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APPLICATIONS AND PORTFOLIO THEORY IN THE SOUTH AFRICAN AGRICULTURAL DERIVATIVES MARKET

BY

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in the

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Deon Scheepers
Pretoria
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ABSTRACT

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Degree: MSc Agric (Agricultural Economics)

Department: Agricultural Economics, Extension and Rural Development

Study Leader: Professor Johann F Kirsten

ABSTRACT

South African agriculture experienced rapid deregulation during the 1990s as the one channel marketing boards were dismantled. For the grains industry this meant the rapid development of a derivatives market (SAFEX). Derivative markets are surely the most intriguing and complex financial markets with the most misunderstood and riskiest instruments of all financial markets. Their complexity also caused its fair share of problems within the South African scenario with the inception of SAFEX in 1996/97.

Not only is this type of market complex but it also creates huge fluctuations in the portfolio value of a derivatives linked portfolio. It is precisely this type of fluctuations and exposure that can be controlled and managed to the preferred level of risk by the correct and responsible application of these instruments.

The successful application of these instruments depends greatly on the fact that the underlying market should be an efficient market which will then in turn allow for cost effective pricing of these instruments and ultimately lead to successful product structuring. The South African agricultural derivatives market was tested for efficiency by using a co-integration analysis which proved market efficiency.

Once market efficiency was established it allowed for the structuring of marketing portfolios which ultimately resulted in a rule of thumb marketing strategy for maize producers. The strategy required the maize producer to fix a price during planting period for delivery in July

the following year. In order for the producer to benefit from any potential upside during the season between price fixing and delivery the producer should buy a call option with an expiry date of the month of March following planting. This will save him at least four months worth of time value on the option premium.

This study also acknowledged the fact that the derivatives market in South Africa is still in its fledgling phase and realises the vast potential for risk reduction through radical innovation by creating and mixing the basic positions of derivatives. This study illustrates by way of examples a few approaches in structured products. In an attempt to achieve successful product development the study applied portfolio theory as a means to quantify risk by using mean return and portfolio variance parameters. It addressed the more obvious price risk situation which is faced by all grain producers by developing a rule of thumb marketing strategy for farmers.

The more complex situation of emerging agriculture was also considered where the objective was to enable a small scale producer to benefit from the risk reduction potential of these instruments. At the same time it would also allow them to access production credit without a traditional balance sheet while allowing the financier to be ring fenced from the risk of price fluctuation on the clients profit profile.

A more adventures approach was followed for the dairy industry by creating a proxy price for milk based on the maize price of SAFEX in an attempt to encourage an increase in the volatility of the milk price which could then be managed very successfully through the use of derivatives which will then ultimately enable cash flow management.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND AND CONTEXT

Price variation is as old as the concept of trade itself; in fact it probably originated with the first transactions between humans. However, dealing with price volatility has been a major problem for many, especially in agriculture. Since agricultural production is characterised by volatile supply and relatively price inelastic demand, the agricultural sector is extremely susceptible to high levels of price volatility. What makes the agricultural sector even more vulnerable to price variation is that its impact only becomes absolutely certain during harvest time when realised harvest time prices can be very different from expected prices.

Essential procedures like budgeting, investing, and planning and production decisions are made very difficult by the presence of price volatility, which in turn implies a possibility for error. It is not surprising that when ones livelihood depends on essential production decisions such as what, how much and when to produce, the possibility of error is definitely an unwanted factor within any agri-business operation. More often than not, when these incorrect decisions do happen, whether it was bad judgement or unforeseen circumstances, it causes instability within agriculture that then becomes the problem of society or consumers at large. In some cases this then leads to various forms of government interventions (Pasour, 1990). The international agricultural scene is strewn with examples of government programs attempting to assist decision-makers in coping with the dreaded occurrence of price volatility (Passour, 1990; Jha & Srinivasan, 1999). Often these governmental policies involved direct interventions in the market. South Africa, has had its fair share of government programs, but has abolished all such programmes during the 1994–1997 period of deregulation. Fortunately price risk also implies that there must be an opportunity for profiting from it, by those whom are on the opposite side of those negatively affected.

This study investigates the post Maize Marketing Board era, by looking at the new market based approach for dealing with price risk through the use of derivative instruments and in particular their insurance role. This study also considers the probability that the futures market can lead to profitable returns to those facing price risks by increasing international competitiveness and speculation strategies.

As mentioned above South Africa has moved away from government supported price stabilising programmes, and given the direction and approaches that the new multilateral trade agreements are heading, government programs will keep on declining as far as price stabilisation is concerned (Pennings & Meulenberg, 1997). This in turn will lead to a higher demand for market based solutions to provide insurance like products to guard against price volatility in the future (Morgan, 1999). It should thus be obvious that current policies should strive to enhance/maintain the current success of the derivatives market and in particular its effectiveness and efficiency in order to provide additional services and products in the future. Simply stated, there will be an increase in the demand for hedging services and products from both a marketing and a finance point of view. This tendency is already observable in the European Union with the recent changes to the Common Agricultural Policy (CAP) in the EU (Pennings, 1998).

1.2 PROBLEM STATEMENT

With the deregulation of the maize marketing industry and the dismantlement of the Maize Board, producers became exposed to extreme price risk, which they were not trained to deal with. Producers never had to deal with market risk themselves since the Maize Board took all marketing activities upon itself. The deregulation also led to the formation of the agricultural markets division of SAFEX, which introduced hedging activities as a crucial part of grain marketing. The question is whether the agricultural futures market currently can provide producers financial stability and even protection against market risk (Peck, 1975).

During 1996 South African farmers awakened to the new concept of an agricultural futures market. Although the futures market is not new to South Africa, it was restricted to financial instruments, were it was seen as a dungeon in which secretive obscure happenings took place, and was only understood by some whom were active in the financial markets. As could be expected, there would be certain establishment problems and a learning process to under go. The issues of a newly born futures market forms the focus in this study. One of the most important questions to be examined is whether this market has improved in efficiency (price discovery) and effectiveness (price insurance), and also to identify possible areas of improvement or opportunity. Because the single most important requirement for effective hedging strategies is that the derivatives market itself has to be efficient and effective.

The issue to be dealt with in this study can be broken down into specific research questions.

1.3 HYPOTHESIS

This study hypothesizes that the responsible usage of derivative products can assist the agricultural finance industry to cope with the ever-increasing volatile agricultural environment. Thus given an effective and efficient derivative market, risk reduction through hedging can be accomplished with great success.

It further argues that for a few selected applications and structured products, derivatives are crucial in risk reduction for agriculture in the twenty-first century. To achieve this however, this research will have to be done in three phases for the one builds on the other. Structured products require the structuring of various derivative and finance instruments into cost effective portfolios. These cost effective portfolios can only be structured if the market providing these instrument is an effective and efficient market (Pennings & Meulenberg, 1997).

1.4 OBJECTIVES

The first phase of this study will show that the agricultural derivatives market is efficient and effective. Once efficiency and effectiveness is accepted, the risk reduction aspect as discussed under the hypothesis can be dealt with.

Against the backdrop of an efficient and effective market as shown through phase one, phase two will apply portfolio theory to structure low cost hedging portfolios. With low-cost/ cost effective hedging a possibility as discussed during phase two, it will then be possible to repeat these structured portfolios in phase three on selected high-risk agricultural cases. Phase three will then illustrate useful risk reduction applications of hedging under various agricultural scenarios.

1.4.1 Efficiency

This study has the aim to investigate whether the South African agriculture derivatives market is now efficient or at least still improving. For a futures market to function properly and provide the participants with an instrument that can help them deal with market risk, the futures market should reflect the impact of current information on the future price (Rausser & Carter, 1982; Washburn & Binkley, 1990). A co-integration relation between future and spot markets can measures this market efficiency. The first study of this kind about SAFEX indicated an absence of market efficiency for at least the first three years of the existence of the market (Wiseman, Darroch and Ortmann, 2000). The study should be applauded though for it did make the important observation that over the period investigated efficiency improved over time as the market matured and the participants' knowledge of the market improved.

1.4.2 Required Date Series

A problem, which also spawns one criticism against the Darroch, *et al* study is the lack of an appropriate database for the spot prices, which the authors also highlighted. This is however to no fault of the authors since a proper official data set did not exist. This study to a large extent also struggled with the same problem, a lack of an official spot price database, but a solution to deal with the lack of a spot price database is proposed in Chapter 4.

This problem is current, simply because there is no official body which has been delegated the responsibility of creating and maintaining such a database. It is important that this point be raised to the appropriate authorities because the lack of data could lead to future problems regarding market actions.

1.4.3 Low-cost Hedging Portfolio

Once market efficiency has been established portfolios will then be structured to investigate whether this new marketing approach can stabilise and/or improve the earnings potential of a producer, applying various hedging strategies and evaluating its results within a minimum variance, high-mean portfolio theory framework.

1.4.4 Other Applications and Structured Finance

Finally a couple of potentially structured financing products will be illustrated to highlight the potential use of derivative instruments for the future development of agriculture within South Africa.

1.5 OUTLINE AND APPLICATION OF THIS STUDY

Chapter two of this study describes the historic development from a regulated maize market to a deregulated derivative based market for maize. Chapter three is a literature review chapter which describes and discusses the necessary concepts used throughout this study. Chapter four is an empirical chapter which tests the futures market efficiency hypothesis which then is used to apply to hedging theory in chapter five. Chapter five also illustrates the reasoning behind the optimum hedging portfolio. Chapter six sees the application of hedging through examples to the weather market, the production cost financing market and the milk industry, in an attempt to reduce various types of risks within those markets. This is followed by the conclusions in chapter seven.

CHAPTER 2

LIBERALISATION OF THE SA MAIZE MARKET AND THE ESTABLISHMENT OF THE AGRICULTURAL DERIVATIVES MARKET

2.1 INTRODUCTION

The purpose of this chapter is dual in nature. Firstly, to give a brief background on how the marketing system has evolved up to 1996. For this discussion Section 2.2 will rely mostly on the book by Bayley, "A Revolution in the Market – the Deregulation of South African Agriculture"-, which provides comprehensive summary of the historical evolution of the South African Agricultural Market. Although much of the legislation during the period up to 1996 covered more than just grains, for the purpose of this study only legislation affecting grains is mentioned. Although Section 2.2 have nothing to do with the futures market it is necessary for the sake of comprehensiveness to give a brief outline of the rise and fall of the era, which led to the derivatives market in the post 1996 grains industry. Also note the reasons mentioned by de Swardt in favour of the Marketing Act of 1937, as some of these reasons could threaten the functionality of the derivatives market in the future.

Secondly, Section 3 provides a brief outline of the formation of the Agricultural Markets Division of the South African Futures Exchange – (SAFEX).

2.2 EVOLUTION OF THE MARKETING ENVIRONMENT FOR AGRICULTURAL COMMODITIES UP TO 1996

2.2.1 Situation Prior to the Marketing Act of 1937

World War One led to a stimulation of agricultural production through all round higher prices caused by the shortage of imported products to South Africa due to the war in Europe. However, after World War I the recession of the early 1920's created credit shortages, which led to declining agricultural prices due to bankruptcies amongst farmers and merchants alike.

The instability which followed resulted in complaints by agricultural spokesmen that agriculture was affected negatively by at least two main factors, inadequate infrastructure and that farmers were the victims of the activities of speculative traders (de Swart, 1983). The government responded with the Co-operatives act (No 28 of 1922) and increased credit through the Land Bank (de Swardt, 1983). The problem of low agricultural prices still persisted and the complaints from the agricultural community continued. A second legislative attempt to deal with low agricultural prices came in the form of the Export Subsidies Act (No 49 of 1931), which allowed for export subsidies on maize, butter, cheese, eggs, meat, fruit, wool, hides, wattle bark, mohair, brandy and wine (Richards, 1935).

The Export Subsidies Act of 1931 was followed with further continuing lobbying for a system of "orderly marketing", "one-channel" sales and compulsory co-operation. This was answered by the government in the from of the Viljoen commission in 1933 (Bayley, 2000), and was accepted by the government in 1934 (de Swardt, 1983).

The commission concluded that;

1. It couldn't recommend compulsory co-operatives since its main objective would be to control prices and not so much the promotion of the essential principals of co-operation.

2. The removal of section 17 from the 1922 Co-operatives act.

3. The proposed one-channel sale by means of a statutory board was not acceptable as this would be no different than compulsory co-operation.

4. It noted the dangers of price fixing especially where a price would be fixed at a level higher that that warranted by a competitive market system.

2.2.2 The Period 1937 to 1996

The period of 1937 to 1996 saw South African grain producers operating under a one channel marketing system. It was brought about by the 1937 Marketing Act, which created the

National Marketing Council and various marketing and control boards in spite of the recommendations of the Viljoen Commission in 1933.

De Swardt (1983) became convinced that “the basic causes of the agricultural marketing problems of that time were not all of a temporary nature”. He published a memorandum in which he stated the problems, which he thought would make the marketing problem a persistent and recurring one, and thus necessitated statutory powers to correct the problem. The arguments listed below as presented by de Swardt led to the government ignoring the Viljoen Commision’s recommendation, and drafted a marketing bill to be presented during the 1936 parliamentary session, which resulted in the 1937 Marketing Act (Bayley, 2000).

- Agricultural products have an inelastic demand.

- Agricultural production was susceptible to supply shocks due to its relative international isolation and susceptibility to weather conditions.

- Imperfect knowledge about market conditions makes importing, exporting and storage activities risky.

- Market imperfections resulted in significant price spreads between the domestic and international markets.

- Market speculation and the suspicion of market manipulation led to dissatisfaction amongst producers.

The purposes of the marketing boards were mainly to increase, price stability, farming efficiency, reduction of producer to consumer price spreads and producer prices. During the period of World War II South Africa experienced food shortages due to both the war and draught, but agricultural producers did not benefit from higher prices as they were apparently persuaded by the boards that price stability over the longer term is more important. After the war prices did not increase and maize farmers pressured for the implementation of the 1937 marketing act to actually increase prices. From 1948 the government responded and the National Party predominantly used the marketing boards as price supporting tools.

During the period of 1937 to 1996 many a change/improvement was most notably seen in the Marketing Act no.59 of 1968 which also underwent many amendments. The objectives included, narrowing the marketing margin, increasing productivity and enhancing price stability. By the early 1990's the act was shrouded in controversy and it was marked by great contempt towards the marketing act. It was clear that the system suffered from many flaws and criticism abounded (Groenewald, 2001). The Minister of Agriculture acknowledged the public debate and appointed the Kassier Commission to investigate the agricultural marketing system and to recommend on corrective actions. The flurry of criticism in response to the conclusions of the Kassier Commission, which essentially concluded that the Marketing Act "did not satisfactorily achieve its intended goals and objectives", forced the Minister to appoint a second committee. He appointed the Agricultural Policy Evaluation Committee (AMPEC), to address the concerns of some of the interest groups. AMPEC reported in 1994 in favour of maintaining the *status quo*, but also a reduction in regulation and increased transparency (Groenewald, 2001).

2.3 MARKETING OF AGRICULTURAL PRODUCTS ACT NO. 47 OF 1996

On the 7th March 1995 the draft Bill to replace the 1968 Act was published in the Government Gazette and was based on the AMPEC report of 1994. The Bill was heavily criticised since it was very similar to the 1968 Act.

According to Bayley the main criticisms of it were that:

- It was still heavily in favour of producers.
- Did not specify criteria against which market intervention should be judged.
- The Bill will still allow parties with vested interests to drive government policy.
- The Bill still allows strong market intervention.

The African National Congress (ANC) responded with their guideline document, which was influenced by the report of the Kassier Commission, and which was in favour of market related pricing and marketing systems. The parliamentary committee wanted the new Bill to have consensus support from both the National Party and the ANC, but before this could happen the National Party left the Government of National Unity and Dr. Kraai van Niekerk was replaced by Mr. Derek Hanekom as the Minister of Agriculture. The ANC then went into consultation with the South African Agricultural Union (SAAU) to negotiate amendments to the guideline document of the ANC, which resulted eventually in the Act of 1996 being passed by Parliament on the 5th January 1997, with public support from the SAAU. The new 1996 marketing act was responsible for the dismantling of marketing boards at the time. However, the 1996 Act was similar to the 1968 Act in the sense that they both delegated statutory powers to the Minister. 1997 saw the then Minister of Agriculture, Mr. Derek Hanekom making use of this new Act when he decided that 1997/98 would see no intervention in the market for maize (Bayley, 2000).

The new Agricultural Marketing Act of 1996 heralded the movement towards a multi marketing channel system for South African grain producers, since all marketing boards had to be phased out by the 5th January 1998 deadline. The objectives included improved market access and export earnings, more efficient marketing and a higher degree of sustainability of the agricultural sector.

This deregulated market also led to extreme price fluctuations as illustrated in Table 2.1 and Figure 2.1.

Table 2.1: Closing Prices at High and Low Points for nearest SAFEX White Maize Delivery Month Contracts Cycles

Date Low point of Cycle	Price at Cycle Low R/t	Date Highpoint of Cycle	Price at Cycle High R/t
01/06/98	620	08/07/98	835
05/11/98	598	17/03/99	989
11/08/00	490	30/01/01	890
29/05/01	733	18/03/02	2140
19/07/02	1630		

(Source: Johannesburg Stock Exchange)

Figure 2. 1: Closing Prices for the Nearest Expiry Contract for White Maize

2.3.1 Development of the South African Derivatives Market for Agricultural Commodities

In a deregulated environment, one approach in dealing with price variability is through hedging. Hedging the crop at the right price level will contribute to sustainability and enhanced international competitiveness by yielding profitable operations even in the face of adverse delivery/spot prices at times of harvest.

Thus given the need for hedging services, the South African Futures Exchange (SAFEX) listed its first agricultural commodities contract under the Agricultural Markets Division (AMD) in the first quarter of 1996. For clarity purposes it should be noted that SAFEX has been operating with various instruments on the financial markets since the 1980's. From here onwards reference to SAFEX in this study, implies the Agricultural Market Division unless stated differently. Thus most of the know how and administration services required to run a futures exchange was already in place, and merely required an expansion of SAFEX to accommodate the Agricultural Markets Division. The first quarter of 1996 saw a total of 485 maize contracts (48 500t) traded. Since those early days the market has seen a substantial increase in volumes with current volumes some times exceeding 5 000 contracts (500 000t or 19 700 000 bushels) per day just on one contract month. Figure 2.2 below shows the exponential growth in volumes experienced by SAFEX.

Contracts for other commodities were also launched, Wheat, Beef, Spud, Sunflowers, and maize contracts of second grade quality. As can be expected the futures market also had its fair share of growing pains and failures, most notably the complete failure of the beef and spud markets, which were eventually discontinued. The remaining commodities still listed, traded with variable degrees of success but with definite improvement in volumes, and hence the future prospects seem positive. With the advantage of hindsight many of the problems could probably have been foreseen, and can most surely be attributable to shortcomings of one or more of the requirements for a successful listed contract.
Source: SAFEX

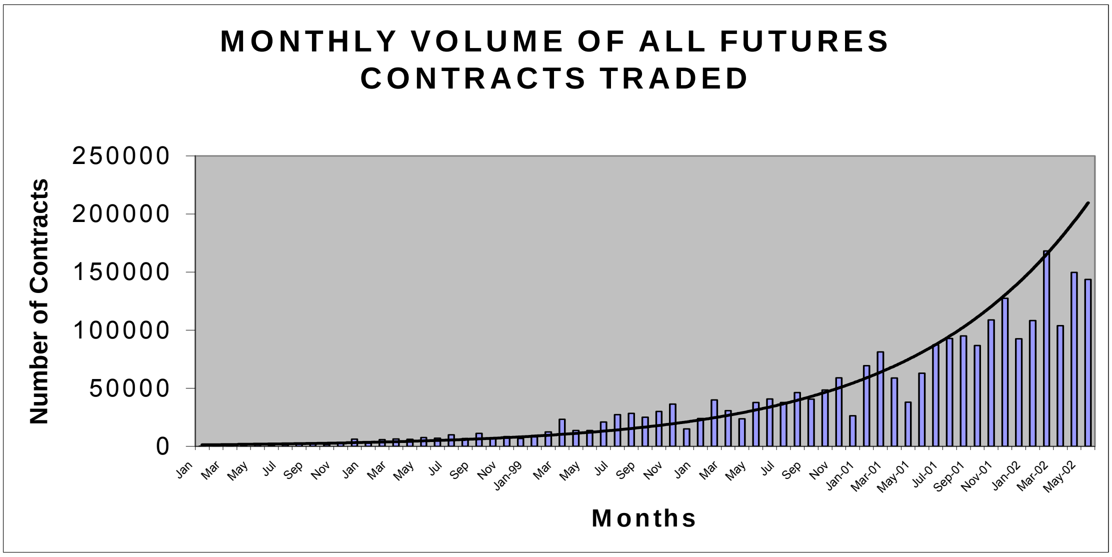


Figure 2.2: Histogram Illustrating Monthly Volumes Traded on SAFEX

A further major milestone in the success of SAFEX and its growth towards a fully-fledged efficient derivatives market came with the listing of options on the underlying contracts. This has opened a whole new industry with high stakes for those involved in the writing and dealing of options. It has also widened the possibilities of risk management and increased the number of hedging alternatives for both producers and consumers alike. The listing of options has also undoubtedly led to an increase in volume due to various option writers/speculators joining and so increasing liquidity, with concepts, phrases and strategies like delta hedging and calendar spreads at the order of the day. Note however that options and futures do trade on the same exchange and for practical purposes it is the same market.

Additional to the above mentioned, but also equally important in its own right, was the listing of contracts for second grade maize and the introduction of the constant delivery month contract. A more complete description of the constant-delivery-month-contract is presented in Chapter 4. Both of these contracts have the objective of assisting in actual physical delivery of the underlying commodity to the futures market. Although physical delivery onto SAFEX is not encouraged nor the main objective, it is no reason for neglecting to improve the process for a smooth running and correctly functioning system especially in the absence of a formally structured underlying cash market. A correctly functioning system is required to improve the efficiency of the derivatives market in terms of conveying information, which will happen through arbitrage between the various spot markets and the futures markets. (Sexton, Kling & Carman, 1991).

One of the most important developments of SAFEX, all though a more philosophical aspect, is the improvement in market efficiency. Previous studies of this nature has shown that although SAFEX did not start out as a completely efficient market, it has been improving over time and will probably continue doing so for some time to come. (Wiseman, Darroch and Ortmann, 2000). One of the reasons for this improvement in market efficiency is the increase in knowledge of potential and current participants, which in itself leads to an increase in active participants, which leads to higher volumes and a larger information base, which ultimately contributes to market efficiency and transparency. This important requirement of knowledge for a successful market (Van Der Vyver & Van Zyl, 1994) has really been boosted by the exchange itself through various educational initiatives.

Table 2.2: Listing Schedules of All SAFEX Contracts Listed to Date

Contract Name	Listing Date	Last Traded Date	De-listing Date
Beef	March 1995	February 1997	January 1999
Cape Wheat	February 1999	December 1999	December 1999
Spud	October 1995	November 1996	January 1999
Sunflower	February 1999	Ongoing	
Maize White WM1	March 1996	Ongoing	
Maize White WM2	July 2000	Ongoing	
Maize Yellow YM1	March 1996	Ongoing	
Maize Yellow YM2	July 2000	Ongoing	
Wheat	November 1997	Ongoing	
Soya	April 2002	Ongoing	

**** WM1, WM2, YM1 and YM2 white and yellow maize of grades 1 and 2.***

2.4 Summary

The first formalisation of the South African grain marketing environment started with the Co-operatives act of 1922 in an attempt to curb the problems experienced during the 1920 economic resision. The Co-operatives act was then supported, first with the Export Subsidies Act of 1931 and then with the 1937 Marketing act. The Marketing Act empowered the National Marketing Council and the various marketing control boards. By this time the one channel marketing system was in operation and remained the *status quo* until the "Marketing of Agricultural Products Act no. 47 of 1996".

The new 1996 marketing act allowed for the deregulation of grain marketing which then saw the start of the South African Futures Exchange (SAFEX). The first trades during 1995 and 1996 were only futures contracts, and options then followed in 1997. Table 2.2 showed all the commodities that were listed on SAFEX although not all the commodities were successful. Figure 2.2 showed the increase in the volumes traded on the exchange since inception and one would expect the rapid increase in volumes to continue for the next few years.

CHAPTER 3

EFFICIENCY, INSTRUMENTS AND PORTFOLIOS IN AGRICULTURAL DERIVATIVE MARKETS

3.1 INTRODUCTION

This chapter consists of four subsections, which deals with the literature reviews of four concepts to be used further in this study. Firstly Section 3.2 provides a literature review on testing for futures market efficiency. Once the level of efficiency between spot prices and futures prices for white maize is known, Chapter 6 proceeds with developing marketing strategies within the market. These marketing strategies consist of the structuring of various market instruments and thus essentially creating a portfolio of instruments in an attempt to protect against price and thus financial risk. This study compares the results of these various portfolios against one another based on the concepts of a mean variance portfolio analysis. Section 3 in this chapter provides a brief description of mean variance portfolio analysis to be used in evaluating the results of Chapter 6. Construction of these portfolios will depend on aspects such as the pricing of options, which is discussed in Section 4.

3.2 DEFINING FUTURES MARKET EFFICIENCY

Market efficiency concerns the flow of information between the various market participants, and the reflection of this information in the market price of the underlying instrument which they trade. Since the underlying instrument which is being traded for this study is a maize futures contract, it is important to realise that the characteristics of the contract it self will play a crucial role in the view of the various market participant who will ultimately trade in the instrument. This makes the contract structure and specifications thus an important factor to enhance the liquidity of the contract which will then ensure an active market which in turn could greatly contribute to the efficiency of the market. The contract requirements and market efficiency will be described under sections 3.2 and the relevant market participants under section 3.3.

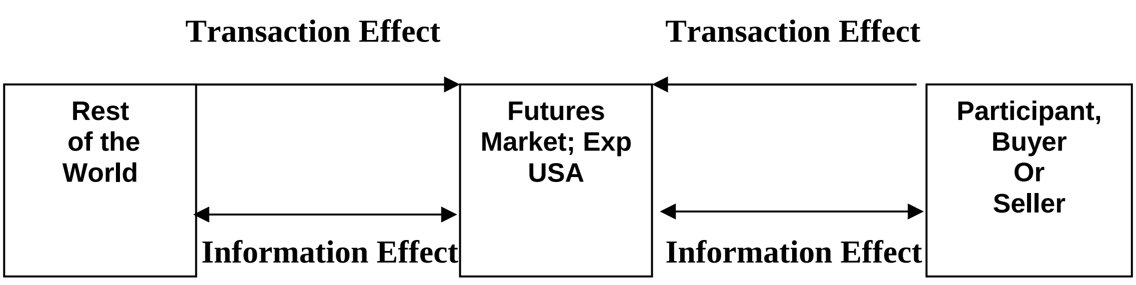
3.2.1 Defining Market Efficiency

For the sake of completeness and the purpose of making this research relevant to the real world, efficiency in this context must firstly be defined. Secondly, only once the essentiality for a futures market to be efficient has been highlighted, can the question of whether SAFEX is efficient or not be raised.

Finance literature often simply define an efficient market as one in which prices reflect all available information (Fama, 1970). The preceding definition is by no means incorrect, and often sufficient, but it does however suffer from a great degree of incompleteness. Given the two aspects of a market, transactions and information, the definition can be expanded to include the facilitation of transactions. An efficient market should therefore facilitate transactions effectively and by so doing; improve the aggregate information based on the terms of the transactions.

The efficiency of a market depends on the ease or difficulty of transferring ownership of a good or service (that is, '**transaction costs'**) as well as on the quality of information conveyed about the terms of the transactions. The quality of information also relates to both the **liquidity** of an asset and the efficiency with which an **asset** is **priced** (Burns, 1983).

Market efficiency is thus related to the three aspects of, liquidity, transaction costs and pricing efficiency. All though this research will not deal with transaction costs, it will focus on pricing efficiency and the issue of market information. For the purpose of this study futures market efficiency is defined in terms of information aspects and pricing efficiency.



Source: Van Der Vyver, 1987

Figure 3.1: The Transaction and Information Effects of a Futures Market

Futures markets are efficient relative to an information basis in such a way that only new unanticipated information will lead to a price change (Chowdhury, 1991). Such a situation of a near perfect information adjustment process will not allow for profitable trading strategies to exist, and so will also lower transaction costs by saving on costly information searches (Wiseman, Darroch and Ortmann, 2000).

From the above can be concluded that an efficient futures market should give a correct, and unbiased, forecast of the future spot price at the maturity date of the specific forward contract. For the effective process of price discovery by means of a futures market, it requires from the futures market to discount all publicly available information correctly into the price of the future contract at the nearest opportunity (Fama,1970). This issue will be dealt with in greater detail in Chapter 5.

3.2.2 A Successful Futures Contract

For a commodity futures contract to be successfully traded certain requirements should be satisfied. They range from product characteristics to market factors. This section briefly highlights the requirements and the effect should one of these requirements not be satisfied, and draws heavily from Van Der Vyver (1994).

3.2.2.1 Product Characteristics for a Successful Contract

It must be a commodity that is homogenous and it must be possible to be graded or classified into a standardised quality and quantity. This would enable all market participants to know exactly what quality of the commodity is being traded without ever seeing the commodity itself. For example, a buyer can buy a contract for maize without ever meeting the producer and he will still know exactly what quality he will be receiving. It implies that commodities such as grains and meat is tradable on a futures exchange and products like bottled wine is not.

The commodity should be storable, and be cost effectively transported in bulk over long distances. This requirement is especially essential to the arbitraging function and thus a necessary requirement for arbitrageurs to function effectively, for arbitrage it self is very crucial action in any derivative market to ensure an effective pricing mechanism (Sexton, Kling and Carman, 1991). The issue of transportability makes it possible to have physical delivery to the derivatives market. If a product does not comply with this criterion it could be possible to create a contract that can only be settled in cash, very similar to the financial futures contracts. This was the case with the potato contract that traded on SAFEX for a while. It does however require a very well established underlying cash market. In the case of the potato contract a five-day average was calculated on the four major markets in South Africa. The result was taken as the underlying commodity price.

3.2.2.2 Market Characteristics for a Successful Contract

The commodity that is being traded on the futures market should also be traded on a well functioning cash market. This market needs to be a market with free moving prices (not regulated); it should be determined by supply and demand factors. It also implies that a few big participants should not manipulate the market.

The commodity traded should also be subject to frequent price variations. If the product is not exposed to price movements there is no price risk, and thus no need for hedging against a movement in price. It will also hinder speculators in participating in this contract for they need frequent price movements, which will create frequent profit opportunities, and so make their efforts worthwhile.

The contracts need to be traded frequently, meaning a high degree of liquidity is needed. When liquidity in a market is absent the situation could arise where a participant cannot take the position required, or maybe not a big enough position to ensure an adequate hedge. This situation would then be adding an additional risk factor to a market that has been designed to reduce risk. The biggest threat of low liquidity though is the possibility that a position cannot be closed quickly enough resulting in monetary losses.

3.3 DEFINING PARTICIPANTS AS FARMERS, SPECULATORS AND CONSUMERS

The success of the market objectives to all participants will be greatly enhanced by an efficient and effective market. It is therefore necessary to look at the participants involved and how market efficiency will benefit them.

3.3.1 Hedgers

Hedgers are all participants whom are involved in the market with the objective of forward pricing in an attempt to protect them selves against cash market price risk. They enter the futures market by taking a position when the futures price is at such a level that production costs is covered and the price also presents a profit margin (Berck, 1981). For their hedging strategies to function properly there has to be a predictable relation between the cash price (spot price) and the futures price. Thus when new information causes the cash price to rise it should also cause the nearest futures contract price to do the same, or when new information causes the futures market to react one should expect the same reaction on the cash market. All though the size of the price movement in the two markets does not necessarily have to be the same, thus introducing basis risk because of a change in the basis size. Thus all though the size of the basis can change the direction of the price changes in the two markets should be the same for the hedging strategies to work, and if not so, at least be explainable and predictable. This reaction of the two markets to the same information is due to an efficient market reacting to market information in an efficient manner (section 3.2.1). In conclusion then, a hedgers hedging strategies will only be effective if the market is efficient in regard to dealing with market information.

Regarding market effectiveness, it requires that hedgers can implement new strategies or adjust current strategies at any time, thus the market should be liquid and transaction costs should be negligibly small. This can only be the case if there is enough participants which thus requires the presence of speculators.

3.3.2 Speculators

Speculators serve a dual purpose in the market by firstly providing market liquidity and secondly disseminating information to the market through the price based on their market actions. In essence a speculator is willing to accept a market position from another party and so expose himself to price risk for as long as he sustains his position. He does this with the aim of passing his risk on to another party later on, and for this service of being prepared to carry the price risk he hopes to closeout his market position at a profit. Speculators aim to profit from price movements by taking a position on the market, which will yield a profit if their market view is correct. Speculators will adjust their market view given the information available to them. Their market views vary in time-span from the very short to longer-term strategies, but always short of long-term investments. The short-term nature of their holdings in the market requires of them to be regular traders in the market in order to adjust their portfolios to their ever-changing views. These regular actions by speculators bring with it much needed liquidity, which in itself contributes to improved market efficiency.

For their efforts to be rewarded they do require though that the market respond in a predictable manner to new information, and thus require a market which is efficient relative to information. This will enable them to profit from market moves by analysing, anticipating and predicting information. Their constant involvement through trading activities based on their use of information in itself contributes to improved market efficiency. They thus discount all available information into the market price through their trading activities.

3.4 A HISTORY OF DEVELOPING A MARKET EFFICIENCY TEST

From a simple explanation of the functioning of a futures market it can be shown that the most simplistic mathematical function to illustrate the efficiency concept is given by the formula below.

$$S_{t+i} = a + bF_{t+i}^{t} + e_{t+i} \qquad (3.1)$$

From this function it could easily be assumed that OLS regression shall be sufficient for measuring efficiency. From the above equation S_{t+i} is the spot price at time interval t+i; F^{t}_{t+i} is the current price at current time t, for the futures contract of S maturing at date t+1 and e_{t+i} is an error (e) random disturbance term with a mean of zero and variance σ_e^2 (Elam & Dixon, 1988). Under this circumstance pricing will be considered efficient and unbiased, if $a = 0$ and $b = 1$, which could be tested with an F-test. Generally the *a's* of these models will test positive, whilst the *b's* will indicate less than 1 especially for most longer dated contracts (Bigman, Goldfarb and Schechtman,1983). With $a > 0$ and $b < 1$ as results from the standard tests, one would conclude, the futures price a biased predictor of the spot price, thus an inefficient market.

Indeed, the above OLS was the approach followed until 1985 when Maberly in his article entitled *Testing Futures Market Efficiency- A Restatement*, disagreed with the conclusions drawn from OLS regression test for market efficiency. He argued that $a > 0$ and $b < 1$ resulted from applying OLS to censored data (Maberly, 1985).

In 1988 Elam and Dixon applauded Maberly for showing that the OLS test tend to incorrectly prove futures markets to be inefficient. However, they challenged his explanation, by stating that "the OLS estimates for a and b are biased because the explanatory variable $F_{t+i}^{t} = E(S_{t+i}) = S_t$ is a lagged value of the dependent variable (S_{t+i}). The bias is caused because there is correlation between the independent variable and previous values for the error term." (Elam & Dixon, 1988). The non-stationarity of the data series in the specific case of futures markets in almost unavoidable and almost wanted, since in an efficient market the one data series F_{t+i}^{t} is literally derived from the other S_t through the actions of spread traders. The only difference between the current spot price S_t and the futures price F_{t+i}^{t} is carrying cost and therefore a direct function of each other, except for where the futures price and the spot price represent crop from different production seasons. Elam and Dixon continued by showing through Monte Carlo testing the inappropriateness of the F-test, of testing for $a = 0$ and $b = 1$, in this circumstance where the equation is usually non-stationary. They also raised the point that non-stationary price series with small sample sizes were more likely to incorrectly be proven as inefficient with the OLS tests (Elam & Dixon, 1988).

Previous attempts to evaluate market efficiencies, and when concluded the absence thereof will in many cases now be concluded otherwise, should these studies be repeated, and should non-stationarity be taken into account. However, if non-stationarity is not a present issue then the initial approach should still be valid. Testing for a non-stationary series should thus be the first step when attempting a futures market efficiency test. Should non-stationarity prevail original approaches will be flawed, potentially resulting in incorrect conclusions.

Given the bias, which results from the correlation between the independent variable and its previous values of the error term, the co-integration technique developed by Engel and Granger in 1987 could be used to test for market efficiency with non-stationary price series. (Shen & Wang, 1990). The inability of making strong statistical inference with respect to a and b in equation 3.1 led to the development of a co-integration approach of testing with a maximum likelihood method (Stock, 1987). This procedure, which was developed by Johansen, allows for formal testing of likelihood ratios of the parameters between non-stationary variables. It is based on a vector autoregressive model, which allows for possible interactions between the spot and futures prices (Johansen, 1988). Lai and Lai suggest the use of the procedure developed by Johansen to test for market efficiency (Lai &Lai, 1991).

Testing for non-stationarity with the South African maize price series will be performed in Section 4.5.

3.5 OPTIONS PRICING

3.5.1 Introduction

The option prices used throughout this study was calculated by using the Black-Scholes options pricing model. The model was first published in the early 1970's by Fischer Black and Myron Scholes (Black and Scholes, 1973):

$$\omega(s,t) = xN(d_1) - xe^{r(t-t^*)}N(d_2) \tag{3.2}$$

where

$$d_1 = \frac{\ln\frac{s}{x} + (r + \frac{1}{2}v^2)(t-t^*)}{v\sqrt{t-t^*}} \tag{3.3}$$

$$d_2 = \frac{\ln\frac{s}{x} + (r - \frac{1}{2}v^2)(t-t^*)}{v\sqrt{t-t^*}} \tag{3.4}$$

All though the formula was originally developed to price American and European options on equities the formula is equally applicable on agricultural derivatives and hence the formula is widely used by all participants on the Johannesburg Stock Exchange (JSE). The relevant variables from equations 3.2, 3.3 and 3.4 are laid out in Table 3.1.

Table 3.1: Variable Descriptions for Equations 3.2, 3.3 and 3.4

S	Market Price
X	Strike Price
ω	Option Price
R	Interest Rate
t	Current Date
t^*	Expiry Date
$t-t^*$	Remaining Time Span of Option
v	Market Volatility

3.5.2. Intrinsic Value versus Time Value

The price of an option can be broken into two components, intrinsic value and time value. Consider for example a R1500/t call option with a future expiry date of December 20xx, which is currently (September 20xx) trading at R150/t and the current December 20xx futures price at R1580/t. This option price includes an intrinsic value of R80/t (R1580/t-R1500/t) and a time value of R70/t(R150/t – R80/t)

Intrinsic value represents the amount that would be realised if the option was to be exercised immediately where as the time value component reflects the potential opportunity cost by which the seller of an option would have to be reimbursed since he sacrifices potential future income. The variables listed in Table 3.1 are the same variables responsible for the price of an option and they can be grouped into the two sub-sections. The first two market price and strike price are responsible for the intrinsic value component and the rest for the time value component.

In the case of a Put-option the lower the strike price *(X)* the cheaper the option and the higher the strike *(X)* the more expensive the option. Regarding the futures market price *(S)*, the lower the market price *(S)* the more the intrinsic value and thus the more expensive the option becomes. The following equation represents these relation ships for a put-option where *OP* represents the options price.

$$OP_t = X - S_t$$

In the case of a Call-option the lower the strike (*X)* the more expensive the option becomes, and the higher the strike (*X)* the cheaper it becomes. Regarding the futures market price (*S)*, the higher the market price (*S)* the more the intrinsic value and thus the more expensive the option becomes. The following equation represents these relation ships for a call-option where *OP* represents the options price.

$$OP_t = S - X_t$$

3.5.3 Option Price Variables

3.5.3.1 Time-Period as Option Price Parameter

This section discusses the three factors which influences an option's time value (Hull, 1997).

Time value originates from the fact that the longer the time until expiration, the more opportunity for buyers and sellers to profit - therefore, the premium will reflect more than just the intrinsic value. The amount of time value depends on the time remaining until expiration. Time value decreases with the length of time until expiration. At expiry date, the time value must be zero. However, the time value does not erode on a straight line basis. It decreases much more rapidly during the last few weeks of an option's life as the chances of a price change diminish progressively. At the beginning of a long-term option's life (three months or longer) the effect of time erosion is usually minimal, but during the last three months it becomes precipitous. Therefore, as seen in Figure 3.2 the loss of time forms a negative exponential curve.

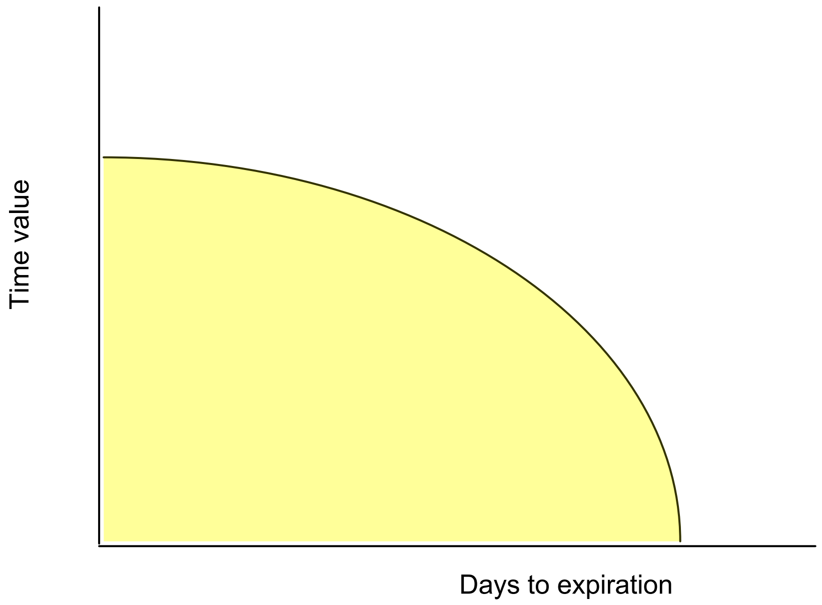


Figure 3. 2: Time Value Decay

Firstly, remaining time-period until expiration. The more time an option has until expiration, the higher its premium. This is because the option and the underlying futures contract price have more time to fluctuate in value. Time increases the probability that the option will, at some point, move into the money and become profitable for the buyer, implying a larger risk for the seller whom needs to be reimbursed accordingly.

3.5.3.2 Volatility as Option Price Parameter

Secondly, the volatility of the underlying futures price. Option premiums are higher during periods of volatile futures prices. Because there is increased price risk associated with a volatile market, and thus the cost of obtaining the insurance through options is also greater. An option is more likely to move in-the-money and become profitable for the buyer when prices are volatile. Sellers on the other hand attempting to avoid losses requires higher premiums to cover increased risk. The most common method of estimating volatility is to use the standard deviation of daily or weekly historical price changes over a longer period (Black and Scholes, 1973).

3.5.3.3 Interest Rate as Option Price Parameter

The third factor affecting time value is interest rates. Since the principle concept of pricing an option is to calculate the present value of a probable futures price the interest rates and option premiums move in opposite directions, all else being constant. When interest rates increase, options premiums decline. If interest rates increase, present value of the expected future profit declines while the implied cost of the option increases.

3.6 SUMMARY

This chapter described the concept of market efficiency by illustrating the flow of information between market participants and the market price. The chapter also described the importance and characteristics of the traded instrument to enhance liquidity, by satisfying the needs of the various market participants who trade these instruments, which could then contribute to efficiency.

Section 3.5 described the mechanics of options and the Black and Scholes pricing formulae for determining option prices. This will be the option pricing formula which will be used throughout this study to calculate the values of the options. All though various other option pricing models has been developed since the Black and Scholes model which might even be more appropriate they are not an alternative for this study. The only pricing model which is used by the JSE trading system to generate options prices is the Black and Scholes model and therefore also the only model predominantly used by all market participants and option writers. Any other model would be an exercise in vain for it would be practically in executable in the SA Market.

CHAPTER 4

DATA AND METHODOLOGY: NON-STATIONARITY AND CO-INTEGRATION

4.1 INTRODUCTION

Chapter five derives a generic timescale strategy for maize producers to reduce price risk at minimum to zero cost compared to normal price insurance while not lowering the net price received and leaving the producer to benefit from any increase in producer prices. This will be achieved through hedging activities by using the South African derivatives market for grain. In order to develop this timescale hedging strategy for maize producers it is important to first test for efficiency of the South African futures market as discussed in Chapter 3. The result of the efficiency test performed is discussed in Section 4.6. Although the co-integration analysis performed here is not the primary objective of this study, it is a crucial part albeit a small part. If market efficiency does not exist then none of the applications as discussed in chapters 5 and 6 will be effective. In other words the success of the applications and solutions in chapter 5 and 6 depend on the assumption of an efficient derivatives market, and this chapter therefore discusses the accuracy of such an assumption (Pennings & Meulenberg, 1997).

The first part of this chapter describes the data problems encountered and the methodology applied to overcome the data problems. Once the data series has been constructed it is applied to a non-stationarity test and co-integration analysis as described in Sections 4.5 and 4.6.

In Section 4.5 the need and the description of the non-stationarity test to be performed on the two data sets are discussed. The results of the non-stationarity tests and the order of stationarity are discussed in Section 4.5.2. After showing the non-stationarity characteristic of the data sets, Section 4.6 will discuss the co-integration approached to be used in testing for long-term co-integration relationship followed by Sections 4.6 and 4.7 which is a discussion of the results and the conclusion on whether market efficiency does exist.

4.2 PRICE DATA SERIES

4.2.1 Introduction

Previous studies (Wiseman, Darroch and Ortmann. 1999) of this nature has been done with a spot price series as obtained from SAFEX. This study does not make use of spot price series for two reasons. Firstly, it was not observed prices but a calculated price series obtained from a few traders across the country and then the linear average was published. Secondly, SAFEX discontinued publishing the spot price series since the inception (April, 1999) of the constant delivery month. For all practical purposes the constant delivery month can be regarded as the spot price for SAFEX, Randfontein, South Africa. It should be remembered that for as far as the logistics of the spot price is concerned it might be more complicated than the constant price on SAFEX but from a price point of view there will be no difference except for occasional premiums for the holder of the grain. This occurs for the simple reason that no producer would sell at a spot price which is less than the SAFEX derived price, if his offered spot is less than the SAFEX derived price the holder of grain would simply switch to delivery on SAFEX, thus making the SAFEX derived price always at least the worst case scenario price for the holder of grain.

The data sets on futures prices were obtained from SAFEX and is the daily MTM prices for the relevant contract months. The exact application and descriptions of the data series' for the various topics in chapters 5 and 6 are clarified in sections 4.2.2 and 4.4 of this chapter.

4.2.2 SAFEX' s Constant Delivery Month Data

SAFEX introduced the constant delivery month contract concept in 1999. This was done to facilitate actual delivery throughout the entire year. This entailed the introduction of additional one month contacts for those seven months of the year which was not covered by the longer contracts. As an example, consider a March$_{(t;x)}$ contract which was launched during the previous year, year$_{(t;x-1)}$, where t-equals time and *x* represents the year. The next contract to this will be the May$_{(t;x)}$ contract also launched during the previous year, year$_{(t;x-1)}$. Physical delivery will therefore be possible during the months of March$_{(t;x)}$ and May$_{(t;x)}$ but not April$_{(t;x)}$. To over come this problem the one month contract –April$_{(t;x)}$ - will be launched approximately half way through March$_{(t;x)}$ and physical delivery on this April$_{(t;x)}$ contract will commence from the very next day after the March$_{(t;x)}$ contract has expired. Once the April$_{(t;x)}$ contract expires, approximately around the 24th of April$_{(t;x)}$ physical delivery will start on the May$_{(t;x)}$ contract. Thus a continuous opportunity for delivery has now been created. In essence this contract thus becomes the daily spot market for maize at Randfontein and from there all the other markets in the country is simply derived from Randfontein with the difference being the transport differential.

The next step is to simply combine the delivery month contract prices into one series to create the constant delivery month series. As an illustration, suppose the current date is March$_{(t;x)}$. The March$_{(t;x)}$ contract prices will be taken as the spot price series, then during April$_{(t;x)}$, the April$_{(t;x)}$ contract prices will be taken and added to the March$_{(t;x)}$ data series and so forth. This will continue up to December $_{(t;x)}$ and then continue with January$_{(t;x+1)}$. The repetition of this process leads to the constant delivery month price series, which for all practical purposes is the spot price series for Randfontein, Johannesburg, South Africa. The repetition of this process led to the constant delivery month price series of which Figure 4.1 is the result.

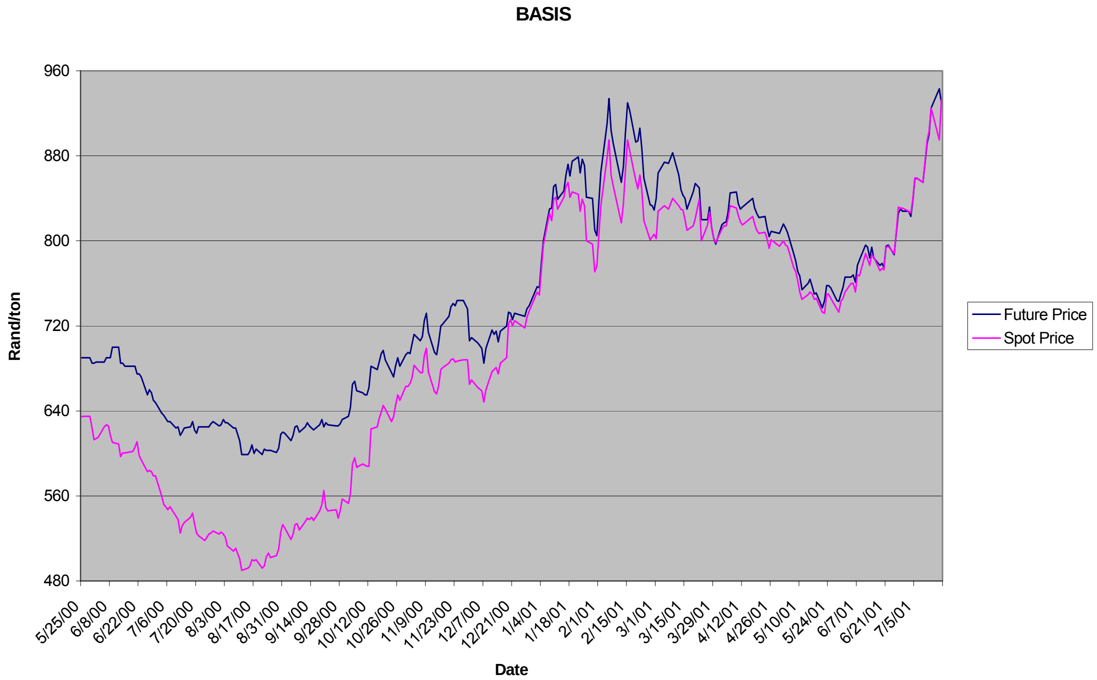


Figure 4.1: Basis Between Futures (July Contract) and Spot Prices

The rationale for regarding this price series as a spot price series can be justified by two reasons. Firstly and most importantly, the last month of a contract, the expiry month will involve very few speculators. By the time that the contact becomes deliverable all speculators would have closed their positions on that specific contract. The only participants will be those who intend to actually execute a physical trade or arbitrageurs between the spot markets and SAFEX. Secondly, strictly speaking these trades during this time can actually be viewed as the Randfontein spot market, which coincidentally happened to be SAFEX's contractually specified location. Furthermore all positions during this delivery month can actually go over into physical deliveries, thus constituting a physical trade.

4.3 THE BASIS PROBLEM WITH DATA IN OTHER STUDIES

The difference in price between the futures and spot prices is known as the basis (Dhuyvetter, 1992). It is caused by carrying and storage cost, and for situations where the spot and futures markets have different geographical locations it will also represent transport costs between the two markets. Figure 4.1 is an illustration of the basis for white maize between the futures price of a July contract and the Near-month (spot price) at Randfontein.

As the contract nears expiry it is characterised by convergence between the two prices, which is depicted in Figure 4.1. If a co-integration analysis were to be performed on such a data series where the two prices converge over time the test will automatically show the market to be inefficient since the data will be flawed. For if the two price series converge over time then eventually the futures price and the spot price will become one and the futures price will not really be a futures price, it eventually becomes a situation where the spot price is tested against itself.

It is therefore important that when a co-integration analysis for testing market efficiency is being performed the time gap between the two series should always be constant. The time gap cannot become smaller since the two series will eventually react as one and thus create an identity. This problem is usually easily over come since the international markets on which similar test have been performed so far have a very high frequency of newly listed contracts. Therefore one can always observe a contract with a two or six or twelve months futures price since there are contracts available for every month at any given point in time. For example if one measures futures market efficiency with a six months period there will always be a contract available which will expire within six months, thus you can easily observe a six month forward rate. On SAFEX this is not always the case with longer dates, although one will always find a constant one-month futures price with the constant delivery month approach, but not necessarily a six or even nine moth futures price. This is one of the major criticisms against the previous market efficiency test performed on SAFEX by Wiseman, Darroch and Ortman (1999) in their paper entitled "Testing the efficiency of the South African futures market for white maize". The authors measured efficiency for 1996 and 1997 by co-integrating the July contract for one year against the spot price and they considered the two years separate. By co-integrating the July contract over the spot price the time gap between the two will gradually become less and thus by sticking to the July contract it implies that the futures price used for one year does not stay a one year futures price it converges to the same price eventually. The reaction of the long run relationship regarding time as performed in the above mentioned study by Darroch *et al* (1999) will be similar to that which is illustrated in Figure 4.1.

In this study an attempt was made to deal with this problem by extracting a futures price series which has a fairly fixed time gap between the spot and futures prices. A detailed discussion on the construction of such a time series is discussed in Section 4.4.

4.4 FUTURES PRICES SERIES FOR CO-INTEGRATION ANALYSIS

To execute the co-integration analysis of the process in equation 4.1, two data series will be required.

$$S_{t+i} = a + bF_{t+i}^{t} + e_{t+i} \qquad (4.1)$$

Firstly, the spot price series as discussed in section 4.2 which is also the dependent variable for the process shown in equations 4.1, 4.3, 4.7 and 4.8. Secondly the independent variables for the process as shown in equations 4.1, 4.3, 4.7 and 4.8 must be a futures price series. One of the requirements for the futures price series to be used is that its expiry date should always be at least a certain predetermined period of time and never less than that. In other words, the time period between the spot price and the futures price should never be less then a certain minimum. If the spot- and futures prices are to close together they are practically the same and thus the futures price series is not a future price of the spot price. For example, Lai and Lai (1991) in their strategy of exchange rates used a spot price and a one month forward rate. Maberly (1985) used a 24 week time differential. Chowdury (1991) used a futures prices with a 3-month time differential for his analysis on nonferrous metals and Wiseman *et al* (1999) attempted to use a 12 month forward price series for there analysis on the South African white maize market.

Wiseman *et al* (1999) argued that a one year forward rate should suffice, since the maize market only experience a once-off supply shock per year during the harvesting period, and that all marketing and storage decision will be made during the year, since all crop will be allocated during the marketing year.
For this study the time differential is taken at 300 days since the production season could span for about 300 days for the country as a whole on average and thus agrees with the arguments of Wiseman *et al* (1999). Using a full 12-month period would have been preferable but unfortunately it is not possible for the maximum length of time that can be constructed for South Africa without having occasional breaks in the data series is 300 days.

The futures price series with an expiry of 300 days forward from the current spot price had to be created. This was done through the application of the underlying process.

Future Price = Price of the Nearest Future Contract Expiring at the Calculated Future Date

where

$$\textit{Calculated Future Date} = \textit{Spot Date} + \textit{300 Days}. \qquad (4.2)$$

This process could be explained by the following example. If the current spot price is 662 on the current date 5/26/1998 the futures price 300 days forward from the current date can be found by adding 300 days to the current date to give 3/22/1999. Thus a March contract, which expires in 1999, will be taken as the futures contract and its price of RX/t will be taken as the futures price corresponding with the spot price on 5/26/1998. Now if however the current date is 5/29/1998 and 300 days gets added it gives the 35th of April 1999. However on the 29th of May 1998 there was no listed April 1999 contract, thus a futures price off exactly 300 days forward cannot be taken. Instead the next contract to an April 1999 contract will be taken as the futures price, which is the longer dated May 1999 futures contract. By repetition of this process a futures price series can be build by connecting the futures prices of futures contracts with an expiry date no less than 300 days from the sport date. Thus the time span between spot and futures prices might fluctuate between a minimum of 300 and a maximum of 355 days, with the objective of always staying as close to the 300 day mark as possible. Table 4.1 shows an extract from the original data base to illustrate the application of this process.

Table 4.1: Extract from Database Illustrating the Spot and Corresponding Futures Date and Futures Contract on the Same Current Date

Spot Date	Spot Price	CFD	NFCE@CFD
5/26/98	662	3/22/99	Mar-99
5/27/98	632	3/23/99	Mar-99
5/28/98	629	3/24/99	Mar-99
5/29/98	624	3/25/99	May-99
6/1/98	620	3/28/99	May-99
6/2/98	635	3/29/99	May-99

CFD: the corresponding Futures Date after adding 300 days to the spot date.

NFCE: the Nearest Futures Contract to the CFD date.

4.5 NON-STATIONARITY

4.5.1 Test Description for Non-stationarity

For testing the characteristics of the various data sets, the first tests were for stationarity, by using the Dicky-Fuller and Augmented Dicky-Fuller tests. When considering the following process:

$$S_t = c + \rho S_{t-1} + \varepsilon_t \quad (4.3)$$

$$F_t = c + \rho F_{t-1} + \varepsilon_t \quad (4.4)$$

S_t -spot price and F_t -futures price will be stationary series if $-1 < \rho < 1$, and non-stationary series if $\rho = 1$. Should $\rho > 1$ the series will be an explosive series which does not make much economic sense and therefore a one sided test will be performed. Non-stationarity will be tested by taking the null hypothesis as $H_o : \rho = 1$ and the one sided alternative of $H_a : \rho < 1$. Should this test fail to reject the Null hypothesis it indicates the presence of a unit root in the level since $\rho = 1$ cannot be rejected and therefore the series is non-stationary.

The Dicky-Fuller tests will then be empirically executed for a second time using the following regression equation:

$$\Delta S_t = c + \gamma S_{t-1} + \varepsilon_t \quad (4.5)$$

$$\Delta F_t = c + \gamma F_{t-1} + \varepsilon_t \quad (4.6)$$

where S_t and F_t are the time series which is being tested, c and γ are parameters and ε_t is an error term. This equation was obtained by subtracting S_{t-1} from both sides of the equation in equation 4.3. Equation 4.6 was created in a similar way by subtracting F_{t-1} from both sides of equation 4.4. It implies $\gamma=1-\rho$. Shouldγbe zero it will indicate non-stationarity in the first difference level, since this will again imply $\rho=1$ and thus the presence of a unit root.

Hence the H_o: γ=0 will indicate non-stationarity upon its acceptance, and stationarity should it be rejected.

4.5.2 Non-stationarity Tests and Results of Unit Root Tests on the Price Data Series

The test were executed using a constant only since for all the cases the trend were statistically not significant. Except for the year contract:

4.5.2.1 Test in the Level

The table below contains the results for the tests in the level and from this it can be seen that the ADF < /1%/ critical value. With the ADF's to the right of the critical value's the Null Hypothesis's has to be excepted, and thus proofs the presence of a Unit root in the level data series'. The presence of a unit root thus implies that the data series' are non-stationary in the level.

Table 4.2: Testing Unit Roots in the Levels

Data Series	ADF Test Statistic	1% Critical Value
Future Prices	1.92	-2.568
Spot Prices	2.17	-2.568

4.5.2.2 Test in the First Difference

From the table below which contains the results for the tests in the first difference it can be seen that the /ADF/ > /1%/ critical value. With the ADF's to the left of the critical value's the Null Hypothesis's has to be rejected, and thus proofs absence of a Unit root in the first difference data series. The absence of a unit root thus implies that the data series are stationary in the first difference.

Table 4. 2: Testing Unit Roots in the First Difference

Data Series	ADF Test Statistic	1% Critical Value
Future Prices	-11.675	-2.568
Spot Prices	-10.948	-2.568

4.5.2.2 Conclusion

Both the spot price and futures price series proofed to be non-stationary in the levels, but exhibited stationarity in the first order.

4.6 CO-INTEGRATION TESTS AND RESULTS: TWO SPOT PRICES

Equation 4.1 shows the basic process which will be tested to determine market efficiency as defined in Section 3.2. The process shows the spot price as a function of a certain length of futures price, i.e. a price one year from spot date or six months or two months or 300 days, etc.

The futures price (S_{t+I}) of which;

$$S_{t+i} = a + bF_{t+i}^{t} + e_{t+i} \quad (4.7)$$

4.6.1 Efficiency Testing

One of the crucial aspects for a market participant seeking to hedge a position is the fact that the future and spot price will converge over time, the spot price will move to the future price , all things equal. Should this not be the case, for obvious reasons the concept of hedging cannot hold. Equally import is the fact that not only should these two-price series move together, but also the futures price should on average not over- or under predict the future spot price. It thus requires the effective functioning of the equations shown below:

$$S_{t+i} = a + bF_{t+i}^{t} + e_{t+i} \qquad (4.8)$$

This is crucial to the correct functioning of the basis. Although we do not expect the basis to be fixed, nor to diminish in a straight line, we do expect the basis to diminish over time. Thus in econometric terms not only should S_t and F_{t+i} be co-integrated, but F_{t+i} should also be an unbiased predictor of S_t.

Co-integration implies that the two series do move together over time, they do not diverge without bounds, and therefore F does have a certain predictive power over S. Market efficiency therefore requires that $a = 0$ and $b = 1$ for F to be an unbiased predictor of S even when F and S are moving closely together, thus the basis being small.

4.6.2 Co-integration Tests and Results: SAFEX's Constant Delivery Month

In the previous section, unit root tests on the two variables (F and S) supported the hypothesis of stationarity of the first differences of both series. If these series are cointegrated, a regression of these two I(1) time series should yield a stationary error process. To evaluate this, the regression of $S_{t+i} = a + bF_{t+i}^{t} + e_{t+i}$ was run and the residuals were subjected to a unit root test. An ADF-statistic of -2.304 was obtained, that supports the hypothesis of a stationary error process (at the 5% critical level). Also, the estimated value for a = -0.58 and the value estimated for β= 1.08. Both coefficients are statistically significant, but α is close enough to zero to satisfy the requirement that a =0. The requirement β = 1 is met and thus the model supports the assumption of an efficient market.

Further econometric modelling would involve the estimation of Vector-error-correction models that incorporate the estimated longrun relationship into a combination of inter-related shortrun and longrun adjustments of both prices in conjunction with shocks from other economic and physical variables that would affect prices (e.g. oil prices, international market prices, weather patterns…)

4.7 CONCLUSIONS

This chapter first addressed the issues surrounding the spot and futures prices data series, which were used to test futures market efficiency. A futures time gap of 300 days between the spot and the futures price were selected to test against, because this would span at least the length of a full production season, and secondly a constant flowing data series of more than 300 days does not exist on the South African Futures Market. Section 4.4 also addressed the gradual declining basis between the two futures prices by structuring a futures price series of which the time gap is never less than 300 days.

Both the spot and futures price data series' were tested for stationarity and both series' exhibited non-stationarity in the levels but proved stationary in the first difference.
Testing for cointegration proved the process of equation 4.1 to be efficient, while also showing the coefficients to be statistically significant.

CHAPTER 5

IMPLICATIONS ON HEDGING STRATEGIES AND THE PORTFOLIO THEORY

5.1 INTRODUCTION

This chapter is intended to answer three crucial questions given the discussions in chapters 3 and 4. With the market exhibiting efficiency as shown in Chapter 4 it should be possible to structure an ideal, low cost, high return, low risk strategy. This chapter considers firstly the question of whether hedging holds any significant advantages for the user of the instruments. Secondly, does hedging hold any significant advantages for the user of the instrument over the longer term compared to simply doing no forward sales and just selling all production into the spot market at harvest time. Lastly, if so can a generic time scale strategy be developed for hedging?

For more than a hundred years hedging has been used as an active approach towards reducing the risk of holding a certain asset or the potential holding of the asset at some date in the future (Berck, 1981). Consider for example a grain producer whom have already planted the crop but as such does not have the grain on hand yet, and might not have it for yet some time to come. He can however already take pro-active steps in reducing the price risk of his future crop by hedging with derivative instruments, being future contracts, options, or a combination of them. The risk faced by the producer in this case is price risk, and the negative aspect of this situation would be a drop in the price of the commodity. Hence the producer would attempt to hedge himself against a drop in the price of the commodity. Price movement towards the upside though would most likely not be regarded as a negative risk and should favour the producer.

From a consumer's point of view though the opposite would apply, with price risk still being the risk factor, but where a higher commodity price will be regarded as a negative risk factor. A consumer of the commodity would thus use the derivatives market to hedge himself against a possible rise in price. A drop in the commodity price would most likely be regarded as positive for it should result in lower input costs or purchase price. This study will investigate the potential benefits of hedging from the producer's point of view but the same will apply to a buyer of maize although their derivative portfolio will just be the opposite of the producer.

The remainder of this chapter discusses the construction of a hedged portfolio to reduce risk, followed by a discussion of hypothetical portfolios regarding various views and concludes with a generic strategy based on the various hypothetical portfolios.

5.2 METHODOLOGY

Sections 5.3 and 5.4 discuss the reasoning behind, and the approach followed to construct a hypothetical hedged portfolio. It introduces the terminology and concept of a structured portfolio as the portfolios will be used in section 5.5.

Within the frame work of the peak delivery period and the average spot prices as will be discussed in section 5.5.1, four hypothetical portfolios are created, each one with a different marketing strategy. The portfolios range from simplistic un-hedged to more advanced marketing strategies. These various hypothetical portfolios will then be compared to each other on two indicators. Firstly, portfolio risk and secondly mean price received to determine which approach out-performed over time. The best performing portfolios strategy can then be suggested as a "rule of thumb" for the ideal hedging strategy.

5.3 PORTFOLIO CONSTRUCTIONS, VARIANCE MINIMISATION AND MEAN PRICE RETURNED

If we regard the holding of maize by a producer as his portfolio **(Π)**, it therefore implies that any variability in the price of his crop has an effect on the value of his crop-portfolio. For various reasons a producer might wish to reduce the variability of his portfolio, which is brought on through price variability of the commodity. Under free market assumptions the producer will however not be able to stabilise the spot market price of the commodity and would thus therefore have to resort to another measure to stabilise his portfolio value. This can be done through hedging which will require the hedger to add a hedge instrument to his portfolio of crop. Consider a maize producers holding of assets as a portfolio **(ΠA)** consisting of cash and a physical commodity. This portfolio will now vary in value as the price of the commodity change. An increase in price will lead to an increase of the portfolio value and vice versa. The risk associated with this portfolio can be measured as the variance of the portfolio (Berck, 1981). Although this study did not perform a mean-variance analysis like that of Berck the concepts of reducing risk and increasing mean-return is still the same but the emphasis differ. This study does not aim to prove the advantages of hedging, for it has already been proved as far back as 1975 (Peck, 1975), but it aims to highlight a strategy to achieve the best high-mean low-variance result.

Thus portfolio variance is a function of spot price and futures price changes. In an attempt to lower the risk of this portfolio the producer now engages on the derivatives market by taking an opposite position to that of his position in the physical market, e.g. a long position of the physical commodity will be hedged by a short contract position. This is achieved by substituting some of his cash holdings towards margin for an appropriate derivatives position, and so creates a new portfolio **(ΠB)** with the same value as **(ΠA)** but a different asset mix. Portfolio B now consist of two risky assets, the commodity and a ratio(Δ) of futures position, and one risk less asset, in the form of cash.

Table 5.1: Symbolic Representation of Single Commodity Portfolio-A and Diversified Portfolio-B

	Portfolio A	**Portfolio B**
Commodity	+ C	+ C
Derivative Position	0	- Δ F
Cash	RX	+ R(X-Δ F M)
Total	Π	Π

Section 5.5 evaluates the results of four simulated portfolios each with a different combination of derivative instruments and physical commodity

5.4 STRATEGIES

A producer wishing to hedge against price risk can do this through executing a short future position. The problem with such an approach is that should the product price increase further after the hedge was created the producer will not be able to benefit from the higher price. The ideal for the producer would be to create a situation where the producer will have the downside protected and the advantage of a potential price increase, thus essentially a strategy which will ensure a “floor price” and open the upside. Such a situation can be created with a long put option which will ensure a floor price at the strike level, and should the price move above the strike level the producer can ignore the put option and sell the crop at the higher level (Purcell & Koontz, 1999). Thus essentially giving the producer the net effect of a call option exposure. A different strategy known as a synthetic long put option can also be employed to achieve the same effect. Instead of the long put option, the producer can short the future and long a call option and thus create a synthetic put option (Hull, 1997).

Another important part of the entire hedging strategy besides using the right type and combination of market instruments is using the right amount(Δ) of instruments. This is the question of hedge ratios(Δ) although for this study the hedge ratio was assumed to be one, which implies that for every ton in the derivatives position there will be one physical ton as well. The hedgers objective is thus to create a minimum variance portfolio by mixing up the right amount of derivative instruments to his physical position. In its simplest form the hedge ratio can be defined as the number of futures positions necessary to hedge the risk of an unprotected portfolio (Bodie, Kane, Marcus. 1995).

Therefore a crude form of the hedging ratio (HR) is presented by equation 5.1.

$$HR = \frac{\Delta \, in \, value \, of \;\; unprotected \;\; maize \;\; holding \;\; for \;\; change \;\; in \;\; maize \;\; price}{Profit \;\; derived \;\; from \;\; one \;\; futures \;\; position \;\; for \;\; change \;\; in \;\; maize \;\; price} \qquad (5.1)$$

However, for the sake of developing the strategy the hedge ratio is not relevant, since, the application of the correct hedge ratio, thus avoiding over or underhedging, will only further enhance the result, as it will lower the hedge cost. Peck (1975) in her analysis also noted this by stating that “hedging a substantial percentage of expected production can significantly reduce a producer’s exposure to the risk. Additionally, a total hedging scheme performed nearly as well as an optimal scheme.” This study suggests developing a strategy, which also includes the hedge ratio as a topic for further research.

5.5 HYPOTHETICAL PORTFOLIOS

5.5.1 Parameter Descriptions/Introduction/Environment Description

Producers hedge in order to obtain the benefits of portfolio variance minimisation. If a farmer did not hedge, would he necessarily have been at a disadvantage to a farmer who did hedge? For answering this question the average SAFEX near month contract price over a three-month period June, July and August will be taken as the average spot price for the peak delivery period for the year. For a discussion on why the near-month contract series can be used as a spot price series, readers are referred to Section 4.2.2. The reason for averaging these particular months is because the majority of the crop gets delivered during this period. The table below illustrates this point over the last two years.

Table 5.2: Share of Total Crop Delivered per Month and Cumulative Delivery (Percentages of Total Crop)

	May	June	July	August	Cumulative
2000	5.40%	13.77%	38.40%	34.02%	86.20%
2001	6.46%	30.58%	42.11%	16.78%	89.47%

The average daily spot price over the period June to August is calculated by taking the nearest month SAFEX contracts for the corresponding months at Randfontein, summing the daily prices and dividing it by the number of trading days over the period. Table 5.3 shows the results of this calculation since 1998.

Table 5.3: Average Daily Randfontein Based Spot Prices Over Peak Delivery Period

Marketing Year	1998	1999	2000	2001
Spot Price Received R/t	735	815	548	889

Within the frame work of the above discussed peak delivery periods (Table 5.2) and the average spot prices (Table 5.3), four hypothetical portfolios will be created, each one with a different marketing strategy. The portfolios range from simplistic no hedging to more advanced marketing strategies. These various hypothetical portfolios are then compared to each other on two indicators. Firstly, portfolio risk and secondly net price received to determine which approach out-performed over time.

5.5.2 Hypothetical Producers

5.5.2.1 Producer- A

Producer-A will do no hedging and only sell into the spot market at harvest time. He will thus receive the spot price as calculated over a three-month period, June July and August.

Table 5.4: Mean Price and Variance Results for Producer-A, Unhedged Portfolio

MARKETING YEAR	98	99	2000	2001	Mean	Variance
Spot Price Received	735	815	548	889	751	21 466
Nett Received Price		815	548	889	751	21 466

His no-hedging strategy will nett him an average price of R751/t, and a portfolio variance of 21466.

5.5.2.2 Producer-B

Producer-B will hedge his crop during planting period by executing forward sales. This will be done by shorting the anticipated crop on SAFEX with a July($year_t$) contract during the planting period of October till the end of December of the previous year ($year_{t-1}$). All relevant data to a specific marketing year is listed under that year($year_t$) even though it was actually observed the previous year ($year_{t-1}$). Thus although the "average hedged price executed", "Strike Level" and "option intrinsic value" figures were observed during the production year they are applicable to the following calendar year ($year_t$) which corresponds with the marketing year ($year_t$).

Table 5.5: Portfolio Statistics for Producer-B, Short Future Hedged Portfolio

MARKETING YEAR	1998	1999	2000	2001	Mean	Variance
Spot Price Received	735	815	548	889	751	21449
Average Hedged Price Executed		654	691	703		
Average Future Price Close Out		855	577	829		
Futures Profit/(Loss)		-201	114	-126		
Nett Received Price		613	662	763	680	3886

By executing forward sales the producer realises a price of R680/t, which is 9.5% less than Producer-A, however his portfolio variance comes to 3 886, which is 82% less than Producer-A. This result should be judged against the background of the price cycles, where Producer-B did not benefit from higher peaks in the price cycle but he did benefit from not having to deal with the extreme lows of the price in 2000 when he realised a price of approximately R114/t (R662/t – R548/t) or 20.8%/t more compared to an un-hedged operation. This is what hedging is meant for, for the question should be asked what the effect of the low prices of 2000 was on the financial health of a farming operation and whether an un-hedged firm might have experienced sever blows to its sustainability and disaster absorption ability. In other words, would an un-hedged operation have been around for the 2001 year to actually benefit from the higher prices, and secondly what would have happened had the follow on years price not increased.

5.5.2.3 Producer-C

Producer-C will also hedge his crop over the same period as producer-B but will also buy call options to open his upside potential. The shorting of contracts will take place at the average SAFEX price of the July contract (period_t), of the following year (year_t) over the current period of October to end of December (year_{t-1}). The acquiring of the call options will also take place over the period of October till the end of December (year_{t-1}), thus for the purpose of pricing the options the period of middle November (year_{t-1}), until expiry (year_t) will be taken. Middle November is thus the average time from the beginning of October to the end of December(year_{t-1}).

Table 5.6: Portfolio Statistics for Producer-C, Short Future, Long July-Call, Hedged Portfolio

Marketing Year	1998	1999	2000	2001	Mean	Variance
Spot Price Received	735	815	548	889	751	21450
Average Hedged Price Executed		654	691	703		
Average Future Price Close Out		855	577	829		
FUTURES PROFIT/(LOSS)		-202	114	-126		
Options Detail						
Strike Level		654	691	703		
Option Price		48	51	51		
Option Intrinsic Value		202	0	126		
Nett Received Price		767	611	838	739	8979

5.5.2.4 Producer-D

Producer-D will build on the fact that agricultural commodity prices tends to be at their lowest levels during the harvest period and at there highest levels just before the next supply shock/ harvest comes to the market, the next scenario will try to exploit this theory. (Campbell & Fisher, 1991; Carman, 1997)

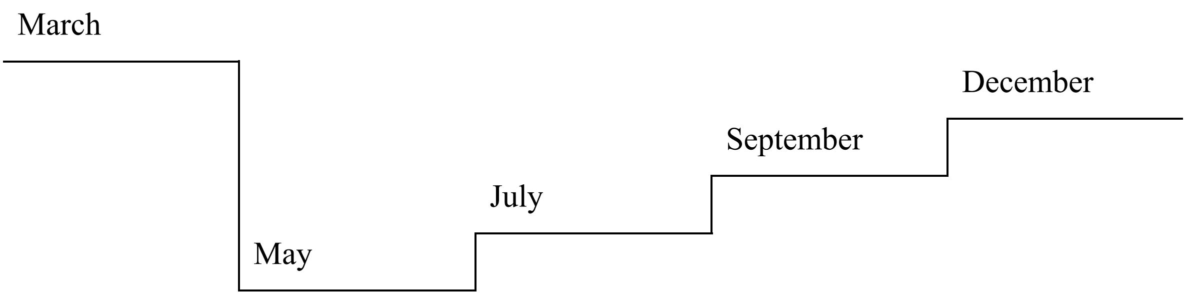


Figure 5.1: Price Relationships amongst Monthly Futures Contracts

For this portfolio the producer will still short the futures for down side protection and buy the call options in order to participate in any potential upside, similar to that of Portfolio-C. The difference with this portfolio lays in the fact that the producer will buy call options with a March ($year_t$) expiry instead of a July ($year_t$) expiry options. Using the shorter dated options has two effects.

Firstly, producer-D will only benefit from any upward price movement until the end of February ($year_t$) when the option expires, should there be any further upward price movement after February to July ($year_t$) the producer will not benefit from it. Considering the notion of the price reaching its seasonal high around February/March this approach on average should not disadvantage the producer.

Secondly, the advantage of buying March ($year_t$) options instead of July ($year_t$) options translates to a saving of four months worth of time value on the option average received price/t.

Table 5.7: Portfolio Statistics for Producer-D, Short Future Long March-Call, Hedged Portfolio

Marketing Year	**98**	**99**	**2000**	**2001**	**Mean**	**Variance**
Spot Price Received	735	815	548	889	751	21450
Average hedged price executed		654	691	703		
Average Future price close out		855	577	829		
Futures Profit/(loss)		-202	114	-126		
Options Detail						
Strike Level		659	799	684		
Option Price		34	41	35		
Expiry Price		702	760	820		
Option Intrinsic Value		196	0	136		
Nett Received Price		776	621	864	754	10063
Volatility	25%					
Time to Expiry	Middle November to expiry at end of February					

5.6 SUMMARY

By the simultaneous application of variance minimisation and mean price maximisation as the two determining parameters for successful portfolio management this study constructed four portfolios. The difference in structure between these portfolios was a mix of derivatives from the same expiry date as well as different expiry dates. The optimum portfolio proved to be that of Producer-D which was a short future for harvest period (July) and a March expiry Call option.

CHAPTER 6

APPLICATIONS OF DERIVATIVES AND STRUCTURED PRODUCTS

6.1 INTRODUCTION

The application of derivatives instruments is arguably one of the most creative ways to structure transactions and create risk reducing structured products. Literally any combination, structure and pay-off profile can be constructed through the creative use of these instruments. It's scope and application boundaries is defined by the creative thinking ability of the person using these instruments. Within the newly founded South African market this will become evident over the next couple of years, as the market matures and participants become more accustomed and advanced in their application and understanding of these instruments. This chapter builds on the work done in the study and illustrates a few of the current advanced applications of these instruments and also highlights some futuristic applications which can be expected within the South African agricultural derivative markets. All topics discussed in this chapter requires extensive further research and this thesis thus recommends all of the under mentioned applications as topics for future research.

6.2 WEATHER AND YIELD DERIVATIVES

6.2.1 Introduction to Weather Derivatives

Weather plays a crucial role in many businesses affecting either their input costs, speed of activity and output that ultimately impacts on profit margins. Agriculture in particular is one of the economic sectors, which is greatly affected by climatic conditions. These can range from temperature levels for deciduous fruit producers, wind strength for exporters and hail and rainfall for most agronomic activities. In South Africa, grain producers in particular, are exposed to inadequate rainfall when needed which cause a decrease in physical output and too much rain over crucial periods can cause a decline in quality, but too little rain being the most severe.

Since 1997 the derivatives industry added weather derivatives to its list of tradable instruments although mostly "over-the-counter" products (Ellithorpe, 1999). Basically it requires a weather index, which varies given climatic conditions based on certain rules, as to how these climatic conditions change the index. There are various type of weather indexes ranging from daily rainfall, temperature or heating degree day (HDD) indexes to longer dated seasonal indexes (Ellithorpe, 1999). Essentially a monetary value gets assigned to an index point and then it is similar to hedging against a financial index. As a weather index in itself this instrument will most likely not be feasible for the South African agricultural sector at this point although it could become in time.

Another alternative is to utilise yield derivatives for predetermined geographic regions, which is covered, by a weather derivative. The specific weather derivative does not have to be an agri-specific weather index but rather an index more broadly used by various industries. This type of instrument can then be used to offset the effect of adverse climatic conditions in a similar fashion like weather insurance although it has very little to do with insurance in the classical sense (Muller & Grandie, 2000)

6.2.2 Structure of a Yield Derivative

The first phase in structuring this product requires a statistical analysis to determine the correlation between rainfall and production yield given a certain geographical area. This correlation coefficient quantifies on a historic basis how that various amounts and frequencies of rainfall correlates with yields. The coefficient will not be 100% since other factors also impact on yield but for the most part it is rainfall. Thus once the coefficient is known a hedge can be structured against the yield derivative to cover any short falls on the yield.

The indicator for triggering the strike level will be negotiated and agreed upon at the start of the life of the instrument and cannot be disputed afterwards. The yield product for example would state a strike price of 3t/ha to be confirmed by the 5^{th} /6^{th} national crop estimate, for Mpumalanga. If the 5^{th} crop estimate published an estimate of 2.5t/ha for Mpumalanga thus a 0.5t/ha shortfall compared to the strike level of 3t/ha the option will be triggered and a 0.5t/ha payout will occur. This will be paid out at a predetermined price/ton to everyone in possession of the instruments. If a yield shortfall does occur it would most likely be the result of a climatic condition against which the yield-option writer hedged himself. He thus profits from his weather derivative exposure plus the derivative premiums received and pays out his loss on the yield-options to the option holders.

6.2.3 Advantages

Instruments like these are crucial for the structuring of price and yield neutral balance sheets and profit profiles. Due to the transparency of the pricing of these instruments their structures would tend to cost less than traditional yield insurance. The fact that derivatives can be structured into tailored risk and payoff profiles also allows the client to increase or reduce premiums according to his exact requirement. This gives the client a lot more flexibility compared to traditional insurance products for example, collars or bear-spreads. Producers can also choose their own level of cover by choosing the strike of the option for example a 3t/ha or 4t/ha option.

A further benefit comes from the fact that payoffs/ compensation of a market traded product can be calculated instantaneously, thus negating the need for damage assessments, onsite inspections and objective interpretation of damage by the insurer which could lead to discrepancies and disagreement. Furthermore, due to the fact that no assessments are required, monitoring and dispute costs become negligible. Since the payout amounts are market based settlement payouts can be very quick.

6.2.4 Disadvantages

These instruments do pose certain risks to the trader of these instruments, and the first of these risks could affect the holder of the cover of the derivative. The first risk stems from basis risk which is the difference between the actual weather outcome of the instrument user and the measured weather at the dedicated weather station responsible for measuring the payout outcome of the instrument (Ellithorpe, 1999). For example, if an individual producer suffers a sever decline in output but the average for the province is unaffected the strike level will not be triggered causing a no-payout situation and the options will expire out-off-the-money and the producer will not be compensated.

For the seller of these instruments the ability to sell the product to a viable critical mass of clients will initially be problematic due to the complicated nature and possible perceived risky ness of this new product, especially to producers who previously made price-hedging mistakes.

The last potential risk is more of a logistical nature which could cause incomplete or even inaccurate data such as the long-term yields of individual clients.

6.2.5 Suggested Use

The product is only to be used by those producers who over the long-term outperform the average yield of the identified area. This could hold a benefit for those producers because if the average of the region drops below strike level it will trigger a payout and all option holders will receive the payout even if their yield was unaffected and/or still above the strike level. This could imply that the producer actually nets an even greater yield, partly in physical output and partly in an additional cash payout. Essentially giving the producer physical and "paper" tons. This advantage in itself would encourage producers to improve their farming practices.

Producers, consistently below average, will tend to be at a disadvantage for their drop in output may be more than the potential payout received, and in severe cases they may not receive a payout at all, even though they experienced some extent of damage.

6.3 STRUCTURED PRODUCTION FINANCING SOLUTIONS

6.3.1 Introduction

Currently derivatives as a risk management tool is only available to participants who produce more than a 100t and who can carry the hedging costs which is a minimum initial outlay of R10 000/100t. These requirements make hedging as a management tool inaccessible to most emerging farmers. Another potential barrier to entry is the complicated nature of these instruments. Generally if a producer cannot use these instruments because he is too small or un-skilled in its use, it could hamper his ability to access production finance from a commercial bank. With the newer approaches by banks to move away from balance sheet financing the commercial banks will only finance if both output volume and price can be protected with either hedging or insurance. Normal balance sheet financing will take place but only to customers with very strong balance sheets, which by definition excludes emerging farmers. It is precisely because of this newer approach by commercial banks to move away from balance sheet financing which saw the establishment of bank alliances with commodity houses and brokers.

6.3.2 Emerging Framer Orientated, Structured Hedging Product

Risk in the agricultural sector can be divided into two categories namely price and production risk. As technology and markets evolve, better means of risk aversion or control can be applied. Using best farming practices and precision farming techniques, farmers can manage the production risk to a certain extent, but there are still a huge number of variables -and thus potential risks, present in agricultural production.

Price risk on the other hand can be managed very effectively by the use of market-based solutions like derivative instruments. By following a low risk approach to hedging, a simple strategy/portfolio can be structured at relatively low cost to insure a pre-determined minimum floor price (Purcell & Koontz, 1999). With further management of this portfolio a potentially higher price can be realised, which will obviously benefit the client. Secondly, by actively managing the hedged portfolio the costs of hedging can be considerably reduced (Hull, 1997).

This section illustrates a potentially simple venture to structure a derivative based product to service emerging farmers while managing all of the above problems, of loan book expansion, actively managed hedged portfolio, lowered hedging cost, minimum or higher realized prices, and lower risk exposure to all parties involved by utilizing and pooling of the resources, expertise and links of all involved parties.

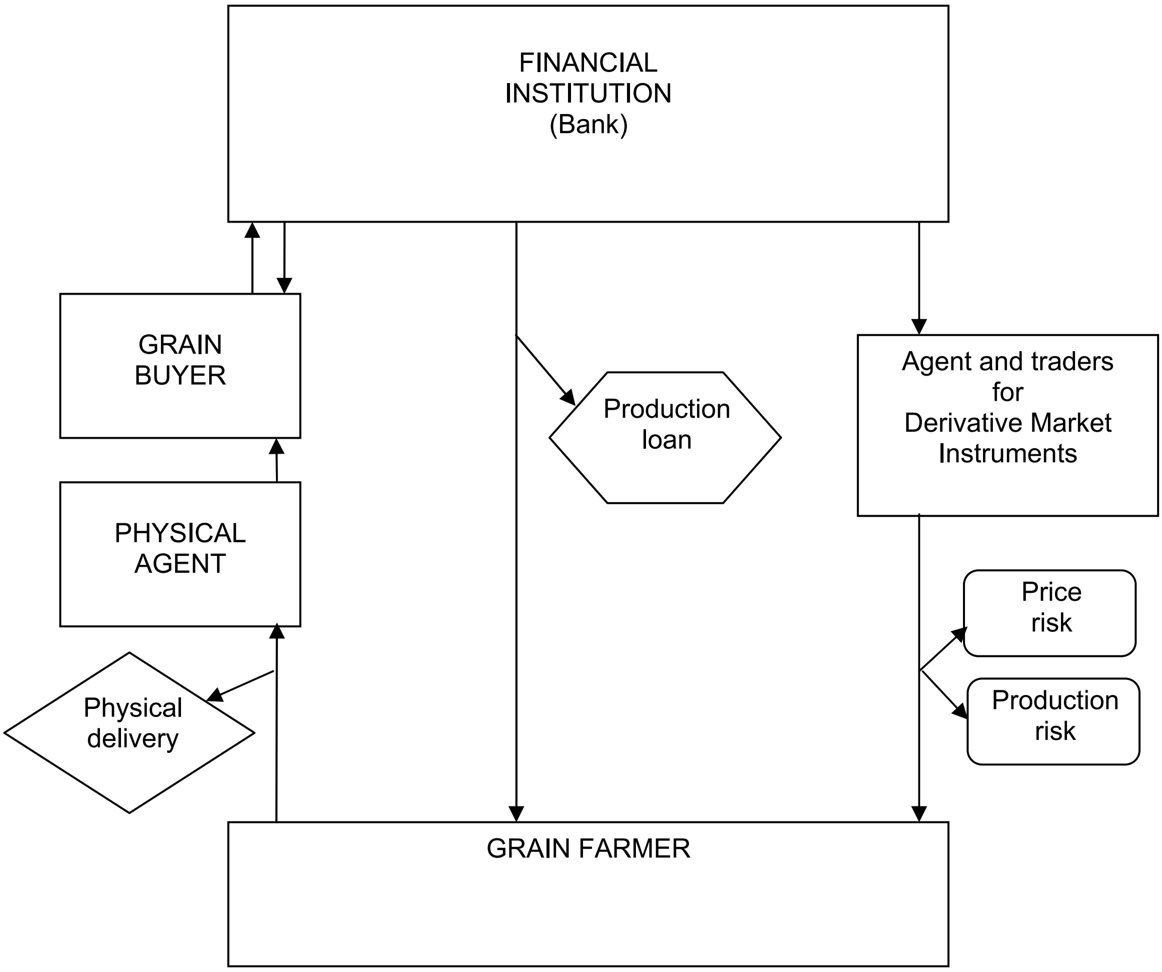


Figure 6.1: Graphical Representation of the Structure of the Joint Venture

Price fluctuations are in no doubt one of the biggest risk factors faced by farmers. By using the derivative market, one aims to fix a floor price ahead of harvesting, and maybe an even higher price once the crop has been harvested. One of the problems faced by these producers is the complex and potentially disastrous nature of this kind of market activity. To participate in the derivatives market, one needs a high level of understanding and training to operate safely within it. Furthermore, depending on the strategy followed it can also be very demanding on ones cash flow as margin movements can occur very quickly and very steeply. However, with the volatile grain prices since deregulation there is no doubt that these market instruments have to be used if one wishes to secure reliable profit margins over time.

Since the majority of crop production takes place with production loans, the lender is also affected by price risk, since adverse price movements have a negative effect on loan repayment ability (Standard Bank, 1999). It would thus be to the advantage of the lender if the client can manage his marketing process in such a way that the producer continually receives a net price higher than his required break-even price which will ensure a positive profit margin and improved repayment ability. The farmer will still be faced with production and yield risk, and thus so will the lender, but this was always the case and can be managed with crop insurance. One of the biggest risk factors, price, can at least now be eliminated which will hold obvious benefits to the lender. It will however, from the lender, be required to investigate the client's hedge portfolio from time to time to ensure that the client does follow an appropriate strategy or even from the lender to build and manage the strategy on behalf of the client, to ensure that the lenders loan book is immunized against price risk.

Even if the client do succeed in successfully managing his hedge portfolio he still has to find a contracting party to take the physical crop off his hands. Physical contracting creates the opportunity of saving on transport cost, handling fees and the potential to benefit from basis risk (Dhuyvetter, 1992). This aspect unfortunately does require very stringent control over the progress of physical production. Even more so than under normal circumstances where producers do not make use of forward contracting, for failure to deliver an agreed amount of product could result in a form of contract breaching.

By pooling emerging farmers into viable groups in respect of hedging they can be taught to use these instruments while in the short term still benefiting from the advantages of hedging. The uniqueness and innovation of this type of product is that it can be structured with emerging farmers in mind and will over time, phase the developing farmers into mainstream agriculture, fully equipped and financially capable to participate in this type of market.

6.4 MILK INDUSTRY SOLUTION

6.4.1 Introduction

This section uses a radically different technique to illustrate the application of derivative instruments in a cross hedging way to assist commercial milk producers to manage price risk of output, income and profitability. This cross hedge will use maize futures to structure a milk pricing model and to allow for milk price to be hedged with a maize future (Dahlgran, 2000).

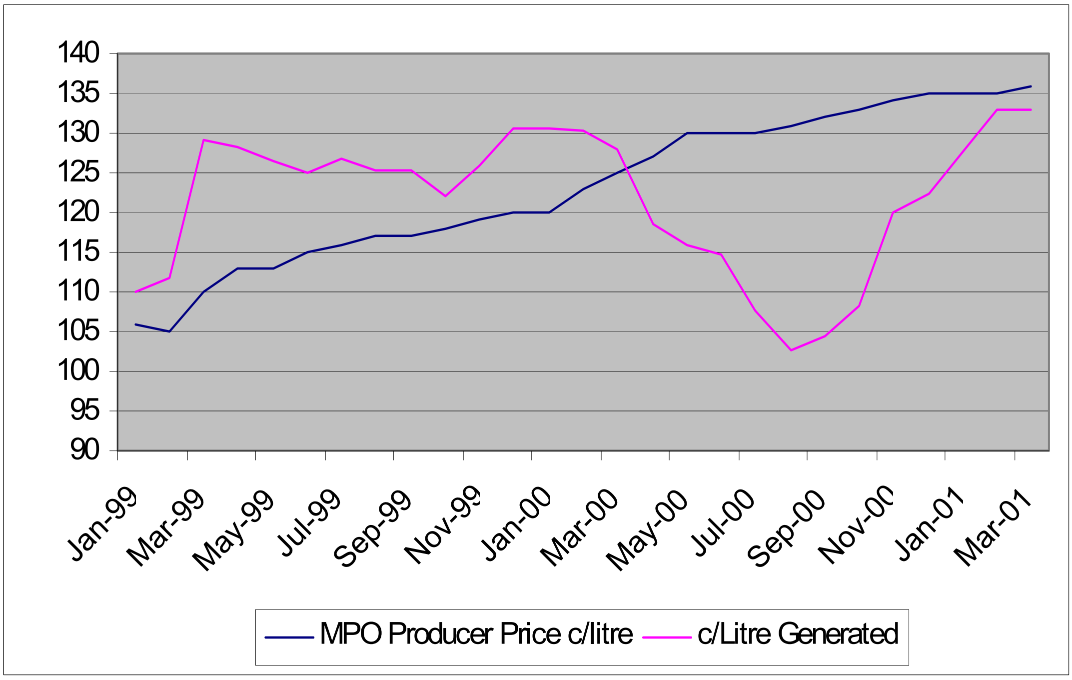


Figure 6.2: Milk Producers Organisation and Generated Milk Price

From Figure 6.2 it is evident that there is very little price volatility just a constantly increasing price, low price risk does not mean risk less cash flow for the farmer. From a producer's side, stable prices but fluctuating input cost can also lead to serious cash-flow variability, the typical cost price squeeze problem. Although cash flow variability is not the result of product price variation but rather input cost variation, and in particularly maize input costs. Alternatively stated profit variability is still the result of price risk, but in this particular case it is the lack of price variation on output while input costs do fluctuate, therefore causing a fluctuating gross profit margin. Dealing with this profitability risk can be achieved by managing the problem of price variation itself. This can be done very successfully through forward selling/contracting and/or hedging. Currently the forward selling of milk with a forward priced contract is flawed in various areas as shown in Table 6.1, which manifests itself in cash flow risk.

A second alternative could be to list a milk future for milk per se. However, due to the required factors for a successful contract as discussed in chapter 1 it is an unviable alternative. Therefore a third alternative should be considered; that of structuring the milk pricing process in such a way that a derivative solution can work.

Table 6. 1: The Characteristics and Shortcomings of Present Dairy Contracts

Transparency	Not an open observable market.
Stability	Can be manipulated due to lack of transparency in the industry as a whole.
Simplicity	Complicated due to the legal nature and approximately 11 different priceing systems.
Mutual trust	Distrust due to the above shortcomings.

6.4.2 Structured Milk Price

The third solution is a derivative instrument based on a proxy for raw milk. Although the suggested approach seems radical at first it satisfies all requirements to be successfully traded on the market, and it will create price volatility. The idea of switching from a stable to a volatile price situation may initially seem like a major step backwards. However, the milk farmer's problem is not price stability but cash flow risks. If we create a variable price situation and together with it comes the opportunity to hedge against the same price volatility, it will enable the farmer to actually manage/minimise cash flow risk by hedging it.

The proxy of the raw milk price that will be used as a hedging instrument should be one that is already traded on SAFEX. We wouldn't have to concern ourselves whether it will work, since it already does. It would also mean lower roll out costs since many players are already geared to participate in the maize market and some already does. It also means that the education of all market participants will be easier and cheaper than in the case of the grain industry when it started in 1996.

The SAFEX near-month listed yellow-maize contract should be the market traded instrument used as the proxy or derivative for the milk price. The logic in using maize is simply that it is already a market-traded instrument, which can be used as a very good proxy for all inputs and is also directly related to milk production. The structured formula should used to calculate the milk price should firstly be an easy accessible market traded instruments such as the maize price mentioned above. Secondly its composition should make economic and practical sense, and since maize is a significant input cost it would make economic sense to link the milk price to input costs. The formula applied does not suggest that maize is the only input cost but that most of the other inputs exhibit the same behaviour as maize since most inputs are exchange rate affected. Maize is simply just a market-traded instrument, which can be used as a very good proxy for all inputs and is also directly related to milk production. The formula should also ensure that the price itself stays between import and export parity levels for milk and it will do so, since the import and export parity levels for maize is also determined by the same major factor, namely the exchange rate.

In its most simplistic form the milk price formula consists of a variable and a "constant" component. The SAFEX based part gets adjusted on a daily basis as the maize price moves, and the fixed component that could be adjusted over time with the producer price index. The two components are used to simulate the present cents/litre price for milk.

This formula is not fixed and only a preliminary version. Its results are illustrated in Figure 7.4.1. From the graphic one can see that, although the calculated price is a lot more variable than the historic producer price it does follow and fluctuates around the historic producer price.

It must be reiterated that the milk price which was calculated by the formula through the movement on SAFEX is similar to the Randfontein price for maize, only a proxy, subtractions and additions can be made to it based on other factors such as transport. An important point is not what the price level is but the change in the level, which causes the risk and needs to be hedged against.

The advantages of a market based solution are the way in which it allows to hedge financial risks. This approach would have calculated similar price levels than the actual observed prices over the last four years at a fraction of the time, cost and emotions.

It should have no negative effects for the consumer. In fact it could lead to a potentially lower hedged price over the longer term for the consumer; similar to what has happened in the grains industry over the last two years is possible.

Once such an approach is accepted the entrepreneurial actions of current participants in similar derivative industries will flow over into the dairy market and new form of the industry will start to develop by itself, progressing and maturing over time whilst creating further opportunities as the role players start to see and exploit potential benefits.

6.4 SUMMARY

This chapter illustrated a few potential applications of derivative to various risky agricultural problems by utilising instruments in an indirect way by structuring them into systems or products. The problems of weather and variable yields were addressed by utilising straight vanilla instruments which requires little ingenuity. The more economic and politically sensitive situation of emerging agriculture were addressed through product structuring for risky clients by ring fencing borrowed funds against two of the biggest risk, yield and price, for the benefit of the financier. Lastly a more opportunistic approach was followed for the milk industry by creating a proxy price model which is linked to the derivatives exchange and could then cause price volatility in milk while providing a hedging solution to manage this new volatility if the industry participant chooses to.

CHAPTER 7

CONCLUSION

7.1 SUMMARY

Prior to the deregulation of the grains industry, derivative instruments were not available and the market was based on a one channel marketing structure. Chapter 2 gave a brief overview of the historic development of this market and mentioned the Viljoen commission's report which stated in 1933 already that such a structure was not to be the best alternative. However the South African agricultural sector still evolved into a one channel marketing structure, but reversed back to a free market system in 1996 together with the development of a derivatives market and the inception of SAFEX.

This thesis aimed to applaud the governments liberalisation approach by illustrating the wide range for applications of derivatives to create profitable opportunities but more important to illustrate its usefulness as a risk management tool in the agricultural sector. For these applications to be successful it requires the market to be an efficiently functioning market and the participant who build these structures to be adequately trained in the instruments due to their potential riskyness. For this derivatives market to function properly and even increase its efficiency it requires the market to be a free competitive market and any future intervention or move away from a free efficient derivatives market will only cause these opportunities to disappear and leave the market participants with no or expensive risk management tools.

Given the discussion in Chapter 3 it implies that a producer will have foresight in the expected price to be realised for his commodity at a future date. His foresight of a specific period can be at least as long as the longest futures contact available to him. Thus such a futures price will reflect all available information, in a processed form, to a participant in one price. It should be obvious how such knowledge can be advantageous in various aspects such as budgeting and planning. Armed with this type of knowledge one will be in a great position to manage price risk (variation) through hedging.

The second relevant point to market users derived from an efficient futures market is it's effect on the underlying spot market by influencing the storage, supply, and demand decisions of hedgers. By influencing these decisions it directly alters the availability of the commodity, which in turn influences the spot price through supply and demand interaction.

7.2 OBJECTIVES ONE AND TWO

The first objective as stated in section 1.4.1 was to determine whether the market is efficient since an inefficient market would almost by definition cause al applications and derived products to be inefficient. Further, to enhance the potential benefits of these type of instruments, market efficiency should always increase government policies, strive to enhance/maintain the current success of the derivatives market and in particular, its effectiveness and efficiency. An example of this should be for government intervention to improve market information flows.

The concept of/and tests for the efficiency of this market was described in Chapter 3, section 3.2 and Chapter 4. Conducting these tests required certain data series of which the spot price series was non-existent and the problem as described in section 1.4.2 had to be dealt with. The solution and structure of the spot price series problem was described and dealt with in section 4.2. and the result of which was plotted in Figure 2.3.1.

Both the spot and future price series were tested for non-stationarity and were found to be non-stationary but proved to be stationary in the first difference. This led to the application of the co-integration analysis technique as was developed by Engel and Granger. The results in Section 4.6 proved the market to be efficient but more importantly it indicated that efficiency increased since the research, which was performed on the same market by Wiseman, Darroch and Ortmann (1995).

7.3 OBJECTIVE THREE

This study also considered the probability that the futures market could lead to profitable returns to those facing price risks by designing appropriate hedging strategies. The question of whether the agricultural futures market could provide producers financial stability and even protection against market risk was also raised. Chapter 5 built on the theory of minimum variance portfolios to design a generic hedging strategy which would enable producers to hedge at minimum cost, considerably reduced portfolio variance and allowed the producer to benefit from market price increase. The strategy required a producer to fix a producer-price during planting period by shorting a $July_{t+1year}$ future and simultaneously buy a $March_{t+1year}$ call option to participate in any upside movement. This basically created a synthetic put option but the time value of the option was only based until March and not July, giving a four-month saving in time value on the premium.

7.4 OBJECTIVE FOUR

Chapter 6 illustrated three structured applications of derivative to assist with agricultural risk reduction. The chosen applications ranged from the more direct weather derivative products of which the market is currently already developing and attracting huge international interest, to the more adventurous structured milk price calculation. Although the milk price product is extreme and would most likely never realise it can still illustrate the unlimited application ability of a structured product by using derivatives.

7.5 FUTURE DEVELOPMENT

Although derivatives have been around since the late 1800's it only recently started in South Africa and for as far as agriculture is concerned it is still in its infancy. Any development to improve efficiency should be embarked upon as soon as possible. Future development could be towards the development of exotic options and starting a regional commodities exchange for the whole of SADC.

There is no doubt that derivatives are the most significant development in the financial world over the last thirty years and will just continue to develop. As our economy integrates itself more into the international world, our biggest challenge would be to get every relevant person, institution and authority adequately trained in the uses and impact of derivatives.

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