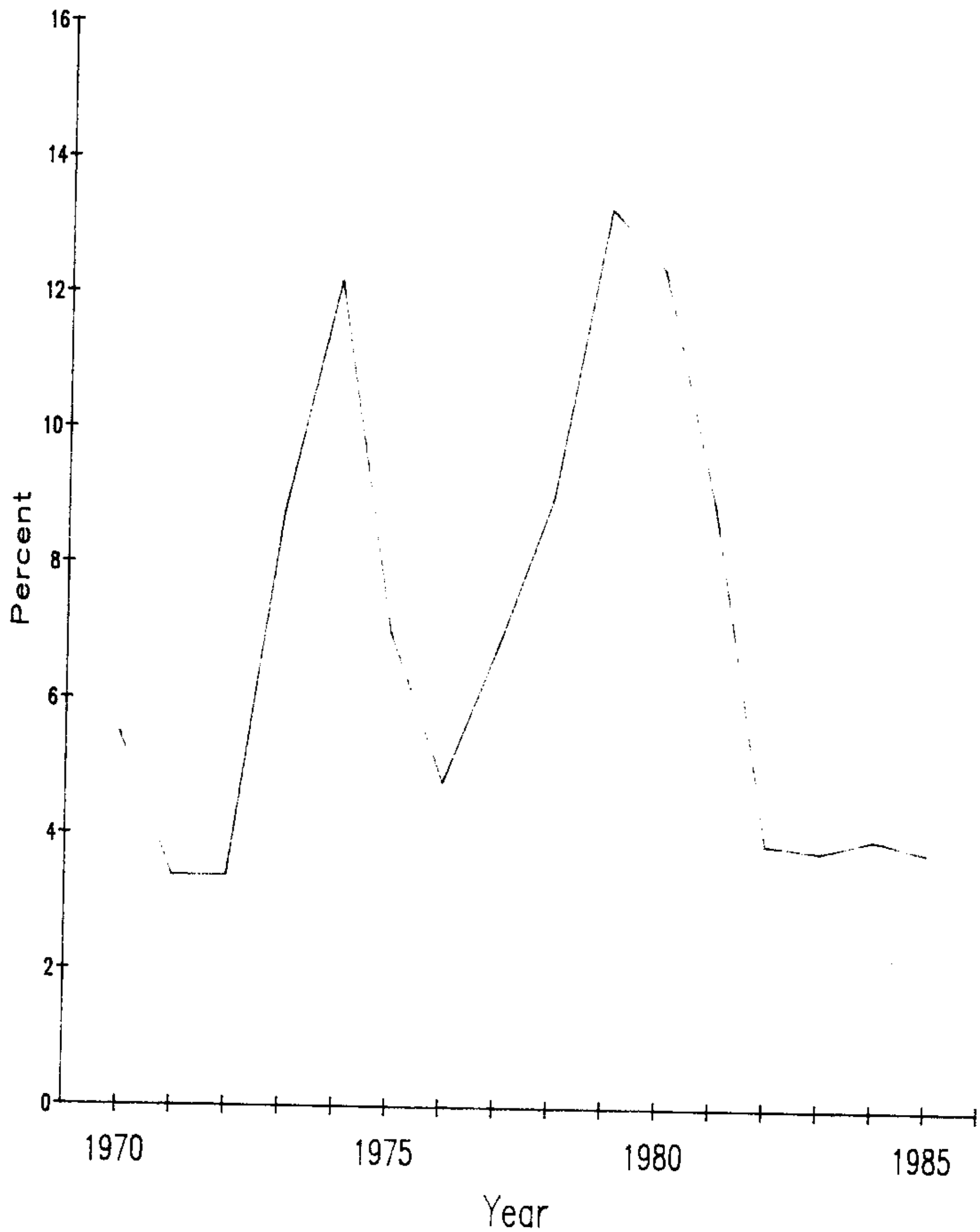
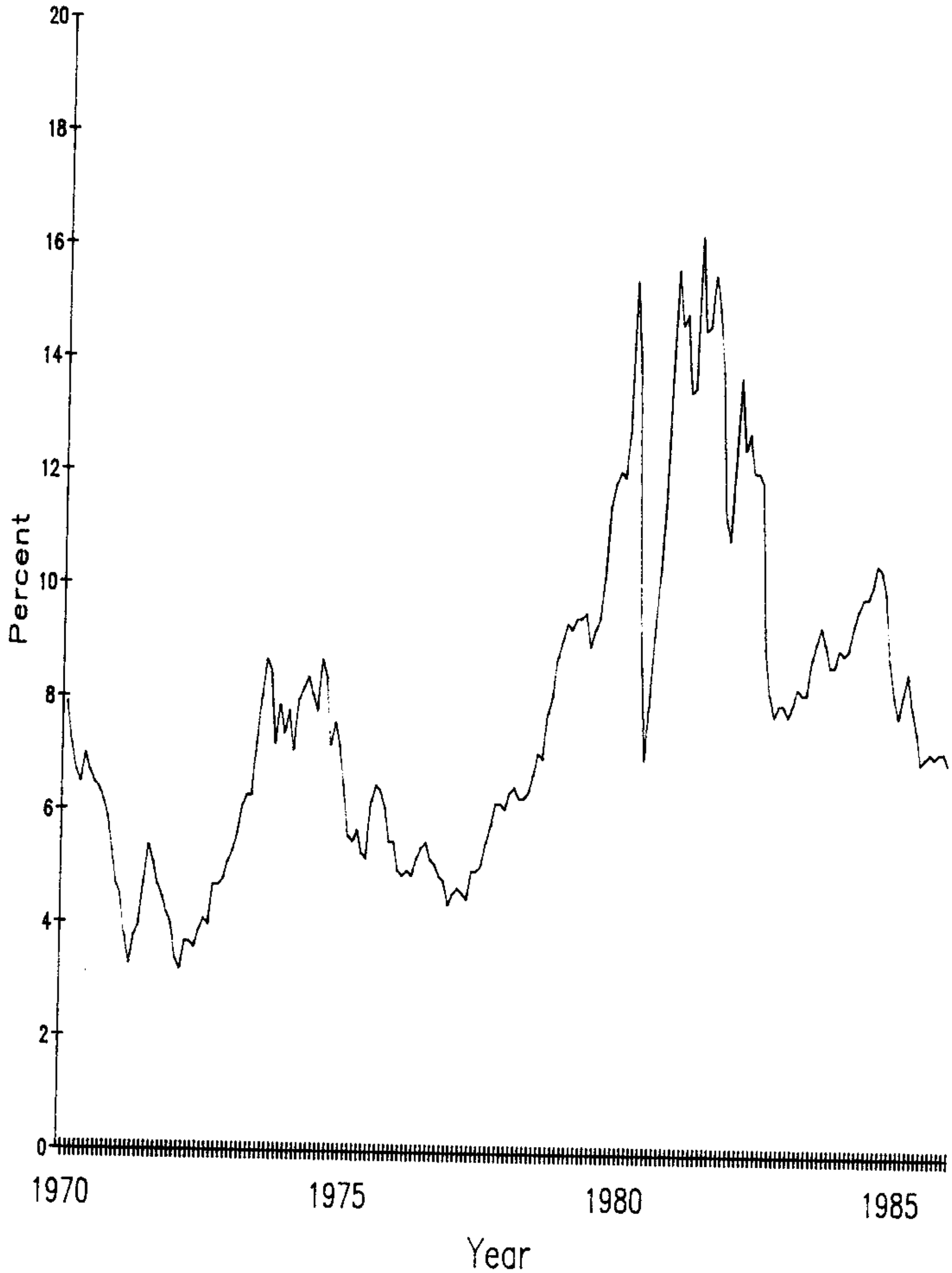


Figure 2-2. Monthly U.S. T-bill Rates
1970-1985



As this cost and uncertainty were increasing, LIC's were dramatically increasing their participation in international markets. The oil price boom of 1973 produced a current account surplus for oil exporting developing countries of $69 billion by 1974, compared to only $7 billion in 1973. In an attempt to recycle these surpluses, international commercial lending surged, as did non-oil developing country borrowing (largely to facilitate a more gradual adjustment to the oil and agricultural commodity price shocks). From 1973 to 1975, external debt for these countries almost tripled, from $130 billion to $337 billion (IMF, 1984). By 1983, and after another oil price surge, this debt had risen to $669 billion.

During this period, the structure of LIC debt was reoriented toward private lenders at commercial terms and short maturities. According to the IMF (1984),

> These changes in the composition of their external debt made the debt-servicing capacity of developing countries more vulnerable to rising interest rates and falling exports. The shift ... meant that the developing countries experienced a rapid increase in their debt service as interest rates rose during 1979-81.

This increasing debt service corresponded with a decline in the annual export earnings growth of non-oil developing countries from 10% in 1978 to 1.7% in 1982. As a result, the external debt service ratio (ratio of total interest and amortization payments to total export revenues) of these countries rose from 27% in 1981 to 32% in 1982 and 37% in 1983.

While Western Hemisphere countries accounted for the bulk of the commercial borrowing and had the highest debt service ratios, African nations were not immune to the problems discussed above. Between 1977 and 1983, debt relative to exports rose from under 140% to over 220% for the African continent (excluding South Africa). Debt service ratios during the same period rose from just under 12% to over 25%. This was despite the fact that most African debt was not commercial in origin, and therefore not as vulnerable to the rising interest rates of the late 1970's and early 1980's.

African countries were especially hard hit by the downturn in the world economy at the beginning of the 1980's. After rising steadily in the 1970's, export revenue fell sharply from 1980 to 1983 (Figure 2-3). During the same period, import volume fell by 12%, due both to falling export revenue and increasing debt service ratios.

Despite these developments, cereal import expenditures remained at historically high levels, having risen rapidly during the 1970's while wheat and maize prices actually fell (Figures 2-4 & 2-5). As a result, many African countries have had to devote a growing portion of export revenues to cereal imports. Table 2-1 shows the trends for cereal imports as a percent of total exports for Africa as a whole, as well as selected countries. The trend throughout the continent is clearly towards greater use of export revenues for basic staple imports. Combined with rising debt service ratios and falling total exports, this trend implies serious food insecurity for many African nations.

Figure 2–3. Nominal Export Revenue, Africa, 1970–1983 (Million U.S. $)

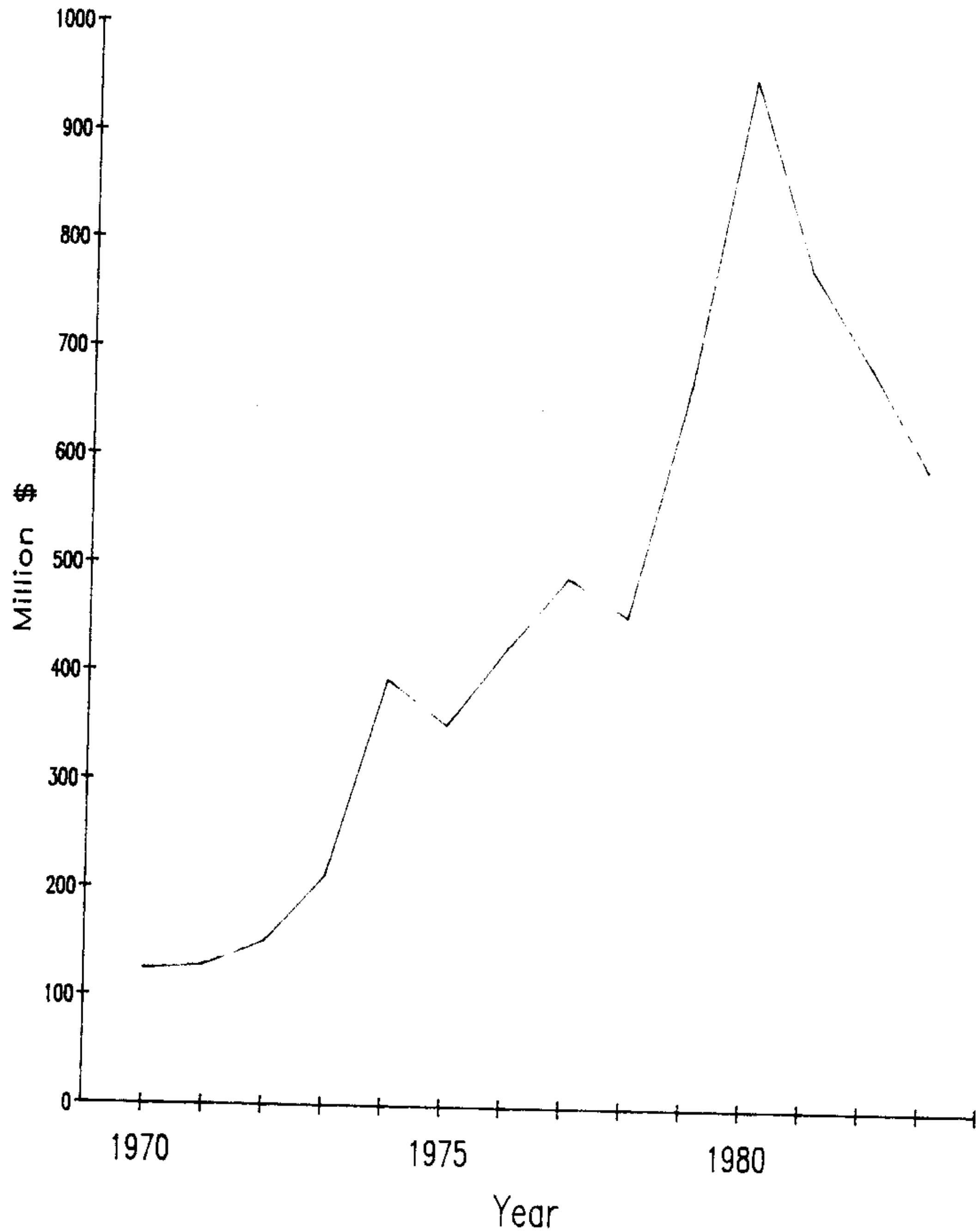


Figure 2-4. Nominal Cereal Imports, Africa, 1970-1983 (Million U.S. $)

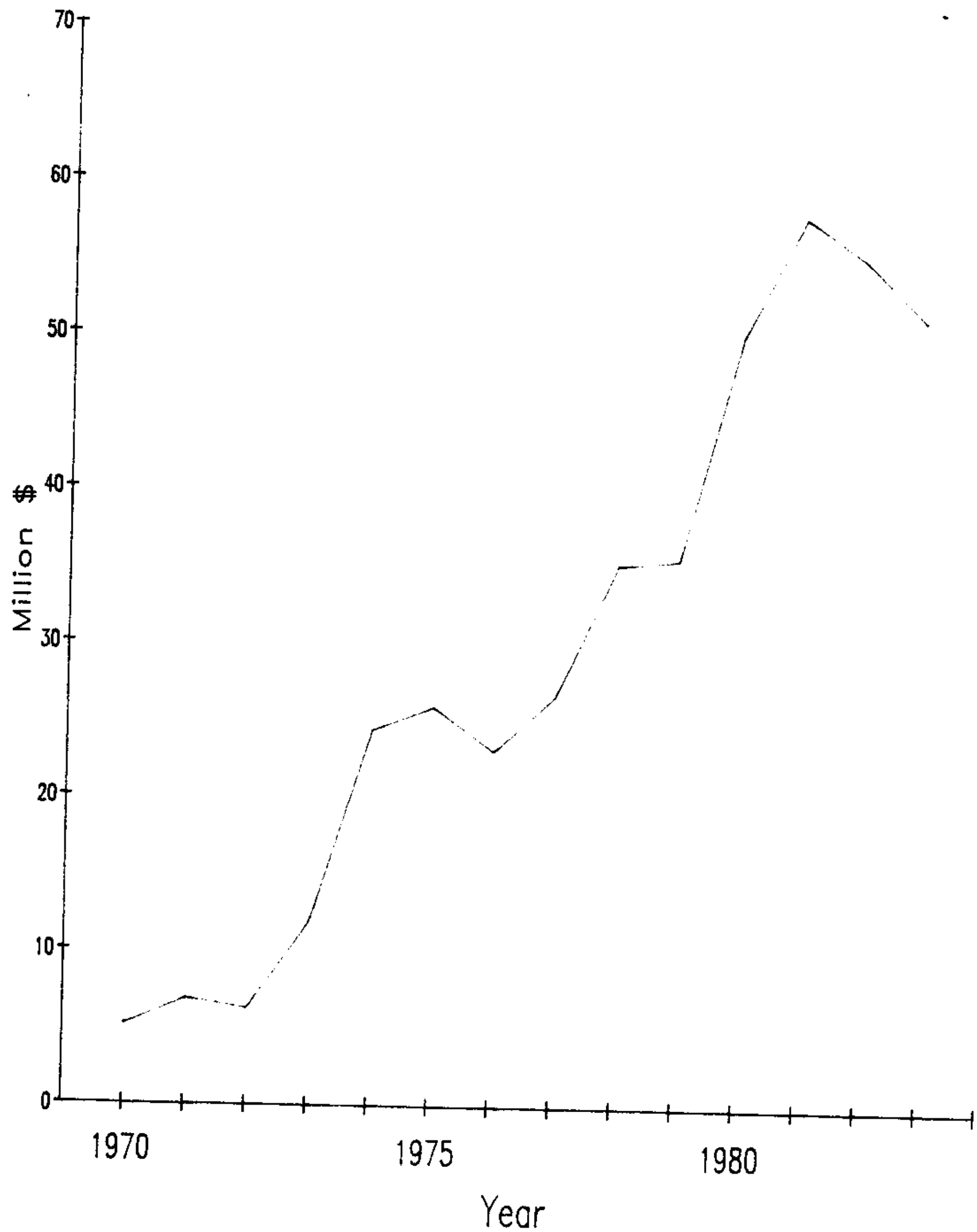


Figure 2-5. Nominal U.S. Corn and Wheat Prices 1970-1984 ($/MT)

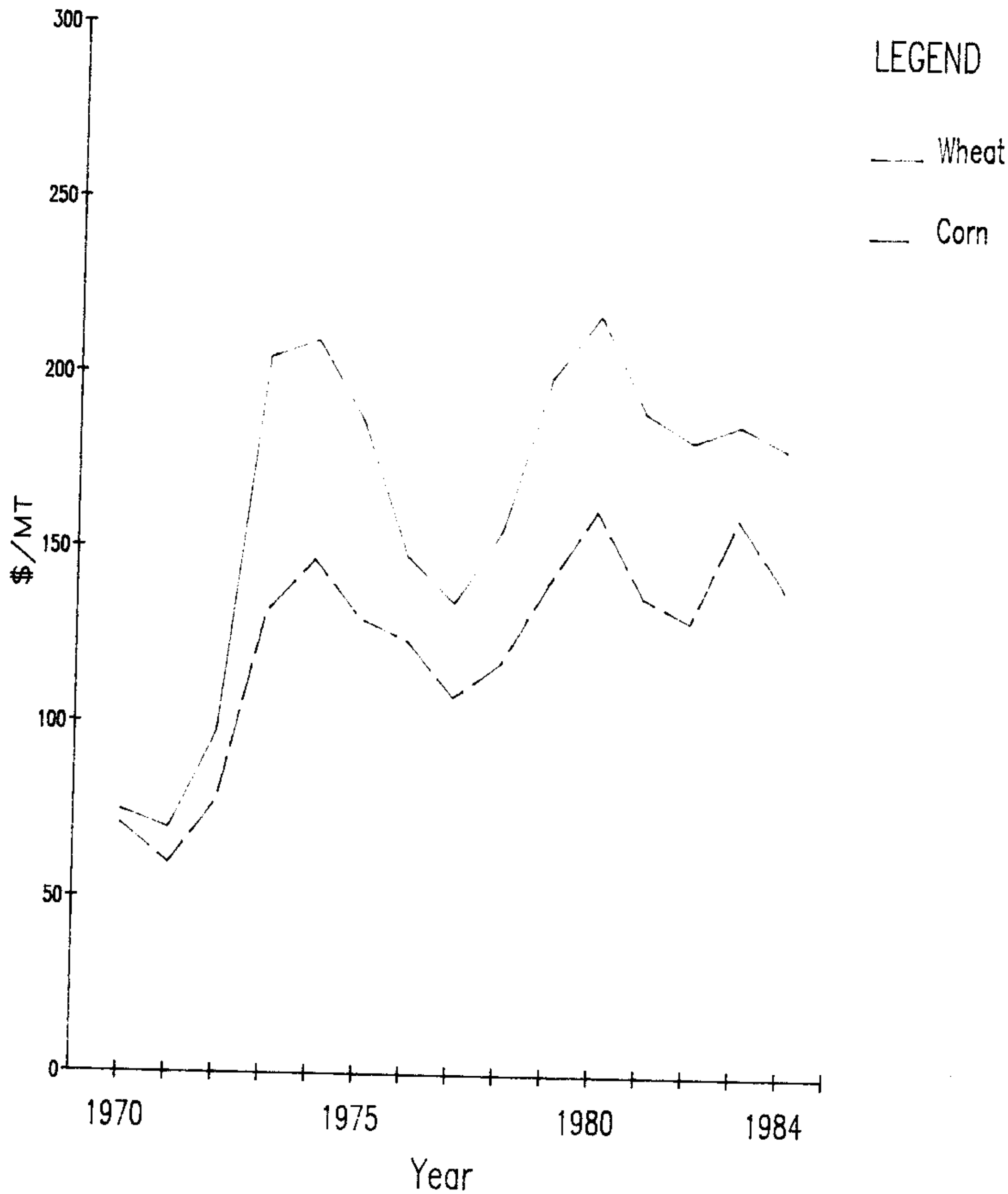


Table 2-1. Cereal Imports as a Percent of Total Export Revenue, 1974 & 1983, and Trend, Selected African Countries

Country	(cereal imports/total exports)*100		
	1974	1983	Trend*
Africa	4.1	8.6	.25
The Gambia	13.3	18.0	1.57
Mozambique	5.0	45.0	2.86
Ivory Coast	3.3	6.4	.26
Ghana	4.0	7.8	.23
Kenya	.80	3.6	.39
Mali**	82.0	24.0	4.40

*Percentage point increase in import/export ratio per year, equal to the trend coefficient from a least squares regression of the ratio on time. All coefficients are significant at .05

** Trend is for 1977-1983. Ratio increased dramatically from 1970-74, fell from 1974-77, then rose steadily

Sources: FAO Trade Yearbook, selected years; UN International Trade Statistics Yearbook, selected years

The above discussion indicates that LIC's as a whole, as well as many of the most food insecure African countries, are increasingly dependent on the world economy. They are therefore increasingly exposed to the risks associated with the variable exchange rates, interest rates, and commodity prices of that economy. Effective management of these risks is one of the factors that will determine the future course of these countries' economic health. The next section gives a brief overview of available risk management tools.

2.2. <u>Available Price Risk Management Tools</u>

Futures markets are not the only risk management tools available to an exporting or importing country. Other tools include forward contracting, compensatory finance, and option markets. International Commodity Agreements have been pursued in part to stabilize export earnings of LIC's. Export diversification and import substitution are strategies that some countries have used to moderate the impact of variable world commodity prices. A well managed import/export operation will choose among these tools as appropriate, and may or may not make use of futures markets. This section will briefly discuss the IMF Compensatory Financing Facility, forward contracting, option markets, and futures markets.

2.2.1. Compensatory Finance

There are currently two compensatory finance schemes in existence: the International Monetary Fund's Compansatory Financing Facility, and the European Community's STABEX scheme. Each represents a different approach to the problem of export earnings instability.

In 1963 the International Monetary Fund created its Compensatory Financing Facility (CFF) to aid LICs in dealing with unstable export revenues. In 1981, the CFF was amended to include imports. As currently organized, the facility allows any of the 137 member countries to borrow at below market interest rates to cover temporary shortfalls in net exports, provided the shortfalls were largely beyond the control of the borrowing government. Net export shortfall is calculated as:

(TREND EXPORTS-ACTUAL EXPORTS) + (ACTUAL IMPORTS-TREND IMPORTS)

From 1978 to 1983, drawings from the CFF rose from SDR 322 million to SDR 3.7 billion, before falling to SDR 1.2 billion in both 1984 and 1985. Since the facility was amended in 1981 to include shortfalls due to import costs, only SDR 962 million have been drawn specifically due to excess imports, with SDR 464 million coming in 1985 alone. The rest of the drawings have been due to export shortfalls.

A World Bank study (Huddleston, et.al., 1984) concluded that such a facility would increase average food consumption stability by between 55% and 85%, depending on a country's internal policies. It would also significantly decrease the probability of consumption falling below 95% of trend, though the size of this decrease again depends on internal policies.

To borrow from the CFF, a country must demonstrate an overall balance of payments problem. If export shortfalls from one crop are offset by increased revenues from another, the country may not borrow. This is not the case with the European Community's STABEX scheme. Under this scheme, any of the EC's 66 African, Caribbean, and Pacific (ACP) states can borrow to cover export shortfalls from individual crops. Excess exports from one crop do not offset shortfalls from another.

The scheme has strong grant elements. All loans are interest free, and the least developed countries pay back nothing. Repayment may be waived for any country if exports remain depressed for a long period. During the period 1975-1982, STABEX transferred $800 million to 44 ACP countries. Between 28% and 53% of all claims were rejected during any one year.

2.2.2. Option Markets

An option is a "unilateral contract which gives the buyer the right to buy or sell a specified quantity of a commodity at a specific price within a specified period of time, regardless of the market price of the commodity" (CFTC, 1985). While a futures contract locks in a specific price or margin which may end up higher or lower than what could have been obtained in the cash market (see below), an option contract is more flexible. It establishes only a minimum price for a seller, or maximum price for a buyer, leaving each the opportunity to capitalize on favorable market moves by not exercising the option.

Options are traded on the same exchanges as are futures contracts. Since beginning with four contracts in 1982 (1 each for sugar and T-bonds, and two for gold), the number of contracts has grown to 24. Included are sugar, soybeans, cotton, wheat, corn, T-bonds, T-notes, three month eurodollars, Deutschmarks, Swiss Francs, and British pounds. The trading volume and number of commodities, currencies, and financial instruments covered by options is likely to continue to grow in the future.

2.2.3. Forward Contracting

A forward contract is a bilateral agreement to deliver (or accept delivery of) a specified quantity of a good at a specified future time and location, at an agreed upon price. The price is usually specified as a certain premium over a specific futures contract price. This price may be that prevailing at the time of the agreement for the contract expiring near the time of delivery. For example, a forward contract signed in May for December delivery would likely use the current price of the futures contract which expires in December. In this case the price level is fixed at the time of the agreement. Alternatively, the parties might use the price prevailing at the time of delivery for a specific futures contract. In this case, the forward contract would specify that the price to which the premium will be added will be that prevailing at delivery in December for the December futures contract. Here, only the premium is established at the time of the agreement, and some uncertainty as to final price level remains.

Forward contracting has been practiced for many years. Its utilization requires less technical expertise than does that of futures or option markets, and in part for this reason it is probably the most common contracting method for most LIC importers and exporters. Forward contracts do have weaknesses, however. First, neither party puts down money at the time of agreement to assure that they will honor the contract. If the contract has a fixed price, there will therefore be an incentive for one party to default if the price moves against him between agreement and delivery. Second, forward contracts are not standardized, and therefore cannot be traded. A trader who enters into a contract and decides later that she does not need (or cannot supply) the commodity, must either honor the contract or default. Despite these problems, active forward markets exist for foreign exchange, internationally traded commodities (agricultural and non-agricultural), and freight rates.

2.2.4. Futures Markets

Futures contracts are essentially standardized forward contracts. Being standardized, they can be more easily traded, and therefore form a more liquid market[2] than do forward contracts.

Viewed from the perspective of a low income importing or exporting country (or a firm within such a country), futures markets provide a means of "locking in" a current price for a future cash transaction, thereby reducing the uncertainty associated with that transaction. These markets offer a form of price insurance, and can facilitate the day-to-day operations and short to medium term planning activities of the organization that uses them effectively.

Organized futures markets in the U.S. first emerged for corn in the mid-1800's in Chicago, and were largely confined to agri-

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[2] Loosely, a liquid market is one in which a seller (buyer) can, at any time, quickly and inexpensively find a buyer (seller) with whom to transact. Market liquidity encourages and is in turn increased by large trading volume.

cultural commodities until the 1970's. With the worldwide economic instability that erupted in that decade, the number and types of futures markets increased dramatically. Markets for livestock products, industrial materials, metals, financial instruments, and currencies suddenly emerged and thrived. Of the approximately 185 futures contracts designated to trade in 1984, 148 were developed since 1970. There is no doubt that the climate of worldwide economic uncertainty contributed strongly to the initial development and continued success of these new contracts.

2.2.4.1. **Agricultural Commodity Futures:** The agricultural commodities most heavily traded on U.S. futures markets in 1985, by number of contracts traded, were soybeans, corn, wheat, soybean oil, soybean meal, and sugar, in that order. Other agricultural commodities of interest to LIC's which were traded in 1985 include coffee, cocoa, cotton, and rice, though the last market was quite small. The various U.S. exchanges on which these commodities are traded, contract sizes, and number of contracts traded in FY 1985 are shown in Table 2-2. The number of grain and oilseed contracts traded more than doubled between 1977 and 1981, remained fairly steady between 1982 and 1984, and fell sharply in 1985.

2.2.4.2 **Currency Futures:** Currency futures markets began to emerge in 1972, following the break-up of the Bretton Woods system. While a highly liquid forward market had existed for over a century, the currency

Table 2-2. U.S. Futures Exchanges and Selected Agricultural Commodities for Which They Have Contracts

Futures Exchange	Commodity	Contract Size	No. of Contracts Traded, 1985
Chicago Board of Trade(CBOT)	Corn	5,000 bu	6,503,220
	Wheat	5,000 bu	2,176,635
	Soybeans	5,000 bu	7,215,779
	Soy oil	60,000 lbs	3,595,503
	Soy. meal	100 tons	3,265,961
MidAmerica Commodity Exchange	Corn	1,000 bu	479,380
	Wheat	1,000 bu	378,285
	Soybeans	1,000 bu	796,981
Kansas City Board of Trade	Wheat	5,000 bu	776,900
Minneapolis Grain Exch.	Wheat	5,000 bu	309,858
New York Cotton Exch. & Assoc.	Cotton No. 2	50,000 lbs	676,341
Coffee, Sugar, and Cocoa Exch.	Coffee "C"	37,500 lbs	516,436
	Sugar No. 11	112,000 lbs	2,853,647
	Cocoa	10 MT	828,811
Chicago Rice & Cotton Exchange	Rice, Milled	120,000 lbs	0
	Rice, Rough	200,000 lbs	76
	Cotton	50,000 lbs	1,706

Source: Commodity Futures Trading Commission, Annual Report 1985 futures contracts prospered under the new economic conditions. Their primary advantage over the forward market is that they provide small customers with access to currency markets under highly competitive conditions (Brown and Geisst, 1983). LICs are somewhat limited in their use of these markets in that their currencies are generally not convertible, meaning that they cannot be traded in foreign exchange markets. These countries must first earn convertible foreign exchange through exports or receive it as aid, and can then trade these convertible reserves on futures exchanges. See Appendix A for a more detailed explanation of exchange rate arrangements.

Table 2-3 shows the currencies traded, the U.S. exchanges on which they are traded, and the number of contracts traded in FY 1985. The number of currency contracts traded has increased over 42 times since 1977, from under 400,000 that year to over 16,000,000 in 1985.

2.2.4.3 **Interest Rate Futures:** Financial instrument futures began to emerge in 1975, following the interest rate jump in 1973 and 1974. Unlike the currency market, no financial instrument forward market existed when the futures market in these instruments began. Possibly as a result of this, their growth has been even more spectacular than that of currency futures. Between 1977 and 1985 the number of contracts traded per year increased almost 120 times, to over 70,000,000. There are a large number of financial futures, but by far the most popular are the International Monetary Market's 90 day treasury bill and the Chicago Board of Trade's 20 year

Table 2-3. U.S. Futures Exchanges and International Currencies for Which They Have Contracts

Futures Exchange	Currency	Contract Size	No. of Contracts Traded, 1985
International Monetary Market	British Pound	25,000	2,616,483
	Can. Dollar	100,000	432,472
	Deutsche Mark	125,000	6,530,280
	French Franc	250,000	10,834
	Japanese Yen	12,500,000	1,964,597
	Mexican Peso	1,000,000	13,551
	Swiss Franc	125,000	4,551,347
MidAmerica Commodity Exchange	British Pound	12,500	20,188
	Swiss Franc	62,500	112,529
	Deutsch Mark	62,500	91,353
	Japanese Yen	6,250,000	30,124
	Can. Dollar	50,000	3,692

Source: Commodity Futures Trading Commission, Annual Report 1985

Table 2-4. Futures Exchanges and Selected Financial Instruments for Which They Have Contracts

Futures Exchange	Instrument	Contract Size	Maturity	No. of Contracts Traded, 1985
Chic. Board of Trade (CBOT)	U.S. T-bond	$100,000	20 yr	36,697,688
	U.S. T-notes	$100,000	6.5-10 yr	2,501,942
Int'l Monetary Market	U.S. T-bill	$1,000,000	90 day	2,657,319
	Eurodollar	$1,000,000	3 mth	8,211,904

Source: CFTC, Annual Report 1985

treasury bond. Table 2-4 presents information on selected financial futures.

2.2.4.4. **The Interaction of Commodity and Currency Futures**: In buying or selling in international commodity markets, a LIC trader is concerned about two prices. One is the price of the convertible currency earned (or paid) in terms of other convertible currencies. This is important, for example, for a firm that has earned French francs through exports, and needs U.S. dollars to import grain. The second price of concern is the domestic currency price of whatever is traded. For example, the trader buying grain with U.S. dollars (which were purchased with French francs) must make a profit in the domestic market, and must therefore know the domestic currency cost of the grain. Exchange rate movements can often be more important than U.S. dollar price movements in determining these two prices. Ignoring these foreign exchange movements would be a serious mistake for any LIC trader.

For example, Senegal earns French francs from exports to that country, and periodically imports U.S. corn. Assume it is 1983, and Senegal decides in August to import 300,000 bu for shipment in January. Among the buying agency's options are: 1) do nothing now, and buy in the cash market in late December; 2) use futures markets to lock-in a corn price now, 3) use futures markets to lock-in a French franc/U.S. dollar exchange rate now, and 4) use futures markets to lock-in both prices now. The choice depends in part on the direction that the agency expects each market to move between now and late December, but also on the degree of uncertainty it is willing to accept. The relevant prices and resulting import costs of each strategy are shown in Table 2-5.[4]

Trading French francs on the futures market reduced the price by FF0.91, while trading corn reduced it by only FF0.17. Trading both resulted in a combined savings of FF1.08.

Of course, there is no guarantee that futures trading will reduce the import price. Table 2-6 shows a commodity/foreign exchange hedge which resulted in higher a higher price. The trader in this example hedged corn and French francs in May, 1978, using that year's September contracts. Over the long run, hedging will likely have an insignificant effect on price, with some trades reducing it and others increasing it. The idea of hedging is not to necessarily obtain better prices, but to reduce uncertainty and help the manager obtain an overall business profit.

2.3. Limitations of Futures Markets

While futures markets can be effective risk management tools under appropriate conditions, there are certain things they cannot be expected to do. While these issues will be discussed in more detail later in the paper, they deserve mention from the outset.

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[4] The mechanics of these trades, and the manner in which they establish the above prices, will be illustrated in the next chapter.

Table 2-5. Impact of Foreign Exchange & Commodity Price Movements on Import Costs: Decreased Cost

	Strategy			
	Buy only in the cash market (no futures trading)	Use Futures to lock in only the corn price	Use futures to lock in only the FF price	Use futures to lock in both the corn and FF prices
COST(FF)	28.54/bu	28.37/bu	27.63/bu	27.47/bu

Sources: Corn prices from Chicago Board of Trade Yearbook, 1983. Foreign exchange futures prices from International Monetary Market Yearbook, 1983.

Table 2-6. Impact of Foreign Exchange & Commodity Price Movements on Import Costs: Increased Cost

	Strategy			
	Buy only in the cash market (no futures trading)	Use futures to lock in only the corn price	Use futures to lock in only the FF price	Use futures to lock in both the corn and FF prices
COST(FF)	9.19/bu	10.64/bu	9.90/bu	11.45/bu

Sources: Corn prices from Chicago Board of Trade Yearbook, 1978. Foreign exchange futures prices from International Monetary Market Yearbook, 1978.

First, futures markets cannot, except under special circumstances, protect against long term (5 years or more) adverse price trends. Futures prices are in many respects informed estimates of future cash prices. As such, they are affected by the same supply and demand conditions which determine cash prices. In addition, arbitrage[5] ensures that futures prices and cash prices in the vicinity of the futures exchange converge at contract expiration. As a result, year-to-year futures prices move with cash prices, largely eliminating the possibility of using futures markets to avoid adverse trends in cash markets.[6]

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[5] Arbitrage is the process of simultaneously buying an asset in one market and selling it in another, with the objective of profiting from price differences between the two markets. For example, if Chicago cash corn prices in December are above the CBOT December corn contract price, traders holding stocks of corn could sell them, buy an equal volume of corn in December futures contracts, and accept delivery on the contracts when they expire. The trader has the corn she needs, and has earned a profit by arbitraging the two markets. If enough traders do this, cash corn prices will be driven down, and the December corn futures price will rise, until the two prices are equal and no further profit opportunities exist. Note that it is the ability to deliver and accept delivery on a futures contract that makes arbitrage possible. In turn, arbitrage performs the important economic function of eliminating price differences between comparable commodities.

[6] An importer (exporter) could use futures to modify the impact of long term price rises (declines) if these prices rose (fell) consistently over the entire period in question (e.g., if each month's or week's average price exceeded the previous period's average price). The importer (exporter) would buy (sell) futures a few months before the cash transaction, then sell (buy) at a higher (lower) price when making the cash transaction. An importer's costs would be decreased below what they would have been, while an exporter's revenue will have increased. However, such consistent price trends over 5 or more years are almost nonexistent. Figure 2-2 and Figure 2-5 demonstrate this for monthly T-bill rates and yearly wheat and corn prices. Anyone trading wheat or corn between 1973 and 1984 would have made a lot of money in some years and lost a lot in others, with a largely neutral effect on average price. Finally, even if such consistent trends could be found, futures trading would modify rather than eliminate the effects of adverse trends.

Second, while some authors suggest otherwise, most studies indicate that futures markets will likely not protect against year-to-year price variability. The fundamental reason is identical to that given above: futures prices are reflections of expected cash prices, and move with those prices. In general, futures prices are no more nor less variable than cash prices on a year-to-year basis, so that futures trading can be expected to have a neutral effect on year-to-year price variability.

Third, futures trading does not guarantee better or less variable prices even in the short run. In general, the expected profit from futures trading is zero, and the profit for a given trade may be positive or negative. This highlights the importance of sound market analysis and quick response to moves in the market, issues which will be discussed in more detail in a later chapter.

Short run price variability may be most usefully viewed as deviations from some subjectively determined expected price. It is precisely this variability that futures markets are designed to reduce. However, they will do so only to the extent that cash and futures prices move in predictable ways relative to each other. If the basis - the difference between the cash and relevant futures prices at a point in time - is less predictable than is the cash price itself, futures trading may increase rather than decrease deviations from expected prices. The analysis in Chapter Six provides some guidance as to how unpredictable the basis can be before hedging becomes inadvisable.

Finally, the level of direct futures market trading appropriate for a given country depends on a number of factors. Import or export quantity uncertainty reduces the effectiveness of hedging. Basis unpredictability also reduces its effectiveness. The combination of these two may eliminate futures markets as practical risk management tools for some countries (See Chapter Six). Futures contract specifications, such as variety, quality, delivery &/or settlement provisions, and margin requirements affect the desirability of the contract for specific traders. Finally, the analytical capability and institutional characteristics of the buying agency play important roles.

These limitations must be understood by anyone considering using futures markets as risk management tools. The first three are general, and apply to anyone trading in futures. However, basis and quantity predictability, suitability of contract specifications, and the analytical capacity and institutional characteristics of the buying agency must be analyzed on a country-by-country basis. The result is that for some countries, futures trading could be a very valuable activity, while for others it might be inadvisable.[7] The decision in each case should be a matter of informed judgement. In the chapters that follow, these critical issues will be discussed in detail. The hope is that this paper will provide some of the understanding necessary to begin making these informed judgements.

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[7] Even those countries for whom direct futures trading might be inadvisable would benefit from greater familiarity with futures markets. The informational benefits to be derived from this familiarity are discussed in Chapter Three.

CHAPTER THREE

FUTURES MARKETS: INSTITUTIONAL FEATURES, TRADING MECHANICS, AND MARKET THEORY

3.1 Introduction

Futures markets are widely used as risk management tools among a variety of U.S. and international firms. Major grain companies' export and import prices are based on commodity futures prices. For a LIC to deal on an informed basis with these companies, and to use futures markets effectively itself, requires a thorough understanding of the institutional features, trading mechanics, and theory of futures markets. This chapter will discuss the most pertinent elements of each.[1]

3.2 Institutional Features

Futures contract trading is centralized on exchanges, which are regulated in the U.S. by the Commodity Futures Trading Commission (CFTC). All contracts are standardized, specifying delivery months, trading units, daily price movement limits, position limits (the maximum number of open contracts a single trader can hold at one time), quality, and delivery specifications. Only prices are not specified, being established by open outcry at the exchange. These institutional features make futures markets highly liquid and largely eliminate the exercise of market power, thus approximating the theoretical ideal of perfect competition (Working, 1962). As a result, futures markets are

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[1] The theory section will be confined to commodity futures markets, not touching on foreign exchange and interest rate futures.

excellent price discovery mechanisms, and futures quotations serve as reference prices for virtually all internationally trader wheat and maize. The Chicago Board of Trade (CBOT) soybean contract is shown in Figure 3-1. See Appendix D for the specifications for other agricultural commodity and currency contracts.

The contract standardization which makes futures markets excellent price discovery mechanisms at the same time makes them inconvenient mechanisms for transfering ownership. This becomes clear when one examines the CBOT's soybean contract. First, the contract limits when one can take or make delivery. For example, one could not use the contract to take or make delivery on soybeans in October. Second, trading is done in units of 5,000 bushels. One could not use the contract to buy or sell, say, 43,000 bushels of soybeans. While this is not a serious limitation, it is one which cash and forward markets generally do not have. Finally, and most important, one must take or make delivery in warehouses located in Chicago and accepted by the Exchange. This would be inconvenient for most U.S. traders located outside of Chicago, and is largely impossible for LIC traders.

It is primarily due to this delivery specification that fewer than 1% of all futures transactions result in delivery of the commodity. Instead, the contracts are either rolled forward (replaced with a later delivery contract) prior to expiration, or offset with an equal and opposite transaction at the time the

Figure 3-1. Summary Specifications for the Soybean Futures Contract, Chicago Board of Trade

Delivery Months	September, November, January, March, May, July, and August
Trading Unit	5,000 bushels
Price quotations and minimum fluctuation	Quoted in cents and quarters of a cent per bushel, with a minimum fluctuation of 1/4 cent per bu ($12.50/contract)
Daily Price movement limits	30 cents per bushel
Position limits	3 million bu (CFTC limit) in any one futureor in all futures combined
Par delivery grade	No. 2 Yellow soybeans
Permitted substitutions on delivery	At a 3 cent premium: No. 1 Yellow soybeans At a 3 cent discount: No. 3 Yellow Soybeans (max. 14.5% moisture)
Delivery	By registered warehouse receipts issued by warehousemen against stocks in Chicago warehouses that have been declared regular by the Exchange
Trading hours	9:30 a.m. to 1:15 p.m. Central Time

* Commodity Trading Manual, p. 158 and Rules and Regularions of the Board of Trade of the City of Chicago. The information here is mean to be representative; it is all subject to change.

commodity is obtained in the cash market.[3] Traders use futures markets to establish prices or margins, not transfer ownership.

The futures clearinghouse plays the central role of third party to all trades. Participants buy and sell standardized contracts with the clearinghouse rather than with other participants.[4] Such an arrangement reduces transaction costs and increases market liquidity, since participants can enter and exit the market without searching for others willing to take positions opposite their's. As official third party, the clearinghouse is also responsible for resolving any conflicts between floor traders. If traders differ on the reported terms of a transaction, the clearinghouse must resolve them prior to market opening

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[3] An example of rolling forward would be purchasing the March maize contract in, say, January, selling it just prior to expiration, and buying the May contract. The trader has rolled her March commitment forward to May. An example of an offsetting transaction will be given later in this chapter.

[4] The actual process is a bit more complicated, but the statement is essentially true. "Participant" in this context refers to individual farmers, millers, importers, and others using the futures market through brokers. These brokers employ "floor traders", who engage in transactions through open outcry on the floor of the exchange. Brokerage firms pay large fees to "buy a seat" on the exchange, i.e. place a trader on the floor. These traders buy and sell huge volumes with other traders, not with the exchange. Assuming their is no disagreement on the terms of each trade, the clearinghouse then becomes third party to the trade. This allows traders to get out of, say, a purchase commitment by later selling an equal number of contracts to any trader rather than to the trader from which they initially bought. In a sense, then, the traders are buying from and selling to the clearinghouse, not other traders. In addition, each trade by a floor trader is composed of many smaller trades by individual participants. For example, a brokerage firm may have received 4,000 buy orders form its clients around the country, totaling 400,000 contracts. It then orders its floor trader to buy 400,000 contracts, which he does in one transaction. Each participant in this transaction has purchased shares from the clearinghouse, not from some other participant selling an equal number of contracts at the same time.

the next day. Market openings can and have been delayed when too many disputes were left unresolved.

To enter a transaction, all traders must deposit a specified amount of money to guarantee their commitment to the terms of the contract. This money is called an initial margin, and is a small proportion of the total value of the contract. For example, the $1,500 initial margin on a soybean contract amounts to 6% of the contract value if soybeans trade at $5.00 (1500/[5000 * 5] = .06)

A contract is called "open" between the time it is purchased (sold) and either offset with a sale (purchase) or settled through delivery. While a contract is open, price movements affect its value. These changes in value are added to the margin each day, in a process called "marking to the market." For example, if the price of soybeans rises 5 cents, $250 per contract (.05*5000) is added to the accounts of all buyers and subtracted from the accounts of all sellers. If a trader's account falls below a specified level, additional money, called maintenance margin, must be deposited. While initial margins are small, a trader with a large and consistently losing position may have to tie up significant volumes of cash to maintain the margin.

Margins and marking to the market practically eliminate the risk of contract default. These characteristics combine with the contracts' high liquidity and standardization to make them the focal point of price formation in all grain markets.

3.3 Trading Mechanics

This section is organized around two sets of examples. Each set contains separate examples for commodity and foreign exchange futures trades. The first set is used to illustrate the basic mechanics of futures trading. The next highlights the impact of the basis - the arithmetic difference between a given cash price and a given futures price - on the success of a trade. Finally, the understanding obtained from these examples will be used to analyze the combined commodity/foreign exchange trades shown in Tables 2-5 and 2-6. The examples ignore brokerage costs and interest on margins.

The mechanics of futures trading involve nothing more than 1) taking a position in the futures market by either buying or selling a futures contract, and 2) offsetting that position with an equal and opposite transaction anytime prior to contract expiration. For a hedger - loosely, someone using the market for risk management rather than profit[5] - an equal and opposite cash market commitment coincides with each futures transaction.[6] This commitment may be a current cash market transaction, or a current commitment to a later cash transaction, and will be explained in more detail in the examples below.

For a hedger, the purpose of the futures transaction is to lock in a desirable or acceptable return prior to the final cash

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[5] The meaning of hedging will be discussed in more detail in the next section.

[6] While the cash commitment must always be opposite that of the futures commitment, it actually need not be equal. Strategies in which the futures position is some positive fraction of the expected cash position are illustrated in Chapter 6. For now, however, the assumption of equal and opposite positions will be used to simplify the discussion.

transaction. Table 3-1 shows a simple example of an importer using the corn futures market to establish a price for corn prior to purchasing in the cash market. Assume it is November 15, and the importer wants to obtain 100,000 bushels of corn on July 15. In July, this corn will be purchased in the international market, then sold in the domestic market. On November 15, then, the importer has a current commitment to a later cash market transaction, that being to sell 100,000 bu of corn on the domestic market on July 15. She therefore takes an equal and opposite position in the futures market, buying 20 July corn contracts (20 contracts * 5,000 bu/contract = 100,000 bu).[7] This is a price she considers low enough to leave an acceptable profit margin. When July arrives and the importer wishes to purchase the corn on the international market, she sells the twenty futures contracts she bought in November, thereby offsetting her futures position. At the same time, she purchases 100,000 bu of corn in the international cash market. The price of $2.70/bu established by these transactions is calculated as the cash price paid on July 15 plus (minus) any losses (gains) in the futures market.

Note that the futures price fell between the time that the importer purchased in the futures market and the time that she sold. As a result, she lost money in the futures market, and

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[7] She could use a different month's contract if she considered doing so more advantageous. Most commonly, however, one uses a contract which expires as close as possible to the time one desires the commodity. A major reason for this is that the basis tends to become more predictable as contract expiration nears. The importance of a predictable basis will be discussed in the next section.

Table 3-1. A Simple Import Hedge, Prices Fall

Date	Cash Commitments	Futures Transactions
Nov. 15	Sell 100,000 bu in domestic mkt in July	Buy 20 July contracts at $2.70/bu
July 15	Buy 100,000 bu corn at $2.25/bu	Sell 20 July contracts at $2.25/bu

Price = Cash price + (futures buy price - futures sell price)
= $2.25/bu + ($2.70/bu - $2.25/bu)
= $2.25/bu + $0.45
= $2.70/bu

Table 3-2. A Simple Import Hedge, Prices Rise

Date	Cash Commitments	Futures Transactions
Nov. 15	Sell 100,000 bu in domestic mkt in July	Buy 20 July contracts at $2.70/bu
July 15	Buy 100,000 bu corn at $2.90/bu	Sell 20 July contracts at $2.90/bu

Price = Cash price + (futures buy price - futures sell price)
= $2.90/bu + ($2.70/bu - $2.90/bu)
= $2.90/bu - $0.20
= $2.70/bu

paid a higher price than she would have had she simply waited until July and purchased in the cash market. However, the price could as easily have risen.[8] In that case she would have made money in the futures market and thereby reduced her price below what she would have obtained by not transacting in the futures market. This scenario is illustrated in Table 3-2.

In both scenarios, the importer received the price she initially transacted at in the futures market ($2.70/bu), despite the opposite movements in futures prices following the initial transaction.

Tables 3-3 and 3-4 illustrate identical scenarios, this time for an exporter. Assume again that it is November 15, and the exporter has contracted with domestic producers to purchase 100,000 bu of corn on July 15. He intends to then sell this corn on the international market. Thus, in November, the exporter has a current commitment to a later cash market transaction, that being to purchase 100,000 bu of corn on the domestic market in July. He therefore takes an opposite position in the futures market, selling 20 July contracts at $2.70/bu. As in the importer example, the trader expects this price to leave an acceptable profit margin. When July arrives, he offsets that position by buying the contracts back, and having obtained the corn in the domestic market, sells it on the international market. Table 3-3 shows prices falling, while in Table 3-4

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[8] The efficient market hypothesis states that the gain from a transaction in an efficient futures market is symmetrically distributed around zero, so that in the long run, any profits will be offset by equal losses. This hypothesis will be discussed in more detail later in this section.

prices rise. Again, the exporter obtains the price at which he first transacted in the futures market. The price is calculated similarly to that in the importing examples, except that losses (gains) in the futures market are subtracted (added) to the cash price rather than added (subtracted). In the case where prices fall, this price is above what he would have obtained by transacting only in the cash market, while the opposite holds true for the case in which prices rise.

In all four examples above, the trader did not take a cash position in November. Instead, he made only a commitment to a later cash transaction. This is characteristic of a type of hedging called anticipatory hedging, which is the type most likely to be practiced by LIC importers and exporters. Anticipatory hedging, along with other types, will be discussed in section 3.4.3.

The basic principles of foreign exchange hedging are identical to those of commodity hedging. Each futures transaction must be matched by an equal and opposite cash market commitment. In foreign exchange hedging, however, this "commitment" is more likely to be an actual cash transaction rather than simply a commitment to a later transaction.

Tables 3-5 and 3-6 illustrate simple foreign exchange hedges for an importer who has French francs and needs U.S. dollars. Assume again that it is November 15, and the importer wants to obtain corn on the international market around June 15 and quickly sell it in the domestic market. She must pay for this corn with U.S. dollars. She has earned French francs from exports to France, or possibly obtained them from the Central Bank.

Table 3-3. A Simple Export Hedge, Prices Fall

Date	Cash Commitments	Futures Transactions
Nov. 15	Buy 100,000 bu in domestic mkt in July	Sell 20 July contracts at $2.70/bu
July 15	Sell 100,000 bu in international mkt at $2.25/bu	Buy 20 July contracts at $2.25

Price = Cash price - (futures buy price - futures sell price)
= $2.25/bu - ($2.25/bu - $2.70/bu)
= $2.25/bu + $0.45
= $2.70/bu

Table 3-4. A Simple Export Hedge, Prices Rise

Date	Cash Commitments	Futures Transactions
Nov. 15	Buy 100,000 bu in domestic mkt in July	Sell 20 July contracts at $2.70/bu
July 15	Sell 100,000 bu in internationl mkt at $2.90/bu	Buy 20 July contracts at $2.90

Price = Cash price - (futures buy price - futures sell price)
= $2.90/bu - ($2.90/bu - $2.70/bu)
= $2.90/bu - $0.20
= $2.70/bu

In either case, she can be viewed as having bought francs (which she will later sell to obtain dollars). Consequently, she takes an opposite position in the futures market, selling June French franc futures. On June 15, she offsets her futures position by purchasing francs, and at the same time sells her francs in exchange for the dollars to be used to purchase corn. Table 3-5 shows a case where prices fall, while in Table 3-6 price rise.

In each commodity and foreign exchange hedge above, the trader obtained a price equal to that at which he first transacted in the futures market. This is not usually the case in real world trades. It happened in the above examples because cash and futures prices were assumed to completely converge at contract expiration. In other words, on July 15 (June 15 for the foreign exchange hedges) the basis was equal to zero in each trade. For example, in Table 3-6,

$$\begin{aligned} \text{Basis}_{\text{June 15}} &= (\text{Cash Price})_{\text{June 15}} - (\text{Futures Price})_{\text{June 15}} \\ &= \$0.126/\text{FF} - \$0.126/\text{FF} \\ &= \$0.00/\text{FF} \end{aligned}$$

Tables 3-7 and 3-8 below replicate Tables 3-1 and 3-5 above, with one difference: the basis remains positive rather than going to zero at the time the futures commitment is offset.

In Table 3-7, the basis on July 15 is \$2.35-\$2.25 = \$0.10, and the price paid for corn is \$2.80. This compares with a basis of zero, and a price of \$2.70 in Table 3-1. In Table 3-8, the basis on July 15 is \$0.120 - \$0.118 = \$0.002, and the price obtained for francs is \$0.124. This compares with a basis of zero and price of \$0.122 in Table 3-5. It is evident from these examples that the price obtained on a hedged commodity can be

Table 3-5. A Simple Foreign Exchange Hedge, Prices Fall

Date	Cash Commitments	Futures Transactions
Nov. 15	Earn FF through exports, or buy from Central Bank	Sell July FF contracts at $.122/FF (FF8.197/$)
July 15	Sell FF on foreign exchange market at $.118/FF (FF8.475/$)	Buy July FF contracts at $.118/FF (FF8.475/$)

Price = Cash price - (futures buy price - futures sell price)
= $.118/FF - ($.118/FF - $.122/FF)
= $.118/FF + $0.004
= $.122/bu
= FF8.197/$

Table 3-6. A Simple Foreign Exchange Hedge, Prices Rise

Date	Cash Commitments	Futures Transactions
Nov. 15	Earn FF through exports, or buy from Central Bank	Sell July FF contracts at $.122/FF (FF8.197/$)
July 15	Sell FF on foreign exchange market at $.126/FF (FF7.937/$)	Buy July FF contracts at $.126/FF (FF7.937/$)

Price = Cash price - (futures buy price - futures sell price)
= $.126/FF - ($.126/FF - $.122/FF)
= $.126/FF - $0.004
= $.122/bu
= FF8.197/$

Table 3-7. An Import Hedge With Non-Zero Basis

Date	Cash Commitments	Futures Transactions
Nov. 15	Sell 100,000 bu in domestic mkt in July	Buy 20 July contracts at $2.70/bu
July 15	Buy 100,000 bu corn at $2.35/bu	Sell 20 July contracts at $2.25/bu

Price = Cash price + (futures buy price - futures sell price)
= $2.35/bu + ($2.70/bu - $2.25/bu)
= $2.35/bu + $0.45
= $2.80/bu

Table 3-8. A Foreign Exchange Hedge With Non-Zero Basis

Date	Cash Commitments	Futures Transactions
Nov. 15	Earn FF through exports, or buy from Central Bank	Sell July FF contracts at $.122/FF (FF8.197/$)
July 15	Sell FF on foreign exchange market at $.120/FF (FF8.333/$)	Buy July FF contracts at $.118/FF (FF8.475/$)

Price = Cash price - (futures buy price - futures sell price)
= $.120/FF - ($.118/FF - $.122/FF)
= $.120/FF + $0.004
= $.124/bu
= FF8.065/$

calculated as:

(1) $$\text{Price} = (\text{Futures Price})_t + \text{Basis}_{t+1} ,$$

where t = time when futures position is assumed (Nov. 15 above), and

t+1 = time when futures position is offset (July 15)

It should also be evident that at time t, the basis at time t+1 is not known. One must predict it. At time t, then, the price the trader expects to obtain at time t+1 is composed of one known value (the futures price at time t) and one unknown value (the basis at time t+1) for which one must form an expectation:

(2) $$E(P)_{t+1} = (\text{Futures Price})_t + E(\text{Basis})_{t+1}$$

For a trader who chooses not to hedge and transacts only in the cash market, the expected price is composed of one unknown value:

(3) $$E(P)_{t+1} = E(\text{Cash Price})_{t+1}$$

It therefore becomes clear that hedging will reduce price uncertainty only to the extent that the basis is more predictable than cash price levels. For U.S. traders, the basis generally is more predictable, and hedging is therefore an effective risk management tool. For LIC traders, the basis may or may not be more predictable, and the effectiveness of futures trading is less certain. The importance and determinants of the basis for LIC traders will be discussed more fully in section 3.4.1 and in Chapter Five.

The understanding gained from the above examples can now be used to analyze the combined commodity/foreign exchange hedges first presented in Tables 2-5 and 2-6. The mechanics of these hedges are illustrated in Tables 3-9 and 3-10 below. As in the initial examples above, the basis is assumed to be zero when futures positions are offset in December.

In two different years, the Senegalese importing agency has decided in August that it needs to purchase corn from the U.S. for shipment in January. It must pay for the corn with U.S. dollars, and has recently earned French francs from peanut exports to France. It is considering hedging these foreign exchange holdings in addition to its expected corn purchase. Among its options are 1) do nothing now and buy in the cash market in late December; 2) hedge the corn purchase now by buying futures; 3) hedge only foreign exchange; and 4) hedge both foreign exchange and corn. The choice depends in part on the direction that the agency expects each market to move between now and late December, but more importantly, it depends on how acceptable it finds the current price of the December futures contract, and on the degree of uncertainty the agency is willing to accept.

In table 3-9, Senegal pays $3.37/bu of corn in the cash market at an exhange rate of FF8.475/$, for a cost in francs of 28.56/bu. It makes this cash transaction whether it hedges in the futures market or not. If it does hedge, this cash price is adjusted for any gains or losses from the hedge. By hedging corn, Senegal reduces its price by FF0.17 to FF28.39/bu. By hedging foreign exchange rather than corn, Senegal reduces its cost by FF0.93, to FF27.63/bu. By hedging both corn and foreign exchange, Senegal combines the savings, reducing its cost by FF1.10 to FF27.46/bu.

Table 3-9. A Commodity and Foreign Exchange Hedge Resulting in an Import Price Lower Than That Obtained With Only Cash Transactions

Date	Hedges: Corn — Cash Mkt	Corn — Futures Mkt	FF — Cash Mkt	FF — Futures Mkt	Corn & FF — Cash Mkt	Corn & FF — Futures Mkt
8/1	Commit to sell corn in domestic mkt in January	Buy Dec. corn contract at $3.35			Commit to sell corn in dom. mkt in Jan.	Buy Dec corn contract at $3.35
			Commit to buy $ in int'l mkt in Dec.	Sell Dec. FF at $.122/FF (FF8.197/$	and buy $ in int'l mkt in Dec.	Sell Dec. FF contract at $.122/FF
12/19	Buy corn at $3.37	Sell Dec. corn contract at $3.37	Buy corn at $3.37		Buy corn at $3.37	Sell Dec. corn contract $3.37/bu
	Sell FF (buy $) at $.118/FF (FF8.475/$)		Sell FF (buy $) at $.118/FF (FF8.475/$)	Buy Dec. FF at $.118/FF	Sell FF (buy $) at $.118/FF (FF8.475/$)	Buy Dec. FF contract at $.118/FF
Futures Mkt Gains (-) and losses(+)						
Corn:		-$.02/bu				-$.02/bu
FF:				-FF.278/$		-FF.278/$
Prices = Cash prices adjusted for futures market gains or losses						
Corn in $:		$3.35/bu		$3.37/bu		$3.35/bu
$ in FF:		FF8.475/$		FF8.197/$		FF8.197/$
Corn in FF:		FF28.39/bu		FF27.63/bu		FF27.46/bu

Sources: Corn prices from Chicago Board of Trade Yearbook, 1983. Foreign exchange prices from Internatinal Monetary Market Yearbook, 1983.

As in the first set of examples above, hedging allows Senegal to obtain the prices at which it first transacted in the futures market, and this is due entirely to the convergence of cash and futures prices in December.

Of course there is no guarantee that hedging will reduce costs, as shown in Table 3-10. In this example, the importer again locks-in the prices it first establishes in the futures market, but these happen to be higher than what would have been obtained by waiting and transacting only in the cash market. So should the trade not have been made? Was it an "unsuccessful" hedge? Quoting Hieronymus (1964), "... not if (the importer) really understood what (it) intended to do." It made its decision in August to buy at what it considered a desirable price, and it obtained that price. A lower price could have been obtained by waiting, but the importer did not know this in August. By placing the hedge at that time, it established a price that would meet its needs, and could then turn its attention to other matters rather than worry about possible price rises between August and December. From this perspective, a hedge does not have to be profitable to be "successful." In fact, Johnson (1985) states that a producer can under certain circumstances rationally choose to hedge his production even if he expects a loss on the futures transaction:

> A bullish price outlook (meaning that one expects prices to rise) obviously leads to a buy recommendation to the speculator ... But consider the farm producer whose objective is to get a bank loan. Because he is a producer ... he is a sell hedger ... As a sell hedger he stabilizes revenues at a sufficient level to pay back a bank loan, enhancing his credit worthiness. Even though the price outlook is

Table 3-10. A Commodity and Foreign Exchange Hedge Resulting in an Import Price Higher Than That Obtained With Only Cash Transactions

Date	Hedges					
	Corn		FF		Corn & FF	
	Cash Mkt	Futures Mkt	Cash Mkt	Futures Mkt	Cash Mkt	Futures Mkt
8/1	Commit to sell corn in domestic mkt in January	Buy Dec. corn contract at $3.35			Commit to sell corn in dom. mkt in Jan.	Buy Dec corn contract at $3.35
			Commit to buy $ in int'l mkt in Dec.	Sell Dec. FF at $.122/FF (FF8.197/$	and buy $ in int'l mkt in Dec.	Sell Dec. FF contract at $.122/FF
12/19	Buy corn at $3.37	Sell Dec. corn contract at $3.37	Buy corn at $3.37		Buy corn at $3.37	Sell Dec. corn contract $3.37/bu
	Sell FF (buy $) at $.118/FF (FF8.475/$)		Sell FF (buy $) at $.118/FF (FF8.475/$)	Buy Dec. FF at $.118/FF	Sell FF (buy $) at $.118/FF (FF8.475/$)	Buy Dec. FF contract at $.118/FF
Futures Mkt Gains (-) and losses(+)						
Corn:	+$0.33/bu				+$0.33/bu	
FF:				+FF.332/$		+FF.332/$

Prices = Cash prices adjusted for futures market gains or losses

	Corn	FF	Corn & FF
Corn in $:	$2.43/bu	$2.10/bu	$2.43/bu
$ in FF:	FF4.378/$	FF4.71/$	FF4.71/$
Corn in FF:	FF10.64/bu	FF9.90/bu	FF11.45/bu

Sources: Corn prices from Chicago Board of Trade Yearbook, 1983. Foreign exchange prices from Internatinal Monetary Market Yearbook, 1983.

> bullish, this hedger is selling in his futures account (and buying back later at a higher price), enabling him to receive the bank loan and proceed with making a profit in his principal business, farming. (p. 43T. Parentheses and emphasis added)

This passage highlights the fact that futures trading should be seen as a means to ensure a profit in one's primary business, rather than a means of directly making a profit.

3.4 <u>Commodity Futures Market Theory</u>

There is a large and varied body of literature dealing with futures market theory. This section will touch briefly on four major issues in that literature: 1) the relationship between cash and futures prices, 2) the distinction between hedging and speculation, 3) the various types of hedging, and 4) the efficient market hypothesis.

3.4.1 Cash-Futures Price Relationships

As demonstrated in the previous sectiopn, the effectiveness of futures trading as a risk management tool is based on the premise that the basis is more predictable than are cash and futures price levels. While a hedger may have little idea whether price levels will rise or fall after placing a hedge, she will be successful in obtaining her expected price (or margin) if she has accurately predicted how each will move relative to the other, i.e., if she has successfully predicted the basis that will prevail when she lifts the hedge and transacts in the cash market. If she cannot predict the basis more accurately than she can predict price levels, futures trading will be an ineffective risk management tool for her.

The basis arises due to spatial, temporal, and quality differences between the cash commodity and the futures contract specifications:

4) Basis = Spatial Basis + Temporal Basis + Quality Basis

Of these, the spatial and temporal bases are most important, since they are variable and can be difficult to predict, while quality discounts are specified in the futures contracts. If there is no difference between the cash commodity and the futures contract specifications in each of these three dimensions, the basis is zero. This explains the observation that cash and futures prices always converge near contract expiration at spot markets located near futures exchanges.[10] This pattern makes the basis highly predictable, and hedging very effective for many traders.

LIC traders are in a more difficult position. While Samuelson (1952) showed that in a competitive equilibrium, the spatial price differences are just equal to transportation costs, Garcia (1984) and Kamara (1982) highlight the impacts on the spatial basis of changes in local supply and demand and seasonal availability of transport. The impacts of these factors on basis variability, and their implications for LIC traders, will be discussed in more detail in Chapter Five.

Consideration of the temporal basis leads directly to the theory of the price of storage, first put forward by Working

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[10] Allowing delivery on contracts ensures that prices converge. See footnote 5 of Chapter Two.

(1953). In this theory, intertemporal price spreads are viewed as market determined prices of storage for traders located near the futures exchange. As initially formulated, the theory focused on simultaneously quoted futures prices of contracts with differing maturities. For example, any premium being paid on a given day for March wheat over December wheat is considered a market determined price of storage between December and March. Later Working (1962) and others (see Kamara, 1982; Heifner,) extended the concept so that the difference between simultaneously quoted spot and futures prices is seen as the price of storage from the time the prices are quoted to contract expiration.

In fact, these two definitions correspond to two different cases - the three period case and the two period case, respectively. In the two period case, the price of storage (established at time t) from time t to time t+1 is:

$$PS_{t(t,t+1)} = PF_{t,t+1} - PC_t \tag{5}$$

where, t = time when the futures position is assumed,
$t+1$ = time when the futures postion is offset
$PS_{t(t,t+1)}$ = the price of storage, established at t, from t to t+1,
$PF_{t,t+1}$ = the price at t of the futures contract which expires at t+1, and
PC_t = the cash price at t

For example, on March 15, the price of storage for wheat from that date until May 15 is equal to the current price of the May wheat contract minus the current cash wheat price.

Table 3-11 shows how a firm located near the futures exchange would obtain this price of storage. In this table, a firm located in Chicago is holding wheat. On September 15, it notes that the local cash price for wheat is \$3.00/bu, while the price of the CBOT December wheat contract is \$3.20/bu. Since the firm is in Chicago, the basis will be zero in December. From equation (1) above, the price it will obtain by hedging the wheat now and holding it until December is:

$$
\begin{aligned}
P_{Dec} &= (PF)_{Sep,Dec} + B_{Dec} \\
&= \$3.20/bu + \$0.00/bu \\
&= \$3.20/bu,
\end{aligned}
$$

where, $PF_{Sep,Dec}$ = the price on September 15 of the December wheat contract

B_{Dec} = the basis on December 15

This compares with a price of \$3.00/bu if it sells the wheat now. Thus, the market will "pay" the firm \$0.20/bu to store wheat. This amount is exactly equal to what would be calculated using equation 5 above (\$3.20/bu - \$3.00/bu = \$0.20/bu).

This example of the firm located near the futures exchange can be generalized to firms located near or away from the exchange. The essential difference is that these latter firms face an uncertain basis, and must form expectations. We know from Table 3-11 that the expectation at t of the return to storage between t and t+1 can be calculated as the expected price obtained by hedging and storing minus the price obtained by selling now:

(6) $E(PS)_{t(t,t+1)}$ = Expected P, hedging & storing - P, selling now

From equation (2) and (6),

$$(7) \qquad E(PS)_{t(t,t+1)} = (PF_{t,t+1} + E(B)_{t,t+1}) - PC_t \; ,$$

Table 3-11. Two Period Price of Storage: Firm Located Near the Futures Exchange

Date	Options		
	Sell Now	Hedge, and Store Until Dec.	
	Cash Commitment	Cash Commitment	Futures Transaction
9/15	Sell wheat stocks at $3.00/bu	Hold wheat stocks	Sell Dec. wheat contract at $3.20/bu
12/15	----	Sell wheat stocks at cash mkt price	Buy Dec. wheat contract at futures mkt price
	P = Cash price = $3.00/bu	$P = PF_{Sep,Dec} + B_{Dec}$ = $3.20/bu + $0.00/bu = $3.20/bu	

$PS_{t,t+1}$ = Price from Hedging & Storing - Price Selling Now
= $3.20/bu - $3.00/bu
= $0.20/bu

where, $E(PS)_{t(t,t+1)}$ = the expectation at t of the price of storage from t to t+1,
$E(B)_{t,t+1}$ = the expectation at t of the basis at t+1

Now the basis at t is:

(8) $$B_t = PC_t - PF_{t,t+1}$$

Solving for $PF_{t,t+1}$ and substituting into equation (7) yields:

(9) $$E(PS)_{t(t,t+1)} = E(B)_{t,t+1} - B_t$$

In other words, the expectation at t of the price of storage from t to t+1 is equal to the expected change in the basis from the time the hedge is placed to the time it is lifted. If the trader accurately predicts this change, she will obtain her expected return. Price levels are entirely irrelevant and can be ignored. This equation holds for traders located near to as well as far from the futures exchange.[11] It also obtains whether a trader is holding wheat and trying to decide when to sell, or if she needs wheat and is trying to decide when to buy. If she can accurately predict the basis one period ahead, she can obtain her expected price of storage.

In the three period case, the price of storage (established at t) from t+1 to t+2 is:

10) $$PS_{t(t+1,t+2)} = PF_{t,t+2} - PF_{t,t+1} ,$$

---

[11] for a trader located near the exchange, $E(PS)_{t(t,t+1)} = -B_t = PF_{t,t+1} - PC_t$, which is identical to equation 5, the original two period price of storage equation. This value is not zero, since the basis converges to zero near the exchange only at contract expiration.

where, $PF_{t,t+2}$ = the price at t of the wheat contract which expires at t+2, and

$PF_{t,t+1}$ = the price at t of the wheat contract which expires at t+1

For example, on January 15, the price of storage for wheat from March 15 to May 15 is equal to the price of the May futures contract minus the price of the March futures contract, both quoted on January 15.

Table 3-12 shows how a trader would obtain this price of storage. Again it is September 15, and a firm located in Chicago needs wheat to fulfill a contract in March. Its storage facilities are currently full, but it anticipates having room in December. Its options are therefore to either wait and buy the wheat in March, or buy in December and store until March. Table 3-12 shows the required transactions and results of each strategy.[12] While in the two period case the trader who decided to hedge and store bought and sold only the December contract, in this case he must buy and sell both the December and March contracts. On September 15, the price of the March contract is \$3.30/bu while the price of the December contract is \$3.20/bu. Since the trader will purchase in the cash market in December, he hedges that purchase now by buying the December contract. He offsets it in December when he makes the cash purchase (this hedge is identical to those illustrated in Tables 3-1 and 3-2

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[12] This example has been simplified for explanatory purposes. While this simplification does not change the results of the analysis, it does make it impossible to show an opposite cash market commitment for each futures market transaction, as required in hedging. Since ignoring these cash commitments makes the example easier to understand while not affecting the analysis, they are ignored. See Appendix A for a complete analysis which includes the commitments.

above). Since the firm is in Chicago, the basis will be zero in December. By equation 1 above, the price obtained from this hedge is:

$$\begin{aligned} P_{Dec} &= PF_{Dec,Sep} + B_{Dec} \\ &= \$3.20/bu + \$0.00/bu \\ &= \$3.20/bu, \end{aligned}$$

where, $PF_{Dec,Sep}$ = the price of the December wheat contract in September.

Since the trader has also bought and sold the March contract, this price of $3.20/bu must be adjusted by any gains or losses on this transaction to find the net cost of obtaining the wheat in December:

$$\begin{aligned} NP_{Dec} &= \$3.20 + (PF_{Mar,Mar} - PF_{Sep,Mar}) \\ &= \$3.20 + (PF_{Mar,Mar} - \$3.30) \\ &= PF_{Mar,Mar} - \$0.10 \end{aligned}$$

where, NP_{Dec} = net price from buying in December and storing until March,
$PF_{Mar,Mar}$ = price in March of the March wheat contract
$PF_{Sep,Mar}$ = price in September of the March wheat contract

The return the firm earns from buying in December, then hedging and storing until March is simply the cash market price the firm would have paid by waiting until March to buy, minus the net price calculated above. But since the firm is in Chicago, the price of the March wheat contract in March will be equal to the cash wheat price in March (i.e., the basis will equal zero). These prices therefore cancel, and we are left with a price of storage between December and March of $0.10/bu:

$$\begin{aligned} PS_{Dec,Mar} &= PC_{Mar} - (PF_{Mar,Mar} - \$0.10) \\ &= \$0.10 \end{aligned}$$

Table 3-12. Three Period Price of Storage: Firm Located Near the Futures Exchange

Date	Options		
	Buy in March	Buy in December, Hedge, and Store Until March	
	Cash Commitment	Cash Commitment	Futures Transaction
9/15			Sell Mar. wheat contract at \$3.30/bu, Buy Dec. wheat contract at \$3.20/bu
12/15		Buy wheat in cash mkt at mkt price and store	Sell Dec. wheat contract at futures mkt price
3/15	Buy at mkt price		Buy Mar. wheat contract at mkt price
	$P = PC_{Mar}$	$P = PF_{Sep,Dec} + B_{Dec} + (PF_{Mar,Mar} - PF_{Sep,Mar})$ $= \$3.20 + (PF_{Mar,Mar} - \$3.30)$ $= PF_{Mar,Mar} - \$0.10$	

PS = Price Buying in Mar - Price Buying Dec., Hedging & Storing
$= PC_{Mar} - (PF_{Mar,Mar} - \$0.10)$
$= \$0.10/bu$

This price of storage is exactly equal to what would be calculated using equation 10 above (\$3.30/bu - \$3.20/bu = \$0.10/bu).

As was done in the two period case, this example of the firm located near the futures exchange can be generalized to firms located near or away from the exchange. Again, the essential difference is that these latter firms face an uncertain basis, and must therefore form expectations. We know from the last example that the expectation at t of the return to storage between t+1 (December) and t+2 (March) can be calculated as the expected price obtained by waiting and buying in the cash market in March, minus the expected price obtained by buying in December and storing until March under a hedge. We also know that this can be written as:

$$(11)\quad E(PS)_{t(t+1,t+2)} = E(PC)_{t,t+2} - [(PF_{t,t+1} + E(B)_{t,t+1}) + (E(PF)_{t,t+2,t+2} - PF_{t,t+2})],$$

where, $E(PF)_{t,t+2,t+2}$ = the expectation at t of the price at t+2 of the futures contract which expires at t+2 (e.g., the expectation on September 15 of the expiring price of the March wheat contract)

Now the expectation at t of the basis at t+2 is:

$$(12)\quad E(B)_{t,t+2} = E(PC)_{t,t+2} - E(PF)_{t,t+2,t+2}$$

Substituting into equation (8) and rearranging gives:

$$(13)\quad E(PS)_{t(t+1,t+2)} = [PF_{t,t+2} - PF_{t,t+1}] + [E(B)_{t,t+2} - E(B)_{t,t+1}]$$

In other words the expectation at t of the price of storage between t+1 and t+2 is equal to the difference in futures prices at t plus any expected increase in the basis from t+1 to t+2. If the trader accurately predicts this basis change, she will obtain her expected return. Like the two period equation, this equation holds for traders located near to or far from the futures exchange.[13] It also obtains whether a trader is holding wheat and trying to decide whether to sell at t+1 or t+2, or needs wheat and is trying to decide whether to buy at t+1 or t+2. Again, the trader needs to predict bases only, not price levels.

The theoretical price of storage curve is shown in Figure 1. During periods of abundant supply, futures prices show a "full carrying charge", exceeding spot prices by the full cost of storage (physical cost plus interest). This market generated carrying charge induces traders to store, increasing inventories. The price of storage will not exceed a full carrying charge as long as storage capacity is not exhausted. In periods of shortage, the spot price begins to rise relative to the futures price, meaning the price of storage falls. In response, traders release stocks, decreasing inventories. In periods of severe shortage, spot prices can exceed futures prices, and the market exhibits an "inverse carrying charge." Unlike the carrying charge, which is limited to the full cost of storage, the inverse carrying charge has no limit. Commercial dealers will not reduce inventories below a certain level, due to both a convenience yield from being able to meet unforseen demand (Tomek & Robinson, 1981), and to their pipeline demand, that minimum level of inventory needed

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[13] For a trader near the exchange, the expected bases at t+1 and t+2 are zero, so equation 13 collapses to equation 10, the original three period price of storage equation.

to carry on day-to-day activities. As a result, spot prices can rise without limit above futures prices during a severe shortage, resulting in a highly negative price of storage.

Figure 3-2 shows an empirical price of storage curve for July through March during 1965-79. This corresponds closely to the theoretical relationship of Figure 3-1.

The concept of the price of storage can now be used to illustrate the expected behavior of the temporal basis in producing and importing regions. This is done in Figure 3-3. Looking first at the producing region and assuming no shortages, the market will exhibit a full carrying charge. The size of this carrying charge decreases as contract expiration approaches, so that the cash price converges toward the futures price. In a sense, the cost of storage is being built into the cash price. This price stabilizes, not at the futures price, but below it by the cost of transportation to the delivery point specified in the futures contract. The cash price in the importing region follows the same pattern as that in the producing region, but lies above it by the cost of transportation from the delivery point specified in the futures contract to the importing region.

This idealized relationship shows that the expected basis facing LIC traders does follow a predictable pattern. Again, local supply and demand as well as variable transport availability determine the variance around this expected value and complicate the situation for these traders. This issue will be discussed more fully in Chapter Five.

FIGURE 3-2. THE PRICE OF STORAGE

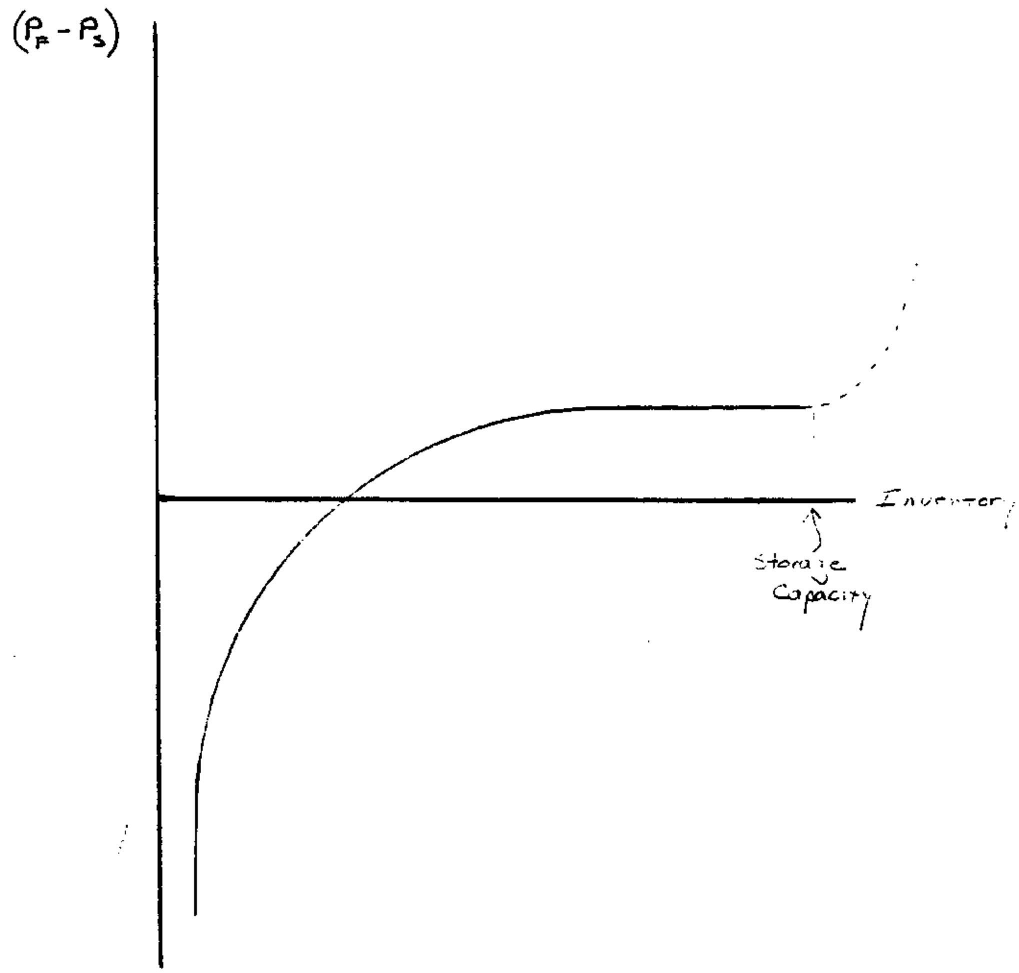


Figure 3-3. Empirical Price of Storage, March-July 1965-1979

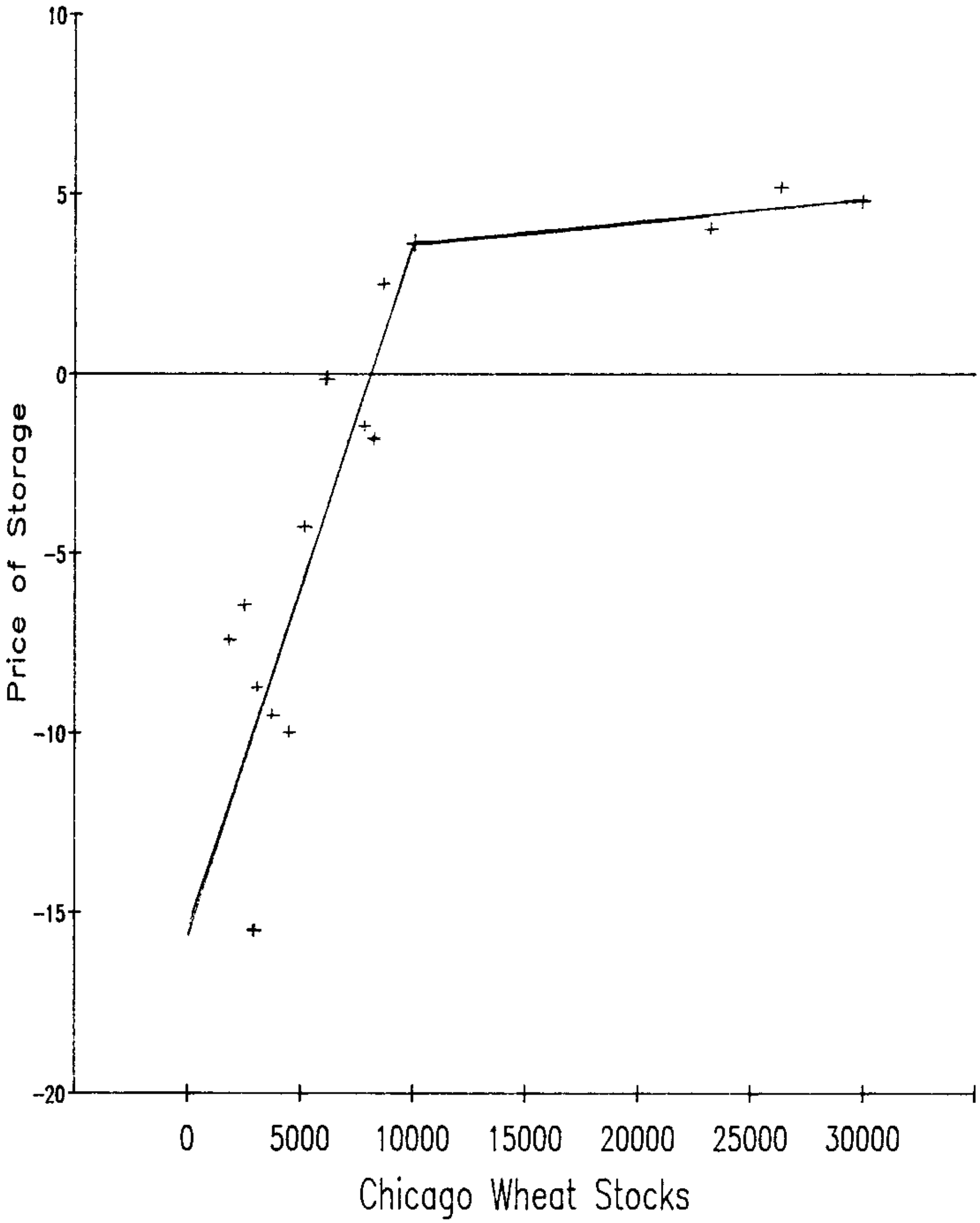
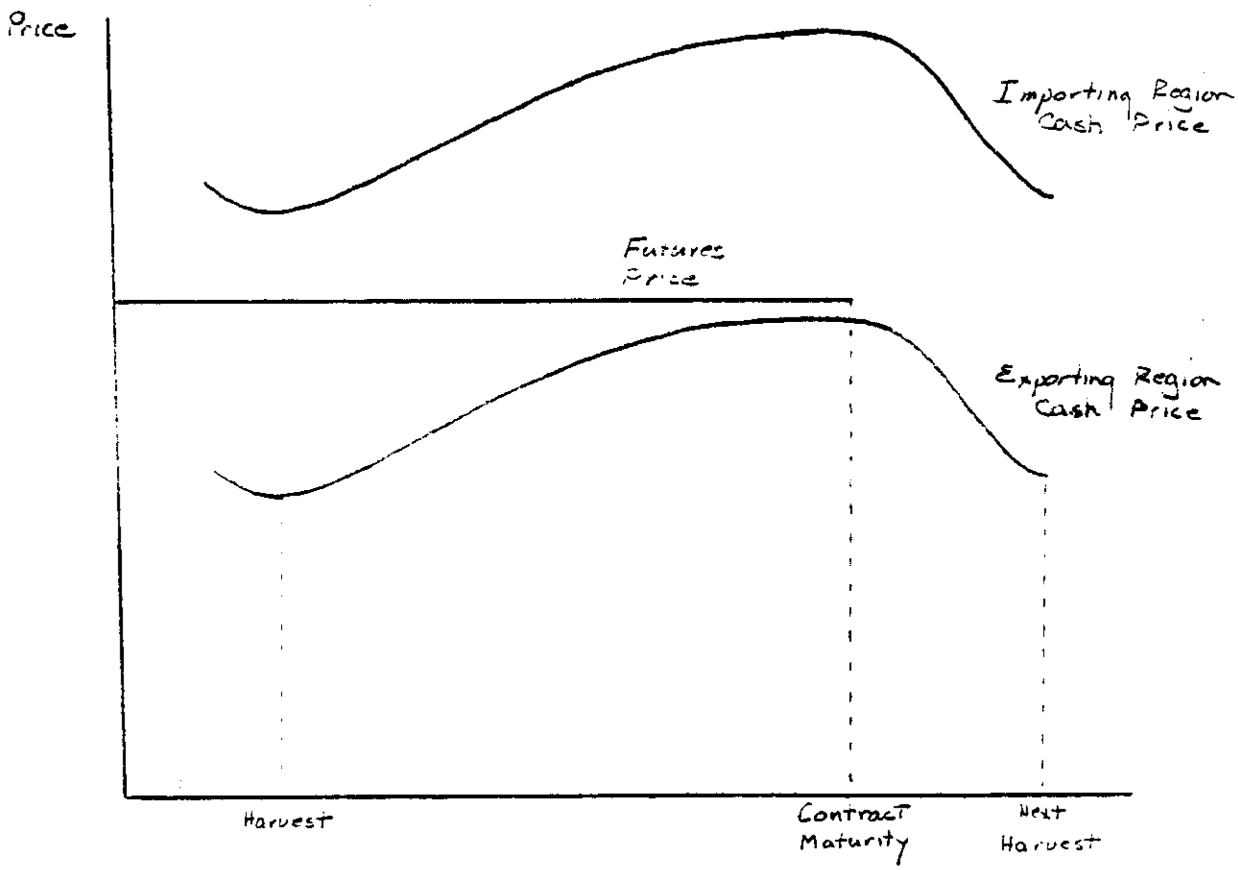


FIGURE 3-4. THEORETICAL TEMPORAL BASIS IN IMPORTING AND EXPORTING REGIONS



3.4.2. Hedgers and Speculators

Hedgers are those traders who use futures markets in conjunction with the production, marketing, or purchase of the underlying physical commodity. In line with this definition, the most commonly accepted concept of hedging is the use of a futures transaction as a temporary substitute for a later cash transaction (Working, 1962). Included among hedgers are farmers, grain companies, processors, and LIC exporters and importers.

Speculators, on the other hand, engage in no cash transactions, and aim to profit directly from their futures trading. While popular opinion is quite critical of speculators, informed study of speculators' role is more positive. Speculation provides two valuable services to futures markets, without which these markets would be of little use to hedgers. First, by increasing the volume of transactions, speculation provides liquidity, meaning that market participants can enter and exit easily and at low cost. Without this liquidity, trading would be hampered, and hedgers might lose interest in the market.

The second service provided by speculators is the constant incorporation of up-to-date market information into prices. By continually following the cash and futures markets and making informed judgements as to future supply and demand conditions, speculators can improve the information content of futures prices. Hedgers then have access to a market which is less affected by fluctuations unrelated to cash market developments and is therefore more effective in reducing uncertainty.

3.4.3. Types of Hedging

The above definition of hedging says little about hedgers' motivation. Specifically, it does not rule out the desire to use hedging as one tool for pursuing business profit, and by implication does not limit hedgers' motivations to pure risk reduction. While early literature focused on risk reduction to the exclusion of other motives, later work has taken the view that most traders desire some optimal tradeoff between profit and reduced risk, claiming that pure risk avoidance hedging does not exist (Kamara, 1982; Gray and Rutledge, 1971).[14] According to many authors, all futures trading, whether defined as hedging or speculating, involves "speculative" price judgements.

While this view is correct as far as it goes, it may obscure two important points. One is that speculators speculate on price levels, while hedgers speculate on the basis. Moreover, by not hedging, a market participant is by default speculating on price levels, since he is at the mercy of cash price movements. For example, a LIC importing agency which knows it needs a certain quantity of wheat in six months is leaving itself open to potentially adverse (as well as potentially beneficial) price movements if it does not hedge its future purchase now. Since the basis is generally more stable and predictable than price levels,

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[14] Pure risk avoidance might be defined as the avoidance of risk to the exclusion of all other motivations. In the context of hedging, it would require that a hedger pay literally no attention to the price level he locks in with a hedge, no matter how large an operating loss that level might imply. Seen in this way, the rejection of pure risk avoidance as a hedging motivation should come as no surprise. If placing a hedge means assuring a very large operating loss, most traders would not hedge, considering a certain large loss less desirable than the uncertain possibility of a smaller loss or even a profit.

hedging substitutes one less risky action (establish a futures position now and offset it when taking a cash position) for another more risky action (do nothing now, and establish a cash position later). So while hedging does involve speculative price judgements, such judgements are inescapable, and hedging is an explicit attempt to reduce the riskiness of whatever judgements one must make.

The second point, already discussed in the Preface and near the end of section 2.3, is that hedging can be used to generate a business profit while not itself generating that profit. Quoting Parrot once more (this passage was first quoted in Chapter One):

> The whole purpose of hedging is to remove credit and price risks or minimize them. Hedging is not used to make a profit, either speculative or otherwise, but to insure one already existing or to limit a loss already threatened ... By using the futures market to shift and minimize risk, management is removed from the constant nerve-wracking distractions which are the companions of a speculative (i.e., unhedged) market position, and can concentrate on management decisions directed to maximizing profits (pp. 193, 203-204, quoted in Peck, 1978. Parentheses and emphasis added).

This benefit of futures trading could be especially important in a LIC setting, where managerial talent is often a seriously constraining resource.

Hedging can be done for a variety of reasons, and it is therefore useful to define different categories of hedging.

1. Inventory or arbitrage hedging was illustrated in Tables 3-11 and 3-12 above. It is carried out simultaneously with the holding of commodity stocks, with the purpose of profiting from storage activities. In this type of hedging, each cash market

transaction is accompanied by an opposite futures transaction, making price levels entirely irrelevant. The trader focuses only on anticipated changes in the basis, as indicated by equation (9) repeated below:

$$(9) \qquad E(PS)_{t,t+1} = E(B)_{t+1} - B_t$$

As long as the trader correctly anticipates the basis that will prevail when the hedge is lifted, she will receive her expected return to storage.

2. Operational Hedging is done to facilitate one's merchandising or processing business, and typically involves an initial purchase of futures. Its chief distinction from inventory hedging is that hedges are placed and then lifted so quickly that basis changes can be largely ignored, while inventory hedging explicitly depends on these changes.

An operational hedge might work like this: A flour miller bids on and receives a contract to supply a large amount of flour at a specified price in two weeks. The miller will typically formulate his bid price as some premium over the prevailing futures price. To cover the sale and maintain inventories, he must purchase an equivalent amount of wheat. Quoting Working (1953),

> To buy that amount of wheat in the spot market, a miller must choose between buying in driblets over days or weeks, as the wheat arrives from the country, or buying from an elevator operator who has the wheat in store, but who asks a price that includes his dealer's margin. And even if the purchase is to be made from an elevator, time may be needed for "shopping" among several elevators, and a good deal of bargaining may have to be done to avoid paying an unnecessarily high price. So if wheat is

purchased immediately to cover a large flour sale, the purchase is usualy made in a futures market.

So the miller purchases in the futures market. Let's say his bid was $3.00, and he buys futures at $2.70. The current basis might be $.05, meaning that cash wheat is trading at $2.75. This leaves a margin of $0.25, which the miller considers sufficient to cover milling and leave an acceptable profit. The miller does not worry about price levels, but does assume that the basis will remain constant. If it does, his $0.25 margin will be realized. Let's say that over the next two weeks, he makes the necessary cash purchases at an average price of $2.85 rather than $2.75. Each time he makes a cash purchase, he offsets an equal amount of futures by selling, until he has acquired the necessary amount of wheat and offset his entire futures position. If the basis remains at $0.05, i.e. if he can offset his futures position at an average price of $2.80, he will realize his $0.25 margin.[15]

So, like inventory hedging, price levels do not matter in operational hedging. Price relationships, i.e. bases, are the critical variables. Unlike inventory hedging, operational hedging depends on a constant rather than a predictably changing basis.

3. Anticipatory hedging was illustrated in Tables 3-1 through 3-4 It is the "buying or selling of futures contracts in anticipation of a (later) commodity purchase or sale" (Peck, 1982). It is practiced by most of the producers, and some of the processors

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[15] He buys futures at $2.70, and sells at an average of $2.80, for a $0.10 profit. Subtracting this from his average cash purchase price of $2.85 gives a final price of $2.75, leaving a $0.25 margin.

who hedge. In addition, it is the type of hedging most likely to be practiced by LIC importers and exporters.

Unlike inventory or operational hedging, the initial futures transaction in anticipatory hedging is not matched by an equal and opposite cash transaction, though the final futures transaction is (recall that in Tables 3-1 through 3-4, the "cash commitment" at the time of the initial futures transaction was a current commitment to a later cash transaction - it was not a current cash transaction). This causes anticipatory hedging to differ from the other two types in a fundamental way: the price level of the initial futures transaction does matter to the hedger. Repeating equation 2 from above,

(2) $$E(P)_{t+1} = (\text{Futures Price})_t + E(\text{Basis})_{t+1}$$

A prospective hedger must examine this initial futures price and ask "will this price level give me an acceptable business profit?" If it will not, she must decide whether to remain unhedged and hope for a beneficial price movement while facing the risk of an even worse price, or accept the low profit or even loss implied by the futures price, and hedge. Once she decides to place the hedge, anticipatory hedging is identical to the other two types in that price relationships rather than levels are all that matter.

3.4.4. The Efficient Market Hypothesis

The Efficient Market Hypothesis can best be presented as a definition, two implications following from that definition, and a question based on the implications. The definition is as follows: a market (futures or cash) is "efficient" if it fully incorporates all information concerning current and future expected supply and demand. The first implication following from this definition is that in an efficient futures market, futures prices will be unbiased predictors of later cash prices. For example, if the CBOT corn contract constitutes an efficient market, the price of its December contract at any time prior to expiration in December will be an unbiased predictor of the cash corn price in Chicago at expiration. The second implication is that no systematic futures trading rule will earn a profit in the long run. Any short-run profits will eventually be offset by equal losses.

The obvious question that follows is "are futures markets efficient?" There has been a great deal of empirical investigation of this question, all of it indicating that one yes/no answer is not possible. Heifner states that "most, but not all, econometric studies have found that observed futures price behavior closely approximates what would be expected in an ... efficient market." In contrast, Kamara (1982) states that "both theoretical and empirical evidence show that the futures price is not an unbiased estimate of teh spot price at maturity."

Probably the best study is by Gray (1961), who states that markets must be investigated for bias individually. He goes on to conclude that "highly developed futures markets neither overestimate nor underestimate prices over long periods of time: but ... other less well used markets may persistently overestimate or underestimate prices over extended time periods." Regarding other commodities, Thompson (1983) concludes that "bias does exist on average in cotton and cocoa futures prices", but that "the bias is small and not assured for any given month or any given year." The implication is that any bias that does exist would be difficult to exploit. It thus seems reasonble to accept the Efficient Market Hypothesis as an initial working assumption in most commodity futures markets.

CHAPTER FOUR

POTENTIAL BENEFITS OF USING FUTURES MARKETS

4.1 Introduction

The potential benefits of using futures markets include 1) greater flexibility in pricing and contracting decisions, 2) greater price information, 3) reduced price (and possibly quantity) uncertainty, and 4) increased real income as a result of behavioral changes made possible by the first three benefits. Important characteristics of these benefits are that they are 1) uncertain, meaning that a trader may or may not realize them, 2) difficult to quantify even if realized, and 3) not readily seen as benefits by those not knowledgable about futures markets. These characteristics influence the decision whether or not to utilize the markets, and will be discussed in more detail in the next chapter.

In this chapter, each potential benefit will be discussed. In addition, empirical studies of the impact of uncertainty on production will be reviewed. Finally, the important issue of the distribution of benefits from futures trading will be discussed.

4.2. Increased Flexibility

In any purchase or sale of a commodity, one must determine quantity, quality, time and point of delivery, and price. In cash and forward market transactions, all these parameters are deterimined simultaneously. Yet it can be analytically and operationally useful to separate the determination of price from that of the other parameters. The objective of a pricing decision is to minimize cost. The objective of the other decisions is to provide the needed quantity and quality of food at the required time and proper -location. These objectives may conflict at a point in time. For example, price may happen to be unusually high at the time a government trading agency must place its order for the country's import needs. To the extent that the objectives do conflict, it is useful to separate the determination of price from that of all other parameters[1]. Futures markets offer a means of doing this. Using these markets, importers can price their purchases at any time they deem favorable, rather than being constrained by the timing of their cash market purchase decisions.

This enhanced flexibility can be of great value to an informed, effective trader. Within a buying agency, pricing activities could take place with a degree of independence from purchasing activities, allowing both to better satisfy their differing objectives.

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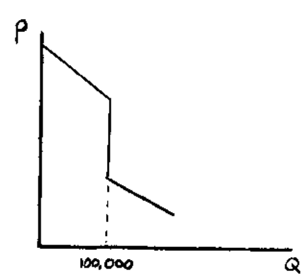
[1] Price and quantity decisions are in a sense inseparable. This is indicated by the concept of a demand curve, where quantity demanded is determined by price. However, the demand curve need not be continuous. For example, a country which knows it needs at least 1,000 metric tons of wheat imports to avoid urban food riots will likely be willing to purchase this amount over a range of prices. The country's demand curve in this case might look like this:



A country in such a situation could use the futures market to price the 1,000 MT prior to the cash market transaction, thus separating the price and quantity decisions.

Of course, this flexibility will be beneficial only insofar as traders have the ability to effectively deal with any uncertainty facing them. Allowing an agent incrased behavioral flexibility when uncertainty is high may worsen rather than improve performance. While futures markets themselves contain information which, if properly utilized, can help reduce uncertainty, no one is guaranteed success. Poor, uninformed trading may do more harm than no trading at all.

4.3. Increased Information

Futures markets provide two major types of information of benefit in reducing the level of uncertainty to anyone trading in international commodity markets, be they cash, forward, or futures markets. First, nearly all international trading in wheat and corn is reference priced on the basis of commodity futures market quotations. In the course of their operational hedging, exporters hedge all contracts on the futures market, and their bids can be usefully viewed as the sum of a futures price and a location-specific basis (Peck, 1982). Importers can make more informed purchasing decisions by calculating and then analyzing the basis. If the quote is FOB, overland freight costs within the country of origin must be analyzed. If the quote is CIF, ocean freight costs must also be considered. While other factors such as supply and demand conditions at points of origin and destination will determine the final price, basis analysis is necessary for any informed decision.

The other major type of information carried by futures markets involves the price of storage. The generalized two and three period equations developed in Chapter Three are repeated here.

2-Period: $E(PS)_{t(t,t+1)} = E(B)_{t,t+1} - B_t$

3-Period: $E(PS)_{t(t+1,t+2)} = PF_{t,t+2} - PF_{t,t+1} + [E(B)_{t,t+2} - E(B)_{t,t+1}]$

If a trader can accurately predict basis changes, he can obtain his expected gross return to storage. To calculate the expected net return, one must subtract the physical and interest costs of storage from the gross returns caculated above.

Heifner provides the following three period example. The January 30, 1985 quotes for March and May delivery of corn were, respectively, $107.08 and $109.44 per metric ton. Let's assume that a trader expects the basis in March to equal that in May. These prices then indicate an expected gross return to storage of $109.44 - $107.08 + $0.00 = $2.36/MT over two months. Borrowing at 10%, the interest cost of carrying the corn for two months would be (2/12)*.10*$107.08 = $1.78 per metric ton. This leaves $2.36 - $1.78 = $0.58/MT to pay for the physical costs of storage.

Both exporters and importers can use this information in their decision. An importer needing corn in May could either 1) place a three period inventory hedge now, purchase in the cash market in March and store under the hedge until May, pr 2) place an anticipatory hedge now using the May contract, purchase the corn in May, and thereby avoid storing. An exporter holding grain could either 1) place a three period inventory hedge now, store under the hedge until May, and sell in May, or 2) place an anticipatory hedge now using the March contract and sell in March, thus avoiding storage.

The complication faced by LIC traders is that transportation, storage, and local supply and demand conditions create a large and potentially variable basis, making accurate prediction of the return to storage difficult. Thus, informed analyis of prospective future bases is critical.

One should note that the informational benefits just discussed may be obtained by importers and exporters whether or not they directly participate in futures market trading. While one who does trade directly will likely follow the markets more closely and therefore extract better information, there is nothing to stop the perceptive non-trader from obtaining similarly valuable information.

4.4. Reduced Price and Quantity Uncertainty

The terms risk, uncertainty, and variability can take on a variety of often unclear meanings in current literature. Their meanings in this paper must therefore be clarified. Variability implies that a value changes over time, i.e., that the focus of interest is a variable rather than a parameter. Risk implies that the value of this variable is drawn from some probability distribution, making it a random variable. Uncertainty implies the accompanying inability to accurately predict the value at each point in time. One measure of the level of uncertainty is the mean squared deviation of the actual value from some subjectively determined expected value.

Following from these definitions, variability in the absence of risk does not necessarily imply uncertainty, i.e., the value of a variable not subject to random influences could conceivably be predicted with certainty.[2] However, this is clearly not the most common empirical case. The value of a variable in the real world is nearly always subject to some random influence, and is therefore uncertain. As a result, variability generally implies uncertainty.[3] A reduction in variability, ceteris paribus, will decrease the level of uncertainty as defined above.

It follows that direct futures trading might reduce price uncertainty in two ways. First, it might reduce the price variability facing hedgers. Second, it might "cut the link" between variability and uncertainty by enabling a hedger to lock in a future price. In other words, the variability of prices might not be reduced, but those prices could be determined ahead of time through futures trading. Each of these mechanisms will now be discussed.

In general, a routine hedging strategy cannot be expected to reduce price variability unless futures prices are less variable than spot prices. Two possibilities deserve mention. First, there may be a seasonal dimension to price variability which hedgers might exploit. Second, futures prices might in general be less variable than spot prices.

Heifner addresses the first possibility. He notes that much year-to-year price variation for LIC commodity importers is

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[2] For example, a given price might be known to increase 5% each year - its value is changing, but is not random, and could therefore be accurately predicted by an agent with the proper information.

[3] This is implicitly recognized in much empirical work on the influence of risk on output decisions which uses the variance of past prices as one measure of risk. See Hurt and Garcia (1982), Traill (1978), Lin (1977), Behrman (1968).

caused by supply shocks in producing areas. These shocks are not apparent until after planting, and so are not normally built into pre-planting price expectations. These expectations, reflected in the pre-planting futures price of the post-harvest contract, may therefore be more stable than the post-harvest cash prices. Heifner suggests that importers might take advantage of this possibility and reduce year-to-year price variability by purchasing in the futures market prior to planting in the U.S.

Tomek and Gray (1970) tested this hypothesis, and found that, between 1952 and 1968, the April 30 price of the December corn contract was 7% less variable than the December cash price (represented by the price of the expiring December futures contract). In soybeans, the April 30 price of the November contract was 26% less variable than the November cash price. An importer using a routine anticipatory hedging strategy on these crops would therefore have reduced year-to-year variability during that period. However, Tomek and Gray conclude that in general, such a strategy cannot be said to be effective, because F tests show that the variances of the cash and futures prices are not significantly different.

Even if Heifner's suggestion were correct, it would have limited applicability to most LIC's. Many of these countries have little flexibility in when they can place import orders, due to the timing of harvest, critical hungry periods in the country, and shipping time requirements to the country (the following information comes from Lanagan, 1983). A country such as Ghana frequently imports corn, but also harvests a major corn crop in July and August. Its critical hungry period tends to fall just prior to harvest, in April, May, and June. To arrive in time for the hungry period, any necessary imports must leave the U.S. in January or February. Thus, Ghana must wait until after its harvest, say in September, to estimate its import needs, and must have them on the ship by the beginning of the next year. Table 4-1 shows the results of a routine strategy of placing an anticipatory hedge using the December contract the first Wednesday of September each year between 1975 and 1984. Unlike Tomek and Gray's analysis, this shows that such a strategy would have increased rather than decreased price variability during the time period analyzed. However, the low F statistic once again indicates that the variances are not significantly different, so that no general conclusions can be reached.

Table 4-2 shows results of similar strategies for countries importing corn and wheat. Both Cameroon and Malawi consume corn. Cameroon would likely make any import decision in October, after its major harvest, and might use the March contract, since its shipments must leave in April or May.[4] Malawi, on the other hand, might decide in January, and use the September contract for shipment in September or October. Both Ethiopia and Morocco consume wheat. Ethiopia might make its import decision in March after the harvest in February, and use the July contract for shipment in July or August. Morocco might make its decision in

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[4] It is important to realize that the March contract will not necessarily be the best one to use. Market analysis might reveal another contract to be superior at a given time. The March contract is the most logical one to use in this example, but is in a sense arbitrary.

Table 4-1. Results of routine anticipatory hedging strategy for corn, 1975-84

Price Variable	Mean	Std. Dev.	Coef. of variation	F Stat*
December Corn				
1st Wed, Sept.	282.00	55.02	19.51	.78
Closing	264.83	48.72	18.40	

* testing the hypothesis that $\sigma^2_c > \sigma^2_f$, where σ^2_c is the variance of the cash price, and σ^2_f is the variance of the futures price. The cash price is taken to be the closing futures price.

Table 4-2. **Results of routine hedging strategies for corn and wheat, 1975-84**

Price Variable	Mean	Std. Dev.	Coef. of variation	F Stat*
March Corn				
Wed of 2nd week, Oct	300.38	59.57	19.83	.94
Closing	293.15	57.64	19.66	
Sept. Corn				
Wed of 2nd week, Jan	289.43	41.42	14.31	1.75
Closing	280.55	54.87	19.56	
July Wheat				
Wed of 2nd week, Mar	357.95	54.18	15.13	1.30
Closing	356.08	61.79	17.35	
Dec. Wheat				
Wed of 2nd week, Aug	379.88	72.06	18.97	.80
Closing	346.48	64.35	18.57	

* testing the hypothesis that $o^2_c > o^2_f$, where o^2_c is the variance of the cash price, and o^2_f is the variance of the futures price. The cash price is taken to be the closing futures price.

August after the July harvest, and use the December contract for shipment in January or February. The results in Table 4-2 largely confirm Tomek and Gray's conclusion. In two of the four cases, the coefficients of variation are nearly identical, while in the other two the CV for the cash prices is higher, but with insignificant F statistics.

The second possibility for futures trading to reduce price variability is if futures prices are in general less variable than spot prices. The theory of the price of storage provides a theoretical basis for expecting this. As shown in Figure 3-1, a market's positive carrying charge approaches a limit at the cost of storage, meaning that the futures price can exceed the cash price only by the cost of storage. However, there is no limit to the inverse carrying charge - how much the cash price can exceed the futures price. Thus, we might expect the futures price to be somewhat more stable than the cash price. This hypothesis has not been empirically confirmed.

On balance, then, there is little evidence of either a seasonal or more general difference in the variability of futures and spot prices. One can therefore not expect routine hedging strategies to consistently reduce price variability.

What then is the price benefit of using futures markets? That benefit lies largely in reducing uncertainty (as contrasted to variability) by using futures trading to lock in approximate prices prior to cash market transactions. While this can be of significant benefit, two qualifications need to be mentioned. First, there are other means of locking in prices, such as forward contracting. While this approach does not offer the pricing and contracting flexibility that futures trading does, it may be preferred by certain countries at certain times. Second, unless the basis at the time the contract is closed is known when the hedge is placed, uncertainty is not completely eliminated. This is a critical issue which severely limits the usefulness of futures markets for some importers and exporters. It will be discussed in detail in the next chapter.

Hedging might also reduce quantity uncertainty for importing and exporting nations. Most LIC importers face serious difficulties borrowing in international capital markets. As a result, they must finance their imports with whatever foreign exchange they are able to earn through exports. If prices rise unexpectedly, they may not have the foreign exchange reserves needed to meet their food deficit. While the IMF's Compensatory Financing Facility and the European Community's STABEX scheme are designed to deal with this problem, many countries have been reluctant to use them. A systematic hedging program might allow these countries to lock-in prices when they are at levels that do allow the food deficit to be met through imports without recourse to the CFF or STABEX.

For example, Figure 2-5 shows the nominal prices of wheat and corn between 1970 and 1984. The dramatic price rise between 1971 and 1974 prevented many coutries from importing needed grain supplies (although some of this shortfall was met through concessionary grain sales and relief shipments from the West). A systematic hedging program would have moderated this price rise, and allowed the countries to more adequately meet their needs.

Of course prices fell rapidly between 1974 and 1977. A hedging program during this period would have resulted in a higher price and may have reduced the countries' imports. The cycle began again in 1977, with prices rising rapidly until 1980, the falling until 1983. But over the entire period from 1971 to 1983, a hedging program would have had a largely neutral effect on prices while possibly reducing the variability of food imports. This could have resulted in fewer people experiencing periods of severe calorie deficiency.

An exporting agency might use the forward pricing function of futures markets to reduce its quantity uncertainty. For example, an agendy in Ghana could use the New York Coffee, Sugar, and Cocoa Exchange to establish prices on later cocoa exports. It could then enter into forward contracts with its cocoa producers, specifying price and quantity. In this way it could be more certain of the quantities it will have for later export, and more able to engage in forward contracting with purchasers on international markets.[5]

4.5. Increased Real Income

Three potential benefits of futures trading have been discussed: 1) increased flexibility in pricing and contracting decisions, 2) increased information, and 3) reduced price and

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[5] It is recognized that these agencies currently engage in forward contracting in international markets, and to a lesser extent in domestic markets. What is claimed is that futures trading, by reducing price uncertainty, can facilitate domestic forward contracting and thereby make such contracting in international markets easier. It is also recognized that quantity uncertainty cannot be eliminated, due largely to weather variability. Forward contracting with domestic producers, however, can help reduce this uncertainty.

quantity uncertainty. The final two benefits directly reduce a trader's overall uncertainty, while the first may allow the trader to capitalize on that reduction.[6] The question then emerges, can futures trading reduce costs or increase income for those government parastatals or private traders who utilize them? In addressing this issue, three separate issues must be considered. These are 1) The Efficient Market Hypothesis, 2) the potential impact of uncertainty reduction on a) output and investment, and b) the freeing of scarce managerial talent for strategic planning activities, and 3) the role of a systematized pricing, risk management, and purchasing (or selling) procedure in reducing uncertainty, and thus facilitating transactions and reducing transaction cost. Each of these issues will be treated in the following sections.

4.5.1. The Efficient Market Hypothesis

The efficient market hypothesis was discussed in in Chapter Three. Essentially, it says that a futures price for a given delivery month in an efficient market is an unbiased indicator of that month's expected cash price. In other words, a futures price in an efficient market will not systematically rise or fall as delivery approaches.

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[6] An example is the storage decision illustrated in section 4.3. In January, the market contained information indicating a certain return to storage between March and May. The presence of a futures market allows the trader to reduce price uncertainty by locking-in an (approximate) price. Furthermore, this price can be locked in while storing or not storing. Finally, having locked-in a price, the trader's behavior need not be influenced by adverse cash price movements - he has the flexibility of responding or not responding, based on other considerations.

Since most studies have shown the major futures contracts to be efficient, futures market trading provides no guaranteed better prices. Any improvement "depends solely on the quality of the speculative price judgements" that one must make (Peck, 1982, p. 88, emphasis added). When to place and lift a hedge, when to establish the price in a basis trade (a type of trade to be discussed in Chapter Six), whether to store for another two months; all these decisions depend on expectations of future price relationships, and must be made on the basis of sound market analysis and good judgement if one hopes to obtain a better price. Any routine hedging stratgegy will in the long run likely yield an average price identical to that obtained by transacting only in the cash market.

This does not mean that there are no benefits to routine hedging strategies. While such strategies cannot be expected to yield better prices, they can reduce uncertainty. The benefits of reduced uncertainty will be discussed in the next section.

4.5.2. Expected Utility Theory: The Impact of Uncertainty on Output/Investment

In a world of perfect information and unlimited ability to process and make use of that information, the objective of every economic organization is to maximize profit, given output price and costs of production. Such an objective becomes inappropriate in a world of uncertainty and limited ability to use information. As D. Gale Johnson (1947) stated:

> ... if expectations are uncertain, the goal of the entrepreneur will generally not be that of maximising income in the traditional sense ... The goal of the firm will be to obtain a maximum return in terms of

income and safety, the particular combination of the two most acceptable to the firm depending upon subjective preferences.

Expected utility theory is one approach to analyzing firm behavior under such conditions. In brief, this theory involves the assumption of risk averse behavior, and the incorporation of risk (variously defined) into an expected utility function to be maximized.[7] The theory shows that risk averse individuals will invest more in a safe asset with a given return than in a risky asset with the same expected return. The implication of this result is that a reduction in the riskiness of an asset will cause risk averters to invest more in it. Appendix D contains a more detailed elaboration of the theory and its implications. A number of empirical studies based on this theory have investigated the impact of risk on the level of agricultural production. These studies, some of which are reviewed below, uniformly demonstrate a negative relationship between the two variables.

Hurt and Garcia (1982) examine the impact of input and output price risk on U.S. sow farrowings over the period 1967-1979. Their general approach is to first estimate output equations without price risk variables, then estimate the same equations with price risk variables added, and compare results.

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[7] A risk averse individual can be defined as one who would prefer a scenario giving a payoff of x with certainty to a scenario giving payoff (x-a) with probability one-half and payoff (x+a) also with probability one-half. See Appendix D for more detail. The theory is not limited to risk averse behavior, being equally applicable to risk loving and risk neutral behavior. But application of the theory is generally limited to risk aversion due to the observation that it is this type of behavior that is most often encountered in the real world.

They use two conceptions of risk, 1) the variance of past prices, and 2) the deviation of actual prices from expected prices. They estimate two equations without risk variables. In formulating expected prices for these equations, one uses a weighted average of actual past prices, while the other uses a series of current futures prices. Of the three equations incorporating price risk variables, two showed both the input and output price risk parameters to be significantly negative at alpha = .05.

Traill (1978) examines the impact of output price risk on U.S. onion acreage response. He estimates a conventional supply equation using an Almon lag structure on past prices, and compares this with three alternative risk equations. The three definitions of risk are 1) absolute value of the deviation of past actual from past expected prices, 2) a moving standard deviation of past actual prices, and 3) a moving probability distribution, defining the probability of price falling below a specified level. The risk variable coefficients all have the expected negative signs and have t statistics between 1.06 and 1.74. Traill feels that these t values are "reasonable". In addition, all risk models predict more turning points than do the conventional models.

Just (1974) investigates the effect of total returns risk on wheat and sorghum acreage in the San Joaquin and Sacramento valleys of California. He estimates one conventional equation and two risk equations for each crop in each area. Each risk equation defines risk as the squared deviation of actual from expected prices. In seven of the resulting eight risk equations, the risk variable was significant at an alpha of .05. Just's superior statistical results (as compared to Traill, and Hurt & Garcia) are attributed to his use of regional rather than national data, an approach which reduces aggregation problems.

Lin (1977) uses a polynomial lag model to estimate the impact of risk on wheat acreage response in Kansas during the period 1950-1975. Risk is incorporated as the three year moving average standard deviation of past actual returns per acre. t statistics on risk variables range from -1.03 for a three year lag to -1.94 for a five year lag. His results indicate that a 1% reduction in risk as he measured it would lead to a .06% increase in wheat acreage planted.

While this effect might appear quite small, it can be significant in periods of heightened risk. For example, the grain market shocks in the 1970's greatly incrased the uncertainty facing world grain traders. Hedging activities during this time would have dramatically reduced this uncertainty, with potentially large payoffs. Lin estimates that had price risk in Kansas in 1975 been at its historical trend rather than the historically high levels actually experienced, 622,000 additional acres of wheat would have been planted.

Behrman (1968) estimates the impact of output price risk on supply response for four major Thai crops from 1938 to 1963. He defines risk as a moving standard deviation of past prices, and estimates equations for 68 different areas. The equations show significant negative responses to risk in a majority of these areas. The risk variable is more frequently significant among the three marketed crops than it is in rice, which is mostly consumed at home.

This theory is relevant for LIC importers and exporters from two perspectives. First, they might be able to pass-on reduced price uncertainty to other market participants. For example, hedging might allow an exporting agency to announce producer prices prior to planting. With price risk eliminated, these producers may respond with greater output. If the agency can consistently announce prices prior to planting and then honor those prices for a number of years, producer confidence in the agency and willingness to produce for it may further increase.

An importing agency must sell to local wholesalers, processors, and other market participants. These participants require a steady supply of the product at a reasonably predictable price to plan their processing and sales activities and satisfy their customers' demand over the short to medium term. Of special benefit to all parties would be the ability to engage in forward contracting. The less price and quantity risk the participants face, the more feasible this contracting becomes.

Application to the importing or exporting agency is not as straightforward. An exporting agency must invest in a domestic purchasing system. An importing agency may have to invest in a domestic distribution system. Both may need to invest in storage facilities. All these investments are risky, but they have long run horizons, and require informed estimates of supply, demand , and price years into the future. Futures markets are essentially short-run risk management tools, and do not reduce uncertainty beyond one year at most. This sequential reduction of short run uncertainties does little to facilitate planning with ten to twenty year time horizons.

But just as other participants might benefit from forward contracting, so might the importing or exporting agency. For the importing agency, reduced price and quantity uncertainty should facilitate forward contracting with wholesalers, processors, and other market participants. An exporting agency, by forward contracting with domestic producers, will be more able to do the same with international buyers. Each agency is more willing to "invest" in current commitments to later transactions since those transactions now carry less risk.

4.5.3. Freeing Scarce Managerial Talent for Planning Purposes

The reduction of short and medium term uncertainty made possible by futures trading may facilitate long-term planning if managerial talent is scarce. This is nearly always the case in LIC settings. While those managers that exist may be well trained and competent, they are nearly always in short supply. Their energies must frequently be devoted to immediate crises, e.g., the price of wheat has just rise, our French franc holdings have just dropped in value relative to the U.S. dollar, and we may not be able to import enough wheat to avoid long bread lines in the cities: what do we do? Or if this has not happened, managers must consider the possibility that it will, and develop plans to deal with it. Managers who must deal with such actual and potential crises on a daily basis have little time to devote to issues of more long-run significance.

A systematized hedging strategy could help relieve managers of such worries, and enable them to devote more time to long-term strategic planning activities. Information of value in such activities, which might previously have been ignored, can now be sought out and used.[8] The quality and therefore the payoff from these planning activities could be expected to increase.

4.5.4. Transaction Costs

"A transaction may be said to occur when a good or service is transferred across a technologically separable interface" (Williamson, 1981). Thus, a farmer obtaining fertilizer, a processor obtaining grain, and a consumer obtaining food all engage in transactions. The manner in which transactions occur, and the costs associated with them, are critical to the analysis of any economic system.

Transaction costs include the cost to sellers (buyers) of finding buyers for (sellers of) their product; the cost of determining the range of prices in the market; the cost of bargaining for a favorable price; the cost of negotiating a contract; the cost of making sure the contract is honored; and the cost of transporting a good from one point to another.

In the absence of uncertainty, only the final three costs would exist, and only the final one would be significant: price

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[8] Heiner (1983) provides a theoretical basis for this assertion. His thesis is that uncertainty leads agents to ignore potentially valuable information - one cannot be certain of its value, and therefore prefers to ignore it rather than act on it and face the risk of a negative payoff. As uncertainty is reduced, one can more effectively analyze the usefulness of a given piece of information, and will therefore be more likely to act on information which is valuable. Heiner's theory can be found in somewhat more detail in Appendix E.

would be known to all market participants, eliminating the need to determine price ranges and bargain for specific prices; market contracts would take time to formalize, but the terms would be easily agreed upon; and cheating on contracts would be easily detected. Transportation costs would remain.

Uncertainty means that prices and trading partners are not known to all participants, leading to search and bargaining costs. Contracts become more expensive to formalize, since terms cannot be immediately agreed upon. Finally, cheating on contracts and other types of opportunistic behavior cannot be easily detected, leading to higher policing costs.[9]

We have demonstrated in previous sections that effective futures trading can reduce uncertainty for government parastatals or private trading firms. The information contained in futures prices aids the analysis of bids received and helps in the storage decision. Reduced price uncertainty made possible by futures trading directly reduces overall uncertainty. In addition, futures trading allows pricing and other contracting activities to be pursued somewhat independently, possibly improving performance in both areas.

These factors should enable a firm to reduce transaction costs: opportunistic behavior in the form of inflated bids can be guarded against through better price information; the storage decision may be made more systematically and at lower cost;

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[9] Williamson (1981) defines opportunistic behavior as "self-interest seeking with guile." Such behavior can be profitable under conditions of uncertainty, largely due to the cost to the other party of detecting it. Such behavior therefore increases transaction costs.

planning is facilitated by the reduction of short-run price uncertainty; pricing decisions can be freed from the constraints imposed by other contracting activities, and vice versa.

As transaction costs decrease, all else constant, the financial performance of the firm will improve. If the firm is a government parastatal, government expenditures should fall, and revenues might rise. Both imply potential benefits to the population as a whole. If the firm is in the private sector, its improved performance implies a potential improvement in the performance of the food sub-system of which it is a part. Whether these potential benefits to the larger population are realized is an important issue which will be taken up in a later section.

4.5. The Distribution of Benefits

To date, our attention has been largely focused on the trading agency, and the benefits it might reap from greater familiarity with and use of commodity futures. But this agency is but one participant in a system, and benefits to it do not necessarily imply benefits to the other system participants. The extent to which the trading agency's benefits are passed on to other participants in the system will determine not only the distribution of benefits, but also the level of system-wide benefits. While this issue is a very complex one, this section will attempt to briefly identify the major system-wide benefits that might be realized, as well as those critical variables which most influence their realization.

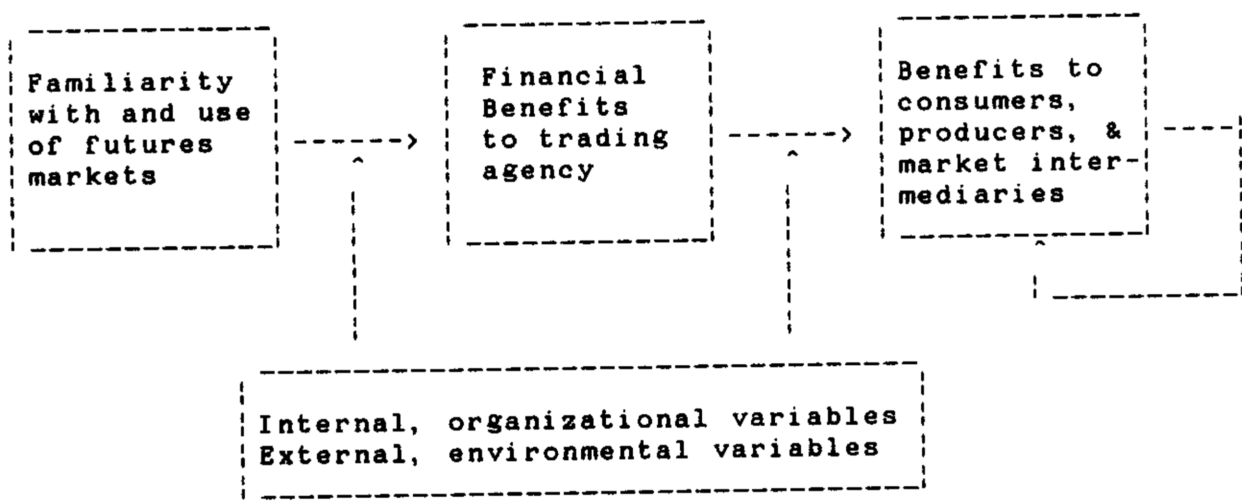
The relevant system is the subsector of that commodity being traded in the futures market. Participants most affected by this trading are producers, the trading agency, market intermediaries (processors, wholesailers, retailers, and other marketing agents), and consumers.

It is useful to view the flow of benefits in two stages, as in Figure 4-4. Initially, a trading agency becomes familiar with and uses futures markets. Whether this activity is translated into financial benefits for that agency is influenced by a set of internal organizational variables, and external environmental variables. Assuming the agency does realize some benefits, whether these are then translated into benefits for other system participants is again influenced by the set of organizational and environmental variables. If other participants do realize benefits, these can take on a dynamic quality and increase the total level of benefits.

If realized, the benefits discussed throughout this chapter should benefit the trading agency through smoother day-to-day operations, reduced transaction costs, a more stable planning environment, and possibly increased investment. All of these benefits imply improved financial performance. The variables influencing whether these benefits are realized are discussed in detail in the next chapter. Briefly, they include 1) the predictability of the basis, 2) quantity predictability - exportable surplus for producing countries, and consumption deficit for importers, and 3) the behavioral flexibility, financial resources, and analytical capacity of the trading agency.

At this point it might be useful to distinguish between public and private trading agencies. For a public agency, the

Figure 4-4. Flow Chart of Potential Benefits from Futures Trading, and Variables Influencing Those Benefits



initial benefits already discussed might result in two separate effects. One is a ripple effect throughout the public sector. Marketing parastatals in many LIC's are quite large, and command major portions of the government's budget. Any increase in operational efficiency thus holds the potential of freeing scarce resources for use in other areas of the public sector. The other effect is shared by both public and private trading agencies. As one participant in a system, any increase in the operational efficiency of these agencies holds the possibility of improved performance throughout the system.

Whether this system-wide improvement is realized depends primarily on two factors. First is the degree to which any cost/revenue benefits to the agency are passed on to consumers (through market intermediaries) or producers in the form of better prices and/or better services.[10] The second is the degree to which the agency's decreased uncertainty is passed on to producers and market intermediaries, in the form of timely price announcement or more extensive contracting (as discussed in section 4.5.2.)

There are numerous variables affecting these two factors. For a public agency, important variables might include:

1. The relative weighting of the elements of the agency's objective function. How important is the provision of employment and accumulate bureaucratic power relative to effective economic performance? The more important they

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[10] Better services can result in better effective prices. For example, the construction of more buying stations reduces farmers' transport cost and leaves more money in their pockets. More distribution stations reduce consumers' cost of obtaining food, and increase their real income.

are, the less likely futures trading is to result in better and less uncertain prices and/or better services for producers and consumers.

2. The incentive structure within the agency. Does it encourage primarily financial and economic, or political and bureaucratic performance?

3. The agency's ideology. Does it feel a responsibility to effectively use its resources for the larger good? What is its conception of the larger good and how it is best served?

4. The competitive environment. In the absence of an appropriate ideology, incentive structure, and objective function, an environment in which the agency must compete with private traders for business may nevertheless encourage the transmission of trading agency benefits to other market participants.

The relevant variables for a private trading agency are similar to those above. The primary difference is that such an agency's objective function is likely to be more heavily weighted toward effective financial performance, and its incentive structure will primarily reward such performance. However, this in no way guarantees the transmission of benefits to other system participants, especially since a private agency's ideology is less likely to contain specific reference to any larger good. The competitive environment takes on special importance in this case, as does the relationship between the public and private sectors. Specifically, does the public sector create an environment, through regulatory and oversight activities, wherein private firms are to an extent constrained to serve the larger public good in addition to their own?

Assuming the trading agency benefits from futures trading and transmits some of those benefits to other system participants, what benefits do these participants stand to gain? If the agency purchases from domestic producers and then exports, the major benefit to be realized is increased production. Abstracting from any price effects, this increase should improve producer income and the country's balance of payments. Increased producer income should result in higher consumption and, assuming availability, increased use of productive inputs. This latter result, to the extent it is realized, will reinforce the initial boost in production.

If the agency imports and sells to market intermediaries and consumers, the major benefits to be realized are smoother operations throughout the system and lower consumer food costs. Lower food costs imply higher real income (especially for those consumers spending a majority of their income on food), which should lead to greater demand, increasing national income.[11]

Finally, one must realize that these benefits are only potential, and even if realized would be extremely difficult to quantify. Relative to a country's economy, they are probably small. Nevertheless, they are important elements in the overall improvement of an economy's performance.

Table 4-3 summarizes our discussion of the distribution of benefits.

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[11] This analysis assumes a slack economy. This seems reasonable, given the widespread underuse of resources such as labor in LICs.

Table 4-3. Potential System-Wide Benefits of Futures Trading

Benefit	Source	Critical Variables
A. PUBLIC, PRIVATE TRADING AGENCY		
Greater op. efficiency, reduced transac. costs, more stable planning environ, poss. inc. in investment	Reduced price uncertainty	Predictability of basis, quality of basis analysis, ability and authority to act quickly
B. MARKET INTERMEDIARIES, (IMPORTING AGENCY)		
Lower, less uncert- in input costs	Cost savings, reduced uncertainty passed-on by trading agency	Rel. weighting of obj. function, incentive struc., ideology, competitive environ. of trading agency (& reg. & monitoring environ. if private agency)
C. CONSUMERS (IMPORTING AGENCY)		
Lower food costs, increased real income, resulting in increased demand	Cost savings, reduced uncertainty passed-on by market intermediaries	Rel. weighting of obj. function, incentive struc., ideology, comp. environ., of mkt. intermediaries (& reg. & monitoring environ. if private intermediaries)
D. PRODUCERS (EXPORTING AGENCY)		
Higher, less uncertain prices, higher income	Cost savings, reduced uncertainty passed-on by trading agency	Same as section B
E. GENERAL		
Inc. production, income, and demand	Reduced uncert. to producers, intermediaries; better prices to producers and consumers	All of the above

CHAPTER FIVE

PRECONDITIONS FOR EFFECTIVE USE OF FUTURES MARKETS

5.1 Introduction

The preconditions for effective use of futures markets have been mentioned in previous chapters. They have to do with basis and quantity predictability, and with the behavioral flexibility, financial resources, and analytical capacity of the buying agency. This chapter will discuss these preconditions in more detail, with section 5.2 concentrating on the determinants of the basis, section 5.3 briefly discussing the impact of quantity uncertainty on hedging effectiveness, and section 5.4 addressing the necessary characteristics of the buying agency.

5.2 The Basis

We know that the basis must be more predictable than cash price levels for futures markets to be effective price risk management tools. In Chapter Three, we said that the basis could be broken into three parts:

(1) Basis = Spatial Basis + Temporal Basis + Quality Basis

The quality basis includes premiums and discounts for varieties and qualities of a commodity different from those specified in the futures contract. In practice, the diversity of qualities of grains is dealt with through fairly standard discounts or premiums. Since these are generally known, quality differences have little effect on a trader's basis risk. Variety differences may have a greater impact, since the prices of two different varieties of a commodity will respond to somewhat different supply and demand signals. In practice, however, variety differences have much less impact on basis risk than do spatial differences.

The temporal basis in a perfect market would be equal to the cost of storage. In imperfect real world markets, the temporal basis is referred to as the price of storage, which may be above or below the physical and interest costs of storage. Too, a trader wishing to hedge a later purchase or sale is generally interested in the basis prevailing near contract expiration. In this case, the temporal basis is equal to zero. Like the quality basis, the temporal basis therefore has little effect on a trader's basis risk.

Such is not the case with the spatial basis. Samuelson (1952) showed that in a competitive equilibrium, spatial price differences are equal to transportation costs. In fact, the spatial basis is strongly influenced by transportation costs, but is also influenced by the degree of integration between the cash market near the futures exchange and that in which the trader makes his cash purchase. Markets which are not well integrated respond to different supply and demand conditions, and their prices may not move together. Basis risk may therefore be much greater in one market than in another. Garcia (1984) notes that "short-term basis behavior at different markets may be influenced considerably by shifts in local supply and demand conditions", and that these shifts can cause different levels of basis risk in different markets. Finally, Kamara (1982) notes that "changes in regional supply and demand patterns and seasonal availability of transport" mean that "the basis may be more volatile for hedgers located far from delivery points than for those located near a delivery point."

LIC traders interested in the possibility of using commodity futures to manage risk must be able to predict with some accuracy what the basis will be at specific times. To do this, they must first understand the historical behavior of the basis. Has it followed consistent patterns, and what have been the determinants of those patterns? Are there trends in its behavior? Basis charts are tools used by every trader to track the behavior of the basis. They are graphs, updated daily, of the basis for a specific crop at a specific place, and relative to specific futures contracts. For example, one chart could show the daily basis for wheat in Senegal relative to the March, May, July, September, and December contracts, extending back as far as data permits. Basis charts should be developed by anyone considering futures trading. An important question in many LIC's is whether there exists a relevant historical cash price series that can be used to calculate the local basis.

Second, LIC traders must have an intimate understanding of the transportation markets that strongly influence the basis. Again, given that transportation rates can be variable, are there predictable patterns within that variability? What opportunities exist to lock-in transportation rates ahead of time? Finally, these traders must closely monitor local and international supply and demand conditions, to predict how prices in the markets where they transact might move relative to international prices. Armed with this knowledge, traders must then make an informed decision as to which price - the cash price level or the basis - they can predict most accurately. If the basis can be less accurately predicted, hedging should not be undertaken. If it can be more accurately predicted, other factors to be discussed below must then be considered before a final decision is made.

If hedging is undertaken, one might then need to decide what proportion of one's exports or imports to hedge. Peck (1975) shows that a full hedge will not necessarily minimize uncertainty. In developing an optimal hedging ratio model[1] for U.S. egg producers, she develops the following formula for the mean squared error (MSE) of the producers' revenue estimates:

$$\text{MSE}(P) = (1-h)^2\sigma_p^2 + h^2\sigma_b^2 - 2h(1-h)\sigma_{pb}, \qquad (2)$$

where, h = the optimal proportion of expected production to be hedged,

O_p^2 = the means squared error of the producer's cash price forecasts,

O_b^2 = the mean squared error of the producer's basis forecasts, and

O_{pb} = the covariance between these two forecast errors

In a fully hedged position (h=1), MSE(P) = O_b^2, while in a non-hedged position (h=0), MSE(P) = O_p^2. But h need not be limited to the values zero or one. In an efficient market, h can be calculated by minimizing equation (2) and solving:

$$h = \frac{\sigma_p^2 + \sigma_{pb}}{\sigma_p^2 + \sigma_b^2 + 2\sigma_{pb}} \qquad (3)$$

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[1] This is a model which generates a hedging ratio, h, which represents the proportion of quantity purchased or sold which should be hedged to optimize a specified objective function.

In Peck's analysis, h most often took on values between zero and one, though it was not restricted to this range and at times was outside of it.

Three qualifications are in order. First, equation (3) gives only an estimate of the true h, since this true value depends on the cash price and basis forecast errors (and their covariance) in the current forecasts, and these are not known. There is no guarantee that hedging a proportion h as calculated above will reduce uncertainty more than a full hedge. Second, foreign exchange and interest rate movements can also affect the basis. A trader holding foreign exchange with which she will purchase grain must hedge both. If the trader is not holding foreign exchange and intends to borrow it, she must use interest rate futures along with grain and foreign exchange futures to deal satisfactorily with the risks confronting her. Finally, Peck's analysis does not include quantity uncertainty, an issue to be addressed in the next section.

5.3. Quantity Uncertainty

All traders must consider quantity in addition to basis uncertainty. These two interact to determine the level of cost (revenue) uncertainty an importer (exporter) faces. The analysis in the next chapter indicates that, for a given level of basis uncertainty, increasing quantity uncertainty has two effects: it decreases the effectiveness of hedging in reducing cost uncertainty, and it increases the probability that hedging will increase rather than decrease this uncertainty. The implication is that, even if one can predict the basis more accurately than cash price levels, quantity uncertainty may make hedging inadvisable. Chapter Six provides some quantitative guidance as to when this might be the case.

5.4 The Buying Agency

5.4.1 Analytical Capacity

The analytical capacity required for effective hedging depends in large part on how "effective" is defined, and this definition depends on the agency's objectives. This paper has stressed the difficulty of obtaining better prices through futures trading, and has taken the view that the primary objective of such trading should be risk reduction which facilitates profits in the firm's primary business. This orientation leads to a fairly mechanistic view of hedging: a trader should do his best to predict the basis, make sure he can predict it better than cash price levels, and then systematically hedge future cash commitments as they become known. Losses in one period should be met with the realization that profits in later periods will probably neutralize them, with little long run impact on cost.

In this case, the analytical capacity of the agency should be directed at understanding the factors affecting its local basis, and predicting with some accuracy how it will behave between the time a hedging position is taken and the time it is offset. This is a challenging analytical task, but should be no more difficult (and may be easier) than predicting cash price levels.

An alternative view is that futures markets, in addition to providing flexibility, improved information, and risk management opportunities, provide opportunieis for direct profit. Many traders classified as hedgers accept this view, and consider futures trading effective only if it increases revenue or decreases cost. Petzel (1985) reflects such a view in stressing the quick judgements and decisions necessary for effective LIC trading.

The analytical capacity needed to consistently earn direct profits from futures trading is far greater than that needed to reduce risk. Daily and longer term price movements[2] must be followed and anticipated. Since thousands of speculators are attempting to do just that every day, the probability of one trader consistently "beating the market" is quite low. Far from reducing risk, such activities will likely increase it.

But not all hedging techniques are purely risk-reducing. An example is a technique called "basis trading", or "tendering the basis" (to be treated in more detail in the next chapter). Briefly, this technique involves negotiating a fixed basis, and then establishing the price level through a futures transaction anytime between the date the basis is negotiated and the date the futures contract expires.[3] Such a technique allows a wide range of behavior, from almost pure risk reduction (establish the price level immediately after negotiating the basis) to speculation (wait for a positive move in the market, then transact). A

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[2] Tracking and anticipating daily price movements is called Technical Analysis. Fundamental Analysis deals with longer term price trends.

hedger tendering the basis needs to at least attempt to anticipate moves in the market and act accordingly. In cases such as these, the distinction between hedgers and speculators becomes blurred.

5.4.2 Financial Requirements

The initial margin on most contracts of five to ten percent can seriously understate the financial commitments a trader may have to make to keep a futures account open. First, all initial and maintenance margins must be in U.S. dollars if the futures exchange is located in the U.S. Second, the process of marking to the market means that a large losing position can require a very large maintenance margin. Finally, the foreign exchange needed to maintain this margin must be highly liquid, since margin calls occur daily.

For example, the price of the December wheat futures contract in 1975 dropped from $3.93 1/2 in July to $2.60 1/4 in December. An importer taking a long position of 500,000 bu in the December contract in July would have put up an initial basis of only $196,750 (500,000*3.935*0.10). However, the value of his position lost $666,250 between July and December, and the trader would have had to commit this amount to the account to keep it open. Interest costs on the intitial and maintenance margins would have been over $21,000 at interest rates prevailing at the time ([196,750+666,250]*[5/12]*.06 = 21,575). All together, the trader would have had to commit almost $900,000 in valuable foreign exchange to keep the account open.

In the long run, positive and negative maintenance margins should nearly cancel each other, so that the average maintenance margin is near zero[4]. The point is that periodic large commitments of foreign exchange are required to participate in the futures market. For a small country with limited foreign exchange holdings, such a commitment may at times be insupportable.

5.4.3 Behavioral Flexibility

The costs of futures trading are highly visible, and may not be readily understood by higher authorities to whom the trading agency must report. If the agency does not have the freedom to access a foreign exchange account to meet daily margin calls, trading may be impossible. While tendering the basis, the agency may need to make quick decisions to avoid large losses. Extensive bureaucratic procedures may make such a trading technique infeasible. Finally, the agency must be given the opportunity to prove its competence over a fairly long period of time. If short run losses in the futures account result in diminished authority or changing of personnel, the agency will be unable to develop and implement a coherent hedging strategy.

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[4] Between 1976 and 1985, this did not happen in the December contract - the market dropped between July and December far more than it rose, resulting in substantial net losses to importers. In the March and July contracts, on the other hand, hedging would have had a negligible effect on cost. See Chapter Six.

5.5 Conclusions

This chapter should make it clear that analysis and planning must not only accompany all futures trading, but must precede the decision whether or not to participate in such trading. Uninformed decisions prior to or during a hedging operation can result in significant and unnecessary losses.

CHAPTER SIX

A MONTE CARLO ANALYSIS OF SIX PURCHASE STRATEGIES

6.1 Introduction

A country importing or exporting an agricultural commodity has a number of buying or selling strategies from which to choose. Each strategy has advantages and disadvantages, and no single strategy will be appropriate for all countries at all times. This chapter will analyze six potential strategies from the standpoint of a country facing quantity, price, and exchange rate uncertainty. The country earns British pounds (L)[1] with which it buys U.S. dollars to import wheat from the United States. The strategies are Cash Only, Forward Contracting, Full Hedging, "Optimal" Hedging, Price Averaging, and Basis Trading. This section will present the assumptions and methods used in the analysis. Section 6.2 will explain each strategy in detail.

Section 6.3 will present and discuss the results of each strategy in terms of the average cost, variance of cost, and mean square error of cost estimates each would have generated had they been used during the period 1976-1985. Section 6.4 will discuss

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[1] British pounds were chosen primarily because they have been widely traded on the IMM for many years, and a complete futures price series is available. By contrast, the French franc has been infrequently traded, and never at high volumes. As a result, the price series is discontinuous and not very useful. While there are no longer any countries with a currency tied to the pound, there are many still tied to the French franc. Any such country earning British pounds (or some other convertible currency) and needing U.S. dollars in the future could use the futures market to establish the $/L exchange rate. It could then use the French franc futures market to establish a $/FF exchange rate, thereby determining the exchange rate for its own currency. This final step is eliminated in the present analysis, but must be considered by any country holding convertible foreign exchange to which its own currency is not tied.

advantages and disadvantages of each strategy not illustrated by the quantitative measures of the previous section. Finally, section 6.5 will analyze the impact of varying levels of basis and quantity uncertainty on hedging effectiveness.

The analysis is a Monte Carlo simulation for the years 1976-1985.[2] It is general, neither limited nor fully applicable to a specific country. Historical wheat futures prices from the Chicago Board of Trade, and historical British pound futures prices from the International Monetary Market are used. These are combined with randomly generated import quantities and basis values.[3] In each strategy, the country purchases U.S. dollars with its British pounds, then purchases wheat. It does this three times a year, in March, July, and December. During each period, the country estimates its expected import quantity and price (in terms of British pounds) for the following period. For example, in March the country estimates its expected cost of importing wheat in July by estimating the amount of wheat it will

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[2] A Monte Carlo simulation is used to generate probability distributions on random "performance" variables which are functions of random "input" variables. First a model is developed which relates these input variables to the performance variables. Next, probability distributions are specified for the input variables. Finally, the model is run a large number (50-100) of times, each run using new input variable values randomly generated out of the specified probability distributions. The result is a probability distribution on the performance variables. In this analysis, the performance variables are average cost, variance of cost, and mean square error of cost estimates. The input variables are import quantity, basis values, and wheat and British pound futures prices.

[3] Import quantity is not a function of price, so that the model assumes infinitely inelastic demand. While this is obviously not a reasonable assumption in the long-run, it is more reasonble in the short-run: a country facing a deficit in a staple commodity such as wheat will likely be willing to fill that deficit through imports over a range of prices.

import, the U.S. dollar price it will pay, and the exchange rate it will obtain. The difference between expected and actual cost is used to calculate the mean squared error of cost estimates over the ten year period. For each strategy, the equation is:

$$(1) \qquad MSE = [\sum_{i}^{10} (C^L - EC^L)^2]/10,$$

where, C^L = actual cost in L, and
EC^L = expected cost in L

The mean and variance of cost are calculated using the appropriate equations and the actual costs incurred by the country.

The theoretical background presented in Chapter Three allows us to anticipate how hedging might affect these three measures. If the wheat and British pound futures markets are efficient, we would expect no significant difference in average cost between Cash Only and the various hedging strategies. Too, the fact that futures prices reflect expected supply and demand conditions in cash markets, and therefore move in conjunction with cash prices, indicates that we would expect no significant difference in the variance of cost between the Cash Only and the various hedging strategies.

On the other hand, we would expect hedging to significantly reduce the mean squared error of cost estimates, providing the traders can predict the basis more accurately than they can predict cash price levels. The analysis to follow will show whether our anticipated results are correct.

To simplify the analysis, the expected wheat import quantity for each period remains constant at 100,000 bu. Actual import quantity is:

(2) $$Q^w = EQ^w + e_q$$

where, Q^w = actual import quantity,
EQ^w = expected import quantity = 100,000 bu, and
e_q = a normally distributed random variable with mean = 0 and standard deviation = 10,000 [4]

Similarly, the expected basis is equal to $0.75/bu throughout the analysis.[5] The actual basis is:

(3) $$B = EB + e_B,$$

where, B = actual basis,
EB = expected basis = $0.75/bu, and
e_B = a normally distributed random variable with mean = 0 and standard deviation = $0.075/bu

Assuming the wheat futures market is efficient,

(4) $$EP^{\$} = PF^{w}_{t(t+1)} + EB,$$

where, $EP^{\$}$ = the U.S. dollar price the country expects to pay in the cash market during the next period, and
$PF^{w}_{t(t+1)}$ = the current price of the wheat futures contract which expires during the next period (e.g., the price in March of the July wheat contract)

Expected U.S. dollar cost is:

(5) $$EC^{\$} = EQ^w * EP^{\$}$$

The equation for calculating actual U.S. dollar price will always use equations (2) and (3), but otherwise will vary by

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[4] The standard deviation for both quantity and basis values was arbitrarily set equal to 10% of their expected values. The implications of higher or lower standard deviations will be analyzed in section 6.5.

[5] This figure is based roughly on transport costs. Over the past 10 years, the average cost per bushel of transporting wheat from U.S. Gulf ports to Egypt, Morocco, and West Africa, has been $0.67. Reasoning that the mark-up for LIC's will not be below freight cost, the figure has been rounded up to $0.75/bu. The analysis will not be significantly affected by using other figures near this level.

purchase strategy. The appropriate equation will be specified while discussing each strategy. Actual U.S. dollar cost is always:

(6) $$C^{\$} = (EQ^{W} + e_{e})*P^{\$},$$

where, $P^{\$}$ = actual U.S. dollar price

The British pound futures market is assumed to be efficient, so:

(7) $$EER = 1/PF^{L}_{t(t+1)},$$ [5]

where, EER = the expected L/$ exchange rate, and
$PF^{L}_{t(t+1)}$ = the current price of the L futures contract which expires during the next period (this price is quoted in terms of $/L)

The expected cost in L is identical in each strategy. Using equations (4) and (7), it is:

(8a) $$EC^{L} = (EP^{\$})*(EQ^{W})*(EER)$$

(8b) $$= [PF^{W}_{t(t+1)}+EB]*[EQ^{W}]*[1/PF^{L}_{t(t+1)}],$$

As was the case with wheat, the equation for calculating the actual exchange rate will vary by strategy, and will be specified when discussing each strategy. Actual cost in pounds is always:

(9a) $$C^{L} = (C^{\$})*(ER)$$

(9b) $$= (EQ^{W} + e_{e})*(P^{\$})*(ER),$$

where, ER = actual L/$ exchange rate

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[5] Jensen's Inequality, by which this equation is incorrect, does not apply in this case, since $PF^{L}_{t(t+1)}$ is not a pure statistical expectation. See Appendix F for a proof.

We further assume that the L basis is always equal to zero. While this assumption is not strictly correct, it is more nearly so than in the wheat market, and it simplifies while not seriously compromising the analysis.

6.2 <u>The Strategies</u>

The following sections will describe each strategy and specify how actual cost in British pounds is calculated. Once this is done, MSE can be calculated using equation (1). Of the six strategies discussed, four involve futures trading. In each of these four, a different wheat hedging strategy is used in conjunction with the same foreign exchange hedging strategy: hedging an amount of British pounds equal to the trader's expected needs. Other, more sophisticated foreign exchange hedging techniques are available, but will not be considered in this analyis. See Tygier (1983), and Walmsley (1983).

6.2.1 Cash Only

As the name indicates, the trader in this strategy transacts only in cash markets. During each period, she uses equation (8b) to calculate expected import costs in L during the following period. She then waits until the following period, and purchases dollars and wheat in the cash market. The actual cost in L incurred at this time is:

(10) C^L = (Actual \$ Price)*(Actual Quant.)*(Actual L/\$ Exch. Rate)

The actual dollar price of wheat is:

(11) $$P^{\$} = PF^{w}_{t+1(t+1)} + EB + e_{B}$$

where, $PF^{W}_{t+1(t+1)}$ = the price of the expiring wheat futures contract (e.g., the price in July of the July contract)

By assuming a basis of zero in the L market, the actual L/$ exchange rate is:

$$ER = [1/PF^{L}_{t+1(t+1)}] \quad (12)$$

Using equation (9b), we can determine the actual cost in L:

$$C^{L} = [EQ+e_{a}] * [PF^{W}_{t+1(t+1)}+EB+e_{B}] * [1/PF^{L}_{t+1(t+1)}] \quad (13)$$

The mean square error of cost estimates over the ten year horizon can then be calculated using equation (1). The costs determined by equation (13) are used to calculate average cost and variance of cost.

6.2.2 Forward Contracting

In this strategy, the trader forward contracts during each period for his expected wheat and U.S. dollar needs during the following period. The wheat contract specifies that the trader will purchase 100,000 bu of wheat during the next period at a price equal to the current price of the contract expiring during the following period, plus $0.75/bu. For example, the price for a contract signed in March for purchase in July would equal the current price of the July contract, plus $0.75/bu. In the foreign exchange contract, the exchange rate is equal to the current price of the L contract which expires during the next period, without any basis adjustment. For a contract signed in July for purchase in December, the price would be the current price of the December L contract.[6]

If the trader's actual needs the following period are greater than the quantities for which he has contracted, he is free to purchase more in the cash market. In this case, his actual costs are equal to the costs incurred in the contract, plus costs incurred in the cash market:

$$(14) \quad C^{L} = [PF^{W}_{t(t+1)} + \$.75/bu] * [EQ] * [1/PF^{L}_{t(t+1)}]$$
$$+ \; e_{Q} * [PF^{W}_{t+1(t+1)} + EB + e_{B}] * [1/PF^{L}_{t+1(t+1)}]$$

However, the trader may not purchase less than that for which he has contracted. If his needs are less than anticipated, he buys the quantities agreed upon in the contract, and stores the extra grain. In calculating MSE, this analysis will ignore storage costs, so that actual costs will equal expected costs. This will result in an underestimate of average cost, and of the true error in the trader's cost estimate, since these storage costs were not anticipated. One should keep this fact in mind when interpreting the results presented in section 6.3.

6.2.3 Full Hedging

In the Full Hedging strategy, the trader estimates her wheat and U.S. dollar needs for the following period, and hedges these quantities in the futures markets. When the following period arrives, she closes out her futures positions and purchases U.S. dollars and wheat in the cash markets. The strategy is called Full Hedging to contrast it with the "Optimal" Hedging strategy

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[6] There is no July L contract, so the contracts signed in March use the September contract in its place. In March, the trader sells the September L contract, and buys it back in July when he purchases wheat. Since he has offset prior to contract expiration, the cash and futures prices may not have completely converged, meaning the basis may not be equal to zero. However, comparison of the September contract prices and cash prices in July shows them to be nearly identical, so that the zero basis assumption seems reasonable.

which follows, where the trader will hedge only a certain proportion of her expected wheat needs.

As in the hedging examples of Chapter Three, the actual cost to the trader can be calculated as the cost incurred in the cash market, adjusted for any gains or losses in the wheat and L futures markets. In the cash market, the trader purchases an amount $EQ+e_{q}$, valued at the exchange rate prevailing when the transaction occurs:

$$(15) \qquad C^{c} = [PF^{w}_{t+1(t+1)}+EB+e_{B}]*[EQ+e_{q}]*[1/PF^{L}_{t+1(t+1)}]$$

where, C^{c} = cash market cost in L, and all other variables are as previously defined.

In the wheat futures market, the trader hedged the quantity EQ. The dollar gain or loss on this transaction is also valued at the exchange rate prevailing when the cash transaction occurs:

$$(16) \qquad GL^{w} = EQ^{w}*[PF^{w}_{t(t+1)}-PF^{w}_{t+1(t+1)}]*(1/PF^{L}_{t+1(t+1)})$$

where GL^{w} = the wheat futures market gain (-) or loss (+), in L.

In the British pound futures market, the trader determined the quantity of L to sell using expected wheat quantity, expected U.S. dollar price, and expected exchange rate:

$$(17) \qquad Q^{L} = EQ^{w}*[PF^{w}_{t(t+1)}+EB]*[1/PF^{L}_{t(t+1)}]$$

This quantity must be multiplied by the futures market price change to calculate the U.S. dollar gain or loss. Once again, this is valued at the exchange rate prevailing at the time the cash market transaction takes place:

(18) $GL^L = Q^L*[PF^L_{t+1(t+1)}-PF^L_{t(t+1)}]*(1/PF^L_{t+1(t+1)})$

where, GL^L = the L futures market gain (-) or loss (+), in L

The total cost in L is equal to the sum of equations 15, 16, and 18:

(19) $$C^L = C^c + GL^w + GL^L$$

6.2.4 "Optimal" Hedging

This strategy is identical to the Full Hedging strategy, except that the trader hedges only a certain proportion of his expected wheat import quantity. He continues to hedge all his expected U.S. dollar needs in the L futures market.

The proportion of expected import quantity the trader hedges is called the optimal hedging ratio, and is determined by an optimal hedging ratio model. This model is similar to Peck's (presented in Chapter Five) but includes quantity uncertainty. The derivation of the model can be found in Appendix G.

The optimal hedging ratio is calculated for each period and each year as:

(20) $$h = (\sigma_{CP}-\sigma_{CB})/[EQ*(\sigma_B{}^2-2\sigma_{PB}+\sigma_P{}^2)],$$

where, σ_{CP} = the product of the forecast errors in the U.S. dollar cost and cash price forecasts, averaged over the past 5 years,

σ_{CB} = the product of the forecast errors in the U.S. dollar cost and basis forecasts, again averaged over the past 5 years,

EQ = the expected wheat import quantity = 100,000 bu,

$\sigma_B{}^2$ = the squared forecast errors in the basis forecast, averaged over the past 5 years,

σ_{PB} = the product of the forecast errors in the U.S. dollar cash price and basis forecasts, averaged over the past 5 years, and

σ_P^2 = the squared forecast errors in the cash price forecast, again averaged over the past 5 years

With three periods per year, and a ten year horizon, thirty optimal hedging ratios will be calculated. These ratios use only information that was available to the trader at the time he was making his decision. Thus, they are optimal only ex-ante. Using hindsight, ratios other than those used might be shown to have been optimal. This will become clear when the results of the analysis are presented.

The equation for calculating actual cost in L under this strategy is identical to that used in the Full Hedging strategy, except that h must be used in calculating the wheat futures market gain or loss:

$$(21)\quad GL^{W} = (h*EQ^{W}*[PF^{W}_{t(t+1)}-PF^{W}_{t+1(t+1)}])*(1/PF^{L}_{t+1(t+1)}),$$

and,

$$(19)\quad C^{L} = C^{c} + GL^{W} + GL^{L}$$

As in every strategy, MSE is calculated using equation (1).

6.2.5 Price Averaging

In this strategy, the trader attempts to average the current futures market price and whatever cash price that prevails when the wheat is purchased. She does this by hedging one-half of her expected wheat needs. This strategy is just a special case of "Optimal" Hedging, with h = .5 in equation (21) above.

6.2.6 Basis Trading

The trader forward contracts only the basis in this strategy. He is then free to establish the price level through a futures transaction anytime between the signing of the basis contract and the receipt of the wheat. For example, in March the trader could negotiate a basis of $0.75/bu. Then anytime between March and July, he could purchase the required number of wheat futures contracts. In July, he would exchange these contracts for wheat at the prevailing futures price. In this final transaction, he has in fact purchased the wheat for a price equal to the current futures price. Thus, the basis on this final transaction is equal to zero. From Chapter Three, we know that when the basis is zero, the price the trader receives is equal to the price at which he first transacted in the futures market. So the trader's futures transactions do in fact determine the price level, to which the negotiated basis of $0.75/bu must be added to find the final price.

To calculate actual cost in L, equation (19) is used once again, with the wheat and L futures market gains or losses calculated as in equations (16) and (18). The calculation of C^c presents certain problems. We know that the U.S. dollar price is equal to the price at which the trader first transacted, plus the negotiated basis. But since the trader can make his first futures transaction at a time of his choosing, we don't know what the price will be. We therefore assume that the trader always transacts at a price equal to the average of the price when the basis contract is signed, and the price at expiration. For example, when the trader negotiates a basis in December for March delivery, the price at which he transacts in the futures market is equal to the average of the price of the March contract in December, and its price at expiration in March. We can then calculate the cash cost in L:

$$(22)\quad C^{c} = ([(PF^{w}_{t(t+1)}+PF^{w}_{t+1(t+1)})/2]+.75)*(EQ+eQ)*(1/PF^{L}_{t+1(t+1)})$$

This assumption is obviously not realistic, and in fact hides many of the advantages and disadvantages of basis trading. Yet the assumption had to be made to make the analysis tractable. In considering the merits of basis trading, one should therefore rely less on the results presented in the next section than on the discussion in section 6.4 of this chapter.

6.3 Results

The model was run 50 times in each of two simulation modes: with foreign exchange hedging incuded in the four hedging strategies; and with it excluded. Table 6-1 shows the average results over the ten year period 1976-1985 from each of these simulations. The results are standardized relative to the Cash strategy.

Examining the results without foreign exchange hedging, we see that Forward Contracting increased cost by 4.6% over Cash. Full Hedging and "Optimal" Hedging showed lower costs which nevertheless exceeded Cash cost by almost 2%. Price Averaging and Basis Trading resulted in cost increases of less than 1% over Cash. None of the cost increases from the hedging strategies were statistically significant even at .5.

Table 6-1. Ten-Year Average Results from 50 Runs of Each Simulation, w/ and w/o Foreign Exchange Hedging

	With For. Exch. Hedging	Without For. Exch. Hedging
Average Cost		
Cash	1.000	1.000
Forward Contract	1.049	1.046
Full Hedge	1.006	1.018
"Optimal" Hedge	1.006	1.018
Price Averaging	0.997	1.009
Basis Trading	0.998	1.008
Var(Cost)		
Cash	1.000	1.000
Forward Contract	0.689	0.687
Full Hedge	0.802	0.954
"Optimal" Hedge	0.855	0.998
Price Averaging	0.812	0.937
Basis Trading	0.807	0.934
MSE(Cost)		
Cash	1.000	1.000
Forward Contract	0.271	0.287
Full Hedge	0.581	0.722
"Optimal" Hedge	0.721	0.859
Price Averaging	0.691	0.755
Basis Trading	0.666	0.737

Note: Non-standardized results may be found in Appendix H.

Brokerage costs average roughly 1% of a contract's value. Average Cost for the Full Hedge, Optimal Hedge, and Basis Trading strategies should be revised upward by this amount. Price Averaging should be adjusted up by 0.5%.

The large cost increase in Forward Contracting is due to the fact that the trader can never purchase less wheat or fewer U.S. dollars than the quantities for which she has contracted. She can purchase more of each if her actual needs exceed her expected needs. Given this shortcoming, an obvious solution, if one wants to forward contract, is to do so for only a portion of expected needs, and purchase any extra requirements in the cash market when those requirements are known. The disavantage of this approach is that one is leaving a potentially large portion of one's total purchase open to price fluctuations.

In the other five strategies, the trader is free to buy more or less than her expected needs, so the cost increases were smaller. Given how small these increases are, it might be informative to examine the results on a monthly basis. This is done in Table 6-2, where average cost from Cash Only is compared with the average of the average costs from the four hedging strategies.

This table shows that in two out of three months (March and July), hedging had almost no effect on average cost, while in the other (December) hedging significantly increased cost. For March and July, the Efficient Market Hypothesis would seem to hold. It did not hold for the December contract during the ten years analyzed, but one may not conclude from this that it will not hold over the next ten years.

Turning now to the cost variance, we see that Forward Contracting had the lowest. This is due to the elimination of downward fluctuations in the quantity of wheat purchased, so that the reduced variance is at the cost of periodically having to

Table 6-2. Comparison of Ten-Year Average Cost, w/o Foreign Exchange Hedging, Monthly

Strategy	Average Cost		
	March	July	December
Cash	23,718,592	20,946,364	19,231,966
Hedging (Avg. of Full Hedge, "Opt." Hedge, Price Averaging, and Basis Trading)	23,754,000	20,829,000	20,158,000
Percent Increase/ Decrease from Hedging	0.15	- 0.60	4.80

purchase more wheat than one requires. The four hedging strategies reduced the cost variance by an average of 4.4%. Again, looking at the monthly figures in Table 6-3 is informative: in July and December, hedging decreased cost variance by an average of 6.2%; and 6.3%, respectively; in March, hedging decreased cost variance by only 0.5%. In addition, hedging periodically increased cost variance during all three months in individual years. Finally, the decreased variance is not statistically significant at .1 for any of the strategies. The implication of these results is that a trader cannot necessarily rely on hedging to decrease the variance of his costs (or his revenues if he is an exporter).

Such is not the case for the MSE of cost estimates.[6] On average, the four hedging strategies decreased MSE by more than 23% below Cash Only. Full Hedging showed the largest decrease, 28%. Interestingly, "Optimal" Hedging showed the smallest decrease, 14%.[7] A monthly analysis shows that the average decrease for all hedging strategies was 5.7% in March (and "Optimal" Hedging actually increased MSE), 19% in July, and 43% in December. Furthermore, in only two of the fifty simulation runs did the average MSE from hedging exceed that from the Cash strategy.

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[6] This statement is strictly true only in the present analysis. See below. Also, none of the decreases are statistically significant at .1 using the F test. But the fact that MSE decreased as expected in every hedging strategy argues for the existence of a systematic relationship between hedging and MSE. To fully test the significance of the decreases, one would have to test the probability of MSE falling in all four cases if in fact there were no relationship. The F test does not do this.

[7] These results are compatible with those of Peck (1975). Remember that the optimal hedging ratio used in this strategy is optimal on ex-ante.

Table 6-3. Comparison of Ten-Year Average Variance, w/o Foreign Exchange Hedging, Monthly

Strategy	Variance		
	March	July	December
Cash	$1.99*10^{13}$	$2.49*10^{13}$	$1.84*10^{13}$
Hedging (Avg. of Full Hedge, "Opt." Hedge, Price Averaging, and Basis Trading)	$1.98*10^{13}$	$2.34*10^{13}$	$1.73*10^{13}$
Percent Increase/ Decrease From Hedging	-0.50	- 6.20	-6.30

As expected, Forward Contracting performed quite well by the MSE criterion. During years when the trader required less wheat than that for which she had contracted, actual costs were equal to expected costs.

Turning now to the results with foreign exchange hedging, we see a similar pattern in average cost. Forward Contracting is again the highest, followed by the four hedging strategies, none of which differ by more than 1% from Cash strategy, and none of which are significantly different from Cash Only even at .5.

The combination of wheat and foreign exchange hedging has reduced cost variance by an average of over 18% compared with 4.4% when wheat alone was hedged. Unlike the latter case, hedging decreased the variance all three months. While these differences are not statistically significant using the F test, the fact that the variance dropped in every strategy argues for the existence of a systematic relationship.

This result was unexpected, and cannot be easily explained. We would expect in any strategy that the price in pounds would be less variable than the price in dollars. This is because a weak dollar makes wheat less expensive for traders holding pounds, thereby stimulating demand and increasing the dollar price of wheat. This combination of a low L/$ exchange rate (or a high price of the pound contract, which is quoted as $/L) with a high dollar price will tend to stabilize the price in pounds. But we would expect this relationship in cash as well as futures prices, so that hedging wheat and pounds would not be expected to reduce the variance below that obtained in a Cash Only strategy.

But hedging has reduced the variance. The reason for this can be seen in Table 6-4: in two out of three months, the covariance between wheat and pound futures prices is higher than that between wheat and pound cash prices. There is no immediately apparent reason for this difference in covariances, and one cannot be sure that it will continue in the future. If it does not, hedging will not reduce the variance of cost below that obtained with Cash Only.

Examining MSE, we find as expected that combining foreign exchange and wheat hedges reduces this measure more than hedging wheat alone - an average decrease of 33% relative to Cash Only, vs. 23%. In none of the fifty simulation runs did the average MSE from hedging exceed that from Cash Only, and all the MSE reductions were statistically significant at .1 (using the F test).

Figures 6-1 and 6-2 summarize the MSE simulation results in the form of histograms. In Figure 6-1 we see that moving from Cash Only to Full Hedging without foreign exchange cover has dramatically shifted the distribution of MSE to the left. Figure 6-2 shows a further leftward shift and narrowing of the MSE distribution when moving from Full Hedging without foreign exchange cover to Full Hedging with foreign exchange cover.

The results of this analysis allow a few generalizations:

1. In neither simulation (with and without foreign exchange hedging) did hedging have a large effect on average cost when the three months were averaged together. However, had an importer used only the December contract, she would have suffered quite a large increase in cost over a Cash Only

Table 6-4. Comparison of Covariance Between Wheat and Pound Cash and Futures Prices

Price	Month		
	March	July	December
Cash	7.6	0.59	4.5
Futures	14.2	0.59	6.4

Figure 6-1. MSE Histogram, Cash Only and Full Hedge Without Foreign Exchange Cover

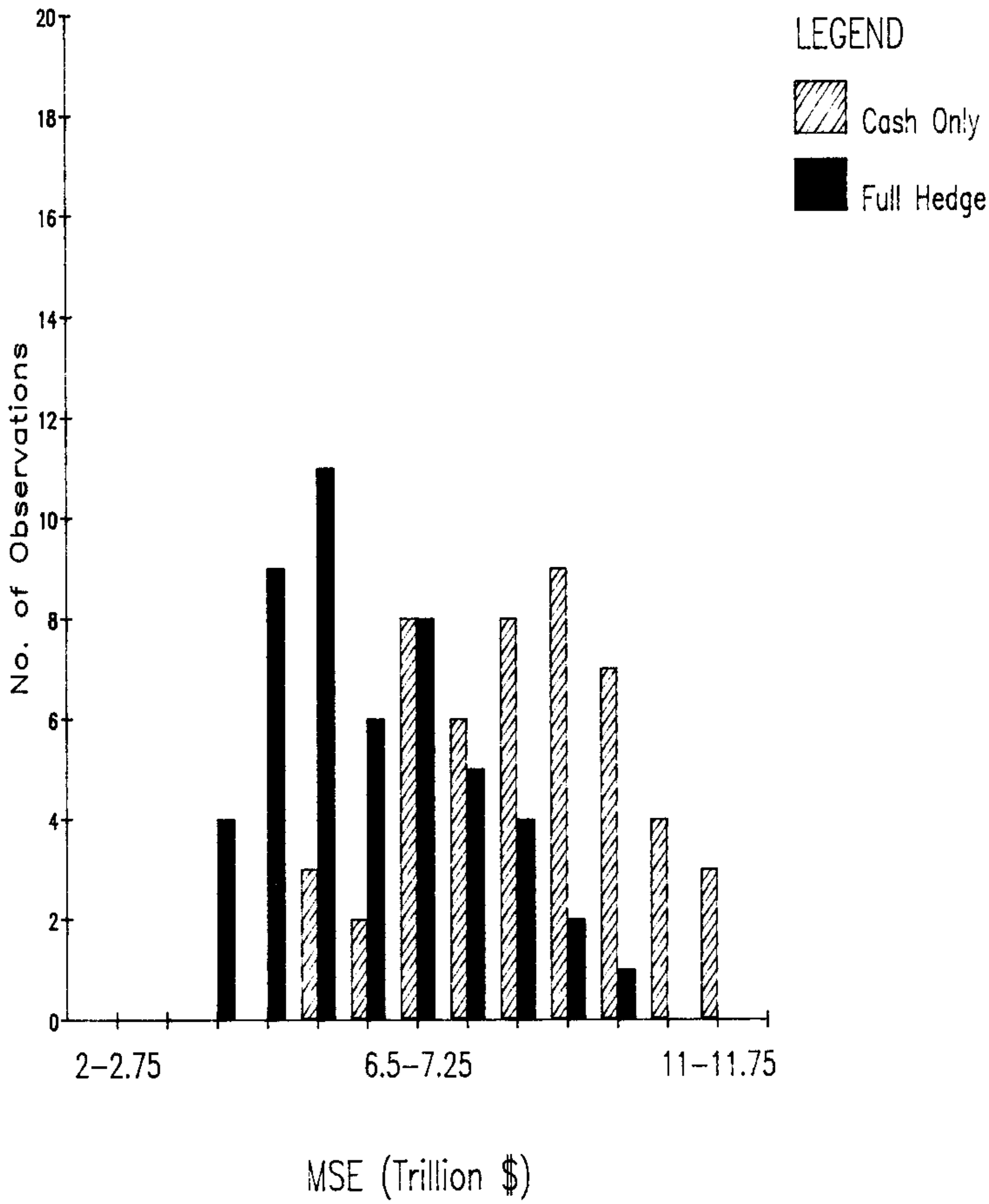
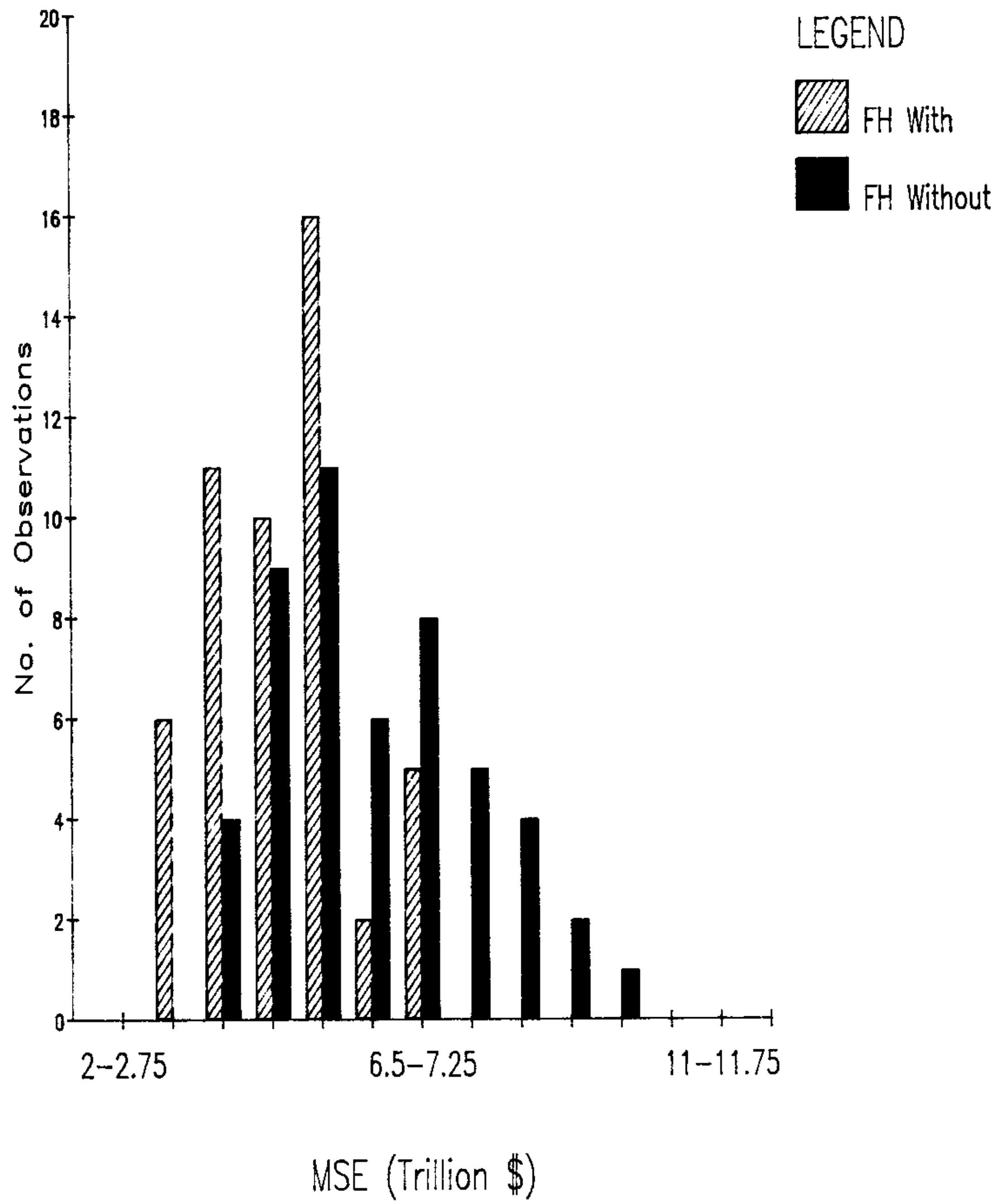


Figure 6-2. MSE Historgram, Full Hedge With and Without Foreign Exchange Cover



strategy. An exporter, on the other hand, would have enjoyed a large increase in revenues. One cannot say whether the same would happen over the next ten years, and in the absence of strong evidence to the contrary, one would have to expect that hedging using the December or any other contract would have a neutral effect on cost (or revenue). The point is that hedging will inevitably result in periodic losses. While these losses will in general be matched by equal gains in the long run, they are highly visible (in the form of margin calls), and as this analysis indicates, may be significant over a period of years.

2. Hedging wheat alone had only a slight impact on cost variance, while hedging it in combination with foreign exchange systematically reduced the variance. However, unless one has reason to expect the futures prices of the currency and commodity being traded to be more highly correlated than the cash prices, one cannot expect a significant reduction in variance due to hedging.

3. Cost forecast errors can be reduced even if hedging has no impact on the variance of cost, as happened during March in the simulation without foreign exchange hedging.

6.4 <u>Other Advantages and Disadvantages of Each Strategy</u>

6.4.1 Cash Only

Using Cash Only, a trader is not locked into purchasing a specified amount of a commodity, as he is in Forward Contracting. Too, he is not subject to the commissions and margin calls of the hedging strategies. Both these costs are quite visible - they appear as losses in financial accounts - and may be politically embarrassing or difficult to explain to a superior not familiar with the costs and benefits of futures trading. On the other hand, a trader with a futures position moving in his favor has money added to his margin account. These are highly visible profits.

The disadvantages of a Cash Only strategy have been discussed at length in Chapter Four. First, such a strategy is not very flexible. A trader can price a commodity only at the time she purchases it, and cannot establish a legal claim to the commodity prior to taking physical possession of it. She therefore risks being unable to obtain needed supplies at affordable prices. Second, a Cash Only trader is less likely to benefit from the information content of futures prices, information used in bids prepared by brokers, and useful in making storage decisions.

Third, a Cash Only strategy leaves a trader open to the uncertainty inherent in volatile world grain markets. Finally, the combination of limited flexibility and information, and pervasive uncertainty may combine to reduce the real income of a firm by hindering planning, limiting investment, and increasing the firms's transaction costs.

6.4.2 Forward Contracting

As this analysis shows, Forward Contracting reduces a great deal of the uncertainty facing a trader. This reduced uncertainty may facilitate planning and reduce a firm's transaction costs. The strategy also allows a trader to establish legal claim to a commodity prior to taking physical possession. This feature may be of great value during periods of possible shortage. For countries facing an unpredictable basis but relative certainty about quantity, Forward Contracting might be the best purchase strategy.

But this strategy suffers from at least three disadvantages. First, it is the least flexible of the six alternatives. Just as in Cash Only, price and quantity are determined simultaneously. Unlike Cash Only, quantity must be determined prior to the time the commodity is needed, implying greater quantity uncertainty.

Second, the inflexibility of Forward Contracting generates an incentive for either the buyer or seller to default. For example, an exporter might sign a contract in July for December delivery of wheat at $1.80/bu. If between July and December the price of wheat rises significantly, the exporter has a strong incentive to default on the contract and sell to someone else at the higher price. The importer would then have to make his purchase in the cash market at the higher price, or do without.

Finally, one is locked into this quantity, which may be higher or lower than actual requirements. If it is higher, one may have difficulty obtaining storage and will suffer unanticipated storage costs, including spoilage. None of these problems were reflected in this chapter's simulation analysis.

6.4.3 Hedging: Full Hedging, "Optimal" Hedging, Price Averaging, and Basis Trading

All four hedging strategies help increase a trader's flexibility and access to information. Along with the reduced uncertainty they make possible, these benefits might facilitate planning and investment, reduce transaction costs, and thereby increase real income. Of the four, Full Hedging and Price Averaging have the advantage of simplicity - one need only forecast expected requirements, then hedge all or half of them. Price Averaging maintains a more speculative flavor, since half of one's expected needs are left open to price fluctuations. It is thus surprising that when hedging only wheat, this strategy reduced MSE by nearly as much as Full Hedging (the latter enjoyed a more significant advantage when both wheat and foreign exchange were hedged).

There is nothing sacred about a hedging ratio of 1.0, or 0.5. A trader can hedge any proportion of expected needs she deems best at the time. She may want to combine some safety with speculation, in which case she would hedge less (more) than 100% of expected needs if she feared a price drop (rise). Such a strategy requires constant tracking of the market, and no one, no matter how skilled, is guaranteed a cost advantage.

Alternatively, one may hedge more or less than 100% of expected needs with the objective of minimizing forecast errors, as in the "Optimal" Hedging strategy. One disadvantage of such a strategy is that it is relatively complicated, requiring the calculation of a new optimal ratio each period. The other disadvantage - that the ratio is optimal only ex-ante - is illustrated by the fact that this strategy reduced MSE less than any of the other hedging strategies. But these results are not an argument for ignoring "Optimal" Hedging. They are an argument for improving the estimates of the optimal ratio. If this can be done, such a strategy would be superior to Full Hedging, Price

Averaging, or a strategy of less systematically determining the hedging ratio.

For LIC importers and exporters facing a less predictable basis, such a strategy is both more difficult and potentially more beneficial. It is more difficult because the optimal ratio may be more difficult to accurately predict. It is potentially more beneficial due to the higher initial levels of uncertainty these traders face.

This discussion points to the possible disadvantage of these three hedging strategies. The basis facing LIC traders may be less predictable than that facing traders located closer to the major futures exchanges, or traders more integrated into world markets. Also, all traders face some quantity uncertainty. The combination of basis and quantity uncertainty may cause hedging to increase rather than decrease overall uncertainty. It is in this case that Basis Trading becomes especially attractive. A trader using this strategy can negotiate a fixed basis, and can then establish the price level at the time of his choosing. Once this level is established, all price uncertainty is eliminated (some quantity uncertainty remains). Basis Trading is also very flexible. A trader can choose to establish the price level soon after negotiating the basis, either to eliminate price uncertainty or avoid a price rise she suspects is coming. Alternatively, she could choose to wait, watch the market, and establish the price level later. In addition to providing the oppportunity for profit (or loss!) this alternative allows the trader to more accurately assess her requirements prior to establishing the price level, thereby reducing quantity uncertainty.

6.5 The Impact of Varying Levels of Basis and Quantity Uncertainty on Hedging Effectiveness

Until now the analysis has assumed specific levels of basis and quantity uncertainty. Actual values of each have been generated from normal distributions centered around expected levels, with standard deviations equal to 10% of those levels. Thus, roughly two-thirds of all basis observations fall between $0.675 and $0.825, with the average observation about equaling the expected value of $0.75. Likewise, about two-thirds of all import quantities fall between 90,000 bu and 110,000 bu, with the average quantity nearly equaling the expected value of 100,000 bu.

As shown in Chapter Three, the ability of hedging to decrease price uncertainty depends on the predictability of the basis. Furthermore, the analysis in that chapter ignored quantity uncertainty. In general, increased quantity as well as basis uncertainty will reduce the effectiveness of hedging in reducing risk. The question then arises, how high can basis and quantity uncertainty go before hedging loses its effectiveness?

Too, the "Optimal" Hedging strategy makes it clear that one need not be confined to a hedging ratio of 1.0 or 0.5. A rule of thumb for many traders is to trade some fairly constant fraction of expected quantity, this fraction often falling between 1.0 and 0.5. What are the benefits of such a strategy, and how is it affected by basis and quantity uncertainty?

Figure 6-3 through Figure 6-6 represent an attempt to answer these questions. They show the percent reduction in MSE of cost estimates achieved by moving from Cash Only to Full Hedge, 75%

Hedge, and 50% Hedge strategies, for varying levels of basis and quantity uncertainty. Full Hedge is identical to that in the earlier analysis. In 75% (50%) Hedge, the trader hedges 75% (50%) of both expected wheat quantity and expected foreign exchange requirements.[6]

To obtain these results, the simulation model was first modified to include the 75% Hedge and 50% Hedge strategies. Next Sigma Q, the standard deviation of quantity forecast errors, was set at a specific level, e.g., 0 in Figure 3. Third, the model was run fifty times at each of four levels of Sigma B (the standard deviation of basis forecast errors), ranging between 0 and 60% of EB. These three steps resulted in four sets of fifty data points for each hedging strategy, each set corresponding to a different level of Sigma B. In the fourth step, linear regressions were run on the four sets of points corresponding to each strategy. These regression lines are what appear in the figures. Finally, these four steps were repeated for different levels of Sigma Q, ranging up to 30,000, or 30% of EQ. Each figure, then, shows percent reduction in the MSE of cost estimates as a function of basis uncertainty, given a specific level of quantity uncertainty.

Sigma Q and Sigma B levels can be most usefully interpreted as follows: a Sigma Q (B) of, say, 10% of EQ (EB), indicates that roughly two out of three times, one can predict actual quantity

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[6] The 50% Hedge strategy differs from Price Averaging in the previous analysis. In the latter, the trader hedges 50% of expected wheat requirements but 100% of expected foreign exchange requirements.

Figure 6–3. % MSE Reduction as a Function of Basis Uncertainty, Sigma Q = 0

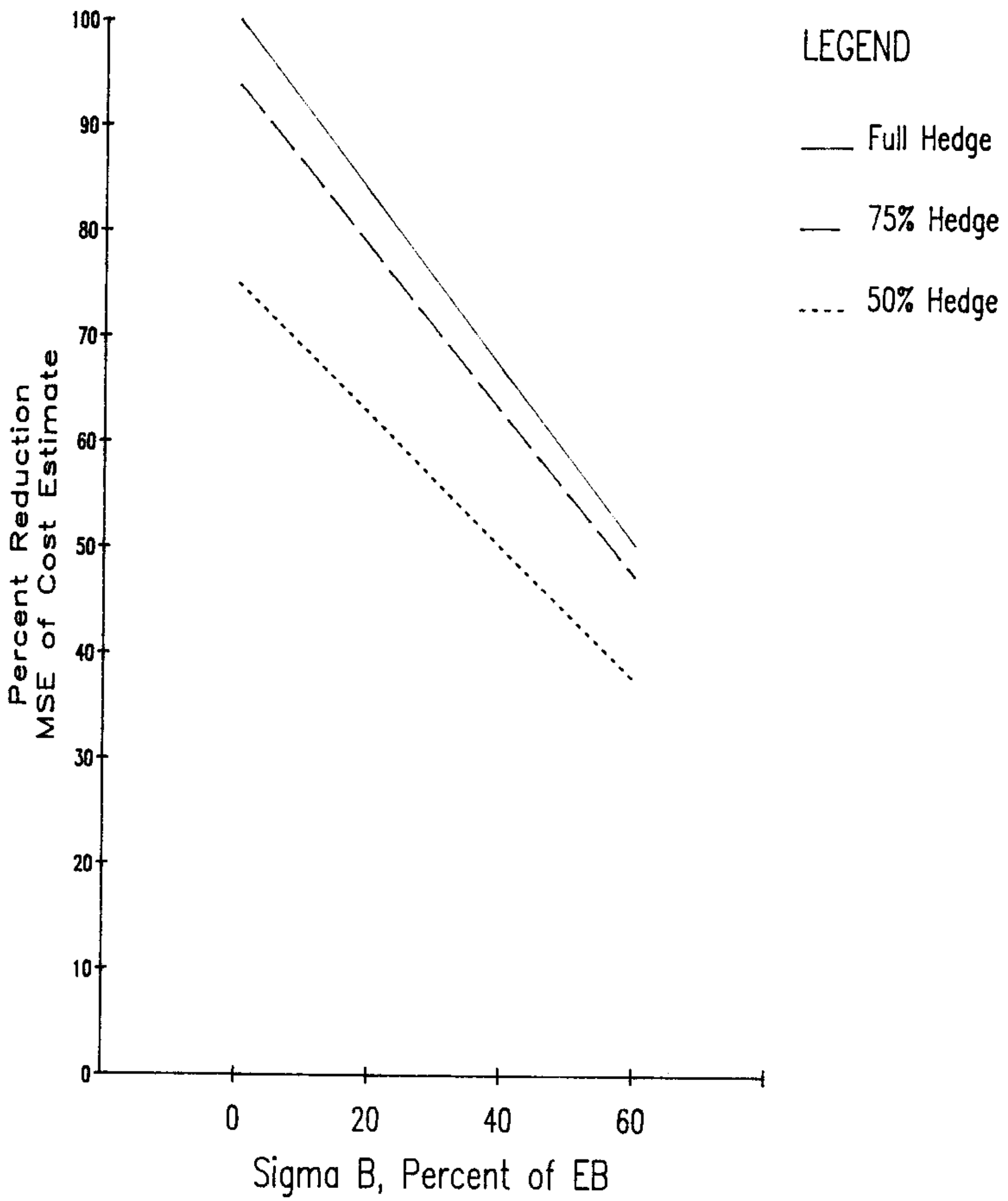


Figure 6-4. % MSE Reduction as a
Function of Basis Uncertainty
Sigma Q = 10% of EQ

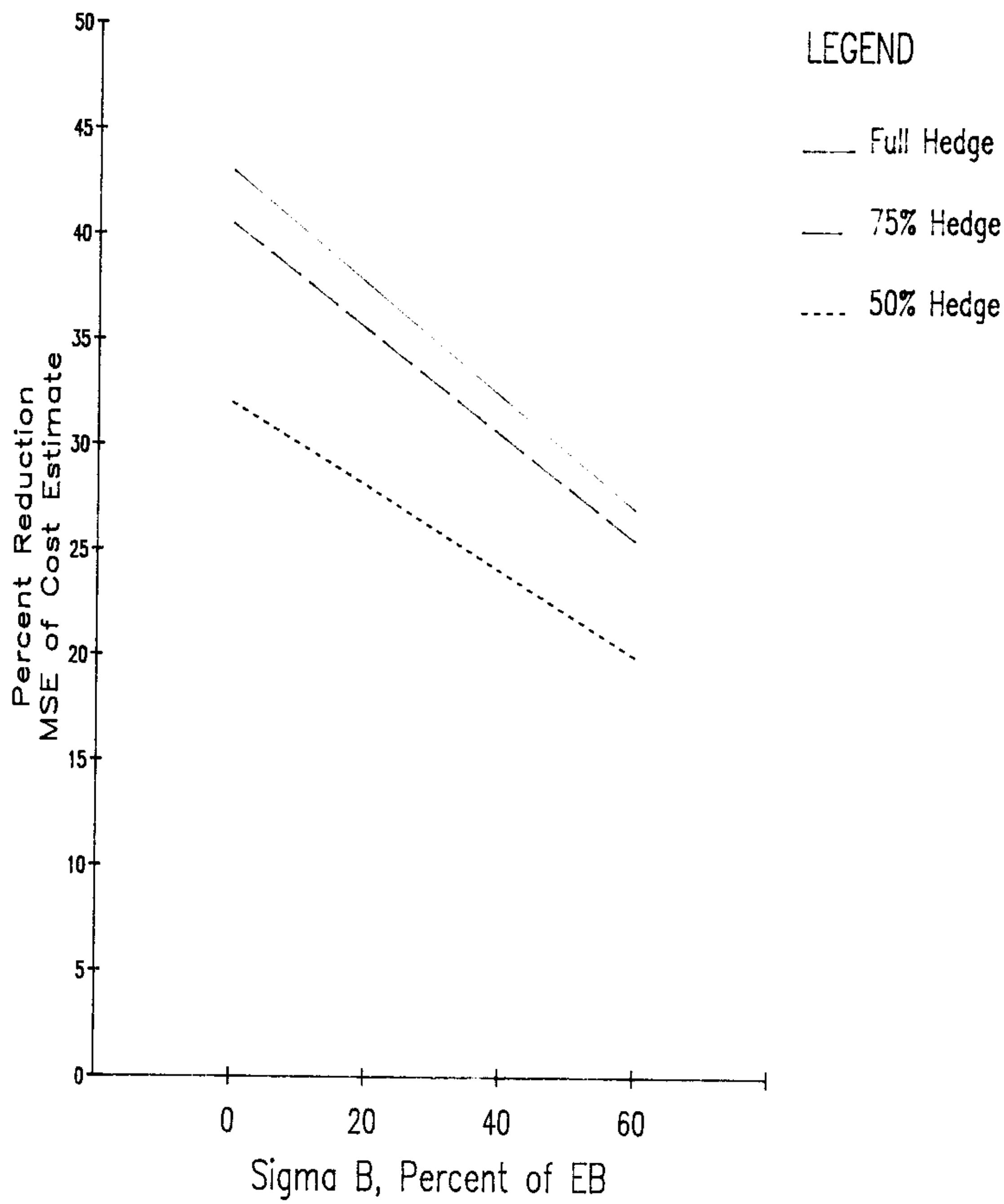


Figure 6-5. % MSE Reduction as a Function of Basis Uncertainty Sigma Q = 20% of EQ

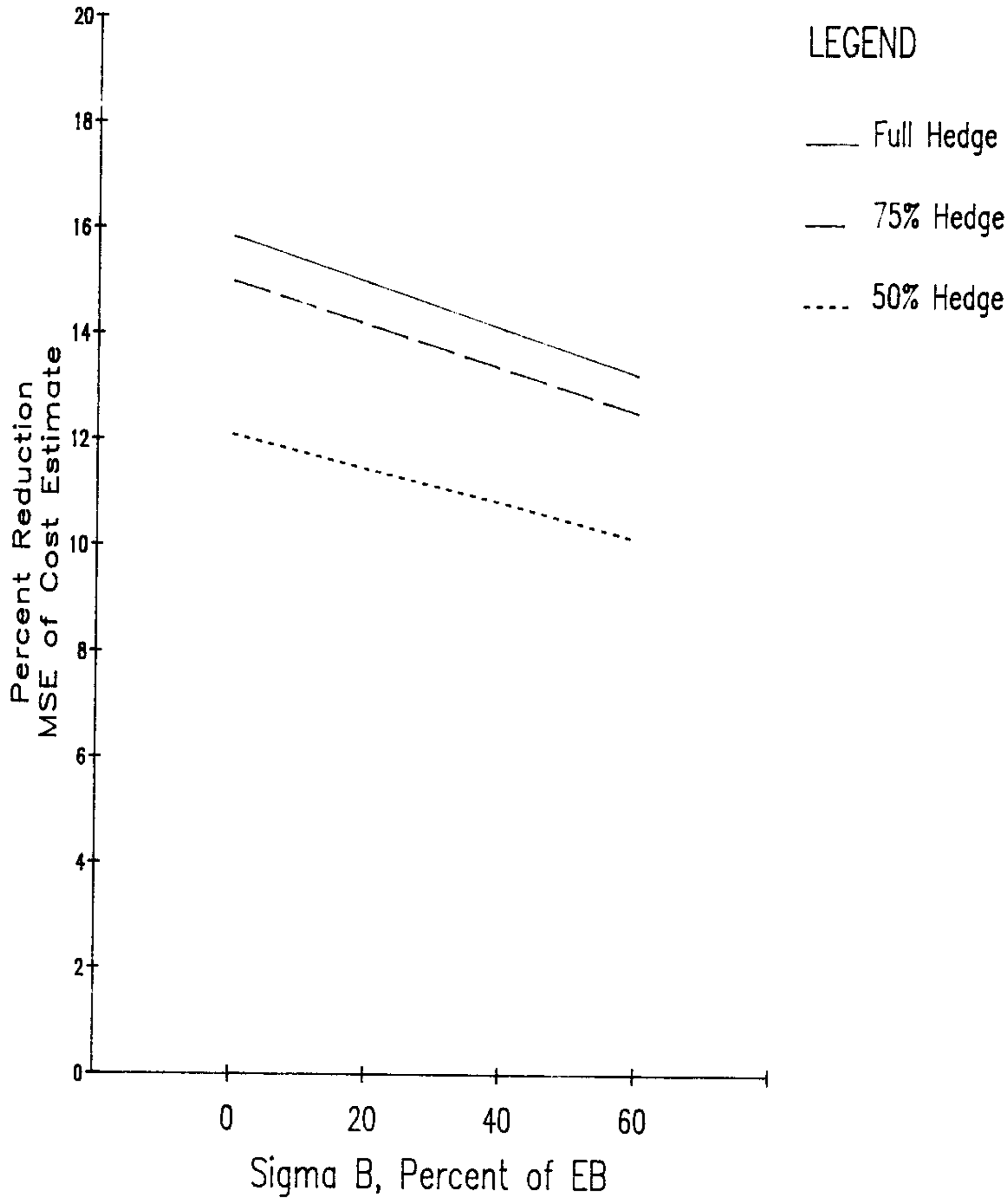
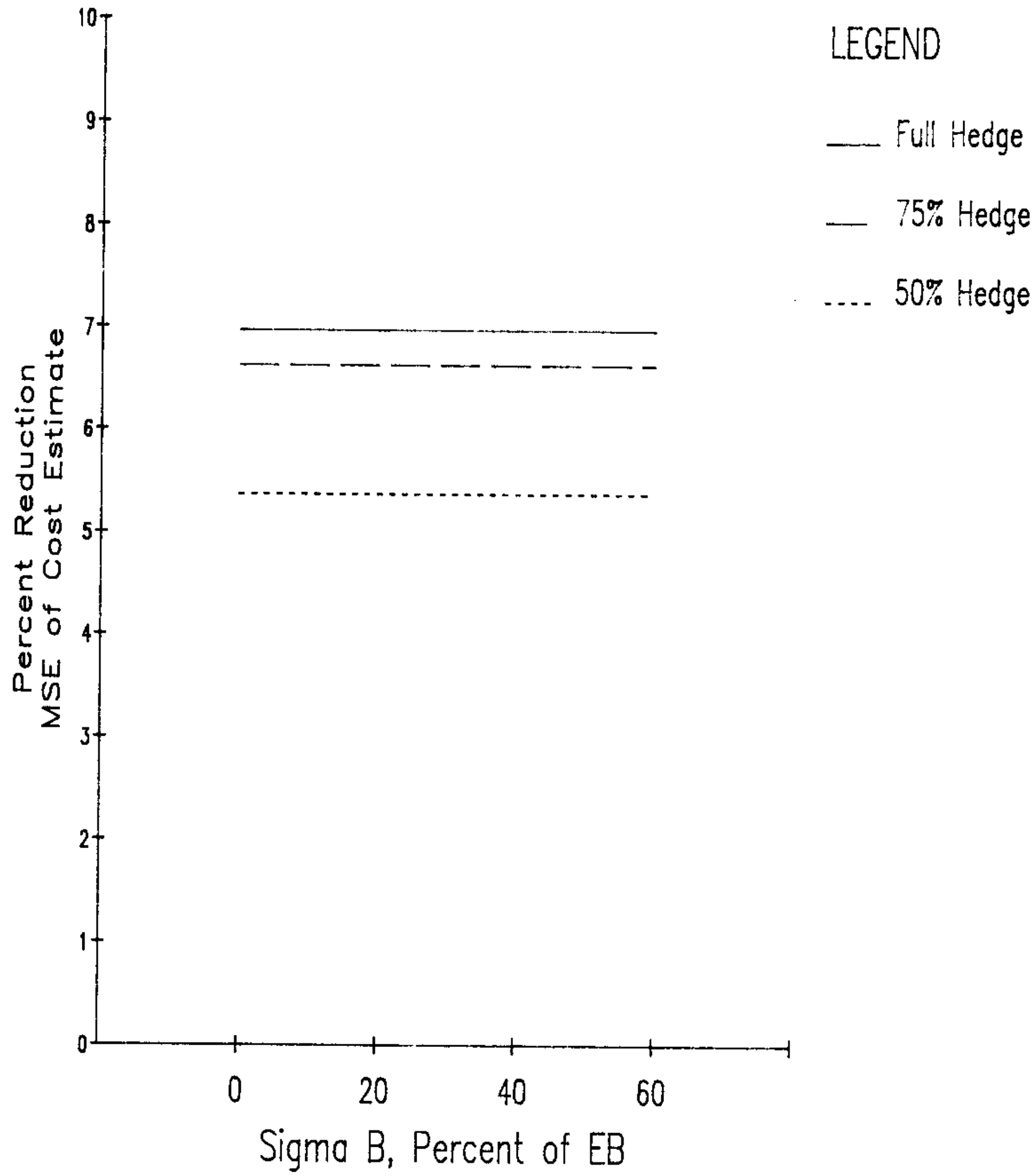


Figure 6-6. % MSE Reduction as a Function of Basis Uncertainty *
Sigma Q = 30% of EQ



* Mean reduction: slope coefficients insig.

(basis values) with an error of 10% or less. Interpreted in this way, Figure 6-3 through Figure 6-6 can provide the basis for rules of thumb as to what kind of results one might expect from hedging, depending on how accurately one can predict bases and quantities.

Several conclusions can be drawn from this analysis:

1. Quantity uncertainty has a very large impact on the effectiveness of any hedging strategy. Even with complete basis certainty, the effectiveness of a full hedge falls from 100% to about 7% as Sigma Q goes from 0 to 30% of EQ. The other two strategies show similar decreases in effectiveness as Sigma Q increases.
2. Basis uncertainty becomes relatively less important as quantity uncertainty increases. This is shown by the progressive flattening of the regression lines as Sigma Q increases.
3. Even at high levels of basis uncertainty, hedging can remain effective if quantity can be forecast with some accuracy. For example, with Sigma B equal to 60% of EB and Sigma Q equal to 10% of EQ, hedging reduces uncertainty by between 20% and 30%, depending on the strategy utilized.
4. The advantage of Full Hedge over the other two strategies diminishes as quantity uncertainty increases. As Sigma Q goes from 0 to 30% of EQ, the difference in MSE reduction beteen Full Hedge and 50% Hedge falls from about 17 percentage points to less than 2 percentage points.

This last conclusion raises the question of what advantage one obtains by hedging less than 100% of expected quantity. If the average percent reduction in MSE from a 100% hedge always exceeds that from a smaller hedge, why would one ever hedge less than 100%?

This question can be answered by examining Table 6-5. The table shows that Full Hedge always results in a greater average MSE reduction than the other two strategies. But it also shows that the variance of the reduction in MSE (the Standard Error of the Regression) is always higher in this strategy than in the other two. At relatively low levels of quantity uncertainty (Sigma Q = 0 to 10% of EQ), this heightened variance is probably not a serious problem. But at higher levels of quantity uncertainty, the large variance from Full Hedge means that this strategy actually increases MSE relative to a Cash Only strategy significantly more often than do the other two strategies. The clear implication is that, at relatively high levels of quantity uncertainty, hedging less than 100% of expected quantity reduces the probability that hedging will increase rather than decrease cost forecast errors. Such a strategy is less risky than a Full Hedge strategy.

All things considered, the results are encouraging. The analysis indicates that if a country can usually forecast its import needs with an error of less than 20%, hedging can significantly reduce its uncertainty even at high levels of basis risk.

Table 6-5. Avg. % Reduction in MSE, Standard Error of the Regression, and "t" Statistic by Hedging Strategy and Level of Quantity Uncertainty

Sigma Q (% of EQ)	Hedging Strategy	Avg. % Reduction, MSE	SER	"t" Statistic*
0	Full Hedge	67.5	9.7	7.0
	75% Hedge	63.3	7.8	8.1
	50% Hedge	50.4	6.8	7.4
10%	Full Hedge	32.2	12.1	2.7
	75% Hedge	30.4	9.8	3.1
	50% Hedge	23.8	8.9	2.7
20%	Full Hedge	14.1	11.9	1.2
	75% Hedge	13.3	8.6	1.5
	50% Hedge	10.8	5.5	2.0
30%	Full Hedge	7.0	8.1	.9
	75% Hedge	6.6	6.0	1.1
	50% Hedge	5.4	3.9	1.4

* "t" = (Avg. % Reduction, MSE)/(SER). This statistic shows how close, in terms of standard errors, the mean reduction in MSE is to zero. It should not be interpreted as a test of the significance of this reduction.

CHAPTER SEVEN

CONCLUSION

7.1. Summary

This report first examined the world economy of the past ten years, stressing the increasing need for Low Income Country importers and exporters to develop systematic risk management techniques to deal with that volatile economy. The report indicated that futures markets are but one of several available techniques, the choice among the techniques depending upon factors both internal and external to the firm. Next, the report discussed the institutional features of futures markets, used examples to illustrate futures trading mechanics, and presented basic futures market theory. The report also addressed the potential benefits and preconditions for effective use of futures trading. Finally, the author developed a simulation model first to analyze six alternative purchase strategies, and second to investigate the impact of varying levels of basis and quantity uncertainty on hedging effectiveness.

7.2. Conclusions and Recommendations

In this section, each major conclusion will be accompanied by a recommendation derived from it. The major conclusions and recommendations drawn from the simulation study are:

(1) Conclusion: There are a number of hedging techniques available to an informed trader, each with its own advantages and disadvantages

Recommendation: A prospective hedger should become familiar with all available techniques and choose among them as appropriate. Different techniques may be appropriate for the same trader at different times.

(2) "Optimal" Hedging is optimal only ex-ante, and will not necessarily outperform Full Hedging or other hedging techniques.

Recommendation: Less emphasis should be placed on devising an "optimal" strategy than on devising a workable set of standard operating procedures which will yield acceptable results over the medium to long run.

(3) Hedging can be effective even at fairly high levels of basis uncertainty if quantity can usually be predicted with an error of 10% or less. See Figures 6-3 and 6-4.

Recommendation: Every attempt should be made to accurately estimate required imports or available exports prior to hedging them. This is not an argument to ignore basis analysis. Good basis analysis remains critical to effective hedging, especially if quantity is fairly certain. Every hedger should develop basis charts as a first step in systematically analyzing relevant bases.

(4) Conclusion: Quantity uncertainty has a very large impact on hedging effectiveness, and basis uncertainty becomes relatively less important as quantity uncertainty increases.

Recommendation: Again, every attempt should be made to accurately estimate required imports or available exports prior to the hedging decision. One approach for importers is to make a number of smaller purchases per year as needs become known, rather than making one or two larger purchases. Exporters should develop and maintain an effective crop forecasting system, and attempt to wait until after production is known with some accuracy to hedge future sales. If prices seem especially attractive before production levels can be ascertained, one could hedge, say, 50% of expected production to obtain the favorable price, and place any further required hedges later when production is known with more certainty.

(5) Conclusion: As quantity uncertainty increases, hedging less than 100% of expected quantity becomes attractive not because it reduces uncertainty more than a full hedge, but because it reduces the probability that hedging will increase rather than decrease uncertainty.

Recommendation: If quantity cannot usually be predicted within 10%, one should hedge less than 100% of expected quantity. The proportion hedged should decrease with increasing quantity uncertainty.

(6) Conclusion: Uncovered exchange rate movements can have very significant impacts on the value of a hedged position, and combining foreign exchange with commodity hedges decreases uncertainty more than a commodity hedge alone.

Recommendation: Convertible foreign exchange holdings should be systematically hedged in conjunction with importable or exportable commodities.

(7) Conclusion: Hedging using a specific months's contract can result in significant returns or losses over fairly long periods. Hedging over similar periods with three or more

contracts should result in little if any net return or loss. Recommendation: Attempt to use several contracts rather than one, and be prepared for periodic significant losses (and gains) from one or more of the contracts. In the long-run, and averaged over all contracts, these losses and gains should nearly cancel each other.

(8) Conclusion: MSE of cost or revenue estimates can be decreased with or without a decrease in cost or revenue variance, if the basis and quantities are sufficiently predictable.
Recommendation: Do not focus on the impact of hedging on cost or revenue variance, since it can reduce uncertainty without affecting variance.

Other conclusions and recommendations are:

(9) Conclusion: One can obtain significant informational benefits from futures markets without direct participation in those markets.
Recommendation: Any governmental agency or private firm involved in importing or exporting agricultural or other commodities should have personnel trained in the theory and practice of futures trading, and capable of analyzing and predicting basis relationships.

(10) Conclusion: Direct futures trading can increase an organizations's pricing and procurement flexibility. Combined with the informational benefits noted above, this increased flexibility can reduce transaction costs, improve operational efficiency, and increase real income.

Recommendation: Any importing or exporting agency should consider direct futures trading as a means of managing risk, with the final decision depending on the level of trained personnel, financial resources, and institutional authority; and the characteristics of the cash and futures markets in which the organization would be participating.

(11) Conclusion: Futures trading is not the only risk management technique available to LIC importers and exporters.

Recommendation: Alternatives to direct futures trading should be seriously investigated whether or not such trading is deemed advisable.

7.3. Suggestions for Further Research

The analysis in this paper suffers from at least two shortcomings. First, it assumes that importers (exporters) are as concerned with unexpected decreases in cost (increases in revenue) as they are about increases (decreases). This is clearly not the case. Many if not all importers (exporters) would like to ensure a maximum (minimum) price while maintaining the ability to capitalize on unexpected favorable price movements. Trading in commodity options would enable them to do this. Research is needed to clarify and analyze the significant costs as well as potentially large benefits of such trading (see Chapter Three for a brief section on options).

The second shortcoming is that it imposes a rather rigid hedging technique on traders. They choose one of the six purchase strategies, and utilize it every period of every year. In practice, informed traders choose among various strategies, depending on which they expect to be most beneficial at a given point in time. The simulation model in this paper could be extended to analyze such behavior. For example, a model could be specified wherein traders utilize decision rules to choose between 1) waiting until the commodity is needed (time t+1) and then purchasing in cash markets (Cash Only from Chapter Six), 2) placing an anticipatory hedge at time t to cover expected cash market purchases at t+1, and 3) purchasing expected needs at time t and storing until t+1 under an inventory hedge. Each time, the trader would examine variables such as cash and futures price levels, costs of production (or expected resale price for importers), basis patterns, and storage costs, and apply a specified decision rule to choose among the three alternatives. Such research could be valuable in suggesting standard operating procedures that might improve a trading agency's performance.

APPENDIX A

EXCHANGE RATE ARRANGEMENTS

Exchange Rate Arrangements

(As of May 31, 1986)[1]

Currency pegged to					Flexibility Limited in terms of a Single Currency or Group of Currencies		More Flexible		
US Dollar	French Franc	Other currency	SDR	Other composite[2]	Single currency[3]	Cooperative arrangements[4]	Adjusted according to a set of indicators[5]	Other managed floating	Independently floating
Antigua & Barbuda Bahamas, The Barbados Belize Djibouti Dominica Egypt Ethiopia Ghana Grenada Guatemala Guinea Haiti Honduras Iraq Lao P.D. Rep. Liberia Nicaragua Oman Panama Paraguay Peru St. Christopher & Nevis St. Lucia St. Vincent Suriname Syrian Arab Rep. Trinidad and Tobago Venezuela Yemen Arab Rep. Yemen, P.D. Rep.	Benin Burkina Faso Cameroon C. African Rep. Chad Comoros Congo Côte d'Ivoire Equatorial Guinea Gabon Mali Niger Senegal Togo	Bhutan (Indian Rupee) Lesotho (South African Rand) Swaziland (South African Rand) Tonga (Australian Dollar)	Burma Burundi Iran, I. R. of Jordan Kenya Libya Rwanda São Tomé & Principe Seychelles Sierra Leone Vanuatu Viet Nam	Algeria Austria Bangladesh Botswana Cape Verde China, P.R. Cyprus Fiji Finland Guyana Hungary Kuwait Madagascar Malawi Malaysia Maldives Malta Mauritania Mauritius Mozambique Nepal Norway Papua New Guinea Romania Singapore Solomon Islands Sudan Sweden Tanzania Thailand Tunisia Zimbabwe	Afghanistan Bahrain Qatar Saudi Arabia United Arab Emirates	Belgium Denmark France Germany Ireland Italy Luxembourg Netherlands	Brazil Chile Colombia Portugal Somalia	Argentina Costa Rica Ecuador El Salvador Greece Guinea-Bissau Iceland India Indonesia Israel Korea Mexico Morocco Nigeria Pakistan Spain Sri Lanka Turkey Uganda Western Samoa Yugoslavia	Australia Bolivia Canada Dominican Rep. Gambia, The Jamaica Japan Lebanon New Zealand Philippines South Africa United Kingdom United States Uruguay Zaire Zambia

Classification status[1]	End of Period													
			1984		1985					1986				
	1982	1983	QIII	QIV	QI	QII	QIII	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Currency pegged to														
US Dollar	38	33	34	34	32	32	31	31	31	32	32	31	31	31
French Franc	13	13	13	13	14	14	14	14	14	14	14	14	14	14
Other Currency	5	5	5	5	4	4	5	5	5	4	4	4	4	4
of which: Pound Sterling	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(–)	(–)	(–)	(–)	(–)
SDR	15	13	11	11	12	12	12	12	12	11	11	12	12	12
Other currency composite	23	27	28	31	31	31	33	32	32	32	32	32	32	32
Flexibility limited vis-à-vis a single currency	10	9	9	7	7	6	5	5	5	5	5	5	5	5
Cooperative arrangements	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Adjusted according to a set of indicators	5	5	6	6	6	6	5	5	5	5	5	5	5	5
Managed floating	20	25	24	20	19	20	20	20	21	21	21	21	21	21
Independently floating	8	8	8	12	14	14	15	16	15	16	16	16	16	16
Total[6]	146	146	147	148	148	148	149	149	149	149	149	149	149	149

[1]Excluding the currency of Democratic Kampuchea, for which no current information is available. For members with dual or multiple exchange markets, the arrangement shown is that in the major market.

[2]Comprises currencies which are pegged to various "baskets" of currencies of the members' own choice, as distinct from the SDR basket.

[3]Exchange rates of all currencies have shown limited flexibility in terms of the U.S. dollar.

[4]Refers to the cooperative arrangement maintained under the European Monetary System.

[5]Includes exchange arrangements under which the exchange rate is adjusted at relatively frequent intervals, on the basis of indicators determined by the respective member countries.

[6]Including the currency of Democratic Kampuchea.

APPENDIX B

SELECTED FUTURES CONTRACT SPECIFICATIONS

Figure 1.--Summary Specifications for the Wheat Futures Contract, Chicago Board of Trade*

Delivery months	July, September, December, March, and May
Trading unit	5,000 bushels
Price quotations and minimum fluctuation	Quoted in cents and quarters of a cent per bushel, with a minimum fluctuation of ¼ cent per bushel ($12.50 per contract)
Daily price movement limits	20 cents per bushel
Position limits	3 million bushels (CFTC limit) in any one future or in all futures combined
Par delivery grades	No. 2 Soft Red, No. 2 Hard Red Winter, No. 2 Dark Northern Spring, No. 1 Northern Spring, and substitutions at differentials established by the Exchange
Permitted substitutions on delivery	At a 1 cent premium: No. 1 Soft Red, No. 1 Hard Red Winter, No. 1 Dark Northern Spring. At a 1 cent discount: No. 3 Soft Red, No. 3 Hard Red Winter, No. 3 Dark Northern Spring and No. 2 Northern Spring (not to exceed 13.5% moisture)
Delivery	By registered warehouse receipts issued by warehouses approved by the Exchange in the Chicago Switching District or Toledo, Ohio Switching District. Deliveries from Toledo are made at a discount of 2 cents per bushel under contract price
Trading hours	9:30 a.m. to 1:15 p.m. Central Time

* Commodity Trading Manual, p. 140 and Rules and Regulations of the Board of Trade of the City of Chicago. The information here is meant to be representative; it is all subject to change.

Figure 2.--Summary Specifications for the Corn Futures Contract, Chicago Board of Trade*

Delivery months	December, March, May, July, and September
Trading unit	5,000 bushels
Price quotations and minimum fluctuation	Quoted in cents and quarters of a cent per bushel, with a minimum fluctuation of ¼ cent per bushel ($12.50 per contract)
Daily price movement limits	10 cents per bushel
Position limits	3 million bushels (CFTC limit) in any one future or in all futures combined
Par delivery grades	No. 2 Yellow corn
Permitted substitutions on delivery	At a ½ cent premium: No. 1 Yellow corn. At a 1½ cent discount: No. 3 Yellow corn (maximum 15½% moisture)
Delivery	By registered warehouse receipts issued against stocks in warehouses that have been declared regular by the Exchange, located in the Chicago Switching District, The Toledo, OH, Switching District, and the St. Louis, MO, Switching District (which includes East St. Louis, IL, and Alton, IL). Deliveries at Toledo and St. Louis are made at a discount of 4 cents per bushel under the (Chicago) contract price
Trading hours	9:30 a.m. to 1:15 p.m. Central Time

* Commodity Trading Manual, p. 147 and Rules and Regulations of the Board of Trade of the City of Chicago. The information here is meant to be representative; it is all subject to change.

SPECIFICATIONS FOR FRENCH FRANC FUTURES CONTRACTS TRADED ON THE INTERNATIONAL MONETARY MARKET

SCOPE OF CHAPTER—This chapter is limited in application to contract specifications of French Franc futures which are open for trading and delivery on the International Monetary Market, a Division of the Chicago Mercantile Exchange. The procedure for trading, clearing, delivery, settlement and any other matters not specifically contained herein shall be governed by the rules of the Chicago Mercantile Exchange.

TRADING UNITS—The unit of trading shall be 250,000 French francs.

TRADING MONTHS—March, June, September, December. Effective April 17, 1980 a new quarterly cycle consisting of January, April, July and October was listed for trading as "regular" contract months in addition to the quarterly cycle of March, June, September and December. In addition, as before, the remaining or "interim" months (February, May, August and November) will be listed for trading on a spot month basis; i.e., each will be listed on the first business day of the preceding month.

TICKER SYMBOL—FR

TRADING HOURS—7:42 a.m. to 1:28 p.m.

PRICE INCREMENTS—Minimum price fluctuations shall be in multiples of $.00005 per French Franc, commonly referred to as five points.

NORMAL DAILY PRICE LIMITS—There shall be no trading at a price more than $.00500 (500 points) above or below the previous day's settlement price, except when the expanded daily price limit schedule goes into effect and on the last day of trading in the delivery month when there shall be no limit.

Effective with the January 1980 Futures Contract the spot month first begins trading without limits on the last day of trading of the preceding month.

EXPANDED DAILY TRADING LIMITS—Whenever on two successive days any contract month of the French Franc settles at the normal daily price limit in the same direction (not necessarily the same contract month on both days) an expanded daily price limit schedule shall go into effect as follows:

1. The third day's daily price limit in all contract months shall be 150% of the normal daily price limit.
2. If any contract month settles at its expanded daily price limit on the third day in the same direction, then the fourth day's expanded daily price limit will be 200% of the normal daily price limit.
3. If any contract month settles at its expanded daily price limit on the fourth day in the same direction then there shall be no daily price limit on the fifth day.
4. On the sixth day of the foregoing progression, the normal daily price limit shall be reinstated.
5. Whenever the foregoing daily price limit schedule is in effect and no contract month settles at the price limit in the same direction which initiated the expanded schedule, then the normal daily price limit shall be reinstated on the following day.

SETTLEMENT PRICE—Effective March 27, 1981: The Settlement Price may be outside of the day's High/Low range, and/or may be different from the midpoint of the Closing Range, per C.M.E. Rule 813.

TERMINATION OF FUTURES TRADING—Futures trading shall terminate on the second business day immediately preceeding the third Wednesday of the contract month.

DELIVERY PROCEDURE—Delivery shall be made on the third Wednesday of the contract month in the country of issuance at a bank designated by the buyer.

If that day is not a business day (in the country of delivery) delivery shall be made on the next business day immediately succeeding.

BUYER'S DUTIES—A clearing member representing a customer that intends to accept delivery in liquidation of his position shall, no later than 11:00 a.m. on the last day of trading, present a **Buyer's Delivery Commitment** to the Clearing House. By 1:00 p.m. the clearing member shall deposit to the account of the Chicago Mercantile Exchange Clearing House in a bank designated by it, a sum sufficient to pay for the delivery. The amount of the deposit shall equal the value of the contract(s) based on the settlement price on the last day of trading. Such deposit shall be made in the form of a certified or cashier's check, or a wire transfer; effective October 10, 1980, in the form of a wire transfer of same day funds.

The buyer shall have made all provisions necessary to receive delivery within the country of issuance.

Note: From time to time, and frequently without warning, countries change the requirements and the restrictions on non-resident bank accounts. These take various forms including interest free deposit requirements, negative interest rates, prohibitions against investment in the country, ceilings on the amount of deposit, restrictions on the period of time such deposits may be maintained, etc.

It is the buyer's responsibility to be familiar with and in conformance with all regulations pertaining to the holding of non-resident bank accounts in a country in which he desires to accept delivery.

SELLER'S DUTIES—The clearing member representing a customer making delivery in liquidation of his position shall, no later than 11:00 a.m. on the last day of trading, present to the Clearing House a **Seller's Delivery Commitment.**

The Seller's clearing member shall be responsible for delivering the foreign currency on the delivery date to a bank designated by the Clearing House.

SELLER'S DESIGNATED BANK—The seller's clearing member shall designate only such banks or other facilities as are acceptable to the Chicago Mercantile Exchange.

PAYMENTS—The Clearing House shall designate a bank in each foreign country into which the seller shall deliver the foreign currency. These banks shall notify the Clearing House when the seller's funds have been received. The Clearing House shall, promptly after receipt of such notification, transfer the funds previously deposited by the buyer's clearing member to the account of the seller's clearing member.

COSTS OF DELIVERY—The seller shall bear the costs of transferring the foreign currency into a bank designated by the Clearing House. The buyer shall bear the costs of transferring the foreign currency out of the bank designated by the Clearing House. Such costs may include, but are not limited to wire transfer charges, negative interest charges, transaction fees, etc.

ACCUMULATION OF POSITIONS—The positions of all accounts owned or controlled by a person or persons acting in concert or in which such person or persons have a proprietary or beneficial interest shall be cumulated.

CONTRACT MODIFICATIONS—Specifications shall be fixed as of the first day of trading of a contract, except that all deliveries must conform to government regulations in force at the time of delivery. If any national or international governmental agency or body issues an order, ruling, directive or law that conflicts with the requirement of these rules, such order, ruling, directive or law shall be construed to take precedence and become part of these rules and all open and new contracts shall be subject to such government orders.

EMERGENCIES, ACTS OF GOD, ACTS OF GOVERNMENT—If it is determined by the Board or the Business Conduct Committee that delivery or any precondition or requirement thereof is prevented by act of government, act of God, or other emergency, it may take action as it deems necessary and reasonable under the circumstances. Its decision shall be binding upon all parties to the contract.

SPECIFICATIONS FOR DEUTSCHEMARK FUTURES CONTRACTS TRADED ON THE INTERNATIONAL MONETARY MARKET

SCOPE OF CHAPTER—This chapter is limited in application to contract specifications of Deutschemark futures which are open for trading and delivery on the International Monetary Market, a Division of the Chicago Mercantile Exchange. The procedure for trading, clearing, delivery, settlement and any other matters not specifically contained herein shall be governed by the rules of the Chicago Mercantile Exchange.

TRADING UNITS—The unit of trading shall be 125,000 Deutschemarks.

TRADING MONTHS—March, June, September, December. Effective April 17, 1980, a new quarterly cycle consisting of January, April, July and October was listed for trading as "regular" contract months in addition to the quarterly cycle of March, June, September, and December. In addition, as before, the remaining or "interim" months (February, May, August and November) will be listed for trading on a spot month basis; i.e., each will be listed on the first business day of the preceding month.

TICKER SYMBOL—DM

TRADING HOURS—7:34 a.m. to 1:20 p.m.

PRICE INCREMENTS—Minimum price fluctuations shall be in multiples of $.0001 per Deutschemark, commonly referred to as one point.

NORMAL DAILY PRICE LIMITS—There shall be no trading at a price more than $.0100 (100 points) above or below the previous day's settlement price, except when the expanded daily price limit schedule goes into effect and on the last day of trading in the delivery month when there shall be no limit.

Effective with the January 1980 Futures Contract the spot month first begins trading without limits on the last day of trading of the preceding month.

EXPANDED DAILY TRADING LIMITS—Whenever on two successive days any contract month of the Deutschemark settles at the normal daily price limit in the same direction (not necessarily the same contract month on both days) an expanded daily price limit schedule shall go into effect as follows:

1. The third day's daily price limit in all contract months shall be 150% of the normal daily price limit.
2. If any contract month settles at its expanded daily price limit on the third day in the same direction, then the fourth day's expanded daily price limit will be 200% of the normal daily price limit.
3. If any contract month settles at its expanded daily price limit on the fourth day in the same direction then there shall be no daily price limit on the fifth day.
4. On the sixth day of the foregoing progression, the normal daily price limit shall be reinstated.
5. Whenever the foregoing daily price limit schedule is in effect and no contract month settles at the price limit in the same direction which initiated the expanded schedule, then the normal daily price limit shall be reinstated on the following day.

SETTLEMENT PRICE—Effective March 27, 1981: The Settlement Price may be outside of the day's High/Low range, and/or may be different from the midpoint of the Closing Range, per C.M.E. Rule 813.

TERMINATION OF FUTURES TRADING—Futures trading shall terminate on the second business day immediately preceeding the third Wednesday of the contract month.

DELIVERY PROCEDURE—Delivery shall be made on the third Wednesday of the contract month in the country of issuance at a bank designated by the buyer.

If that day is not a business day (in the country of delivery) delivery shall be made on the next business day immediately succeeding.

BUYER'S DUTIES—A clearing member representing a customer that intends to accept delivery in liquidation of his position shall, no later than 11:00 a.m. on the last day of trading, present a **Buyer's Delivery Commitment** to the Clearing House. By 1:00 p.m. the clearing member shall deposit to the account of the Chicago Mercantile Exchange Clearing House in a bank designated by it, a sum sufficient to pay for the delivery. The amount of the deposit shall equal the value of the contract(s) based on the settlement price on the last day of trading. Such deposit shall be made in the form of a certified or cashier's check, or a wire transfer; effective October 10, 1980, in the form of a wire transfer of same day funds.

The buyer shall have made all provisions necessary to receive delivery within the country of issuance.

Note: From time to time, and frequently without warning, countries change the requirements and the restrictions on non-resident bank accounts. These take various forms including interest free deposit requirements, negative interest rates, prohibitions against investment in the country, ceilings on the amount of deposit, restrictions on the period of time such deposits may be maintained, etc.

It is the buyers responsibility to be familiar with and in conformance with all regulations pertaining to the holding of non-resident bank accounts in a country in which he desires to accept delivery.

SELLER'S DUTIES—The clearing member representing a customer making delivery in liquidation of his position shall, no later than 11:00 a.m. on the last day of trading, present to the Clearing House a **Seller's Delivery Commitment.**

The Seller's clearing member shall be responsible for delivering the foreign currency on the delivery date to a bank designated by the Clearing House.

SELLER'S DESIGNATED BANK—The seller's clearing member shall designate only such banks or other facilities as are acceptable to the Chicago Mercantile Exchange.

PAYMENTS—The Clearing House shall designate a bank in each foreign country into which the seller shall deliver the foreign currency. These banks shall notify the Clearing House when the seller's funds have been received. The Clearing House shall, promptly after receipt of such notification, transfer the funds previously deposited by the buyer's clearing member to the account of the seller's clearing member.

COSTS OF DELIVERY—The seller shall bear the costs of transferring the foreign currency into a bank designated by the Clearing House. The buyer shall bear the costs of transferring the foreign currency out of the bank designated by the Clearing House. Such costs may include, but are not limited to wire transfer charges, negative interest charges, transaction fees, etc.

ACCUMULATION OF POSITIONS—The positions of all accounts owned or controlled by a person or persons acting in concert or in which such person or persons have a proprietary or beneficial interest shall be cumulated.

CONTRACT MODIFICATIONS—Specifications shall be fixed as of the first day of trading of a contract, except that all deliveries must conform to government regulations in force at the time of delivery. If any national or international governmental agency or body issues an order, ruling, directive or law that conflicts with the requirements of these rules, such order, ruling, directive or law shall be construed to take precedence and become part of these rules and all open and new contracts shall be subject to such government orders.

EMERGENCIES, ACTS OF GOD, ACTS OF GOVERNMENT—If it is determined by the Board or the Business Conduct Committee that delivery or any precondition or requirement thereof is prevented by act of goverment, act of God, or other emergency, it may take action as it deems necessary and reasonable under the circumstances. Its decision shall be binding upon all parties to the contract.

SPECIFICATIONS FOR BRITISH POUND FUTURES CONTRACTS TRADED ON THE INTERNATIONAL MONETARY MARKET

SCOPE OF CHAPTER—This chapter is limited in application to contract specifications of British Pound futures which are open for trading and delivery on the International Monetary Market, a Division of the Chicago Mercantile Exchange. The procedure for trading, clearing, delivery, settlement and any other matters not specifically contained herein shall be governed by the rules of the Chicago Mercantile Exchange.

TRADING UNITS—The unit of trading shall be 25,000 Pounds Sterling.

TRADING MONTHS—March, June, September, December. Effective April 17, 1980, a new quarterly cycle consisting of January, April, July and October was listed for trading as "regular" contract months in addition to the quarterly cycle of March, June, September and December. In addition, as before, the remaining or "interim" months (February, May, August and November) will be listed for trading on a spot month basis; i.e., each will be listed on the first business day of the preceding month.

TICKER SYMBOL—BP

TRADING HOURS—7:38 a.m. to 1:24 p.m.

PRICE INCREMENTS—Minimum price fluctuations shall be in multiples of $.0005 per Pound Sterling, commonly referred to as five points.

NORMAL DAILY PRICE LIMITS—There shall be no trading at a price more than $.0500 (500 points) above or below the previous day's settlement price, except when the expanded daily price limit schedule goes into effect and on the last day of trading in the delivery month when there shall be no limit.

Effective with the January 1980 Futures Contract the spot month first begins trading without limits on the last day of trading of the preceding month.

EXPANDED DAILY TRADING LIMITS—Whenever on two successive days any contract month of the British Pound settles at the normal daily price limit in the same direction (not necessarily the same contract month on both days) an expanded daily price limit schedule shall go into effect as follows:

1. The third day's daily price limit in all contract months shall be 150% of the normal daily price limit.
2. If any contract month settles at its expanded daily price limit on the third day in the same direction, then the fourth day's expanded daily price limit will be 200% of the normal daily price limit.
3. If any contract month settles at its expanded daily price limit on the fourth day in the same direction then there shall be no daily price limit on the fifth day.
4. On the sixth day of the foregoing progression, the normal daily price limit shall be reinstated.
5. Whenever the foregoing daily price limit schedule is in effect and no contract month settles at the price limit in the same direction which initiated the expanded schedule, then the normal daily price limit shall be reinstated on the following day.

SETTLEMENT PRICE—Effective March 27, 1981: The Settlement Price may be outside of the day's High/Low range, and/or may be different from the midpoint of the Closing Range, per C.M.E. Rule 813.

TERMINATION OF FUTURES TRADING—Futures trading shall terminate on the second business day immediately preceeding the third Wednesday of the contract month.

DELIVERY PROCEDURE—Delivery shall be made on the third Wednesday of the contract month in the country of issuance at a bank designated by the buyer.

If that day is not a business day (in the country of delivery) delivery shall be made on the next business day immediately succeeding.

BUYER'S DUTIES—A clearing member representing a customer that intends to accept delivery in liquidation of his position shall, no later than 11:00 a.m. on the last day of trading, present a **Buyer's Delivery Commitment** to the Clearing House. By 1:00 p.m. the clearing member shall deposit to the account of the Chicago Mercantile Exchange Clearing House in a bank designated by it, a sum sufficient to pay for the delivery. The amount of the deposit shall equal the value of the contract(s) based on the settlement price on the last day of trading. Such deposit shall be made in the form of a certified or casher's check, or a wire transfer; effective October 10, 1980, in the form of a wire transfer of same day funds.

The buyer shall have made all provisions necessary to receive delivery within the country of issuance.

Note: From time to time, and frequently without warning, countries change the requirements and the restrictions on non-resident bank accounts. These take various forms including interest free deposit requirements, negative interest rates, prohibitions against investment in the country, ceilings on the amount of deposit, restrictions on the period of time such deposits may be maintained, etc.

It is the buyer's responsibility to be familiar with and in conformance with all regulations pertaining to the holding of non-resident bank accounts in a country in which he desires to accept delivery.

SELLER'S DUTIES—The clearing member representing a customer making delivery in liquidation of his position shall, no later than 11:00 a.m. on the last day of trading, present to the Clearing House a **Seller's Delivery Commitment.**

The Seller's clearing member shall be responsible for delivering the foreign currency on the delivery date to a bank designated by the Clearing House.

SELLER'S DESIGNATED BANK—The seller's clearing member shall designate only such banks or other facilities as are acceptable to the Chicago Mercantile Exchange.

PAYMENTS—The Clearing House shall designate a bank in each foreign country into which the seller shall deliver the foreign currency. These banks shall notify the Clearing House when the seller's funds have been received. The Clearing House shall, promptly after receipt of such notification, transfer the funds previously deposited by the buyer's clearing member to the account of the seller's clearing member.

COSTS OF DELIVERY—The seller shall bear the costs of transferring the foreign currency into a bank designated by the Clearing House. The buyer shall bear the costs of transferring the foreign currency out of the bank designated by the Clearing House. Such costs may include, but are not limited to wire transfer charges, negative interest charges, transaction fees, etc.

ACCUMULATION OF POSITIONS—The positions of all accounts owned or controlled by a person or persons acting in concert or in which such person or persons have a proprietary or beneficial interest shall be cumulated.

CONTRACT MODIFICATIONS—Specifications shall be fixed as of the first day of trading of a contract, except that all deliveries must conform to government regulations in force at the time of delivery. If any national or international governmental agency or body issues an order, ruling, directive or law that conflicts with the requirements of these rules, such order, ruling, directive or law shall be construed to take precedence and become part of these rules and all open and new contracts shall be subject to such government orders.

EMERGENCIES, ACTS OF GOD, ACTS OF GOVERNMENT—If it is determined by the Board or the Business Conduct Committee that delivery or any precondition or requirement thereof is prevented by act of government, act of God, or other emergency, it may take action as it deems necessary and reasonable under the circumstances. Its decision shall be binding upon all parties to the contract.

SPECIFICATIONS FOR MEXICAN PESO FUTURES CONTRACTS TRADED ON THE INTERNATIONAL MONETARY MARKET

SCOPE OF CHAPTER—This chapter is limited in application to contract specifications of Mexican Peso futures which are open for trading and delivery on the International Monetary Market, a Division of the Chicago Mercantile Exchange. The procedure for trading, clearing, delivery, settlement and any other matters not specifically contained herein shall be governed by the rules of the Chicago Mercantile Exchange.

TRADING UNITS—The unit of trading shall be 1,000,000 Mexican Pesos.

TRADING MONTHS—March, June, September, December. Effective April 17, 1980, a new quarterly cycle consisting of January, April, July and October was listed for trading as "regular" contract months in addition to the quarterly cycle of March, June, September, and December. In addition, as before, the remaining or "interim" months (February, May, August and November) will be listed for trading on a spot month basis; i.e., each will be listed on the first business day of the preceding month.

TICKER SYMBOL—MP

TRADING HOURS—7:32 a.m. to 1:18 p.m.

PRICE INCREMENTS—Minimum price fluctuations shall be in multiples of $.00001 per Mexican Peso, commonly referred to as one point.

NORMAL DAILY PRICE LIMITS—There shall be no trading at a price more than $.00150 (150 points) above or below the previous day's settlement price, except when the expanded daily price limit schedule goes into effect and on the last day of trading in the delivery month when there shall be no limit.

Effective with the January 1980 Futures Contract the spot month first begins trading without limits on the last day of trading of the preceding month.

EXPANDED DAILY TRADING LIMITS—Whenever on two successive days any contract month of the Mexican Peso settles at the normal daily price limit in the same direction (not necessarily the same contract month on both days) an expanded daily price limit schedule shall go into effect as follows:

1. The third day's daily price limit in all contract months shall be 150% of the normal daily price limit.
2. If any contract month settles at its expanded daily price limit on the third day in the same direction then the fourth day's expanded daily price limit will be 200% of the normal daily price limit.
3. If any contract month settles at its expanded daily price limit on the fourth day in the same direction, then there shall be no daily price limit on the fifth day.
4. On the sixth day of the foregoing progression, the normal daily price limit shall be reinstated.
5. Whenever the foregoing daily price limit schedule is in effect and no contract month settles at the price limit in the same direction which initiated the expanded schedule, then the normal daily price limit shall be reinstated on the following day.

SETTLEMENT PRICE—Effective March 27, 1981: The Settlement Price may be outside of the day's High/Low range, and/or may be different from the midpoint of the Closing Range, per C.M.E. Rule 813.

DELIVERY PROCEDURE—Delivery shall be made on the third Wednesday of the contract month in the country of issuance at a bank designated by the buyer.

If that day is not a business day (in that country of delivery) delivery shall be made on the next business day immediately succeeding.

TERMINATION OF FUTURES TRADING—Futures trading shall terminate on the first business day immediately preceeding the third Wednesday of the contract month.

Effective with the July 1980 Futures Contract, futures trading shall terminate on the second business day immediately preceding the third Wednesday of the contract month.

BUYER'S DUTIES—A clearing member representing a customer that intends to accept delivery in liquidation of his position shall, no later than 11:00 a.m. on the last day of trading, present a **Buyer's Delivery Commitment** to the Clearing House. By 1:00 p.m. on the day following the last day of trading, the clearing member shall deposit to the account of the Chicago Mercantile Exchange Clearing House in a bank designated by it, a sum sufficient to pay for the delivery. The amount of the deposit shall equal the value of the contract(s) based on the settlement price on the last day of trading. Such deposit shall be made in the form of a certified or cashier's check, or a wire transfer; effective October 10, 1980, in the form of a wire transfer of same day funds.

The buyer shall have made all provisions necessary to receive delivery within the country of issuance.

Note: From time to time, and frequently without warning, countries change the requirements and the restrictions on non-resident bank accounts. These take various forms including interest free deposit requirements, negative interest rates, prohibitions against investment in the country, ceilings on the amount of deposit, restrictions on the period of time such deposits may be maintained, etc.

It is the buyer's responsibility to be familiar with and in conformance with all regulations pertaining to the holding of non-resident bank accounts in a country in which he desires to accept delivery.

SELLER'S DUTIES—The clearing member representing a customer making delivery in liquidation of his position shall, no later than 11:00 a.m. on the last day of trading, present to the Clearing House a **Seller's Delivery Commitment.**

The Seller's clearing member shall be responsible for delivering the foreign currency on the delivery date to a bank designated by the Clearing House.

SELLER'S DESIGNATED BANK—The seller's clearing member shall designate only such banks or other facilities as are acceptable to the Chicago Mercantile Exchange.

PAYMENTS—The Clearing House shall designate a bank in each foreign country into which the seller shall deliver the foreign currency. These banks shall notify the Clearing House when the seller's funds have been received. The Clearing House shall, promptly after receipt of such notification, transfer the funds previously deposited by the buyer's clearing member to the account of the seller's clearing member.

COSTS OF DELIVERY—The seller shall bear the costs of transferring the foreign currency into a bank designated by the Clearing House. The buyer shall bear the costs of transferring the foreign currency out of the bank designated by the Clearing House. Such costs may include, but are not limited to wire transfer charges, negative interest charges, transaction fees, etc.

ACCUMULATION OF POSITIONS—The positions of all accounts owned or controlled by a person or persons acting in concert or in which such person or persons have a proprietary or beneficial interest shall be cumulated.

CONTRACT MODIFICATIONS—Specifications shall be fixed as of the first day of trading of a contract, except that all deliveries must conform to government regulations in force at the time of delivery. If any national or international government agency or body issues an order, ruling, directive or law that conflicts with the requirements of these rules, such order, ruling, directive or law shall be construed to take precedence and become part of these rules and all open and new contracts shall be subject to such government orders.

EMERGENCIES, ACTS OF GOD, ACTS OF GOVERNMENT—If it is determined by the Board or the Business Conduct Committee that delivery or any precondition or requirement thereof is prevented by act of government, act of God, or other emergency, it may take action as it deems necessary and reasonable under the circumstances. Its decision shall be binding upon all parties to the contract.

SPECIFICATIONS FOR JAPANESE YEN FUTURES CONTRACTS TRADED ON THE INTERNATIONAL MONETARY MARKET

SCOPE OF CHAPTER—This chapter is limited in application to contract specifications of Japanese Yen futures which are open for trading and delivery on the International Monetary Market, a Division of the Chicago Mercantile Exchange. The procedure for trading, clearing, delivery, settlement and any other matters not specifically contained herein shall be governed by the rules of the Chicago Mercantile Exchange.

TRADING UNITS—The unit of trading shall be 12,500,000 Japanese Yen.

TRADING MONTHS—March, June, September, December. Effective April 17, 1980, a new quarterly cycle consisting of January, April, July and October was listed for trading as "regular" contract months in addition to the quarterly cycle of March, June, September, and December. In addition, as before, the remaining or "interim" months (February, May, August and November) will be listed for trading on a spot month basis; i.e., each will be listed on the first business day of the preceding month.

TICKER SYMBOL—JY

TRADING HOURS—7:40 a.m. to 1:26 p.m.

PRICE INCREMENTS—Minimum price fluctuations shall be in multiples of $.000001 per Japanese Yen, commonly referred to as one point.

NORMAL DAILY PRICE LIMITS—There shall be no trading at a price more than $.000100 (100 points) above or below the previous day's settlement price, except when the expanded daily price limit schedule goes into effect and on the last day of trading in the delivery month when there shall be no limit.

Effective with the January 1980 Futures Contract the spot month first begins trading without limits on the last day of trading of the preceding month.

EXPANDED DAILY TRADING LIMITS—Whenever on two successive days any contract month of the Japanese Yen settles at the normal daily price limit in the same direction (not necessarily the same contract month on both days) an expanded daily price limit schedule shall go into effect as follows:

1. The third day's daily price limit in all contract months shall be 150% of the normal daily price limit.
2. If any contract month settles at its expanded daily price limit on the third day in the same direction, then the fourth day's expanded daily price limit will be 200% of the normal daily price limit.
3. If any contract month settles at its expanded daily price limit on the fourth day in the same direction then there shall be no daily price limit on the fifth day.
4. On the sixth day of the foregoing progression, the normal daily price limit shall be reinstated.
5. Whenever the foregoing daily price limit schedule is in effect and no contract month settles at the price limit in the same direction which initiated the expanded schedule, then the normal daily price limit shall be reinstated on the following day.

SETTLEMENT PRICE—Effective March 27, 1981: The Settlement Price may be outside of the day's High/Low range, and/or may be different from the midpoint of the Closing Range, per C.M.E. Rule 813.

TERMINATION OF FUTURES TRADING—Futures trading shall terminate on the second business day immediately preceeding the third Wednesday of the contract month.

DELIVERY PROCEDURE—Delivery shall be made on the third Wednesday of the contract month in the country of issuance at a bank designated by the buyer.

If that day is not a business day (in the country of delivery) delivery shall be made on the next business day immediately succeeding.

BUYER'S DUTIES—A clearing member representing a customer that intends to accept delivery in liquidation of his position shall, no later than 11:00 a.m. on the last day of trading, present a **Buyer's Delivery Commitment** to the Clearing House. By 1:00 p.m. the clearing member shall deposit to the account of the Chicago Mercantile Exchange Clearing House in a bank designated by it, a sum sufficient to pay for the delivery. The amount of the deposit shall equal the value of the contract(s) based on the settlement price on the last day of trading. Such deposit shall be made in the form of a certified or cashier's check, or a wire transfer; effective October 10, 1980, in the form of a wire transfer of same day funds.

The buyer shall have made all provisions necessary to receive delivery within the country of issuance.

Note: From time to time, and frequently without warning, countries change the requirements and the restrictions on non-resident bank accounts. These take various forms including interest free deposit requirements, negative interest rates, prohibitions against investment in the country, ceilings on the amount of deposit, restrictions on the period of time such deposits may be maintained, etc.

It is the buyer's responsibility to be familiar with and in conformance with all regulations pertaining to the holding of non-resident bank accounts in a country in which he desires to accept delivery.

SELLER'S DUTIES—The clearing member representing a customer making delivery in liquidation of his position shall, no later than 11:00 a.m. on the last day of trading, present to the Clearing House a **Seller's Delivery Commitment.**

The Seller's clearing member shall be responsible for delivering the foreign currency on the delivery date to a bank designated by the Clearing House.

SELLER'S DESIGNATED BANK—The seller's clearing member shall designate only such banks or other facilities as are acceptable to the Chicago Mercantile Exchange.

PAYMENTS—The Clearing House shall designate a bank in each foreign country into which the seller shall deliver the foreign currency. These banks shall notify the Clearing House when the seller's funds have been received. The Clearing House shall, promptly after receipt of such notification, transfer the funds previously deposited by the buyer's clearing member to the account of the seller's clearing member.

COSTS OF DELIVERY—The seller shall bear the costs of transferring the foreign currency into a bank designated by the Clearing House. The buyer shall bear the costs of transferring the foreign currency out of the bank designated by the Clearing House. Such costs may include, but are not limited to wire transfer charges, negative interest charges, transaction fees, etc.

ACCUMULATION OF POSITIONS—The positions of all accounts owned or controlled by a person or persons acting in concert or in which such person or persons have a proprietary or beneficial interest shall be cumulated.

CONTRACT MODIFICATIONS—Specifications shall be fixed as of the first day of trading of a contract, except that all deliveries must conform to government regulations in force at the time of delivery. If any national or international government agency or body issues an order, ruling, directive or law that conflicts with the requirements of these rules, such order, ruling, directive or law shall be construed to take precedence and become part of these rules and all open and new contracts shall be subject to such government orders.

EMERGENCIES, ACTS OF GOD, ACTS OF GOVERNMENT—If it is determined by the Board or the Business Conduct Committee that delivery or any precondition or requirement thereof is prevented by act of government, act of God, or other emergency, it may take action as it deems necessary and reasonable under the circumstances. Its decision shall be binding upon all parties to the contract.

Appendix C - Three Period Price of Storage

This appendix provides a complete version of Table 3-12. Refer to section 3.4.6. for background.

Table 3-12. Three Period Price of Storage: Firm Located Near the Futures Exchange

Date	Alternatives		
	Buy in Mar.	Buy in Dec., Hedge, and Store Until March	
	Cash Commitment	Cash Commitment	Futures Transaction
9/15		Buy in Dec., store until March	Sell Mar. wheat contract at \$3.30/bu,
		Sell stored wheat in March	Buy Dec. wheat contract at \$3.20/bu
12/15	stocks	Buy wheat contract at at mkt price & store	Sell Dec. wheat at futures mkt price
3/15	Buy & sell at mkt price	Sell at mkt price	Buy Mar. wheat contract at mkt price
	$P = PC_{Mar}$	$P = PF_{Sep,Dec} + B_{Dec} + (PF_{Mar,Mar} - PF_{Sep,Mar})$ $= \$3.20/bu + (PF_{Mar,Mar} - \$3.30/bu)$ $= PF_{Mar,Mar} - \$0.10/bu$	

$$
\begin{aligned}
P\ (\text{Storage}) &= P \text{ Buying in March} - P \text{ Buying Dec., Hedging, \& Storing} \\
&= PC_{Mar} - (PF_{Mar,Mar} - \$0.10/bu) \\
&= \$0.10/bu
\end{aligned}
$$

Appendix D - Expected Utility Theory

A risk averter is defined as someone who, beginning from a position of certainty, is unwilling to accept an actuarially fair bet (Arrow, 1965). The preferences of such a person can be characterized by a utility function showing strictly decreasing marginal utility of wealth. Figure 1 represents a risk averter faced with two choices. She can choose scenario A in which she will receive income Y_0 with certainty. In this case, she will enjoy utility U_0. Alternatively, she can choose scenario B, where income is a random variable taking on the values Y_1 and Y_2 each with probability = .5. The expected value of the random variable is Y_0. In this case, expected utility is equal to $U_1 < U_0$. The risk averter prefers the certain to the risky scenario, despite the positive probability of earning a greater return in the risky scenario. This result follows directly from the condition of decreasing marginal utility of wealth.

We now turn our attention to the impact of risk on an individual's decision to divide a given amount of wealth between safe and risky assets. First, we know by the definition of risk aversion that the risk averse individual will invest nothing in the risky asset unless its expected return is sufficiently higher than that of the safe asset. The required difference between the return of the safe asset and the expected return of the risky asset increases with the level of risk, and is called the "risk premium." Intuitively, it is the amount the individual must be paid (or must earn) to invest in the risky asset. The risk premium is shown diagrammatically in Figure 2.

Figure 1. Risk Aversion

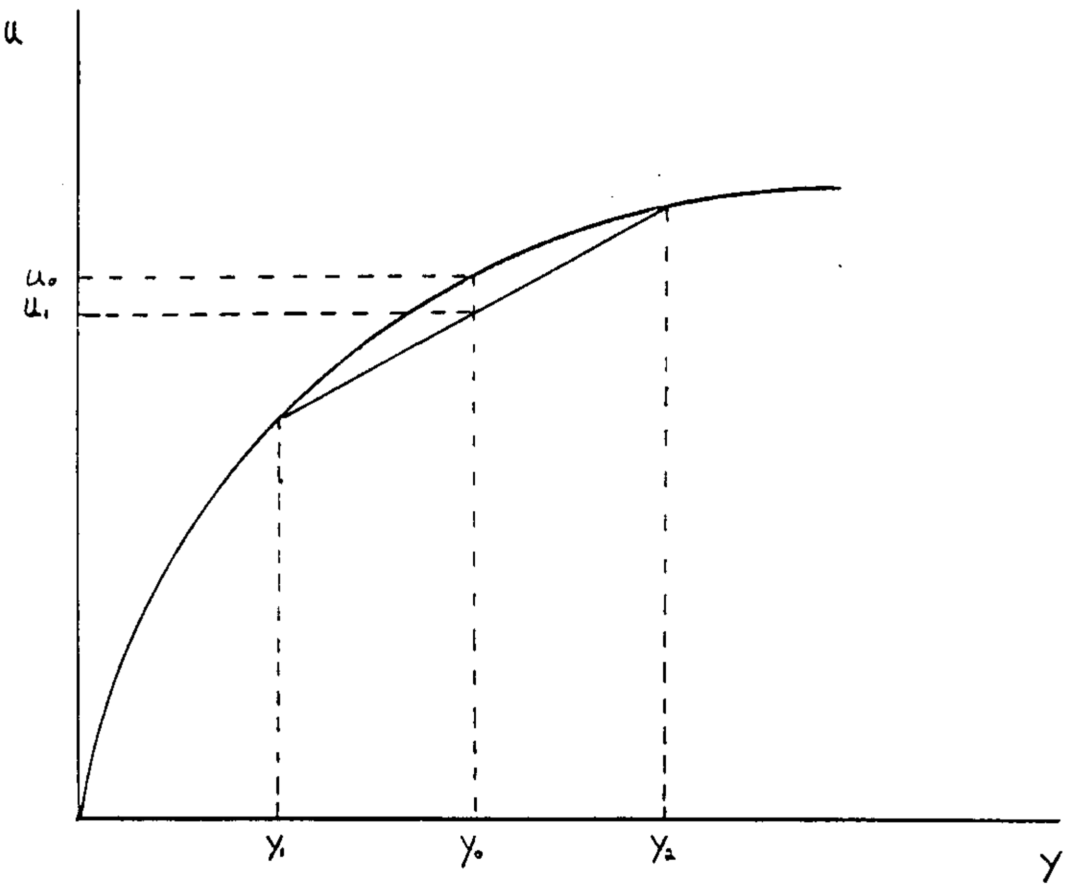
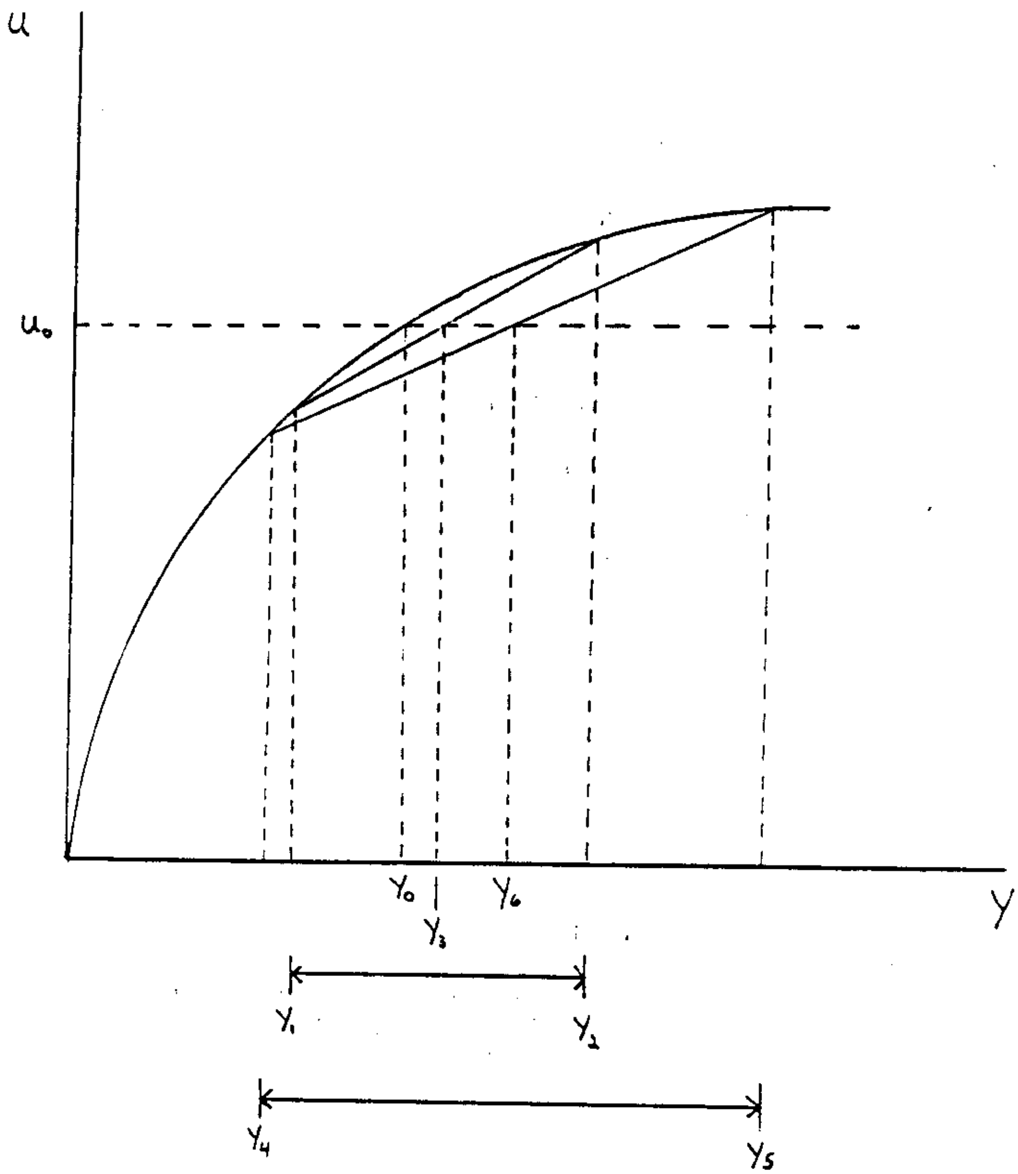


Figure 2 - The Risk Premium



The safe asset gives total return Y_0 with probability 1. Such a return corresponds to utility level U_0. Risky asset A gives return Y_1 with probability = .5 and Y_2 with probability = .5. The expected return for this asset is Y_3, corresponding to the same utility level as the safe asset (U_0). The risk premium in this case is [Y_3 - Y_0]. Risky asset B pays Y_4 and Y_5, each with probability = .5, with expected return Y_6 corresponding again to utility level U_0. In this case, the increased risk has increased the risk premium to [Y_6 - Y_0].

Now let

A = initial wealth
a = amount of initial wealth invested in a risky "asset."[1]
m = amount of initial wealth invested in safe asset = A-a
X = rate of return on risky asset (a random variable)
Y = final wealth

Assuming for the moment that the safe asset yields a zero return, we have:

(1) $$Y = A + aX$$

Given risk aversion, the individual's objective is to choose a to maximize expected utility from wealth, rather than maximizing wealth itself.

Final wealth is a random variable whose variance depends on 1) the variance of X, and 2) the size of a:

(2) $$var[Y] = a^2 * var[X]$$

An individual holding a given amount of a risky asset with a given probability distribution on X will enjoy a utility level such as U_1 in Figure 1. An increase in the variance of X with a fixed will increase the variance of Y and decrease utility. This scenario is depicted in Figure 3. Initially, X takes on the

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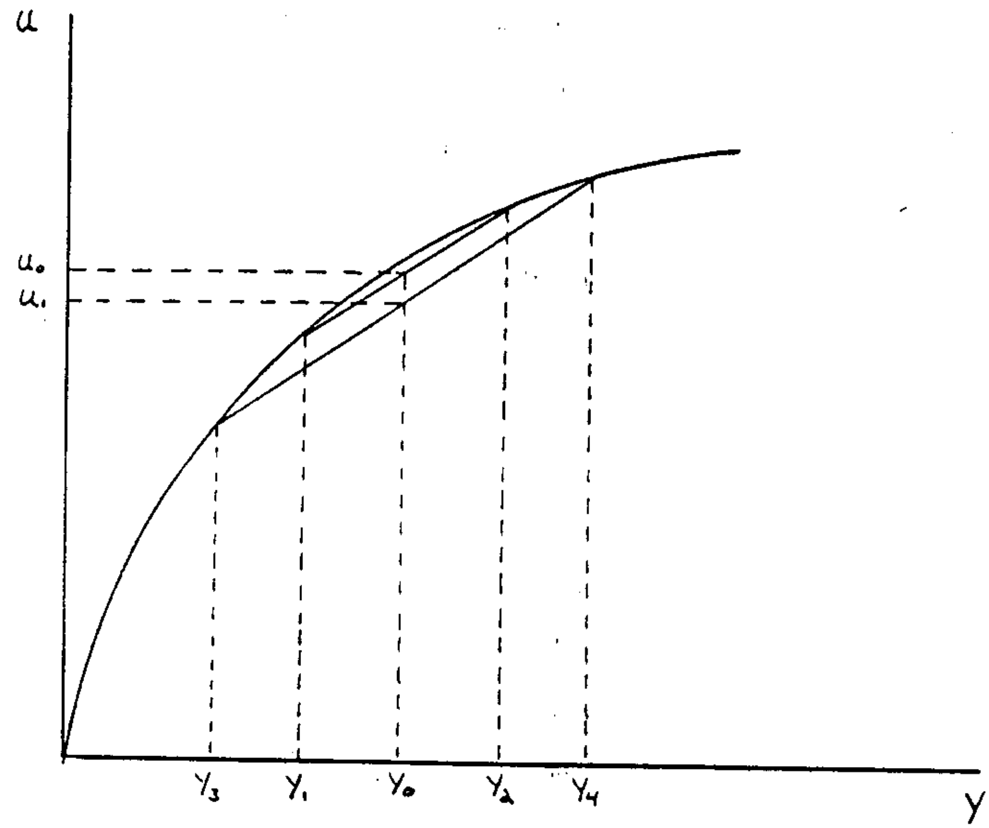
[1] This "asset" may be defined as any good, financial security, or unit of capital yielding a return which is a random variable. This definition thus includes production inputs as well as actual assets such as plant capacity or bonds. On a more abstract level, planning may be considered a risky asset - it requires resources, and yields an uncertain return. As a result, the following analysis applies equally to an individual dividing wealth between money and bonds, a farmer making input decisions for the current crop year, an importer (exporter) making import (export) and other decisions in the absence of complete production and price information, and a firm manager engaged in long and short-term strategic planning.

Figure 3. The Impact of Increased Variability on Utility



values $(Y_1-A)/a$ and $(Y_2-A)/a$, with equal probability, so that Y takes on the values Y_1 and Y_2 with equal probability. Utility in this situation is U_0. Now the variance of X increases, so that Y takes on the values Y_3 and Y_4 with equal probability. Utility falls to U_1. Given this greater variance of X, the only means of restoring utility to its initial level is to reduce a. Thus, the response of any risk averse individual to an increase in risk is to decrease investment in the risky "asset."

Appendix E - Flexibility Constrained Behavior

This appendix is an extension of footnote 8 in Chapter Four concerning the role of reduced uncertainty in heightening an agent's sensitivity to potentially valuable information.

In his paper The Origin of Predictable Behavior, Heiner (1983) suggests that rule-governed behavior emerges due to uncertainty, which in turn emerges from environmental complexity and limited ability to deal with that complexity. Rules by definition limit the flexibility with which one can respond to changing environmental conditions, so that rule-governed behavior results in predictable, relatively inflexible patterns of behavior. Only as uncertainty is reduced, either through reduced environmental complexity or increased ability to deal with that complexity, does it benefit an agent to allow more flexible response to available information.

An insight driving Heiner's analysis is that uncertainty implies that the information reaching an agent is to an extent unreliable, in the sense that the received value of a parameter differs in unknown ways from the true value. Given this unreliability, it is not in the agent's interest to use and sensitively respond to all available information. Only as uncertainty decreases will the agent increase its use of that information.[1]

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[1] A useful analogy involves an econometrician estimating the parameters of a system for use in formulating policy. Each parameter estimate differs in an unknown direction and largely unknown amount from the true parameter. Given this, should the econometrician urge the policymaker to respond sensitively to small changes in parameter estimates? The answer, implied by Heiner's analysis, is clearly "no." However, as the reliability of the estimate increases (i.e., as its standard error falls), the econometrician would be more comfortable in urging the policymaker to respond to a given change in the estimate. A good econometrician, then, behaves just as Heiner says any agent will behave under uncertainty.

One of the implications of Heiner's theory is that "uncertainty generates rules which are adapted only to likely or recurrent situations." As a result, an agent's repertoire of actions "excludes actions which will in fact enhance performance under certain conditions, even though those conditions occur with positive probability." This implies that behavioral rules do not approximate optimization, at least in the conventional meaning of that term.[2] Furthermore, the probability of occurence p below which an action is excluded increases with uncertainty. In other words, at a given level of uncertainty, an agent's repertoire will include actions appropriate for conditions which occur with frequency as low as f. As uncertainty increases, a given condition must occur with a frequency greater than f for the agent to include in his repertoir actions suited specifically to those conditions. As a result, uncertainty increases the divergence between optimal and actual behavior.

Note that this result is qualitatively different from that of expected utility theory. The latter continues to assume optimizing behavior under uncertainty. For any given environmental condition and structure of uncertainty, the agent selects that action which will maximize expected utility. In Heiner's terms, expected utility theory assumes that uncertainty does not cons

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[2] Of course, "optimization" can be defined so generally as to include this type of behavior. The optimization which this theory rejects is that in which an agent, at every point in time, examines all available information, determines its reliability, and chooses that course of action which is expected to maximize an explicit objective function. In Heiner's view, agents specifically ignore some information, information that might in fact be quite valuable. They do not always (or even frequently) make the decision which is optimal in light of all available information.

train the behavioral flexibility of the agent. In Heiner's paradigm, on the other hand, uncertainty does constrain the agent's flexibility, resulting in deviations from optimizing behavior. These deviations increase with uncertainty.

Returning to our question of the impact of commodity futures trading on income, we can state the following: to the extent that such trading reduces uncertainty, it will decrease the divergence between optimal behavior and an agent's actual behavior. Assuming income enters the agent's objective function, a reduction in uncertainty should thus increase that income. For example, an importer formerly unfamiliar with futures markets may have had little basis on which to judge the quality of a given bid, and may have therefore been at a disadvantage in negotiations. Lacking understanding of the market, the importer may have followed the rather rigid "rule" of always doing business with the same broker, and basing most decisions on information provided by that broker. Such a rule clearly holds the potential of sub-optimal performance for the importer. Greater familiarity with futures markets makes the trader more knowledgable, informs him as to what information to seek and where, and enables him to become a more informed and effective negotiator.

Knowing that a futures market generates prices of storage allows a trader to determine these prices, seek the other information needed to make a storage decision, and thereby make such decisions in a more knowledgeable and likely more profitable manner.

Through "tendering the basis" (a hedging technique discussed in Chapter Six), the importer can completely lock-in a price long before taking delivery. With uncertainty about future expenditures eliminated, the trader can devote his attention to other matters, and possibly capitalize on an opportunity he might otherwise have missed.

Appendix F - A Demonstration That Jensen's Inequality Does Not Apply to Equation (7) of Chapter Six

Jensen's Inequality states that the expectation of a convex or concave function of a random variable is not equal to the function of the expectation:

(1) $$E[f(x)] = f[E(x)]$$

If this inequality held in the case of futures markets, it would invalidate equation (7) of Chapter Six, and all equations which follow from it. The following example will show that Jensen's Inequality does not hold.

Assume we have 2 futures contracts:

1. A British pound contract denominated in U.S. dollars:

$$P = \$/L$$

2. A U.S. dollar contract denominated in British pounds:

$$P' = L/\$$$

Now a trader begins with 0.5 pounds. If $P = 2$ and $P' = 0.75$, he could sell the pound contract, receiving 1 dollar for 0.5 pounds. With this 1 dollar, the trader could sell the dollar contract, receiving 0.75 pounds. Through arbitrage, the trader will have earned 0.75-0.50 = 0.25 pounds. The trader would continue to sell the two contracts until no more profit could be earned, that is until $P' = 1/P$.

Now assume that random variable X is the cash market \$/L exchange rate at t+1. Then by the efficient market hypothesis E(X) is the current price of the pound contract - P. Further, 1/X (also a random variable) is the cash market L/$ exchange rate at t+1 and E(1/X) is the current price of the dollar contract - P'. The arbitrage example above showed that we must have:

$$P' = 1/P, \text{ or}$$

$$E(1/X) = 1/E(X)$$

This contradicts Jensen's Inequality, and shows that it does not hold for futures markets. This result is obtained because a futures price is a "best estimate" of the later cash price, rather than a pure statistical expectation.

Appendix G: Derivation of the Optimal Hedging Ratio with Basis and Quantity Uncertainty

A trader is subject to both import quantity and basis uncertainty. At time t, she hedges a cash transaction which is to take place at t+1. Under the assumption that the futures market is efficient, the trader's objective is to minimize the mean square error of her cost estimate:

(1) $$\min MSE(Cost) = E[C-E(C)]^2,$$

where, MSE(Cost) = the measn square error of the trader's cost estimate
E[ ] = the expectational operator, and
C = cost

Now if the trader hedges a proportion h of her expected purchase quantity, then:

(2) $$C = Q*PC_{t+1} + h*E(Q)*[PF_{t(t+1)} - PF_{t+1(t+1)}]$$

where, Q = quantity purchased = $E(Q) + e_q$,
e^q = a normally distributed random variable with mean = 0 and variance = o^2_q
PC = cash price,
$PF_{t(t+1}$ = the price at t of the futures contract which expires at t+1, and
$PF_{t+1(t+1)}$ = the expiration price of the same contract

Now,

(3) $$PF_{t+1(t+1)} = PC_{t+1} - B_{t+1},$$

where, B_{t+1} = the basis at time t+1 = $E(B) + e_B$, and
e^B = a normally distributed random variable with mean = 0 and variance = o^2_b

Substituting into equation (2),

(4) $$C = Q*PC_{t+1} + h*E(Q)*[PF_{t(t+1)} - PC_{t+1} + B_{t+1}]$$

Expected cost can be calculated by substituting expected values for actual values in equation (4):

(5) $$E(C) = E(Q)*E(PC_{t+1}) + h*E(Q)*[PF_{t(t+1)} - E(PC_{t+1}) + E(B_{t+1})]$$

We can now calculate the error of the cost estimate:

(6a) $$C-E(C) = [Q*PC_{t+1}] + h*E(Q)*[PF_{t(t+1)} - PC_{t+1} + B_{t+1}] - E(Q)*E(PC_{t+1}) - h*E(Q)*[PF_{t(t+1)} - E(PC_{t+1}) + E(B_{t+1})]$$

(6b) $$= [CC-E(CC)] + h*E(Q)*[(B-E(B))-(PC-E(PC))],$$

where, CC = cash cost at t+1 = $Q*PC_{t+1}$, and all prices and quantities are at t+1.

Simplifying notation and substituting into equation (1),

(7) $$MSE = E[\sigma_C + h*E(Q)*(\sigma_B - \sigma_P)]^2$$

$$= \sigma^2_C + 2*E(Q)*h*(\sigma_{CB} - \sigma_{CP}) + E(Q)^2*h^2*(\sigma^2_B - 2\sigma_{PB} + \sigma^2_P)$$

Maximizing with respect to h and solving gives:

(8) $$h = (\sigma_{CP} - \sigma_{CB})/[E(Q)*(\sigma^2_B - 2\sigma_{PB} + \sigma^2_P)]$$

σ_{CP} is a measure of the correlation between cash cost erros and cash price errors. Similarly, σ_{CB} is a measure of the correlation between cash cost and basis errors, while σ_{CP} is a measure of correlation between cash cost and cash price errors. Finally, σ^2_B and σ^2_P are measures of the squared basis and squared cash price errors, respectively.

To utilize equation (8), an importer must estimate these variables using information available at the time he is making his decision. While this can be done in various ways, in this analysis, he estimates the variables by averaging them over the past five years. Specifically,

$$O_{CP} = \frac{\sum_{1}^{5} [Q*PC-E(Q)*E(PC)]*[(PF_{t+1(t+1)}+E(B)+e_B)-(PF_{t(t+1)}+E(B))]}{5}$$

$$= \frac{\sum_{t-6}^{t-1} [(E(Q)+e_Q)*(PF_{t+1(t+1)}+E(B)+e_B)-E(Q)*(PF_{t(t+1)}+E(B)]*[dPF+e_B]}{5}$$

$$= \frac{\sum_{t-6}^{t-1} [E(Q)*(dPF+e_B)+e_Q*(PC_{t+1}]*[dPF+e_B]}{5}$$

$$O_{CB} = \frac{\sum_{t-6}^{t-1} [E(Q)*(dPF+e_B)+e_Q*(PC_{t+1}]*[e_B]}{5}$$

$$O_{PB} = \frac{\sum_{t-6}^{t-1} [(PF_{t+1(t+1)}+E(B)+e_B)-(PF_{t(t+1)}+E(B))]*[e_B]}{5}$$

$$= \frac{\sum_{t-6}^{t-1} [(dPF+e_B)*(e_B)]}{5}$$

$$O^2_B = [\sum_{t-6}^{t-1} (e_B)^2]/5$$

$$O^2_P = [\sum_{t-6}^{t-1} (dPF+e_B)^2]/5$$

An importer making a decision in March for wheat needed in July would need the following information:

1. The past five years' futures price changes for the July wheat contract between March and July (dPF)

2. The past five years' actual and expected July bases, to obtain e_B

3. The past five years' cash price prevailing at contract expiration in July (PC_{t+1})

4. The past five years' actual and expected import quantities for July ($E(Q)$, Q, and e_q)

If the trader was making a decision in July for delivery in December, he would need the same information, taken in December rather than July.

It should be clear that the optimal hedging ratio obtained through this model is optimal only ex-ante. It is only as good as the estimates of the above variables. Ex-post analysis may show that ratios other than those calculated would have been optimal. This will become clear in analyzing the results of the analysis in Chapter Six.

Appendix H - Non-Standardized Monte Carlo Analysis Results

Table 1. Ten-Year Average Results from 50 Runs of Each Simulation, w/ and w/o Foreign Exchange Hedging

	With For. Exch Hedging	Without For. Exch. Hedging
Average Cost		
Cash	21,198,583	21,298,974
Forward Contract	22,235,109	22,286,995
Full Hedge	21,334,287	21,678,778
"Optimal" Hedge	21,329,196	21,675,154
Price Averaging	21,144,358	21,488,876
Basis Trading	21,146,950	21,479,185
Var (Cost)		
Cash	$2.05*10^{13}$	$2.11*10^{13}$
Forward Contract	1.41	1.45
Full Hedge	1.64	2.01
"Optimal" Hedge	1.75	2.10
Price Averaging	1.66	1.97
Basis Trading	1.65	1.97
MSE (Cost)		
Cash	$8.26*10^{12}$	$8.48*10^{12}$
Forward Contract	2.24	2.43
Full Hedge	4.80	6.13
"Optimal" Hedge	5.96	7.29
Price Averaging	5.71	6.41
Basis Trading	5.51	6.25

GLOSSARY

Anticipatory hedging: Buying or selling futures contracts in anticipation of a later commodity purchase or sale, without a current cash transaction. Unlike other types of hedging, the price level of the initial futures transaction is important. Anticipatory hedging is practiced by most of the producers, and some of the processors who hedge. See section 3.4.3. See hedging, operational hedging, inventory hedging.

Arbitrage: The process of simultaneously buying an asset in one market and selling it in another to profit from price differences in the two markets. Combined with the ability to delivery or accept delivery on futures contracts, arbitrage ensures that futures prices and cash prices in the vicinity of the futures exchange converge at contract expiration. See section 2.3.

Basis: The arithmetic difference between a cash price and a specific futures price. For example, on September 15, the current basis on December corn would be the current cash corn price minus the current price of the December corn contract. Successful hedging is based on the premise that the basis is more predictable than are price levels. If this is not the case, hedging will not be successful in reducing risk.

Basis Charts: A graph showing the daily basis for a specific crop at a specific location and relative to specific futures contracts. Basis charts can go back many years, and are used to guide hedging decisions.

Basis Trading: A hedging strategy whereby the trader negotiates a fixed basis and then establishes the price level by a sale (if exporting) or a purchase (if importing) in the futures market. See sections 6.2.6 and 6.4.3.

Buy Hedge: See Long Hedge.

CBOT: The Chicago Board of Trade. The CBOT is the largest futures exchange in the world

CFTC: The Commodity Futures Trading Commission, the government agency responsible for regulation and supervision of futures trading in the U.S.

Convertible currency: A currency which is tradable on international foreign exchange markets. The deutschmark, French franc, Swiss franc, British pound sterling, U.S. dollar, Canadian dollar, Mexican peso, ... are all convertible.

(the) Efficient Market Hypothesis: The hypothesis that futures prices are unbiased predictors of cash market prices prevailing at the time of contract expiration. For example, one might hypothesize that the price of the July CBOT corn contract at any time prior to expiration is an unbiased predictor of the cash price that will prevail at expiration in July. If a market is efficient, then no routine trading rule will earn a profit or loss in the long run. See section 3.4.4.

(futures) Exchange: The institution under whose rules and within whose facilities futures trading takes place. The Chicago Board of Trade, the Kansas City Board of Trade, and the Coffee, Sugar, and Cocoa Exchange are all examples of futures exchanges. See CFTC.

Floor trader: A trader who buys and sells through open outcry on the floor of the futures exchange. Floor traders often work for brokerage firms which carry out transactions for many clients.

Forward Contract: A bilateral agreement to deliver (or accept delivery of) a specified quantity of a good at a specified future time and location, at an agreed upon price. The price is usually specified as a certain premium over a specific futures contract price. That futures price may be the current price of the contract expiring most closely to the desired time of delivery, in which case the price is fixed for both parties. Alternatively, one could use the price prevailing on the futures contract at the time of delivery. In this case, both parties face some price uncertainty between the time the forward contract is agreed to and the time delivery is made.

Fundamental Analysis: Analysis of supply and demand with the purpose of predicting medium and long term futures price movements.

Hedge: The use of a futures contract as a temporary substitute for a later cash transaction. Hedging is used most basically to reduce risk, though that is generally not the only motivation. Hedging is not done with the intent of profiting directly from one's futures transactions. See Speculation.

Inventory hedging: Hedging carried out simultaneously with the holding of stocks, with the purpose of ensuring a profit on storage activities. Inventory hedging decisions are made on the basis of the price of storage. Unlike anticipatory hedging, price levels are entirely irrelevant in inventory hedging. Unlike operational hedging, this type of hedging is based on predicting changes in the basis over the period of a hedge. See section 3.4.3. See also hedging, anticipatory hedging, operational hedging, price of storage.

Liquid: A liquid market is one in which buyers and sellers can enter and exit easily and at little cost. A liquid market exposes its participants to less risk and lower transactions costs than does an illiquid market. Market liquidity is enhanced by high trading volume and the legal and practical entry and exit requirements. The institutional features of futures markets contribute to their generally high liquidity. See Chapter 3.

Long Hedge: A hedge established with an initial purchase of futures contracts. Such a hedge makes a trader "long" in the commodity, i.e., the trader must accept delivery of the commodity at contract expiration unless the contract is offset. A long hedge is used by traders who want eventually to buy in the cash market. See hedge, short hedge, offset.

Margin: The amount of money a trader must deposit at the exchange to assume a futures position. The amount is specified in the contract specifications, and is generally about 5% of the value of the contract. See section 3.2. See also margin call, marking to the market.

Margin call: The amount of additional margin money a trader must either deposit or have credited to his account as the value of his futures position changes. As the price of a contract falls, for example, traders who have purchased are required to deposit an amount equal to the decreased value of the contract, while those who have sold have an equal amount credited to their accounts. See section 3.2. See also margin, marking to the market.

Marking to the market: The process of calculating the and making margin calls. This is done each day by the exchange, and ensures that each trader's margin will remain a relatively constant percent of the contract value. See section 3.2. See also margin, margin call.

Monte Carlo Simulation: A method for generating probability distributions for variables of interest which are functions of random variables. First, the functional relationship is specified. Then probability distributions for the random variables are specified. Finally, the model is run a large number (50-100) of times, each run using different values of the random variables drawn from the probability distributions. See Chapter Six.

(to) Offset: To cancel a futures position by taking an equal and opposite position. A hedge is generally offset at the time the hedger assumes a cash market position. If the hedge is not offset, a long hedger must "stand for delivery", while a short hedger must deliver. 99% of all hedges are offset. See hedge, short hedge, long hedge.

Open contract: A contract which has not been offset or delivered upon. For example, a December contract which was sold in September is open until it is purchased back or delivered upon at expiration.

Operational hedging: Hedging done to facilitate one's merchandising or processing business. Operational hedging differs from other types of hedging in that it explicitly assumes an unchanging basis. Hedges are placed and lifted so quickly that this assumption is generally warranted. See section 3.4.3 See also hedging, anticipatory hedging, inventory hedging.

Optimal Hedging Ratio: An estimate of the proportion of expected purchase or sale quantity which should be hedged in a given period to optimize some objective function. This function generally includes income (or cost), and some measure of its uncertainty (such as variance, or mean square error of a forecast). The ratio is optimal only ex-ante, and ex-post analysis may show that some other ratio was the true optimum. See sections 6.2.4 and 6.4.3.

Price Averaging: A hedging strategy whereby a trader attempts to average the present futures price with whatever cash price prevails at contract expiration. She does so by hedging one-half of her expected sale or purchase. See sections 6.2.5 and 6.4.3

Price of Storage: Can be defined under a 2 period or 3 period case. In the 3 period case the price of storage is defined as the price difference between futures contracts of differing maturities. For example, the price of storage on January 15 (period 1) for corn between March 15 (period 2) and May 15 (period 3) is calculated as the price of the May contract minus the price of the March contract, both quoted on January 15.

In the 2 period case, the price of storage is defined as the difference between simultaneously quoted cash and futures prices. For example, the price of storage on March 15 (period 1) for corn between March 15 and May 15 (period 2) is calculated as the current price of the May futures contract minus the current cash price.

These prices apply only for traders near the futures exchange. Traders not near the exchange must calculate an expected price of storage. The 2 period calculation is:

$$E(PS)_{t,t+1} = E(B)_{t+1} - B_t$$

The 3 period calculation is:

$$E(PS)_{t(t+1,t+2)} = [PF_{t,t+2} - PF_{t,t+1}] + [E(B)_{t,t+2} - E(B)_{t,t+1})]$$

See section 3.4.1.

(to) Roll forward: To replace an open contract with one of later maturity. For example, a trader may have purchased the July maize contract. To roll that commitment forward to September, the trader would sell the July contract, usually just prior to expiration, and buy the September contract. In December (the next contract month), this commitment could be either rolled forward again or offset.

Sell Hedge: See Short Hedge.

Short Hedge: A hedge established with an initial sale of futures contracts. Such a hedge makes a trader "short" in the commodity, i.e., the trader must deliver the commodity at contract expiration unless the contract is offset. A long hedge is used by traders who want eventually to sell in the cash market. See hedge, long hedge, offset.

Speculation: The use of a futures contract without any intended present or future cash market position. Speculation can be characterized as assuming risk by establishing a futures position with the goal of profiting directly from that position. Hedgers transfer risk to speculators. See Hedge.

Spot market: Used interchangeably with "cash market."

Technical Analysis: A type of analysis used to predict daily futures price movements.

Tendering the Basis: See Basis Trading.

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