ANALYZING THE SUCCESS OF STRATEGIC ROLLOVER HEDGING FOR COCOA

by

TAMIKA NICHOLE TOLBERT

(Under the direction of Dr. Steven C. Turner)

ABSTRACT

There have been wide swings in cocoa prices, and periods of extremely high and low prices. Attempts have been made through the International Cocoa Agreement to stabilize cocoa prices, but its efforts have been unsuccessful. The purpose of this research is to analyze cocoa prices from 1961-2000 and find alternative ways to protect producers from unstable cocoa prices.

Several procedures were used in this analysis. First, attention is given to previous research on the causal factors of price volatility in the cocoa market and the history of the structural changes that took place in the cocoa market from the 1960s to 2000. Next, a fundamental analysis of the cocoa market was done to determine the relationship between end-of-year cocoa stocks and prices. A seasonal analysis also was done to determine if a seasonal pattern existed for cocoa prices and to determine which month had the highest seasonal index. Lastly, alternative price risk management strategies, such as routine hedging, strategic rollover hedging, and cash sales at harvest were analyzed to determine if any of the strategies were successful at stabilizing routinely volatile cocoa prices.

The results of this research indicate that despite the effectiveness of strategic rollover hedging to improve average net prices for commodities such as corn and soybeans, the outcome for cocoa was unsuccessful. Using strategic rollover hedging from 1971-2000, resulted in a loss of $304,825.72. This included $50 per round turn for brokerage fees, without the consideration of margin calls. However, implementing the routine hedging strategy every year in the month with the highest seasonal index generated net revenues of $15,916.34 from 1971-2000.

INDEX WORDS: Strategic rollover hedging, Routine hedging, Cocoa prices, Fundamental analysis, Seasonal analysis, Futures market, Price risk management strategies

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DEDICATION

To my family, my chorus of encouragers who faithfully cheer me on as I strive to accomplish every endeavor and realize every dream I have in life. Your prayers and constant support have made the completion of this thesis possible.

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TABLE OF CONTENTS

Page

ACKNOWLEDGEMENTS v

LIST OF TABLES ix

LIST OF FIGURES x

CHAPTER

I. INTRODUCTION 1

Introduction to Cocoa's Problem of Price Volatility 1

Price Risk Management and Structural Tools 2

Problem Statement 4

Objectives 5

Procedures 5

Data 6

Organization 6

II. PREVIOUS RESEARCH AND HISTORY OF STRUCTURAL CHANGES IN THE COCOA MARKET 7

Previous Research on Causal Factors of the Price Volatility in the Cocoa Market 8

Brief History of the Structural Changes in the Cocoa Market 12

III. RESEARCH PROCEDURES FOR COCOA MARKET ANALYSIS AND PRICE RISK MANAGEMENT ASSESSMENT 25

Fundamental Analysis 25

Seasonal Analysis 27
Routine Hedging 28
Strategic Rollover Hedging.....29
IV. DATA AND RESULTS 33
Fundamental Analysis.....33
Seasonal Analysis 36
Routine Hedging 36
Strategic Rollover Hedging.....39
V. CONCLUSION AND IMPLICATIONS 50
Study limitations and further research.....53
APPENDIX 54
REFERENCES 59

LIST OF TABLES

Page

Table 1. World Cocoa Bean Stocks/Grinding Ratio and Annual Prices from 1970-1999 55

Table 2. Example of Strategic Rollover Hedging Potential 32

Table 3. Estimated Coefficients of the Regression Analysis for End of Year Cocoa Stocks from 1960-2000 34

Table 4. Pearson Correlation Coefficients for Yearly Average Prices and End of Year Cocoa Stocks from 1960-2000 37

Table 5. Monthly Cocoa Seasonal Index 1971-2001 38

Table 6. Routine Hedging Results from 1971-2000 40

Table 7. May Cocoa Futures Price Distributions 1968-2000 43

Table 8. Opportunity Time in the Futures Market to Implement Strategies 1968-2001 44

Table 9. Strategic Rollover Hedging for Cocoa 1971-2000 46

LIST OF FIGURES

Page

Figure 1.1. Yearly Average Cocoa Bean Spot Prices from 1961-2001 9

Figure 1.2. Cocoa Prices' Average Standard Deviation Per Decade 10

Figure 1. Plot of Prices Per Year 56

Figure 2. Plot of Stocks Per Year 57

Figure 3. Plot of Prices*Stocks 58

CHAPTER I

INTRODUCTION

Introduction to Cocoa's Problem of Price Volatility

After coffee and sugar, cocoa is the most important agricultural export in international trade. It is produced in countries within 10 degrees north and 10 degrees south of the equator where the climate is appropriate for growing cocoa trees. The largest producing countries are Cote d'Ivoire, Ghana, Indonesia, Nigeria, and Brazil (ICCO 2000).

A characteristic of the world cocoa market is that world cocoa prices are routinely volatile. Frequently, there are large price movements within seasons and from one season to the next. At times these movements have been larger than most major primary export commodities for a long period of time (Short 1987, 50).

Supply variability, often due to weather factors in the major producing areas of West Africa, is the single major factor in price fluctuations. One factor contributing to short-run swings in price is that cocoa beans undergo a great amount of processing and differentiation, and are transformed into a variety of retail products. This and other factors typically contribute to a lag between the adjustment of final demand for cocoa-derived products and the constantly changing prices of cocoa beans. Frequently, this lag amplifies swings in short-run bean prices. For example, bean prices may be rising, as a result of an anticipated deficit in the West African cocoa crop. At the same time, demand for cocoa by chocolate manufacturers may be increasing as a delayed response to a fall in

cocoa prices six to twelve months earlier. As a result, there is an increase in the price rise. The process works in a similar manner in the opposite direction (Short 1987, 51).

Price Risk Management and Structural Tools

Price uncertainty is one of the biggest problems facing agricultural producers. There have been many attempts at devising policies or seeking solutions to reduce this uncertainty, many of which are based upon intervention into markets by governments or their agents (Morgan 1999). The International Cocoa Agreement is a structural tool designed to stabilize prices in the cocoa market.

The International Cocoa Agreement

The instability of world cocoa prices has been of concern for many years. It was one of the main arguments used by the British Government to establish cocoa marketing boards in former West African colonies after World War II in order to stabilize prices. On the International level, involvement in the problem began in 1956 when the Food and Agriculture Organization Committee on Commodity Problems established the Cocoa Study Group. (Okorie and Blandford 1979). The group also produced a draft International Cocoa Agreement.

International commodity agreements are a type of structural tool formed to help support prices in a given market (Gilbert 1996). The International Cocoa Organization administered the International Cocoa Agreements of 1972, 1975, 1980, 1986 and 1993 (ICCO 2000). The International Cocoa Agreement has been ineffective in stabilizing cocoa prices due to the lack of financial resources, the absence of the United States, the world's largest consumer of cocoa, and the Cote d' Ivoire, the world's largest producer of cocoa as members, and its initial reliance on buffer stock stabilization (Gilbert 1996).

Commodity Futures Markets

Perceptions of the International Cocoa Agreement's ability to stabilize cocoa prices are now largely negative. This has prompted a search for alternative means of stabilizing cocoa prices. One choice is the use of commodity futures markets.

Futures trading is an organized and highly liquid form of trading in forward contracts. It provides an alternative means for managing the variability and risk associated with producing and trading soft commodities. It offers users the benefits associated with forward pricing without the need to make a physical transfer of the commodity (Morgan, Rayner, and Ennew 1994).

Futures markets perform several functions. Primarily, they (1) facilitate the management of risk; (2) aid firms in discovering forward prices; (3) provide a means for firms to request and secure additional operating capital; and (4) provide a source of information for decision making (Leuthold, Junkus, Cordier 1989, 3).

Cocoa futures and options are traded on the Coffee, Sugar and Cocoa Exchange (CSCE) in New York, the London Terminal Market, and the Kuala Lumpur Commodity Exchange (KLCE). The deliverable amount is 10 metric tons of cocoa, and is quoted in dollars per metric ton. (Bridge Commodity Research Bureau 1999).

Strategic Rollover Hedging

Another option to stabilize prices in the cocoa market and improve producer returns is the use of strategic rollover hedging. Strategic rollover hedging is a type of price risk management tool with the intent of allowing producers to obtain higher average prices over some time frame (usually three or more years) (Huang 1993). If producers could receive higher average prices for several years' production, the possibility for

substantial profits would exist (Kenyon and Beckman 1997). Hedge-to-arrives or rollover contracts might also be useful to reduce the variability of receipt, or to speculate on old-crop-new-crop spread (Lence and Hayenga 2001).

Using strategic rollover hedging, the producer retains positions for multiple years. He /she will enter the market only when the price trades above the entry price and offset and exit his positions only when the price is higher than the exit price level. The entry and exit levels are based on historical futures data and are chosen by the hedger. Suppose a producer decides to use strategic rollover hedging to attempt to receive a higher average price for the next three years. Prior to hedging, he may examine the historical futures data to set entry or exit levels. Assume the producer sets his entry level at the upper 5% of the historical database, and his exit level at 25% above the entry level. When the futures price is above the entry price, it is possible the farmer can receive a higher average price for crops to be harvested each year for the next three years (Huang 1993).

Problem Statement

Annual fluctuations in world prices for cocoa result from changes in supply for the product. It takes some years for the decision to expand acreage to be reflected in higher production. Periods of supply shortages, often associated with losses in output due to adverse climatic conditions or spread of diseases and pests, result in the reduction in stocks of cocoa beans in relation to demand. "Historically, there is an inverse relationship between changes in the world cocoa stocks-to-grindings ratio, which is defined as the ratio of total end-of-season stocks of cocoa beans to annual world grindings. This ratio measures the world demand for cocoa beans and the movement of cocoa bean prices"(ICCO 2000).

Specifically, in the cocoa market, rising price levels are often associated with a declining stocks-to-grindings ratio and vice versa. When stock levels fall below normal industry requirements, there is strong upward pressure on prices (see Table 1 in Appendix) (ICCO 2000).

Cocoa prices are volatile. Producers need help in dealing with this volatility. Attempts have been made through the International Cocoa Agreement to stabilize cocoa prices, but its efforts have been unsuccessful (Roberts 1986). With the use of strategic rollover hedging, there exists a possibility that cocoa producers or marketing boards can receive higher average prices for more than one crop year, thus reducing the concern of volatile cocoa prices in the cash market.

Objectives

The International Cocoa Agreement's attempt to stabilize prices has been largely unsuccessful. Thus, the general objective of this paper is to analyze the cocoa market and find alternative ways to stabilize cocoa revenues. The specific objectives of this study are:

1. To analyze cocoa prices from 1961-2000.
2. To examine alternative price risk management strategies.
    a.) Routine hedging
    b.) Strategic rollover hedging
    c.) Cash Sales at harvest

Procedures

In order to achieve these objectives, several procedures were used. First, attention is given to previous research on the causal factors of price volatility in the cocoa market

and the structural changes that took place in the cocoa market from the 1960s to 2000, to give the reader background information about the distinctiveness of the cocoa market. Next, a fundamental analysis of the cocoa market was done to evaluate the relationship between end-of-year cocoa stocks and prices. A seasonal analysis was also done to determine if a seasonal pattern existed for cocoa prices and to determine which month had the highest seasonal index. The alternative price risk management strategies--routine hedging, strategic rollover hedging and cash sales at harvest were analyzed to determine if any of the strategies were successful at stabilizing routinely volatile cocoa prices.

Data

Daily closing futures prices for the May cocoa from 1961-2000 were used in this study. The data was obtained from PROPHET database (Prophet 2000). The end-of-year stocks and yearly prices from 1960-2000 were obtained from International Cocoa Trade and the International Cocoa Organization. World Cocoa monthly prices from 1971-2001 were obtained from the International Cocoa Organization.

Organization

This thesis has five chapters. Chapter 2 is background information about the previous research and the history of structural changes that took place in the cocoa market from the 1960s to 2000. The research procedures for the cocoa market analysis and price risk management assessment are presented in Chapter 3. The data and results are presented in Chapter 4. The conclusion and implication of the results are presented in Chapter 5.

CHAPTER II

PREVIOUS RESEARCH AND THE HISTORY OF STRUCTURAL CHANGES IN THE COCOA MARKET

Cocoa beans, from which cocoa products are derived, come from the cocoa or cacao tree, a tropical plant that bears cantaloupe-sized pods. The pods contain cocoa beans that can be processed into cocoa, cocoa butter, and various chocolate products. This tree grows up to 14 m tall. It originated in the tropical forests of Central and South America and can take up to 4 years from planting before producing sufficient fruit for harvesting. They may live up to 80 years or more, although the fully productive period is usually between 15 and 30. The trees productive years begins to decline between 40 and 50 years and can no longer be used in commercial production. The cocoa tree is highly vulnerable to pests and diseases, and it is also very sensitive to climatic changes (Africa South of the Sahara 2000).

During harvesting, the ripe pods are cut from the tree, where they grow directly out of the trunk and branches. When opened, cocoa pods release a mass of beans surrounded by white mucilage. After harvesting, the beans and mucilage are scooped out and fermented. Fermentation lasts several days, allowing the flavor to develop. The mature fermented beans, dull red in color, are then dried and bagged as raw cocoa, and then processed or exported (Africa South of the Sahara 2000).

Many different sorts of products are derived from cocoa. Some examples of its uses are: animal feed from cocoa husk, production of soft drinks, alcohol, potash, jam

and marmalade. Once the cocoa beans have been fermented and dried they can be processed to produce additional products. These products include: cocoa butter, cocoa powder, and cocoa liquor, which is used in the production of chocolate (Africa South of the Sahara 2000).

Previous Research on Causal Factors of the Price Volatility in the Cocoa Market

Over the 1960s and 1970s, the price volatility for tropical beverages was some two-thirds higher than the average for all commodities. This was partly attributable to the price instability of cocoa beans during these two decades, which is used in the production of hot cocoa that far exceeded the great majority of other traded commodities. The main reason for this price instability was a series of poor crops, which led to a worldwide shortage during the 1970s. Contributing to the price instability was the oil crisis in the mid-1970s that also caused many commodities to have volatile prices during this decade. As a result, prices reached record highs. However, since the early 1980s, the commodity price instability has been moderate but somewhat to a lesser extent for cocoa (see figure 1.1 and figure 1.2) (Maizels, Bacon, Mavrotas 1997, 23).

The volatility inherent in the world market for cocoa is reinforced by two market features. The first is the low price-elasticities of both demand and supply, especially in the short term, which results in a considerably larger proportionate change in price than in output or exports. Moreover, there is a delayed supply response to higher world prices. It takes several years for the decision to expand acreage to be reflected in higher production. Consequently, it is likely to create an oversupply situation in future periods if demand does not respond accordingly. Conversely, the lag in supply in response to a fall in prices will create a shortage later if demand by then has increased. Thus, supply

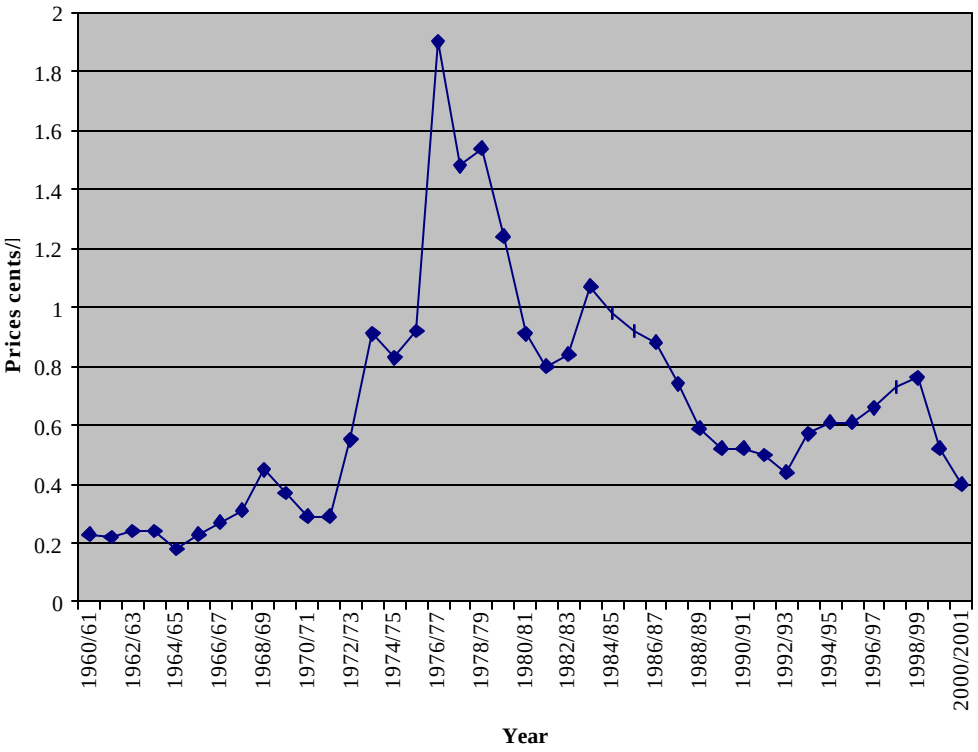

Figure 1.1 Yearly Average Cocoa Bean Spot Prices from 1961-2001

Source: Horticultural and Tropical Division, FAS/USDA, 1997

ICCO 2000

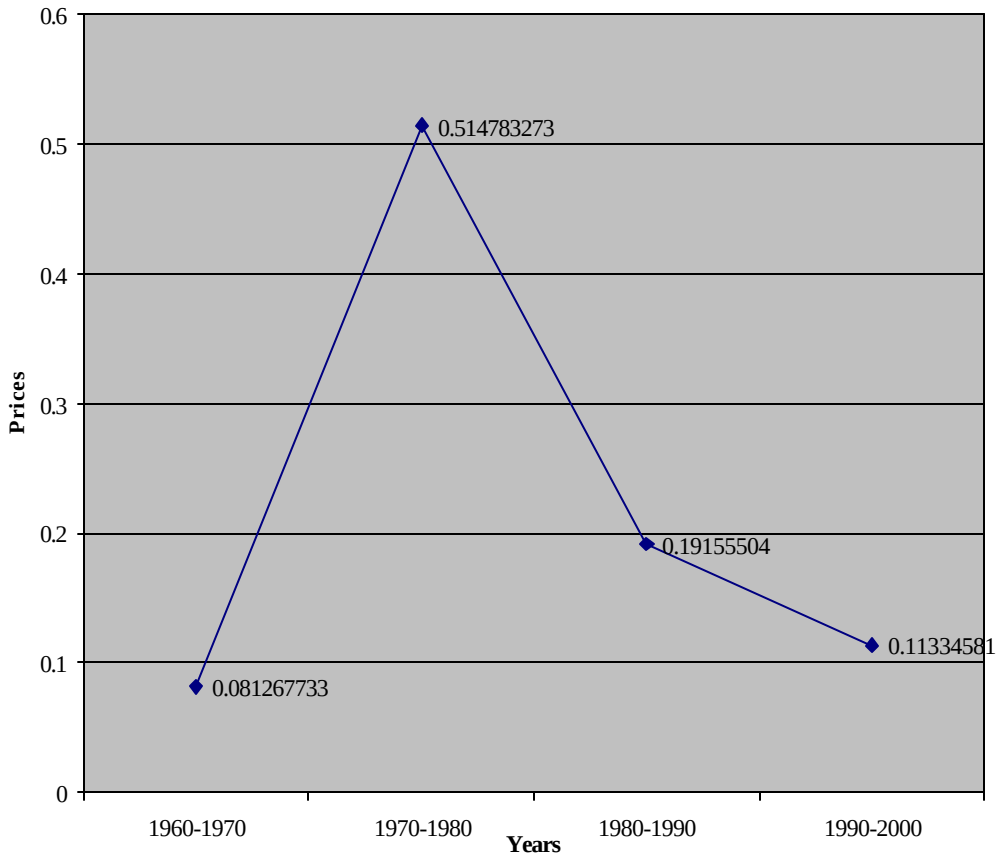

Figure 1.2 Cocoa Prices' Average Standard Deviation Per Decade

lags tend to result in price cycles and uncertainty, particularly where demand is itself subject to short-term variability (Maizels, Bacon, Mavrotas 1997, 25).

The second element adding to short-term fluctuations on the cocoa market is the flow of speculative funds into and out of cocoa futures contracts traded on the terminal markets (which are mainly in London and New York). To the extent that speculators buy (sell) when prices are rising (falling), they will amplify the price fluctuations arising from fluctuations on the supply and demand sides of the 'real' market for physical cocoa (Maizels, Bacon, Mavrotas 1997, 25).

Cocoa price movements can be separated into three categories: long- term, short-term, and intermediate. Each of the three classes of price fluctuations can be identified with its own causal mechanisms (Weymar 1968, 6).

Long-term cocoa price fluctuations are produced by the response to various relationships in the cocoa market, linking cocoa prices with the rate of new plantings, plantings with production, production with inventories, and inventories with prices. The dynamics generated include: (1) a period of low prices; (2) the substantial delay required to clear the pipeline of maturing trees results in production leveling off and perhaps declining; (3) with normal growth, consumption begins to exceed production, causing inventories to fall; and (4) cocoa prices climb, bringing a resurgence in new plantings. The length of the period between successive peaks and troughs in these long-term fluctuations is in large measure determined by the average length of the delay between the time of planting and the time of peak production of a cocoa tree (Weymar 1968, 6).

At the opposite extreme, short-term month-to-month price fluctuations, in part,

reflect the bullish and bearish speculative enthusiasm in the world cocoa market. Speculators in the market tend to focus their attention on one or two background developments that may have an important effect on future cocoa prices. For example, trends in the influence of natural hazards on production (Weymar 1968, 7).

In between the long and short types of behavior, lie the intermediate-term movements in cocoa prices, consumption, and inventories. These fluctuations represent the response in the cocoa industry to annual variations in world cocoa production (Weymar 1968, 7). For example, in response to a weather-caused crop shortage, inventories and expectations regarding future inventories, both fall, causing the price to rise. After adjustment lags, consumption and consumption expectations decline toward a level more in line with the declining crop, but not before the stocks in inventory have been further depleted and the price is forced even higher. As a result of the price increase, production increases, and consumption is reduced below the production rate. The price now begins to fall, but the consumption rate does not end its decline until after an adjustment lag. By this time, the stocks in inventory are increasing even further, causing the price to continue to decline. Consumption finally begins to climb in response to the lower prices. (Weymar 1968, 7,8).

Brief History of the Structural Changes in the Cocoa Market

In the 1960s, cocoa production increased by 60 percent and consumption increased by 59.3 percent from the late 1950s. Stocks at the end of the 1964/65 season reached a record of 845,000 tons, equivalent to eight months supply, resulting in the price of cocoa falling to a low of 90 pounds on the London Market and 12 cents/lb in New York, its lowest level for 18 years (Economist Intelligence Unit 1989). Full scale

conferences were held in 1963, 1966 and 1967 to attempt to initiate the first International Cocoa Agreement, but all were unsuccessful. (Okorie and Blandford 1979).

In the later years of the 1960s, consumption continued to expand while production began to stagnate. In a rapid turnaround, prices began to boom while stocks declined. By the end of the 1968/69 season, stocks had fallen to 433,000 tons, equivalent to less than four months supply, and the price of cocoa had peaked at 482 pounds/ton. As a result, the volume of grindings began to fall back slightly but quickly recovered as the price began to decline during the late 1969, 1970 and 1971.

In 1972, the fourth UN Cocoa Conference took place in Geneva and resulted in the first International Agreement. It was adopted by 52 countries, although the United States, the world's principal cocoa importer, did not sign. During the 1972/73 season, the growing conditions in practically all cocoa growing regions of the world were drier than normal, resulting in reduced global production from 1.59 to 1.41 million tons. In response, prices rose quickly to all time highs. Poor crops in Ghana and Nigeria further exacerbated the situation the following year, which helped keep world production below world consumption. In 1974, the price of cocoa peaked at 1,375 pounds/ton in London and 131 cents/lb in New York. A return to surplus forced prices down during 1975, but further declines in production during the next two years, most noticeably in Ghana and Nigeria, together with currency considerations at the time, as well as the general inflationary pressure caused by the oil crisis, forced market prices up into a completely new dimension. Throughout 1976, the price of cocoa increased from a low of 770 pounds/ton to a new high of 2,295 pounds/ton in London and from an average of 56 cents/lb to 135 cents/lb in New York. This rise was due to increased speculative activity

on the markets, but supplies were exceptionally tight and world stocks were falling to historically low levels. At the end of the 1976/77 season, stocks accounted for less than ten weeks' supply (Economist Intelligence Unit 1989).

During early 1977, the market continued on its upward path reaching a record 2970 pounds/ton in London on March 7 and a record average of 182 cents/lb in New York. On March 10, the London Cocoa Terminal Market Committee announced that it would be introducing on March 14 special selective deposits of 10,000 pounds per lot (10 tons) for non-trade and non-members with net positions in excess of 100 lots in order to calm the market down. Similar action was taken in New York, where deposits were raised from $4000 to $6000 per lot and the daily limit was raised from 4 to 6 cents/lb. These announcements had an immediate and rather dramatic effect on the market, which fell 760 pounds/ton in the next three days of trading (Economist Intelligence Unit 1989).

The decline came to an end in late April by the publication of higher than anticipated grinding statistics for the first quarter of the year. Combined with fears over physical availability in Europe, and delays in shipments of cocoa from origin, the prices began to climb again. Concern over severe shortages in spot supplies in both Europe and the United States encouraged the rise. Much of the early activity on the market resulted from speculative activity, however, this resurgence of a strong bull market was mainly the result of a physical shortage of cocoa, backed by increasing awareness that production in both Ghana and Nigeria was unlikely to recover much during the 1977/78 season. Consequently, the market peaked in mid-July, reaching 3,740 pounds/ton in London and 248 cents/lb in New York (Economist Intelligence Unit 1989).

With an improvement in shipments of cocoa, the tight stock position was eased in consuming countries and prices began to retreat during late July and early August 1977. Within four weeks of reaching its record highs the market had fallen by nearly 600 pounds in London and stabilized around this new level for the next two to three months. In New York, however, an acute shortage of spot Ghana cocoa forced its price to a new high of 260 cents/lb (Economist Intelligence Unit 1989).

As shipments of the new cocoa crop from Africa began to increase, and the market became increasingly aware that extraordinary high values for cocoa were depressing grinding, as well as stimulating the use of substitutes, the market started to collapse. The fall continued until around the middle of February when it was known that Ghana's production was not going to recover and that the 1977/78 crop was likely to be below expectation. This reversed the downward trend and prices began once again to climb strongly from an average of 1655 pounds/ton in February 1978 to 2011 pounds/ton in March. In New York the average increased from 124 cents/lb in February 1978 to 153 cents/pound in March 1978. The price fluctuated around this level for a while, reflecting both the decline in consumption and the inflexibility in supply. The expectation of a substantial shortfall in supply during the 1978/79 season, dominated the market during the last quarter of 1978, but such an expectation was false and that while the crop might be slightly lower in 1978/79 than in 1977/78, production would exceed grindings. Consequently, prices began to fall. By September 1979, the price of cocoa had fallen to 1427 pounds/ton and the average price in New York fell to 146 cents/lb (Economist Intelligence Unit 1989).

Alarmed by such a fall, Cote d'Ivoire announced that it was going to ban further sales of cocoa until the price recovered. Problems with the collection and shipment of cocoa from Ghana helped push prices slowly upwards. During November 1979, producers and consumers met in Geneva to try to negotiate a new International Cocoa Agreement to stabilize prices, however, the meeting failed. There had been two previous Agreements, in 1972 and 1975, but because the market was experiencing extraordinary high prices during the time, the effectiveness of neither Agreement was tested.

Apart from an increase of speculative activity in February, the market was exceptionally quiet in early 1980. Negotiations for a new International Cocoa Agreement failed again and the old one lapsed in March 31, 1980. Cocoa producers were alarmed by the turn of events. A meeting was held to discuss ways in which the price could be forced back up to acceptable levels. But the meetings were unsuccessful.

As a result, the price of cocoa began to fall steadily. Cote d'Ivoire was unable to maintain its ban on sales and had to dispose of its accumulated stock. Consequently, the market fell to new lows, with contracts in New York at less than $1.00/lb and London prices dipping below 1000 pounds/ton for the first time in four years (Economist Intelligence Unit 1989).

A conference held in Geneva in 1980 on the International Cocoa Agreement boosted confidence that a solution to the price volatility was close at hand, especially as the meeting concluded with agreement to keep the accumulated buffer stock funds intact. The market, however, did not share this confidence and prices remained unaffected. Under the terms of the new Agreement, the buffer stock was the sole instrument for stabilizing prices. The new price range was: minimum 100 cents/lb, lower intervention

price 110 cents/lb, upper intervention price 150 cents/lb and the maximum 160 cents/lb (Economist Intelligence Unit 1989).

Cote d'Ivoire, however, refused to join the Agreement arguing that the price range was too low. The new Agreement began with a massive handicap with Cote d'Ivoire, accounting for almost a quarter of world production, and the United States, the largest consuming country refusing to join. News that heavy rains affected production in Brazil coincided with higher than expected grinding figures, helped stabilize and support the market during the first few months of 1981. Nonetheless, by April, rapid selling by a number of countries helped push the price back down below the 1000 pound/ton level and 95 cents/lb in New York. The downward trend continued throughout May and early June. By late June the price of spot cocoa on the London market had reached 890 pounds/ton and the September futures position was trading at 786 pounds/ton, the lowest level since March 1976, and an average 75 cents/lb in New York, its lowest average since April 1976 (Economist Intelligence Unit 1989).

At the end of June 1981, a meeting was held in Geneva at which 35 countries indicated that they would be prepared to sign the new International Cocoa Agreement. This had a positive effect on the market. Prices moved upwards in anticipation of an effective buffer stock operation. The International Cocoa Organization's indicator price rose from a low of 72 cents/lb in mid-June to well over 100 cents/lb by September.

It was decided that the buffer stock manager could only purchase, direct from origin, up to 36,000 tons for shipment not later than July 1982 and that bulk cocoa exporting members would have the option of selling a further 60,000 tons for shipment later than September 1982 on a deferred payment basis. Unfortunately, purchases for the

buffer stock had a temporary effect on prices as the market failed to remain within the target price range (Economist Intelligence Unit 1989).

November 1982 proved to be the low point of the market. However, news that West Africa was experiencing a drought, which would seriously affect production, completely reversed the downward trend. Prices averaged 88.4 cents/lb in 1982/83 and production setbacks caused prices to rise sharply again, to an average 109.4 cents/lb in 1983/84, a season in which net output fell short of grindings by 212,000 tons. Prices decreased to an average of 100.8 cents/lb in 1984/85 and 97.5 cents/lb in 1985/86 as production returned to normal and another surplus emerged.

The changing perceptions of the future of the International Cocoa Agreement also influenced the market during this time. Fears that a new International Cocoa Agreement would not be negotiated, and that the 100,000 tons of cocoa held by the buffer stock would have to be released onto the market, forced the market downward during the first six months of 1986. However, following a ten-day meeting of 70 nations in Geneva in July 1986, an agreement was finally reached on the establishment of a new International Cocoa Agreement. This had a dramatic effect on the market, forcing the price up from 1330 pounds/ton in early July to 1550 pounds/ton by the end of August in London and from an average of 92 cents/lb in July to 94 cents/lb in August in New York (Economist Intelligence Unit 1989).

During September 1986, the market began to ease, partly because surplus production was expected for 1986/87. By December the price had fallen back to around 1390 pounds/ton and an average of 89 cents/lb. The old Agreement expired on September 30, 1986. The new agreement came into force on January 20, 1987, and the

1986 International Cocoa Agreement was provisionally brought into force. It was not fully effective until March 27, 1987, when the rules governing the operation of the buffer stock were established (Economist Intelligence Unit 1989).

The price of cocoa remained weak throughout the first quarter of 1987 reflecting the expected excess of global supplies over demand for the third successive season. By the end of March, the price on the London market had fallen to 1277 pounds/ton. The finalization of the buffer stock rules helped firm prices temporarily but it was not long before they began to fall once again. The market remained relatively weak, only showing signs of activity each time the International Cocoa Organization met to try to overcome the stalemate that had been established. As each meeting ended in failure, the market retreated even further, reaching a low of 1035 pounds/ton during the second week of December and an average of 86 cents/lb in during the month of December (Economist Intelligence Unit 1989).

The possibility of a resolution of the problem during a special meeting in January 1988 helped fuel a modest recovery. News that the International Cocoa Organization resolved its differences of opinion over the revision of its price range and agreed on rules for the withdrawal scheme, helped push prices up even further, but not enough to reach the new price range. As a result, the buffer stock was forced to resume its operations almost immediately and within a month had purchased a further 75,000 tons taking it to its maximum holding of 250,000 tons. This triggered another meeting of the International Cocoa Organization to consider the automatic introduction of the withholding scheme under which producing members agree to withhold up to a total of 120,000 tons from the market at their own expense. However, doubt was expressed as to

whether there was sufficient money in the buffer stock fund to finance the cost of the withholding scheme. This, combined with disagreement over the level of price support, paralyzed the International Cocoa Organization, and the International Cocoa Organization ended without agreement. Without the support, the market plunged, reaching a low of 895 pounds/ton on March 18, 1988 in London, and fell to an average of 76 cents/lb in New York, its lowest average in six years (Economist Intelligence Unit 1989).

Throughout the remainder of April and May the market remained fairly quiet due to a low volume of sales. Although the refusal of the authorities in Cote d'Ivoire to release any further cocoa onto the world market slowly helped prices recover from their six year lows. News that the USDA revised its estimate for Malaysia's cocoa production to 215,000 tons did push prices down for a while (Economist Intelligence Unit 1989).

The market fell back during June but recovered in early July due to the news that the buffer stock manager had to buy over 2000 tons of cocoa as a result of dealers who had previously contracted to supply the buffer stock with Ivorian cocoa failed to pay. During August and September, rumors that Cote d'Ivoire had made sales and news that the September session of the International Cocoa Council failed to resolve any of the outstanding issues forced the market lower, decreasing to an average 56 cents/lb in September, its lowest average since 1975 (Economist Intelligence Unit, 1989).

Towards the end of 1988, prices began to rally due to a rumor that Cote d'Ivoire had arranged to sell 400,000 tons of cocoa to a French trading house. However in 1989, the cocoa market certainly represented a commodity in crisis, as cocoa futures in New York and London fell to sixteen-year lows, with averages falling as low as 44 cents/lb, as

a result of increasing surpluses forecasted into the early 1990s. In late 1989, cocoa futures fell to 41 cents/lb, the lowest level since 1973 (Economist Intelligence Unit 1989).

In 1990/91, current prices reached sixteen-year lows. However, after spending the first weeks of 1990 at this dismal point, the London futures price gained more than 250 metric tons in two short months. At the International Cocoa Organization's meeting in 1990, the International Cocoa Agreement was extended for two years until September 1992. The buffer stock continued to exist but the manager would not intervene to stabilize prices. This took away the upper price cap and the market showed a favorable response to that decision (Economist Intelligence Unit 1989).

Cocoa stocks were down for the first time in seven years in 1991/92. However, the cocoa market still had heavy stocks in consuming countries. The efforts of cocoa producers to reinstate the International Cocoa Organization in 1991 were largely unsuccessful. Little progress was made to reestablish the Agreement and many delegates felt an Agreement was no longer needed (Bridge Commodity Research Bureau 1991).

Cocoa bulls were disappointed in 1992. The cocoa surplus in 1991/1992 began to erode. Consequently, in the second half of the year, prices rallied sharply from around 39 cents/lb to over 50 cents/lb. The continued presence of large stocks ultimately negated the impact of a second straight year of drought and disease reduced crops, however, and the market fell back to new lows by the end of the year. Late in the year, the market was negatively influenced in part by USDA estimates of an increase in total world production to 2.35 million metric tones, four percent higher than 1991/92's estimated 2.27 million metric ton crop (Bridge Commodity Research Bureau 1991).

World cocoa prices floundered during the first half of 1993 between 36 cents/lb to 45 cents/lb. The action was a continuation of a decade-long downtrend. The new International Cocoa Agreement was adopted on July 16, 1993. The new International Cocoa Agreement contained no provisions allowing direct intervention in the market to regulate prices. Nor any provisions related to the International Cocoa Organization's buffer stock (Stainer 1993). As a result, prices firmed during the second half and closed the year near their high (Bridge Commodity Research Bureau 1993).

The new International Cocoa Agreement entered in force on February 22, 1994. The new International Cocoa Agreement, negotiated in 1993, allowed for a production management plan designed to achieve a lasting equilibrium between world production and consumption. In 1994, the International Cocoa Organization decided to slowly reduce its buffer stockpile during the next few years. World cocoa prices neared a five-year high in mid-1994, which overshadowed prospects of a record large 1994/95 production. The price increase reflected fears that the world crop would trail initial expectations, but the bullish enthusiasm proved short-lived and by year-end 1994, prices were about midway between the year's high and low. The International Cocoa Agreement's success was uncertain due to some reluctance from some producing nations to voluntary limit their production (Bridge Commodity Research Bureau 1994).

World prices drifted lower during 1995, with an average price of 65 cents/lb in New York. World cocoa production for 1996/97 was forecasted at 2.7 million metric tons, down 8 percent from the record 1995/96 crop of 2.9 million metric tons. As a result, average prices increased one cent to 66 cents/lb (Bridge Commodity Research Bureau 1996).

The world cocoa market experienced ups and downs during 1997/98, passing through several periods of strength as well as periods of weakness. The major factors which influenced cocoa prices movements during the 1997/98 cocoa year, included: the changing perception of the outcome of the current 1997/98 crop, in the latter part of the year, reports concerning the development of the coming 1998/99 world crop, and concerns of a slowdown in global demand amid the increasing prospects of a recession in a number of economic areas of the world economy. World stocks of cocoa declined in 1997/98 resulting in the average price increasing to 73 cents/lb (International Cocoa Organization 1998).

The world cocoa market passed through several phases during the 1998/99 cocoa year but the general direction was downwards. The market followed a clear downward trend for the first eight months of the 1998/99 cocoa year-from the beginning of October 1998 to the end of May 1999. The first significant recovery in prices during the year was seen in June when the market reacted to a perception of a possible nearby supply shortage and to signs of economic recovery in Asia, Eastern Europe and Latin America due to improving consumption prospects. This resulted in average prices increasing to 76 cents/lb in 1999 (International Cocoa Organization 1999).

The USDA forecasted world cocoa production in 1999/2000 at 2.89 million metric tons, up one percent from the previous season. This would be the largest crop since the 1995/96 crop of 2.94 million metric tons. Facing lower cocoa prices from a large crop, Cote d'Ivoire's producers banded together to protest the low prices by reducing the amount of cocoa that they would sell. Prices responded by moving higher but then fell back. World production of cocoa exceeded consumption, and global cocoa

stocks increased by the end of 1999/00, resulting in average prices reducing to 51 cents/lb, its lowest average since 1993 (Bridge Commodity Research Bureau 2000).

CHAPTER III

RESEARCH PROCEDURES FOR COCOA MARKET ANALYSIS AND PRICE RISK MANAGEMENT ASSESSMENT

Fundamental Market Analysis

Fundamental analysis is a method of research that involves the use of economic theory and data (e.g., supply, demand, seasonal price influences, government agricultural programs, international political agreements etc.) to examine the underlying factors that will affect supply and demand and thus the price of a stock or futures contract. Some of the key attributes of fundamental analysis include the following: A.) It provides an extra dimension of information not available to the purely technical trader, such as knowing why a market is acting as it is, which can be invaluable in trading decisions. B.) It may sometimes forecast a major price move well in advance of any technical signals. C.) A knowledge of fundamentals permits a trader to adopt a more aggressive stance in those situations in which the fundamentals suggest the potential for a major price move. D.) An understanding of the underlying fundamentals can provide the trader/hedger incentive to stay with the winning trade. E.) The way in which a market responds to fundamental news can be used as a trading tool (Schwager 1995, 3, 229, 230).

Regression Analysis

In the cocoa literature, it is noted that as end-of-year stocks increase, the price of cocoa beans decrease and vice versa. For example, in the years when the first two International Cocoa Agreements were implemented, the cocoa market was experiencing

record high prices. These high prices were not associated with the implementation of the International Cocoa Agreement, but rather a decline in the end-of- year stocks. Therefore, a regression analysis was undertaken in order to determine if there is an inverse relationship between end-of-year cocoa stocks and prices.

Regression analysis is a type of fundamental analysis that is concerned with describing and evaluating the relationship between a given variable and one or more other variables. The primary goal of regression analysis is to define a mathematical relationship between the dependent variable and the independent variables (Schwager 1995, 241). Regression analysis provides an efficient learning tool for understanding the interrelationships between various fundamental factors and price. Using regression analysis, relationships depicted in tabular and graphic form can be translated into a single precise equation:

$$(1)\ P_t = a_0 + a_1 \text{stocks}_{t-1} + a_2 \text{Year} + E_t$$

The dependent variable in (1) is yearly average cash prices P_t. The explanatory variable in (1) is the end-of-year cocoa stocks. Year is an explanatory variable used as a function of time. E_t is the error term and a_0 *and* a_2 are unknown model parameters. The regression procedure in SAS was used to calculate a regression analysis in order to evaluate the relationship between cocoa prices and end-of- year stocks. Yearly average cash prices and end-of-year stocks were plotted to visualize the relationship between prices and end-of-year stocks, and to determine whether prices and end-of-year stocks are currently increasing or decreasing. Pearson correlation coefficients were also calculated to determine if there is an inverse relationship between end-of-year stocks and prices. I

expect the results to show that there is an inverse relationship between end-of-year stocks and prices.

Seasonal Analysis

Seasonal analysis provides a source of additional information that can complement traditional fundamental and technical analysis. The fundamentals in most markets are heavily influenced by seasonal factors. For example, crops are harvested at specific times of the year, and for many commodities, demand exhibits seasonal fluctuations as well. Thus, it is hardly surprising that most commodity markets exhibit seasonal price patterns (Schwager 1984, 70).

Utilizing seasonal price patterns in making trading decisions is useful, because its concept is based on the assumption that seasonal influences will cause biases in the movement of market prices. However, this is not always the case. It is hardly uncommon for markets to move opposite to their normal seasonal trends. The key question is whether, there is enough positive correlation between future price movements and past seasonal patterns for such information to be useful (Schwager 1995, 115).

Apparent seasonal patterns would be expected to appear even in random series, however, it is difficult to determine to what extent seasonal price patterns reflect true biases as opposed to random occurrences. Hence, there is an unavoidable degree of subjectivity in deciding how much weight to give past seasonal patterns (Schwager 1995, 115). However, ignoring seasonal patterns can easily lead to the misinterpretation of fundamental data (Schwager 1984, 70).

In order to determine whether a seasonal pattern existed for cocoa prices, a seasonal index was calculated from 1971-2001. The average percentage method is the

simplest approach for calculating a seasonal index. This method involves the following approach:

1. Calculating an annual average for each year.
2. Expressing each monthly value as a percentage of the corresponding annual average.
3. Averaging the percentage values for each month (Schwager 1995, 117).

I expect the results of the seasonal analysis to reveal that there is a seasonal pattern for cocoa prices. The results of this analysis will be used in the routine hedging strategy to evaluate its success if one enters the futures market in the month when the seasonal index is highest.

Routine Hedging

Routine hedging is a type of price risk management strategy. It is the most basic hedging strategy. With a routine hedging strategy, a producer will enter and exit the futures market at the same time every year in order to reduce risk. A routine hedge goes as follows: suppose a producer decides to sell futures contract(s) in quantity equal to one crop at the beginning of the planting season(s) for delivery at the harvest of the year. At harvest, he sells the crop, and the futures contract(s) is bought back. The strategy is repeated every year (Huang 1993).

In order to determine whether routine hedging is successful at stabilizing volatile cocoa prices, one May cocoa contract was sold around the 15th of the month with the highest seasonal index from 1971-2000. Brazil is one of the leading cocoa producers and is used for illustrative purposes. The main cocoa season in Brazil is from October to April. Thus, the contracts were offset in mid-April from 1971-2000. Total net revenues

from 1971-2000 will be evaluated to determine if the routine hedging procedure is successful at minimizing risk or improving returns of cocoa producers.

Strategic Rollover Hedging

The intent of strategic rollover strategies is to allow producers the opportunity to obtain higher average prices over some time frame (usually three or more years). With the use of strategic rollover hedging, there is a possibility that cocoa producers or marketing boards can receive higher average prices for more than one crop year, thus reducing the concern of volatile cocoa prices in the cash market.

It has been shown that strategic rollover hedging improved producer returns for corn and soybeans. These strategies were entered when prices were at historically high price levels and exceeded price forecasts based on current yield estimates. As a result, average net prices over 1980-1992 improved. However, the success of strategic rollover hedging has been limited to only a few commodities and unsuccessful for commodities such as livestock (Kenyon and Beckman 1997).

Kenyon and Beckman (1997) suggests that further research should focus on individual commodity characteristics and market dynamics that determine whether or not these strategies will be successful in the long run. Thus, the objective of this research is to evaluate cocoa and determine if it is a candidate for strategic rollover hedging.

Strategic Rollover Hedging Procedure

Assume producers make hedging decisions to reduce cash price risk and maximize their returns. Consequently, the entry and exit price levels have to be determined in order for producers to receive a higher average price that will reduce the

risk of price volatility and increase returns. The entry and exit levels are developed based on frequencies selected by the hedger.

The strategic rollover hedging procedure used in this analysis is as follows:

1. A three-year strategic rollover hedging period was used in this analysis. The first step in developing multiple-year pricing strategies is to determine historical futures price distributions. Brazil is used for illustrative purposes in this analysis as well. Therefore, the May contract was used to develop multiple year pricing strategies. The daily closing futures prices for May cocoa are used from 1961-2000. Seven years of daily historical futures prices are used to develop a distribution. In each successive year, an additional year of futures prices is added to the previous distribution and the beginning years' data is deleted. Thereby, creating a moving seven-year distribution.

2. Any price at or above the top 5% of the distribution represents an entry signal or opportunity time for the producer. At any time a price equal to or exceeding the price in the top 5% of the distribution, the hedger will sell 3 contracts, unless a rollover hedge is already in place. For example, assume the price trades in the top 5% of the distribution on January 2, 1997 the producer would sell three May 1997 cocoa contracts. At harvest in 1997, the three May cocoa contracts will be offset and two May 1998 contracts will be sold. At harvest in 1998, the two May 1998 contracts would be offset and a May 1999 contract would be sold and then offset at harvest in 1999 (see table 2).

3. Using strategic rollover hedging, producers can experience large losses if futures prices increase after initiating the strategies for several years. Thus, to reduce losses an exit rule is established. According to that rule, the producer will lift the hedge if prices increase by more than 25% of the entry price. At any time the price increases

25% or more than the entry price, the hedger will close all positions in the futures market and will only sell at harvest in the cash market until the price is favorable to implement the rollover strategies in the futures market. An asterisk (*) denotes when the exit rule was enforced in table 9.

4. Returns from cash sale at harvest, and returns from using the strategic rollover hedging strategies will be evaluated to determine whether strategic rollover hedging is successful for cocoa.

Table 2. Example of Strategic Rollover Hedging Potential

Date	Cash	Futures	Gain/loss
1/2/97	After examining the historical database, May 97 Cocoa futures is in the top 5% of the historical distribution, so the farmer decides to enter the market	He Sells 3 May 97 @.65 for April delivery	
4/97	Farmer decides to harvest 22046lbs of cocoa. The average world price is .71.	He Buys 3 May 97 harvest @ .69	$.65/lb -$.69/lb -.04 x 3= -.12/lb Net Revenue without hedge=$15,652.66 Net Revenue with hedge = $13,007.14
4/97	The farmer adds this year's contract into his historical data base.	Farmer rolls over two of next year's contracts He Sells 2 May 98@ .68	
4/98	Farmer harvests 22046lbs of cocoa. The average world price is .78.	He buys 2 May 98@ .74	$.68/lb -$.74/lb -.06 x 2 = -.12/lb Net Revenue without hedge=$17,195.88 Net Revenue with hedge = 14,550.36
4/98	The farmer adds this year's contract into his historical database.	Farmer rolls over next year's contract He sells 1 May 99@ .79	
4/99	Farmer harvests 22046lbs of cocoa. The average world price is .53.	He buys 1 May 99 @ .53	$.79/lb -53/lb .26 x 1 = .26/lb Net Revenue without hedge=$11,684.38 Net Revenue with hedge=$17,416.34
Total without hedge = $44,532.92			
Total with hedge = $44,973.82			**Net Revenue with Strategic Rollover Hedging = $440.90**

CHAPTER IV

DATA AND RESULTS

The research procedures for the cocoa market analysis and price risk management assessment were discussed in the previous chapter. In this chapter, the data and results of each strategy will be presented separately.

Fundamental Analysis

Data and Results

End-of-year cocoa stocks and yearly average cash prices from 1960-2000 were obtained from the International Cocoa Trade and the International Cocoa Organization. Equation (1), $P_t = a_0 + a_1 stocks_{t-1} + a_2 Year + E_t$, was estimated using the regression procedure in SAS. The estimated coefficients and the t statistics for the intercept, and the explanatory variables stocks and year appear in Table 3. The t statistic is used to test the null hypothesis that a parameter is zero. The independent variables in this model are stocks and year. If the p-value is less than the significance level .05 of the test, then the null hypothesis is rejected in favor of the alternative that the parameter is not zero. The p-values for stocks and year are both 0.0001. Thus, the null hypothesis is rejected in favor of the alternative hypothesis that the parameters end-of-year stocks and year are significant variables (see table 3).

The coefficient of determination, r-square, is used to measure the amount of variation in the dependent variable explained by the regression model. The r-square of

Table 3. Estimated Coefficients of the Regression Analysis for End of Year Cocoa Stocks from 1960-2000

Variables	Estimated Coefficients	Standard Error	T-Values	P-Value
Intercept	-130521	20402	-6.40	.0001
Stocks	-2.00226	.29783	-6.72	.0001
Year	67.30736	10.39739	6.47	.0001
F-Value	24.25			.0001
Durbin Watson	.423			
Degrees of Freedom	40			
R-Square	.5607			
Adjusted R-square	.5376			
1st Order Autocorrelation	.716			
Number of Observations	41			

the regression model is 0.5607. For time series data, r-square is in a reasonable range when it is greater than .7. Thus, the r-square value is not high for time series data.

To determine whether there is a linear relationship between the dependent variable and the explanatory variables in the model, a two tailed test for the null hypothesis Ho: B1=0 was conducted, which means that there is no significant relationship between the dependent variable and the explanatory variables. The alternative hypothesis is Ha: B1≠ 0, means that there is a significant relationship between the dependent variable and the explanatory variables in the model. The model mean square is divided by the error mean square in order to compute the F statistic. The F statistic is the ratio of the explained variation to the unexplained variation. If the p-value is less than .025, then the null hypothesis is rejected in favor of the alternative that that there is a significant relationship between the dependent variable and the explanatory variables in the model. The p-value for the f statistic is .0001. Therefore, we reject the null hypothesis that there is no relationship between the dependent variable and the explanatory variables. Thus, there is a significant linear relationship between the dependent variable yearly average prices and the explanatory variable end-of-year stocks.

The Durbin-Watson test statistic was used to test for autocorrelation. Autocorrelation is common with time series data because each observation comes from a different time period. When there is no autocorrelation, the expected value of the Durbin-Watson test statistic *d* is approximately 2.0. When there is positive autocorrelation $d < 2.0$. When there is negative autocorrelation $d > 2.0$. The *d* in this regression model is .423. Thereby, indicating that there is positive autocorrelation. When there is positive autocorrelation, adjacent residuals tend to be similar. The reasons

for autocorrelation in this regression model may be due to an omitted explanatory variable or slow adjustments in regressors.

The dependent variable yearly average prices and the explanatory variable end-of-year stocks are inversely related, with a Pearson correlation coefficient of -.27627 (see table 4). However, -.27627 is not a very strong negative correlation. The plot of stocks per year and prices per year indicate that interaction is present between the variables prices and stocks. The nonparallel scheme indicates that the change in prices depends on the end- of- year stocks. The plot of the prices per year from 1960-2000 indicate that prices are declining. Conversely, the plots of end-of-year stocks per year indicate that stocks are on the rise (see appendix Figures 1, 2, and 3). Thus, the price decline (increase) in the cocoa market is somewhat influenced by the rise (decline) in the end-of-year cocoa stocks.

Seasonal Analysis

Data and Results

World cocoa monthly prices from 1971-2000 were obtained from the International Cocoa Organization. The monthly seasonal indexes ranged from a low of .98 in June to a high of 1.02 in September (table 5). Thus, there was not much variation in the monthly seasonal indexes from 1971-2001. This was because the volatility that occurred in the cocoa market was yearly related and not seasonal.

Routine Hedging

Data and Results

World cocoa average representative monthly prices were obtained from the International Cocoa Organization. Closing futures representative prices for the May

Table 4. Pearson Correlation Coefficients for Yearly Prices and End of Year Cocoa Stocks from 1960-2000

Simple Statistics	**Stocks**	**Prices**
Mean	777.63415	1191
Standard Deviation	418.20191	693.87414
Sum	31883	48832
Minimum	263.00000	389.000000
Maximum	1549	3130
N	41	41
Pearson Correlation Coefficients -.27627		

Table 5. Monthly Cocoa Seasonal Index 1971-2001

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
71	1.11	1.04	1.00	1.01	0.95	0.98404	1.0598	1.102	1.0233	0.9198	0.8989	0.89194
72	0.83	0.85	0.89	0.90	0.96	0.96707	1.0031	1.065	1.1269	1.1328	1.1153	1.14477
73	0.63	0.66	0.74	0.83	1.04	1.13121	1.3706	1.252	1.1747	1.1449	1.0113	1.00877
74	0.71	0.82	0.95	1.16	1.16	0.9935	1.0131	1.039	1.0228	1.1193	1.0686	0.90981
75	1.18	1.20	1.10	0.99	0.84	0.79483	0.9356	0.943	0.9288	1.0037	0.9911	1.05913
76	0.68	0.70	0.69	0.80	0.86	0.94071	0.9568	1.037	1.1687	1.2655	1.4303	1.45451
77	0.91	1.00	1.06	0.94	0.99	1.12208	1.1512	1.047	1.0162	0.9745	0.9186	0.84295
78	0.87	0.83	0.99	1.01	0.92	0.87916	0.9296	0.988	1.1021	1.1247	1.1843	1.16005
79	1.11	1.06	1.03	0.98	1.02	1.05692	0.9876	0.952	0.9786	0.929	0.916	0.96785
80	1.21	1.24	1.18	1.11	0.99	0.95943	0.9467	0.888	0.9165	0.8855	0.8349	0.8106
81	1.0	0.98	1.01	1.01	0.93	0.79955	0.9864	1.082	1.1255	1.0463	0.9903	1.01348
82	1.25	1.19	1.11	1.0	0.98	0.90229	0.9061	0.895	0.968	0.9403	0.8848	0.94355
83	0.84	0.91	0.87	0.88	0.97	1.0845	1.0869	1.087	1.0092	0.9886	1.0477	1.19927
84	1.09	1.04	1.05	1.05	1.12	1.03727	0.9252	0.924	0.9647	0.9422	0.9413	0.89344
85	0.98	1.00	0.99	0.99	0.94	0.92774	0.9802	1.009	1.0388	1.0481	1.0191	1.05534
86	1.12	1.07	1.01	0.96	0.92	0.92186	0.9779	1	1.0668	1.0023	0.977	0.95566
87	0.99	0.98	1.00	1.03	1.04	1.0021	1.0594	1.013	0.9957	0.9578	0.9708	0.9503
88	1.24	1.13	1.06	1.04	1.07	1.0249	1.0149	0.914	0.782	0.823	0.9316	0.94769
89	1.15	1.19	1.13	1.04	0.97	1.00888	1.0838	1.035	0.9192	0.857	0.8133	0.78171
90	0.78	0.80	0.89	1.05	1.14	1.04432	1.061	1.017	1.0813	1.0309	1.0659	1.02016
91	1.03	1.01	1.01	0.95	0.89	0.87087	0.8624	0.953	1.0662	1.0878	1.1009	1.14352
92	1.16	1.08	1.02	0.94	0.91	0.87548	1.0026	1.071	1.0233	0.9741	0.9785	0.94205
93	0.92	0.89	0.87	0.91	0.89	0.88358	0.9491	0.982	1.1348	1.1569	1.1896	1.2129
94	0.90	0.88	0.93	0.89	0.99	1.045	1.1118	1.111	1.0643	1.0371	1.0292	1.00237
95	1.02	1.05	1.03	1.03	1.01	1.00277	0.9517	0.986	0.9746	0.9731	1.0023	0.96201
96	0.9	0.94	0.91	1.00	1.05	1.05619	1.0274	1.03	1.0141	1.0147	1.0094	1.01287
97	0.88	0.84	0.94	0.97	0.97	1.0429	1.0361	1.021	1.0931	1.0757	1.0468	1.07313
98	0.99	0.97	1.02	1.03	1.07	1.02736	1.0217	1.005	1.0068	0.9824	0.9516	0.90384
99	1.27	1.23	1.15	1.04	0.93	1.01915	0.9766	0.927	0.931	0.896	0.8091	0.80584
00	1.03	0.96	1.05	1.03	1.02	1.06059	1.0551	0.989	0.9948	0.9891	0.9022	0.90514
01	0.88	1.06	1.03	0.99	0.99	0.89289	0.8882	0.95	0.9366	0.9964	1.1395	1.22778
Avg	**0.99**	**0.99**	**0.99**	**0.98**	**0.98**	**0.97933**	**1.0103**	**1.01**	**1.021**	**1.0103**	**1.0055**	**1.00653**

Source: ICCO 2000

cocoa futures contracts from 1961-2000 were obtained from PROPHET database (Prophet 2000).

The results from the routine hedging strategy are in table 6. The results from the seasonal analysis indicated that September had the highest seasonal index. Thus, on September 15, 1970, one May 71 was sold at .33. At harvest in 1971, the amount equivalent to one cocoa contract was sold in the cash market at .24 and the May 1971 contract was bought back at .25. This process was repeated every year from 1971-2001. The results indicate that entering the market in mid-September and offsetting the contracts in mid-April generated net revenues of $15,916.34 from 1971-2000. This included $50 per round turn for brokerage fees without the consideration of margin calls. The total profit without the hedge from 1971-2000 was $514,553.64. The total profit with the routine hedge was $531,969.98. Therefore, the routine hedging strategy was successful at minimizing price risk from 1971-2000 (see table 6).

Strategic Rollover Hedging

Data and Results

Daily closing futures prices for the May cocoa from 1961-2000 were obtained from PROPHET database (Prophet 2000). World cocoa average monthly prices were obtained from the ICCO.

Table 7 reports the price at the 5, 10 and 15% upper tail of distribution, the number of contracts and the number of observations from 1968-2000. Table 8 reports the opportunity time for the producer to implement strategies at the 5% upper tail of distribution from 1968-2000. In 1973, 1975, 1977 and 1997 the prices traded above the top 5% of the distribution. Thus, the strategies were implemented. However, in 1971,

Table 6. Routine Hedging from 1971-2000

Date	Cash	Futures	Gain/loss	WO	With Hedge
9/15/70		Sell 1 May 71@.33			
4/15/71	Sell 22046@ .24	Buy 1 May 71@ .25	.08	5291.04	7054.72
9/15/71		Sell 1 May 72@ .25			
4/14/72	Sell 22046@ .26	Buy 1 May 72@ .24	.01	5731.96	5952.42
9/15/72		Sell 1 May 73@ .33			
4/16/73	Sell 22046@ .43	Buy 1 May 73@ .43	-.1	9479.78	7275.18
9/15/73		Sell 1 May 74@ .58			
4/15/74	Sell 22046 @ .82	Buy 1 May 74@ .93	-.35	18077.72	10361.62
9/16/74		Sell 1 May 75@ .64			
4/15/75	Sell 22046@ .56	Buy 1 May 75@ .58	.06	12345.76	13668.52
9/15/75		Sell 1 May 76@ .50			
4/15/76	Sell 22046@ .74	Buy 1 May 76@ .81	-.31	16314.04	9479.78
9/15/76		Sell 1 May 77@ 1.02			
4/15/77	Sell 22046@ 1.62	Buy 1 May 77@ 1.64	-.62	35714.52	22046
9/15/77		Sell 1 May 78@ 1.64			
4/17/78	Sell 22046@ 1.56	Buy 1 May 78@ 1.59	.05	34391.76	35494.06
9/15/78		Sell 1 May 79@ 1.66			
4/15/79	Sell 22046 @1.47	Buy 1 May 79@ 1.38	.28	32407.62	38580.50
9/15/79		Sell 1 May 80@ .66			
4/15/80	Sell 22046@ 1.32	Buy 1 May 80@ .57	.09	29100.72	31084.86
9/15/80		Sell 1 May 81@ 1.11			
4/15/81	Sell 22046 @.96	Buy 1 May 81@ .91	.2	21164.16	25573.36

Date	Cash	Futures	Gain/loss	WO	With Hedge
9/15/81		Sell 1 May 82@ 1.06			
4/15/82	Sell 22046@.79	Buy 1 May 82@ .75	.31	17416.34	24250.60
9/15/82		Sell 1 May 83@ .79			
4/15/83	Sell 22046@ .85	Buy 1 May 83@ .80	-.01	18739.1	18518.64
9/15/83		Sell 1 May 84@ .96			
4/16/84	Sell 22046@ 1.15	Buy 1 May 84@ 1.09	-.13	25352.9	22486.92
9/14/84		Sell 1 May 85@ 1.03			
4/15/85	Sell 22046@1.02	Buy 1 May 85@ 1.09	-.06	22486.92	21164.16
9/16/85		Sell 1 May 86@ 1.03			
4/15/86	Sell 22046@ .90	Buy 1 May 86@ .80	.23	19841.4	24911.98
9/15/86		Sell 1 May 87@ 1.01			
4/15/87	Sell 22046@.94	Buy 1 May 87@ .89	.12	20723.24	23368.76
9/15/87		Sell 1 May 88@ .88			
4/15/88	Sell 22046@.75	Buy 1 May 88@ .68	.2	16534.5	20943.7
9/15/88		Sell 1 May 89@ .54			
4/15/89	Sell 22046@ .59	Buy 1 May 89@ .59	-.05	13007.14	11904.84
9/15/89		Sell 1 May 90@ .50			
4/15/90	Sell 22046@ .60	Buy 1 May 90@ .59	-.09	13227.6	11243.46
9/17/90		Sell 1 May 91@ .63			
4/15/91	Sell 22046@ .52	Buy 1 May 91@ .49	.14	11463.92	14550.36
9/16/91		Sell 1 May 92@ .58			
4/15/92	Sell 22046@ .47	Buy 1 May 92@ .42	.16	10361.62	13888.98
9/15/92		Sell 1 May 93@ .48			
4/15/93	Sell 22046@ .46	Buy 1 May 93@ .42	.06	10141.16	11463.92
9/15/93		Sell 1 May 94@ .56			

Date	Cash	Futures	Gain/loss	WO	With Hedge
4/15/94	Sell 22046 @ .56	Buy 1 May 94@ .51	.05	12345.76	13448.06
9/15/94		Sell 1 May 95@ .65			
4/15/95	Sell 22046@ .67	Buy 1 May 95@ .60	.05	14770.82	15873.12
9/15/95		Sell 1 May 96@ .61			
4/15/96	Sell 22046@ .66	Buy 1 May 96@ .61	0	14550.36	14550.36
9/16/96		Sell 1 May 97@ .65			
4/15/97	Sell 22046@ .71	Buy 1 May 97@ .64	.01	15652.66	15873.12
9/15/97		Sell 1 May 98@ .77			
4/15/98	Sell 22046@ .78	Buy 1 May 98@ .70	.07	17195.88	18739.1
9/15/98		Sell 1 May 99@ .74			
4/15/99	Sell 22046@ .53	Buy 1 May 99@ .49	.25	11684.38	17195.88
9/15/99		Sell 1 May 00@ .46			
4/14/00	Sell 22046@ .41	Buy 1 May 00@ .37	.09	9038.86	11023

Average Cash Price = **$.78** Average Futures Price = **$.86**
Average Futures Gain/year = **$.03**

Total Profit Without hedge = **$514,553.64**
Average/year without hedge = **$17,151.79**

Total Profit With hedge = **$531,969.98**
Average/year with hedge = **$17,732.33**

Net Revenue from 1971-2001= **$17,416.34 ($531,969.98-$514,553.64)**
-1,500.00 (brokerage fees)
$15,916.34

Table 7. May Cocoa Futures Price Distributions 1968-2000

Year	Contracts Included	Number of observations	Price at 5% upper tail of distribution	Price at 10% upper tail of distribution	Price at 15% upper tail of distribution
1968	1961-1967	1749	.272	.266	.26
1969	1962-1968	1749	.28	.27	.266
1970	1963-1969	1746	.39	.29	.28
1971	1964-1970	1744	.41	.39	.37
1972	1965-1971	1743	.41	.39	.37
1973	1966-1972	1745	.41	.39	.37
1974	1967-1973	1743	.41	.40	.38
1975	1968-1974	1742	.58	.52	.45
1976	1969-1975	1743	.68	.63	.60
1977	1970-1976	1746	.69	.66	.63
1978	1971-1977	1749	1.37	.95	.76
1979	1972-1978	1747	1.65	1.56	1.40
1980	1973-1979	1747	1.73	1.64	1.58
1981	1974-1980	1752	1.73	1.64	1.59
1982	1975-1981	1754	1.73	1.64	1.59
1983	1976-1982	1757	1.73	1.64	1.59
1984	1977-1983	1760	1.73	1.64	1.59
1985	1978-1984	1765	1.68	1.60	1.54
1986	1979-1985	1768	1.63	1.51	1.44
1987	1980-1986	1766	1.45	1.37	1.18
1988	1981-1987	1763	1.14	1.09	1.04
1989	1982-1988	1765	1.14	1.09	1.04
1990	1983-1989	1764	1.14	1.09	1.04
1991	1984-1990	1765	1.14	1.09	1.04
1992	1985-1991	1762	1.04	1.02	1.00
1993	1986-1992	1762	1.00	.95	.91
1994	1987-1993	1765	.91	.89	.86
1995	1988-1994	1765	.91	.82	.73
1996	1989-1995	1764	.68	.66	.64
1997	1990-1996	1762	.65	.64	.63
1998	1991-1997	1760	.68	.65	.64
1999	1992-1998	1759	.77	.72	.68
2000	1993-1999	1758	.77	.75	.73

Table 8. Opportunity Time in the Futures Market to Implement Strategies 1968-2000

Year	Contracts Included	Opportunity time at 5% upper tail of distr.	Price at 5% upper tail of distribution	Price at 10% upper tail of distribution	Price at 15% upper tail of distribution
1968	1961-1967	*	.272	.266	.26
1969	1962-1968	*	.28	.27	.266
1970	1963-1969	*	.39	.29	.28
1971	1964-1970	NA	.41	.39	.37
1972	1965-1971	NA	.41	.39	.37
1973	1966-1972	.41	.41	.39	.37
1974	1967-1973	RO	.41	.40	.38
1975	1968-1974	.58	.58	.52	.45
1976	1969-1975	RO	.68	.63	.60
1977	1970-1976	1.33	.69	.66	.63
1978	1971-1977	RO	1.37	.95	.76
1979	1972-1978	RO	1.65	1.56	1.40
1980	1973-1979	NA	1.73	1.64	1.58
1981	1974-1980	NA	1.73	1.64	1.59
1982	1975-1981	NA	1.73	1.64	1.59
1983	1976-1982	NA	1.73	1.64	1.59
1984	1977-1983	NA	1.73	1.64	1.59
1985	1978-1984	NA	1.68	1.60	1.54
1986	1979-1985	NA	1.63	1.51	1.44
1987	1980-1986	NA	1.45	1.37	1.18
1988	1981-1987	NA	1.14	1.09	1.04
1989	1982-1988	NA	1.14	1.09	1.04
1990	1983-1989	NA	1.14	1.09	1.04
1991	1984-1990	NA	1.14	1.09	1.04
1992	1985-1991	NA	1.04	1.02	1.00
1993	1986-1992	NA	1.00	.95	.91
1994	1987-1993	NA	.91	.89	.86
1995	1988-1994	NA	.91	.82	.73
1996	1989-1995	NA	.68	.66	.64
1997	1990-1996	.65	.65	.64	.63
1998	1991-1997	RO	.68	.65	.64
1999	1992-1998	RO	.77	.72	.68
2000	1993-1999	NA	.77	.75	.73

NA means the price did not trade above 5% of the historical distribution.
RO indicates the contracts that were rolled over after the strategies were implemented.
* World cocoa monthly average prices unavailable.

1972, 1980-1996, and 2000, the prices did not trade in the top 5% of the distribution. Consequently, the strategies were not implemented.

The strategic rollover hedging results for cocoa from 1971-2000 are illustrated in table 9. On March 26, 1973, the price traded at the 5% upper tail of the distribution. Thus, three May 73 contracts were sold in the futures market at $.41/lb. At harvest, 22046 lbs of cocoa were harvested and sold in the cash market at $.427/lb and 3 May 73 contracts were offset. Two May 74 contracts were sold at $.37/lb. On May 7, 1973, the price increased 25% above the entry- level price. Thus, the exit rule was enforced and two contracts were offset. The next time the price was favorable was on January 2, 1975. Therefore, the strategies were implemented. However, on April 6, 1976, the price increased above 25% of the entry price, Consequently, the exit rule was enforced and the remaining contracts were offset. On January 3, 1977 the price traded above the entry-level price. As a result, the strategies were implemented. From 1981-1996, the price never reached the upper 5% of the historical distribution. Consequently, the strategies were not implemented. The strategies were implemented again on January 2, 1997.

The second column in table 9 illustrates the price the producer received each year in the cash market. The average price was $.80. The third column illustrates the positions the producer held in the futures market. The fourth column represents the futures loss or gain. The average loss per year was .19. The fifth column illustrates the profit the producer would have received without the hedge. The total without the hedge is $492,323.34. The sixth column illustrates the net revenue with the hedge. The total net revenue with the hedge is $188,647.62. Using strategic rollover hedging from 1971-2000, a producer would have incurred a loss of $304,825.72. This included $50 per

Table 9. Strategic Rollover Hedging for Cocoa 1971-2000

Date	World Cocoa Prices	Futures	Futures loss/gain	Net Revenue W/O	With Hedge
3/26/73	Opportunity time	Sell 3 May 73@ .41			
4/73	Harvest time Sell 22046lbs @ .427	Buy 3 May 73@ .42	-.09	9413.64	7429.50
4/73		Sell 2 May 74@ .37			
*5/7/73	Sell 22046lbs@ .53	Buy 2 May 74@ .51	-.28	11684.38	5511.50
1/2/75	Opportunity time	Sell 3 May 75@ .58			
4/75	Sell 22046lbs@ .56	Buy 3 May 75@ .61	-.09	12345.76	10361.62
4/75		Sell 2 May 76@ .54			
*4/6/76	Sell 22046lbs@ .65	Buy 2 May 76@ .74	-.40	14329.90	5511.50
1/3/77	Opportunity time	Sell 3 May 77@ 1.33			
4/77	Sell 22046lbs@ 1.62	Buy 3 May 77@ 1.63	-.90	35714.52	15873.12
4/77		Sell 2 May 78@ 1.38			
4/78	Harvest time Sell 22046lbs@ 1.56	Buy 2 May 78@ 1.62	-.48	34391.76	23809.68
4/78		Sell 1 May 79@ 1.40			
4/79	Harvest time Sell 22046lbs@ 1.47	Buy 1 May 79@ 1.41	-.01	32407.62	32187.16
4/79		Sell 1 May 80@ .70			
4/80	Harvest time Sell 22046lbs@1.31	Buy 1 May 80@ .58	.12	28880.26	31525.78
4/81	Sell 22046lbs@.95			20943.70	
4/82	Sell 22046lbs@ .79			17416.34	
4/83	Sell 22046lbs@ .85			18739.10	
4/84	Sell 22046lbs@ 1.15			25352.90	

Date	World Cocoa Prices	Futures	Futures loss/gain	Net Revenue W/O	With Hedge
4/85	Sell 22046lbs@ 1.01			22266.46	
4/86	Sell 22046lbs@ .90			19841.4	
4/87	Sell 22046lbs@ .93			20502.78	
4/88	Sell 22046lbs@ .74			16314.04	
4/89	Sell 22046lbs@ .58			12786.68	
4/90	Sell 22046lbs@ .60			13227.60	
4/91	Sell 22046lbs@ .51			11243.46	
4/92	Sell 22046lbs@ .47			10361.62	
4/93	Sell 22046lbs@ .46			10141.16	
4/94	Sell 22046lbs@ .56			12345.76	
4/95	Sell 22046lbs@ .66			14550.36	
4/96	Sell 22046lbs@ .66			14550.36	
1/2/97	Opportunity time	Sell 3 May 97@ .65			
4/97	Harvest time Sell 22046lbs@ .71	Buy 3 May 97@ .69	-.12	15652.66	13007.14
4/97		Sell 2 May 98@ .68			
4/98	Sell 22046lbs@ .78	Buy 2 May 98@ .74	-.12	17195.88	14550.36
4/98		Sell 1 May 99@ .79			
4/99	Harvest time Sell 22046lbs@.53	Buy 1 May 99@ .53	.26	11684.38	28880.26
4/00	Sell 22046lbs @ .41			9038.86	

Avg. Cash Price **=$.80**
Avg. Futures Price= **$.80**
Avg. Futures loss/year = **$-.19**
Total Profit With Hedge= **$188,647.62**
Average With Hedge= **$17,149.78**

Total Profit Without Hedge= **$492,323.34**
Avg. Per Year Without Hedge = **$17,011.15**

Total losses from 1971-2001 using Strategic rollover hedging
($188,647.62-492,323.34) = **-$303,675.72**
-(brokerage fees)
-$304,825.72

round turn for brokerage fees, without the consideration of margin calls. Thereby, indicating that cocoa is not a candidate for strategic rollover hedging.

In this chapter we have shown that end-of-year cocoa stocks somewhat influence cocoa prices and that the routine hedging was the only price risk management strategy that was successful in stabilizing cocoa prices from 1971-2000. Further discussion and conclusions drawn from the results are presented in the next chapter.

CHAPTER V

CONCLUSION AND IMPLICATIONS

Cocoa is the third most important agricultural export in international trade. A problem facing cocoa producers is its price volatility. Due to the importance of cocoa in international trade, the problem of price volatility prompted a search for tools to stabilize cocoa prices. The International Cocoa Agreement is a structural tool designed to stabilized cocoa prices. However, despite the implementation of the International Cocoa Agreements of 1972, 1975, 1980, 1986 and 1993, cocoa prices still remained volatile.

The objectives of this study were to analyze the cocoa market and find alternative ways to stabilize cocoa revenues for producers. The specific objectives of this study were to 1) analyze cocoa prices from 1961-2000, 2) examine alternative price risk management strategies. They included: a) routine hedging, b) strategic rollover hedging, c) cash sales at harvest.

The first objective was achieved by giving attention to the causal factors of price volatility and the structural changes that took place in the cocoa market from the 1960s to 2000. This provided background information on the distinctiveness of the cocoa market that was useful in the cocoa market analysis. Additionally, a fundamental analysis was done to determine whether end-of-year cocoa stocks have an impact on the movement of prices. The results from this study indicate that there is an inverse relationship between end-of-year cocoa stocks and prices and that end-of-year cocoa stocks somewhat influenced cocoa prices. A seasonal analysis was done in addition to the fundamental

analysis to determine whether a seasonal pattern exited for cocoa prices. The results indicated that there was not much seasonal variation in cocoa prices with monthly seasonal indexes ranging from .98 to 1.02. This was because the volatility that occurred in the cocoa market was not seasonally related but yearly related.

The second objective was to find alternative ways to stabilize producer returns in the cocoa market. This was achieved by examining the alternative price risk management strategies—routine hedging, strategic rollover hedging and cash sales at harvest in order to determine whether any of the strategies were successful at stabilizing routinely volatile cocoa prices.

The results of the routine hedging strategy indicate that implementing a routine hedge every year in the month with the highest seasonal index from 1971-2000 generated net revenues of $15,916.34 from 1971-2000. This suggests that routine hedging would be an appropriate strategy for cocoa producers to decrease risk.

On the other hand, the results of strategic rollover hedging indicate that despite its effectiveness to improve average net prices for commodities such as corn and soybeans, the outcome for cocoa was unsuccessful. During the past 30 years, cocoa was not a good candidate for strategic rollover hedging. Using strategic rollover hedging from 1971-2000 a producer would have incurred a loss of $304,825.72. This included $50 per round turn for brokerage fees, without the consideration of margin calls.

The reason for its failure was the fact that strategic rollover hedging is based on the assumption that prices will continue to fluctuate within a range similar to those of previous years. However, the cocoa market underwent major structural changes in the last forty-years that might have affected the success of strategic rollover hedging. These

structural changes include the mounting fluctuation of the end-of-year cocoa stocks and the implementation of the International Cocoa Agreement in 1973, and the agreements of 1975, 1980, 1986, and 1993.

The end-of-year cocoa stocks had an impact on prices due to the distinctiveness of the cocoa market. Twelve countries dominate world cocoa production. Thus, a shortage or an excess of production in a major cocoa producing country has an effect on the market because there is an inverse relationship between end-of-year cocoa stocks and prices. Whenever end-of-year cocoa stocks are low, this prompts a price increase. Likewise, when end-of-year cocoa stocks are high this results in a price decline.

The implementation of the International Cocoa Agreement had little effect on the cocoa market. Although the International Cocoa Agreement failed at its attempt to stabilize prices in the cocoa market, the agreement was effective in improving cocoa prices prior to its implementation. It appears speculation about a new agreement had a psychological influence on prices. As a result, prices increased during the discussion stage. But after its implementation, prices quickly retreated.

The structural changes that took place in the cocoa market from 1961-2001 caused the 5, 10, and 15 % upper tail of the price distributions to have large price gaps for several years. For example, the price at the 5% upper tail of the distribution increased from $.69 in 1977 to $1.37 in 1978 because of declining world stocks to historically low levels. Consequently, from 1981 to 1996, the strategies were not implemented because the price never reached 5% of the upper tail of the distribution (table 9). This resulted in the failure of strategic rollover hedging because it is based on historical futures price distributions.

Study Limitations and Further Research

The amount of time the routine hedging and rollover hedging strategies were analyzed was a limiting factor in this study. Futures prices were available from 1961-2000. However, world cocoa average monthly prices were not available until 1971. A longer time frame may have yielded different results for both strategies.

Further research is recommended to determine if strategic rollover hedging is successful for cocoa by implementing the strategies at the 10 or 15% upper tail of the distribution, and to evaluate its effectiveness with other tree crop commodities. This research provides evidence for further study into the success and failure of rollover hedging strategies.

APPENDIX

Table 1. World Cocoa Bean Stocks/Grinding Ratio and Annual Prices from 1970-1999

Cocoa Year	Stocks/Grinding Ratio	Annual Average Prices
	%	Cents/lb
70/71	35	0.27
71/72	35	0.25
72/73	24.9	0.39
73/74	21.7	0.55
74/75	25.2	0.49
75/76	24	0.65
76/77	18.4	1.42
77/78	26.8	1.22
78/79	26.3	1.23
79/80	37.1	0.98
80/81	43.4	0.79
81/82	48.7	0.75
82/83	41.1	0.82
83/84	27.2	1.05
84/85	28.9	1.01
85/86	34.9	0.86
86/87	38	0.73
87/88	46.1	0.58
88/89	57.4	0.47
89/90	63.7	0.41
90/91	66.3	0.39
91/92	63.8	0.38
92/93	64.1	0.34
93/94	57.5	0.44
94/95	48.2	0.43
95/96	51.3	0.45
96/97	47.9	0.51
97/98	41.8	0.73
98/99	46	0.63

Source: Dand 1999

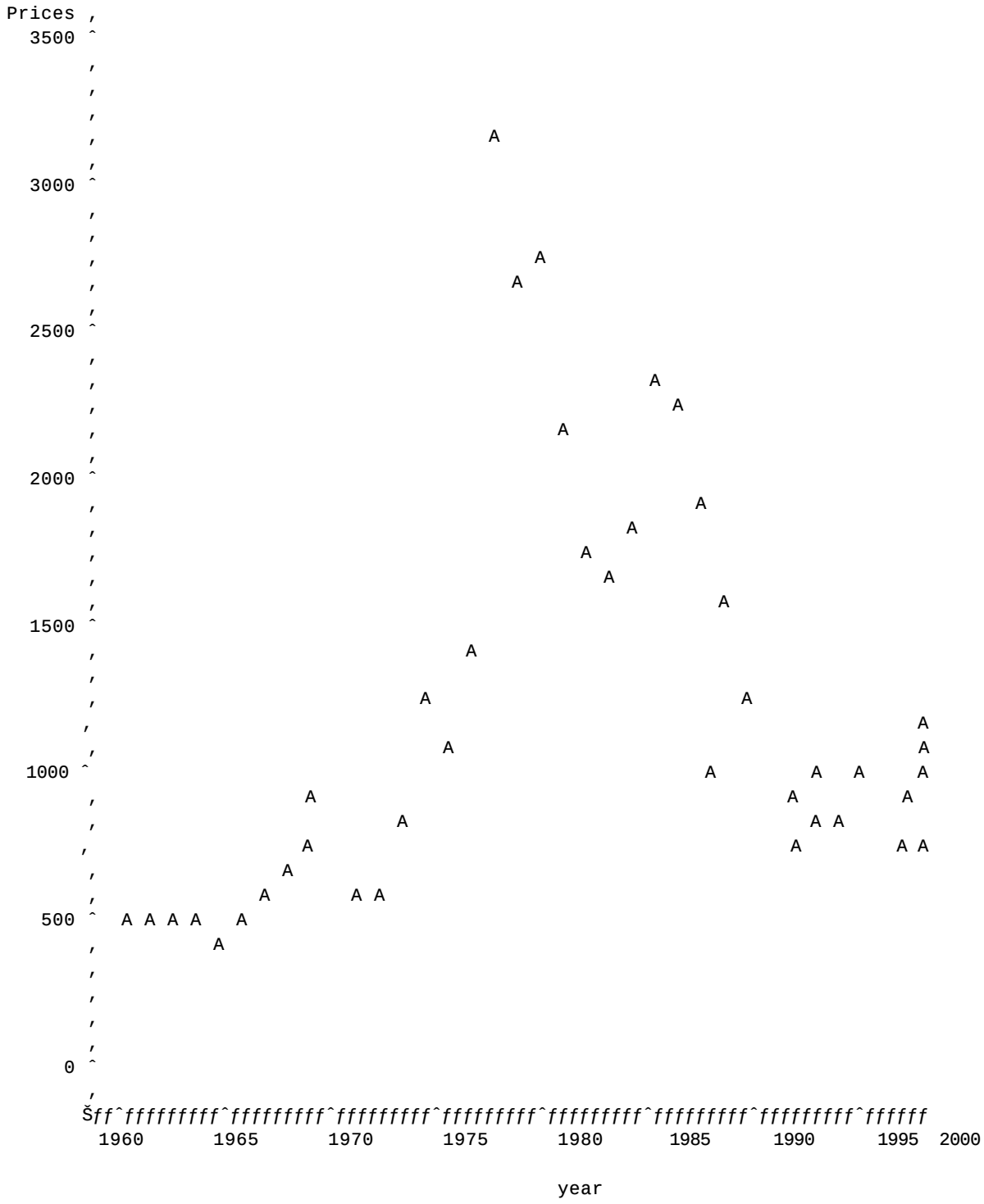

Figure 1. Plot of Prices Per Year

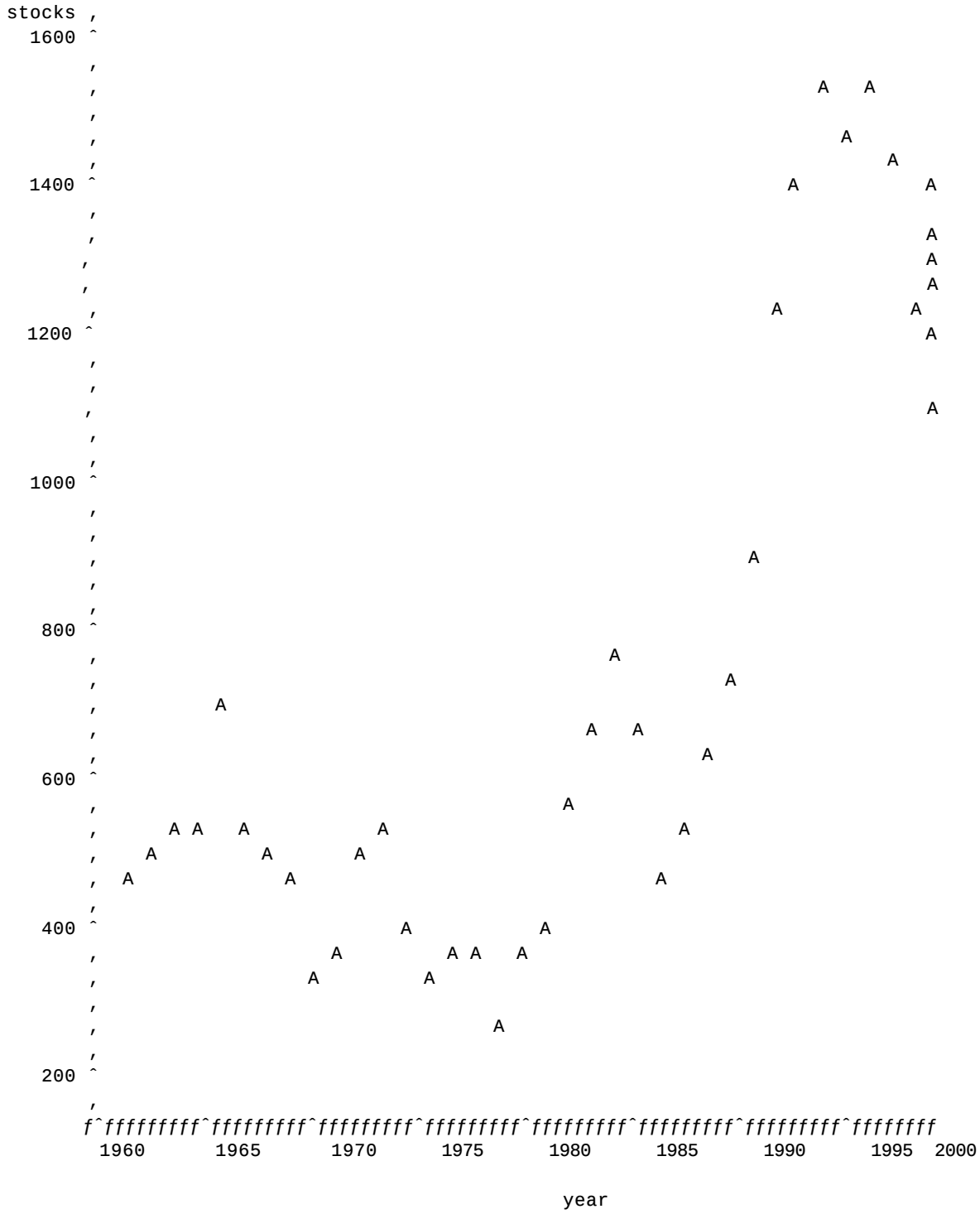

Figure 2. Plot of Stocks Per Year

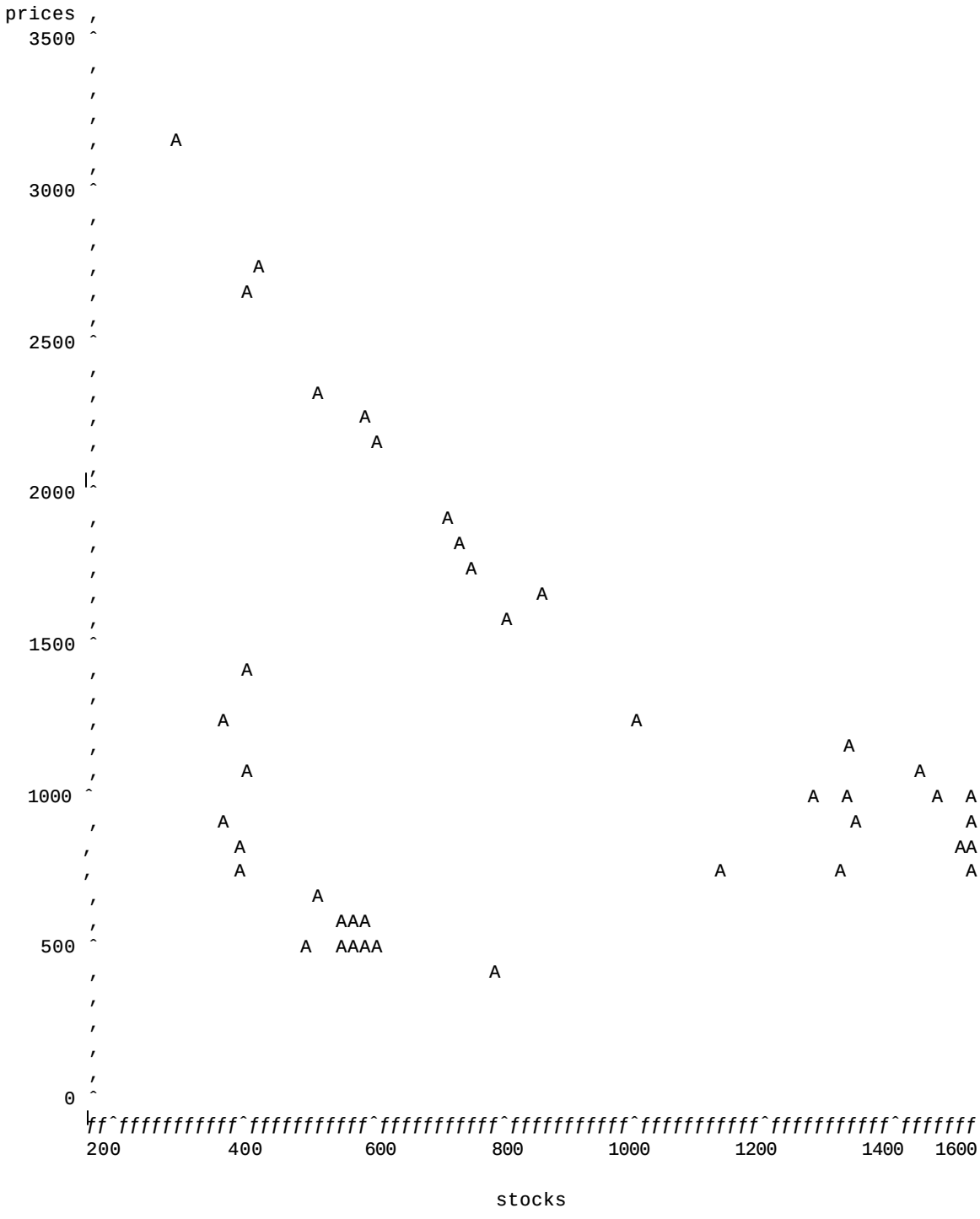

Figure 3. Plot of prices*stocks

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