RURAL ECONOMY

FLEXIBLE PRICING AND PAYMENT ALTERNATIVES ON CANADIAN WHEAT BOARD POOLING FOR WHEAT

James Unterschultz and Frank Novak

Staff Paper 97-02

Staff Paper

Department of Rural Economy
Faculty of Agriculture, Forestry
and Home Economics
University of Alberta
Edmonton, Canada

Flexible Pricing and Payment Alternatives on Canadian Wheat Board Pooling for Wheat

James Unterschultz and Frank Novak

The authors are assistant professor and associate professor respectively.

Acknowledgements: The authors thank the Canadian Wheat Board for their assistance. Funding was provided by the Alberta Agricultural Research Institute and the Canadian Wheat Board.

The purpose of the Rural Economy 'Staff Papers' series is to provide a forum to accelerate the presentation of issues, concepts, ideas and research results within the academic and professional community. Staff Papers are published without peer review.

Summary: Flexible Pricing and Payment Alternatives on Canadian Wheat Board Pooling for Wheat

J. Unterschultz & F. Novak, University of Alberta

This research investigates *flexible pricing and payment alternatives* (FPPA) that can be incorporated within the CWB pooling system for wheat. FPPA allow the CWB to remove some or all of the price uncertainty within a crop year to participating farm managers and let them arrange cash inflows more suited to their business. More specifically this research:

1. Investigates the practical and theoretical issues involved in providing participating farmers with forward contracts or full pay outs on wheat sales during the crop year while insulating the current pooling system from FPPA.
2. Investigates the practical and theoretical issues on the level of risk the CWB is assuming by providing FPPA and examines ways to quantify and manage this risk.

The project reviewed CWB pooling. Different FPPA products were examined and requirements for successful products presented. Two models for measuring risk and valuing FPPAs based on the Pool Return Outlook (PRO) and financial models were used to illustrate the CWB risk associated with FPPA. Methods for managing CWB risk were also discussed.

Pooling Description

Deliveries of grain are placed into the relevant pricing pools in the CWB system. For example all wheat (including CWRS) grades excluding durum are placed into a single pool as the grain is sold. As the different classes/grades/protein levels of wheat are sold, these dollars are deposited into a single pool. A series of quality grade/protein level price differentials are tracked over the course of the year and used to calculate the final selling price within each pool for each grade/protein level. The pool is finalized when all grain delivered during the crop year is sold. This final pool value determines the total pay out to the farm. Individual pooling can closely emulate CWB pooling as a tool for averaging prices over time. However, individual pooling would not capture any of the other benefits ascribed to single desk selling.

Closely tied to pooling is the federal government's price guarantee. Farmers delivering wheat are paid a federal government guaranteed initial payment of so many dollars per tonne. This guarantee is equivalent in principle to a specialized put option with a strike price equal to the initial payment. The put is provided by the federal government and it is essentially paid for by the federal government. The guarantee will affect farm participation in FPPA.

Types of FPPA

Three types of FPPAs are examined in the report. These are:

1. Fixed Price Contracts (FPC)
2. Early Pool Cash Out (EPCO)

3. Negotiable Producer Certificates (NPC)

FPC are equivalent to forward contracts. The EPCO has the CWB pay out the expected final payment earlier in the crop year to participating farms. NPC lets individuals trade their rights to the final payments. Each of these products, depending on the time of year, will allow the manager to fix a price and manage their cash flow.

Many factors enter into the design of a successful contract. The following points provide a basis for discussing contract design. The essential requirements for a forward are:

1. Willing buyer and seller. At the time the contract is opened both parties must essentially view the contract as having zero value.
2. Asset values that fluctuate. Unless the asset value has significant fluctuations then the risk management component of the contract has little value. With low asset value fluctuations, the demand for the contract may come from access to delivery issues.
3. Asset to be delivered can be adequately described in terms of quality with quality discounts and premiums specified in the contract. The discounts for different grades should be included in the contract.
4. Fixed quantity.
5. Known delivery period and specified delivery locations.
6. Easy to understand and use.
7. Access to public information on prices. The information on which the forward contract is based must be available to both sides in the contract and if possible information provided independently from the two parties.

Several risk issues arise for the CWB if it provides a forward contract. These issues are price risk, basis risk and default or counter party risk. There are two access issues of importance to farm managers. The first issue is access to forward contracts. The second issue is access to delivery on the forward contract. Management of the deliveries is not trivial since the CWB objectives are to maximize the overall efficiency of the system. Managers may value these contracts more for their access rights to the grain handling system than as any price risk management tool.

The most likely first time users of fixed price contracts may depend on how the contracts are constructed. If the contracts are similar to the contracts for canola, then the first time users may be experienced canola growers or specialty crop growers who are used to entering into forward price contracts on a portion of their expected production. If the contracts are quite different from contracts that farm managers are familiar with, then the expected usage may well be very low while farm managers evaluate the usefulness of these contracts.

A rough upper bound on the CWB FPC program after a trial period, using the Canola market as a guide would be 3% of wheat production for CWRS 1, 2 and 3 in February prior to the beginning of the crop year. Using the mean production from the past twenty years this would be approximately 420,000 tonnes. Using a figure of 9% by May would be a total tonnage under the FPC of 1.3 million tonnes. If guarantees continue as part of the CWB pricing pooling system, then this would likely reduce the FPC participation. Managers

participating in the FPC give up the upside associated with the guarantee.

There are two separate situations under the EPCO payment system. The first situation is essentially paying out the farm manager prior to the end of the crop year. A payment is made by the CWB to the farm. The farm no longer participates in the final payment. This pay out, could in principle occur at any time during the crop year. The CWB still has quantity and grade uncertainty as well as price risk. The second alternative is to pay out the farm manager at the end of the crop year when all quantities and grades in the pool are finalized. From the farm perspective the main issues are the price of the early pay out contract compared to the expected final payment. The CWB has issues of timing, whether the price should fluctuate daily and access to this contract.

Negotiable producer certificates (NPC) allow farm managers to trade their rights to all future interim and final payments. There are several benefits of such a program to the CWB but there also several problems that must be addressed. NPC do not require the CWB to implement any strategies to manage risk associated with the pool. The largest requirement would be the administrative aspects associated with tracking the NPC and making the final pay outs to the correct parties. On the administrative side, the CWB or it's agent would be acting as a clearing house for this market. A market will have to be created that brings together buyers and sellers so that the certificates can be easily traded.

Valuation and Risk Issues

FPPAs need to be valued and this requires some type of pool forecast. There is uncertainty or risk associated with these values since none or only some of the pool may be priced. Unbiased forecasting is a critical issue if the Pool Return Outlook (PRO) is to be used as a key input into valuing any FPPA. Unbiased forecasting simply means that on average the PRO and final realized pool price are equal. Related to the issue of bias in the PRO forecast, is the PRO variance or forecast error. Variance simply measures the dispersion of the PRO around the final pool price. Unbiased PRO forecasts still have variance due to market and other related risks. Ideally, unbiased forecasts with a small variance are preferred to unbiased forecasts with a large variance.

Forecast price error has exceeded $80/t and spread error has exceeded $6/t based on the historical PRO. An example Monte Carlo examination of the dollar risk using the PRO error suggested that over 30% of the time the total error could exceed plus or minus $65.2 M if there were participation rates similar to the canola market and no risk management activities were undertaken. These Monte Carlo simulations indicate the substantial dollar risks associated with FPC and EPCO when price risk, spread risk and quantity risk are combined together.

Financial models developed for FPPAs provide a benchmark for comparison to the PRO model and also provide an alternative method for valuing FPPAs and their associated risk. Monte Carlo simulations using these financial models evaluated the forecast risk and illustrated an alternative FPPA valuation method. Using market prices and exchange

rates, expected pool values are simulated. These financial models provided a forecast risk measure comparable to the result used in the PRO Monte Carlo simulation. Government price guarantees are an important consideration in valuing the EPCO or FPC. If the guarantees have value, then the farm manager has a different value of the pool versus the CWB. This will reduce demand for FPC and EPCO.

Managing Risk

The constraint placed upon any FPPA under the CWB pooling system is that the general pool must be insulated from the activities associated with FPPA. The risk can be split into three major components. The first component is overall price risk including wheat prices and currency risk. The second component is the price spread risk between the different grades. The third component is the quantity risk. This project was to identify strategies to manage risk however, actual empirical investigation of the effectiveness of various risk strategies was specifically excluded from the project.

There are three main public risk markets with wheat contracts that can be used to manage wheat price risk. These are CBOT, KBOT and MGE. The issues that need to be addressed with these markets are:

1) How should trade between the three different exchanges be allocated to most closely match the way prices vary in the CWB pool.
2) Contract volume is a major concern for liquidity and ease of trading. Without liquidity, the CWB may experience problems placing hedges in specific contract months.
3) Ideally, the hedges should be placed with different contract months to match the expected sales program. There may not be contracts available far enough into the future to hedge the entire quantity through time. This will require the use of shorter term contract months and then rolling the hedge as the other contracts become available or more liquid. Some risks are associated with rolling hedges where short term hedges are used to protect longer term positions.

Over-the-counter markets are worthwhile exploring as an alternative risk market for wheat price risk. It may be difficult to tailor derivative products that exactly offset CWB wheat pool risk because the final pool value is not independent of the CWB actions. However other arrangements in the over the counter market may be possible and should be explored. Currency risk can be managed using existing over-the-counter markets.

The spread risk and the quantity risk are related. The price spread between grades in the final pool may differ from the grade spread specified in the derivative contracts. Part of the spread risk is related to world markets. Thus, some of this can be managed using public risk markets. However, part of the risk may be directly related to the distribution of grades sold by the CWB. This risk, unique to the CWB, cannot be directly hedged. Of course, the total quantities that are priced under FPPAs directly impact on the total dollar risk the CWB assumes.

Conclusion

Substantial dollar risk will be accepted by the CWB if it offers flexible pricing and payment alternatives to Western Canadian farmers. Empirical work is required to evaluate the CWB's remaining residual risk after appropriate risk management activities have been introduced. This requires further appraisal of the PRO and the financial models examined in this report. Monte Carlo and historical simulation can be used as part of this evaluation. Information derived from further evaluation of FPPA should greatly assist the CWB to evaluate its position on flexible pricing and payment alternatives.

Table of Contents

Table of Tables

Table of Figures

FLEXIBLE PRICING AND PAYMENT ALTERNATIVES ON CANADIAN WHEAT BOARD POOLING FOR WHEAT

1. INTRODUCTION

Primary grain producers are negatively affected by short term price risks and the inability to adequately manage cash flows. High levels of price risk and cash flow uncertainty reduce the farm manager's incentive to increase production and significantly increase the risk of bankruptcy. The concern over cash flow and price risk management has been expressed on several occasions in recent years. The Western Grain Marketing Panel (1996) concluded from their study of the Western Canadian grain marketing system that any system needs to provide good price signals and allow farm managers ways to manage risk and cash flows. Specifically the report stated:

> "Several briefs and submissions to the Panel pointed out that an ideal marketing system needed to be efficient and flexible, giving returns to all stakeholders including farmers. In order to maximize the net returns of farmers over the long term, there are two important subsidiary requirements. Firstly, the marketing system must provide good market signals to farmers so that they will have sufficient knowledge of the returns they are likely to receive from alternative production decisions. Secondly, the system must provide an adequate mechanism for managing risk and cash flow requirements." (section 6.2, page 206).

The Canadian Wheat Board (CWB), first established in 1935, is responsible for marketing all barley and wheat produced on the prairies and destined for export. The CWB objectives are to maximize producer returns. Examining ways to make the CWB more flexible and timely in its payment system to prairie farmers within the context of its single desk seller status is the primary objective of this project.

Therefore, this research investigates *flexible pricing and payment alternatives* (FPPA) that can be incorporated within the CWB pooling system for wheat. FPPA allow the CWB to remove some or all of the price uncertainty within a crop year to participating farm managers and let them arrange cash inflows more suited to their business. More specifically this research:

1. Investigates the practical and theoretical issues involved in providing participating farmers with forward contracts or full pay outs on wheat sales during the crop year while insulating the current pooling system from FPPA.
2. Investigates the practical and theoretical issues on the level of risk the CWB is assuming by providing FPPA and examines ways to quantify and manage this risk.

The benefits of the project are threefold. First, the CWB is prepared to answer prairie

farm managers' questions on flexible pricing and payment alternatives on pooled grain. Such questions include how grain is priced, when is the farm business paid and how is the program to be managed? Secondly, ways to measure and manage the risk from FPPA are identified and examined since no management strategy can remove all risk. Thirdly, further research is identified to evaluate FPPA.

The project begins with a review of selected background information on CWB pooling. This focuses on the nature of the current pooling system and the role of the government price guarantee. Next different FPPA products are examined and requirements for successful products are presented in Chapter 3. Any FPPA must be easy to use and priced as publicly as possible. Two models for measuring risk and valuing FPPAs are developed in Chapter 4. These models focus on the CWB Pool Return Outlook and derivative pricing models from finance. Methods for managing CWB risk are discussed in Chapter 5. This discussion focuses on both public and over-the-counter markets for transferring risk. An empirical investigation of the effectiveness of any risk management activities was specifically excluded from the project. Chapter 6 concludes the report.

2. BACKGROUND

Western Canadian farm managers are interested in more pricing flexibility within the current CWB pooling system (Western Grain Marketing Panel 1996, CWB). Their interests stem from a desire to improve cash flow management and control revenue uncertainty. Uncertainty exists at delivery as to the farm gate final realized wheat price. Also the farm cash inflow from wheat sales is potentially spread out over one and one half years from the time of delivery. Uncertainty over prices and delayed cash inflows increase the difficulty of managing a farm. Price pooling mechanisms and its risk management role are discussed next.

2.1. ISSUES IN POOLING

The CWB's mandate is to serve farm managers in Western Canada by marketing their crops around the world for the best possible price. Deliveries of grain to the CWB are grouped into pools based on the type of grain. The grain from each pool is sold with the CWB acting as the marketing agent for the farm manager. The total revenue (less marketing costs) is returned to the farm based on the total tonnes delivered by each manager into a specific pool. The revenue returned to the farm consists of an initial payment upon delivery of the grain, upward adjustments to the initial payment as pool revenues become less uncertain and a final payment when all sales from the pooled grain have been finalized. The actual pooling mechanism is described next and then the role of the Federal government guarantee to the pool is examined.

2.1.1. POOLING DESCRIPTION AND PRICING

Deliveries of grain are placed into the relevant pricing pools. For example all wheat (including CWRS) grades excluding durum are placed into a single pool (CWBa) as the grain is sold. As the different classes/grades/protein levels of wheat are sold, these dollars are deposited into a single pool. A series of quality grade/protein level price differentials are tracked over the course of the year and used to calculate the final selling price within each pool for each grade/protein level (CWB). These differentials appear to be a simple average over time. The pool is finalized when all grain delivered during the crop year is sold. This final pool value determines the total pay out to the farm.

Formal exploration of price determination within the pool is essential to fully understand the risk management aspects and how this will impact on FPPAs. Define number 1 CWRS as the base grade from which all other discounts and premiums are determined. Let D_i be the average discount or premium on each class/grade/protein level determined by the pool managers. Let Qi be the quantity of each class/grade/protein level "i" sold by the pool manager. Then the calculation of the final pay out becomes a simple calculation to determine the value per tonne of number 1 CWRS ($P_{1\text{-CWRS}}$). That is, the pool managers solve a single equation for one unknown variable, $P_{1,\text{CWRS}}$ described in the following equation.

$$TotalNetPoolAccount\$ = \sum_i Q_i (P_{1-CWRS} - D_i)$$

1. or solving for $P_{1\text{-}CWRS}$ gives

$$P_{1-CWRS} = \frac{TotalNetPoolAccount\$ + \sum_i Q_i D_i}{\sum_i Q_i}$$

where total net pool accounts, total quantities and discounts are calculated as;

$$TotalNetPoolAccount\$ = \sum_t \sum_i Q_{t,i} P_{t,i} - MarketingCost$$

2. $$Q_i = \sum_t Q_{t,i}$$

$$D_i = \sum_{t=1}^{T} \frac{(P_{t,1-CWRS} - P_{t,i})}{T} = \sum_{t=1}^{T} \frac{(D_{t,i})}{T}$$

The $Q_{t,i}$ is the actual quantity of a particular class/grade/protein level sold in each transaction at a particular point in time for price $P_{t,i}$.

The individual farmer "j" then receives a final price based on the total tonnes and type of grain sold through the CWB, X_j. Thus the final price is a blend of a quantity weighted price and a time weighted discount/premium. The farm's total revenue for a particular class/grade/protein level of wheat (ignoring time value) becomes;
$TR_j = X_{j,i}(P_{1-CWRS} - D_i)$ where $X_{j,i}$ is farm quantity of sales into the pool for that particular type of wheat such that over all farms;

3. $$Q_i = \sum_j X_{j,i}$$

Given this description of price pooling several issues arise in the types of risk managed or not managed by this type of pooling. These have a direct bearing on any discussion of flexible pricing contracts. The next sections examine these risk issues.

2.1.2. RISK ISSUES IN POOLING

Price pooling as described above changes or reduces two risks and adds other risks to the farm manager. First, the risk of price fluctuations related to the timing of sales is changed and it is averaged over all farmers. Possible pricing at a market low or high may be removed depending on the sales timing of the pool managers. From the individual's viewpoint, market timing of sales is not of critical importance in the pricing decision with pooled grain. The market timing and pricing role is transferred to the pool manager who presumably has expertise in this role. Implicitly, basis is also being averaged in this pooling mechanism since the cash price always reflects the net cash less the relevant basis. Secondly, price fluctuations related to the class/grade/protein level (a part of basis) over time are averaged. In exchange for these averaging functions, the manager gives up some control over the timing of cash inflows and accepts uncertainty regarding the final realized price. Conceptually, individual pooling can closely emulate CWB pooling as a tool for averaging prices over time. However,

individual pooling would not capture any of the benefits described by Kraft et al (1996) in their study.

2.1.3. FEDERAL PRICE GUARANTEES AND POOLING

Closely tied to pooling is the federal government's price guarantee. Farmers delivering wheat are paid an initial payment of so many dollars per tonne. The federal government guarantees this initial payment. If subsequent total pool returns are not sufficient to cover the initial payment, the federal government pays the difference on the pool and the farmer does not have to return any money to the CWB. The CWB with approval of the federal government does adjust the initial payment upward through out the course of the crop year if markets and prices indicate a higher pool return than that covered by the initial payment.

Again a clear conceptual foundation is required to evaluate this federal guarantee. The guarantee is a floor price or minimum price guarantee where the money is paid up front to the farmer. This guarantee is equivalent in principle to a put option with a strike price equal to the initial payment (Merton 1977). The put is provided by the federal government and it is essentially paid for by the federal government. The value of a put or call option (i.e. the option premium) is essentially the risk adjusted present value of the potential pay off from this financial asset. It is European in nature since there is no early exercise in the formal sense.

The federal guarantee is a key point in discussing FPPAs and will be addressed in detail here. Chapter 4's suggestions for measuring risk are based in part on the following discussion. This discussion abstracts from many of the real world details surrounding price pooling at the CWB however, this stripped down model allows a clearer understanding of just what is involved with a guarantee.

A put gives the holder the right but not the obligation to exercise (sell) the underlying contract at the strike price. For the moment, ignore the pooling aspects of the CWB and the timing of the payment and examine the guarantee. Let the initial price be designated as "I". Let the final realized price (at the end of the crop year) on the grain be $\overline{S}_T$. Then the terminal put payoff using standard notation for options is;

4. $putpayoff = Max[I - \overline{S}_T, 0]$

This put payoff corresponds to the final pool value. If final pool value does not cover the initial payments made, the farm does not have to pay back the difference and gets to keep this difference of $I - \overline{S}_T$. If the final pool value is greater than the initial payment then, the put value has a final pay out of 0. Prior to delivery of grain to the CWB the farmer views the potential terminal payoff as being the greater of the initial payment or the final realized price $\overline{S}_T$. This then is a potential terminal payoff prior to grain delivery of;

5. $Farmgrainvalue = Max[I - \overline{S}_T, 0] + \overline{S}_T$

If the final price is above the initial payment, "I" the farm gets $\overline{S}_T$, since the $Max[I - \overline{S}_T, 0] = 0$. If the final price is below the initial then the farm gets $I - \overline{S}_T + \overline{S}_T = I$,

which is simply the initial payment. Puts have value and there is a recognized literature for valuing put options (Merton, 1990; Ingersoll 1987; Hull 1993). The government's guarantee value is implicitly paid for by the federal government. So prior to delivery, the value of the grain in the bin is equal to $P[I,\bar{S}_t]+E_t(\bar{S}_T)$ where $P[I,\bar{S}_t]$ is the put premium with strike price I and value price S_t. The put premium is not paid by the farm and it includes the farm value of the government guarantee.

There are several wrinkles on this simple definition when the actual methods for providing this guarantee are examined. Loan guarantees only come into effect if there is default. Here the initial payment is paid upon delivery of the grain and this occurs before expiry of the guarantee (option expiry). Upon delivery the farm receives a risk free bond in the form of the initial payment "I" and is issued a call which gives the holder the right to any future value above the initial value[1]. That is, upon delivery, the farm exchanges the expected value discussed above ($P[I,\bar{S}_t]+E_t(\bar{S}_T)$) for the new (and equal value) of $C[I,\bar{S}_t]+I$ where $C[I,\bar{S}_t]$ is the call premium for an option with a strike price "I" and an underlying asset value of S_t. The call option's terminal payoff (final payment) is

6. $Max[\bar{S}_T - I, 0]$

$C[I, S_t]$ represents the *risk adjusted present value* of the future final payment for the grain that has been delivered. The farmer simply lets the call option expire if the final pool value is below the initial payment. However, if the final pool value is above the initial payment, the farmer will exercise the option (the exercise is automatic similar to commercial exchanges such as the CBOT) and receive the final payment. Most years this call expires in the money (i.e. with value).

Valuing any of the derivatives discussed above (i.e. the farm value of the final payment) would be relatively straight forward if it were not for the quantity weighted price averaging in S_t. However, the final value of S_t ($\bar{S}_T$) is in reality a value calculated as shown in equation (1). This makes the options a specialized derivative using an average price. These are sometimes referred to Asian options (Hull, 1993). Further complicating the issue is that no single cash price or futures price exactly matches the price for wheat. This makes valuation more difficult to achieve. Canadian wheat is sold in many different markets around the world and some of the prices do not closely correlate with existing futures markets.

There are several results common to the finance literature that shed further light on the discussion above. Put options increase in value as the strike price ("I") increases (Hull 1993). Higher initial guarantees have more value to the farm since there is a greater chance that final pool prices will be below the initial price. Conversely then, the higher the strike price (initial payment), the lower the value of a call given to the producer after delivery of the grain. There is less chance of the final pool price ending above the initial price. The more variable the price (i.e. the wider the dispersion of possible outcomes) the more valuable the option. Asian

[1] Readers familiar with option pricing may recognize the put-call parity relationship implied in this part of the discussion.

options are lower in value than comparable standard European options (Kemna and Vorst, 1990; Hull, 1993 p. 421) since the averaging precludes the option expiring with a really high value relative to the average of prices observed throughout the year. Finally, the more time there is to the maturity of the option (final payment) the more value the option has.

The federal price guarantee is really a specialized Asian put provided free of charge by the Canadian taxpayer to the farm manager. Even when there is no final pay out ex post, these guarantees have value ex ante to the farm manager. Conceptually, individuals could duplicate this risk management aspect if specialized Asian puts were available commercially to Canadian wheat farmers. However, now the farm is paying the option premium. The option premium includes the discount for the time value of money and it also includes the price risk. In principle the value of this federal guarantee can be determined each year using option pricing theory. Therefore one benefit of the pooling program has been the put option provided by the federal government to the grain farmer.

2.2. SUMMARY

This section examined price pooling. Individual farm managers can duplicate the mechanics of price pooling. The federal price guarantee is a benefit to the farm manager and this impacts on their assessment of expected pool value. Several alternatives for managing farmer cash flow and price risk are under consideration. Alternative FPPAs and related issues are discussed next.

3. DESCRIPTION OF DIFFERENT POSSIBLE FPPAS

Numerous possibilities exist for different types of FPPAs. Several of these have been discussed by the CWB and other organizations. These alternatives vary from allowing a manager to price a portion of the crop before seeding to payment of the final payment at the end of the crop year. This discussion only examines CWRS #1, #2 and #3. These CWRS grades are the most common grades sold by the CWB and public risk markets related to these grades are found in the United States. Many of the conceptual results could be extended to other wheat types in the pool. The quantities of wheat sold in CWRS #1, #2 and #3 are substantial and vary from year to year. (See Appendix: Table 1).

Three types of FPPAs are examined here. These are:

1. Fixed Price Contracts (FPC)
2. Early Pool Cash Out (EPCO)
3. Negotiable Producer Certificates (NPC)

FPC are equivalent to forward contracts. The EPCO and NPC alternatives have features similar to a specialized call. Each of these products, depending on the time of year, will allow the manager to fix a price and manage their cash flow.

These alternatives, examined in detail later in this chapter, are subject to two constraints. The first constraint is that participation by any farm in early pay outs is voluntary. The second constraint is that any FPPA must have no impact on the final payment received by those farms that choose not to participate in any FPPA.

Conceptually, there are no constraints on offering other FPPA products such as minimum price contracts on the pool (i.e. specialized puts); however these may not have the desired cash flow characteristics. Also the initial payment is already a minimum price guarantee[2]. Specialized calls on the pool are also possible. These could be combined with FPC or EPCO to allow the farm to manage cash flow yet still speculate on higher pool prices. Such specialized calls would not contribute significantly to risk reduction for the farm manager if FPC or EPCO are available. Thus there is no further discussion on these alternative contracts.

Any FPPA considered requires some form of price forecast. In recent years the CWB has provided a price forecast called the Pool Return Outlook. Prior to discussing the different FPPAs, the CWB Pool Return Outlook is discussed since this will be one of the methods for forecasting prices in these contracts.

[2] Offering a minimum price contract would imply that the CWB is guaranteeing a price that is significantly above the initial payment if the initial payment is announced or guaranteeing a price much closer to the expected pool value. The farm manager would be charged a put premium to guarantee the floor. Financial models discussed in Chapter 4 provide a conceptual basis for pricing this specialized put. It might also be possible through Monte Carlo simulation to use the Pool Return Outlook to provide some value on this minimum price contract. However, depending on how the contract was structured (i.e. if the put is only paid out at the end of the crop year if pool prices are below the floor price), it would not change the current situation regarding the timing of cash flows.

3.1. CWB POOL RETURN OUTLOOK (PRO) DESCRIPTION

In recent years the CWB has developed and released price forecasts on the pool. The two forecasts are the Pool Return Outlook (PRO) and the Expected Pool Return (EPR). The difference between the two of them is essentially the time of year that each is given. The following is a brief description of the PRO/EPR and then there is a discussion as to their value as forecasts.

The PRO starts in February prior to seeding and is a projected pool price (less CWB costs) for the crop year that begins in the August following the first PRO. Each month from this first February to February of the next year a new PRO is released. The following month, March, the price released is called the EPR and it is then released quarterly until the pool is closed. Much of the grain in the pool has been priced by the time the name switches to EPR. Both the PRO and EPR are calculated in the same way, except that there is more concrete sales information by the time the name changes to the EPR. Little uncertainty should revolve around the CWB costs, such that major uncertainties would come from volume, grades and price.

Calculation of the PRO starts out as a complex weighting of the expected sales volume by grade/protein level and buyer/country times the expected prices less expected CWB operating costs. Prices are developed by a committee based on an amalgam of relevant futures prices and CWB market analysis along with the expected CWB sales program by country or region. The CWB market analysis consists of detailed demand and supply analysis. Through time as sales occur, the projected volumes and prices are replaced by actual sales volumes and sales prices. Thus pool returns uncertainty is reduced over time.

The PRO addresses the information issue referred to above by the Panel report. It provides market signals to farm managers so that they can plan their appropriate crop mix. The benefits of the PRO in providing market information and helping with farm planning is an empirical issue that will be resolved over a longer period of time. Since this is more information than was provided in earlier times, we expect that this is a useful step in the more efficient allocation of resources. Three questions immediately arise on the use of PRO. Is the PRO an unbiased forecast, what is the forecast error and is the PRO perceived by farm managers to be an unbiased forecast? These issues are discussed next.

3.1.1. CONCEPTUAL ISSUES IN PRO

Unbiased forecasting is a critical issue if the PRO is to be used as a key input into any FPPA. Unbiased forecasting simply means that on average the PRO and final realized pool price are equal. Mathematically, this implies that $E_t(\bar{S}_T) = \bar{S}_T$ where $E_t(\bar{S}_T)$ is the PRO and $\bar{S}_T$ is the final realized pool price for a particular grade. If the PRO is consistently biased and used to value FPPAs then either the farms will be consistent net beneficiaries or the CWB/federal government will be consistent net beneficiaries. If farms are consistent “winners” then any FPPA mechanism will consistently lose money from the viewpoint of the CWB and it will

fail. Furthermore farm managers will take advantage of any bias in their favour which would increase CWB losses over time. If the farmers are consistent "losers", they will not use the FPPA and the instrument will disappear due to a lack of interest. The definition of winners and losers above needs to be adjusted for risk. That is, some individuals may be willing to pay a risk premium to CWB (i.e. accept a lower price) in order to shift this risk from the farm to the CWB. However, the CWB as a diversified farm representative covered by government guarantees may not require a risk premium.

The potential sources of bias in the PRO can arise from the futures prices or the CWB analysis. Futures in theory may be rational "biased" price forecasts (see Hull 1989, p. 168). Empirically, the results on futures as unbiased forecasts are mixed (Blank 1989; Fama and French 1987)) however, longer forecast periods tend to increase the bias in futures as forecasts of the spot price. The presence of "bias" in futures prices when based on the usual theoretical models (Hull, 1989, P 168) may not be a problem for valuing options but it may be a problem for direct price forecasting and providing forward type contracts. The extent of the bias in futures when futures are used as price forecasts is an empirical question and could be partially answered by a combined literature review and empirical analysis. However, the answer to this bias question is not easy to derive as attested to by the rich literature on bias and market efficiency tests in futures markets. The presence of contango (futures are upward biased estimates of the spot price) or normal backwardation (futures are downward biased estimates of the spot price) has been debated since Keynes. Until more empirical information is available, the simplest assumption is that the futures prices are unbiased forecasts of the spot price expected in the future.

The presence of consistent bias in the market analysis forecasts is again an empirical issue if there are sufficient years of data that can be used to check the forecasts. A priori, there is no reason to expect systematic bias in the CWB market analysis price forecasts. However, principle-agent theory does suggest where possible sources of bias may arise. Principle-agent theory essentially states that the best outcomes on behalf of the principle (the CWB/farmer) may not be achieved due to individual incentives for the market forecasters (agents of the CWB) to systematically bias the forecast. For example, if the market forecasters are penalized (i.e. reprimand, impact on salary negotiation etc.) when they overestimated the final pool price and a subsequent FPPA account loses money from the CWB's perspective, then consistent downward biases may be expected in the forecasts. The key point here is that the incentives to the market analysts must be aligned such that from their individual view point providing unbiased price forecasts is the optimal outcome.

Related to the issue of bias in the PRO forecast, is the PRO variance or forecast error. Variance[3] simply measures by how much does the PRO miss the final pool price or the

[3] The usual way this "variance" is calculated for this type of problem is as a Mean Square Error although other measures such as Mean Absolute Deviation or Mean Absolute Percentage Error are other ways to measure the dispersion of the forecasts around the actual price outcome.(i.e. see Bowerman and O'Connell 1987 or other statistics textbooks). The Mean Square Error (and related measures such as variance or standard deviation) penalize big forecast errors much more severely than small errors.

dispersion of the PRO around the final pool price. Ideally unbiased forecasts with a small variance are preferred to unbiased forecasts with a large variance. The variance surrounding the PRO will be a critical factor in determining the risk assumed by the CWB for any FPPA based on the PRO. The greater the variance; the greater the risk. The variance should decrease as the length of the forecast period decreases. This issue is evaluated in Chapter 4.

Measuring the bias or the variance of the PRO will be difficult. The PRO has not been in existence long enough to provide enough data to estimate either the bias or the variance directly. Two possible solutions to this measurement problem are plausible. If the CWB has enough data, then PRO projections could be recreated for the past 25 years and used to provide some measures of bias and dispersion. If this sort of historical data is impossible to recreate then Monte Carlo simulation could be used to provide some estimates of the dispersion parameter although this would not measure the bias. Monte Carlo are numerical procedures that simulate the price movements and are then used to measure the dispersion. The ideal solution would be to use historical data to measure the bias and dispersion and then use Monte Carlo to further explore the total risk surrounding the PRO. A financial model, presented in Chapter 4 provides an alternative method for measuring some PRO risks.

Monte Carlo procedures require distribution assumptions on prices, estimates of the moments to use in the distribution and assumptions on what prices to include in the simulation. These are not trivial assumptions and require some empirical justification. Complicating the simulation is the quantity risk. Quantity forecasts also have a mean and a variance and possibly higher moments. Conceivably, certain grades of Canadian wheat have a non-zero correlation between price and quantity (i.e. Appendix: Tables 1 and 2 or Tables 10 and 11). Theory would suggest that these non-zero correlations are more likely to exist where Canada provides a substantial part of the world market for that kind of wheat (i.e. possibly #1 CWRS high protein). The key point here is that doing this simulation is a major undertaking and requires careful consideration of the parameters. Monte Carlo examples based on the PRO error and on financial models are presented in Chapter 4 as illustrations of this technique.

The discussion above presented information on the biases and variance surrounding the PRO. While the PRO may be unbiased, farm managers may perceive the PRO to be biased. Discussions with CWB officials indicate that some farmers feel that the PRO for 94/95 and 95/96 (essentially rising wheat price markets) was biased downward. While the PRO may not be biased, it may be difficult to convince farms that it is a reliable forecast due to the low number of years that it has been available. Farmers must perceive the PRO to be unbiased if it is to be successfully used in any FPPA for price forecasting and valuation. Alternative FPPAs are discussed next.

3.2. FIXED PRICE CONTRACTS (FORWARDS)

Fixed Price Contract (FPC) could be offered in the months of February, March, April May and possibly June prior to the beginning of the crop year. Later dates would also be possible. Contracts would lock in a fixed cash price for delivery. The grain covered under a fixed price contract would not participate in any further pool accounts from the viewpoint of the farm

manager. The physical grain would still be a part of the CWB pool from the CWB's viewpoint and it would be included in the calculations of the pool pay outs.

The FPC contracts would be entered into prior to or during seeding. FPCs are forward contracts and would have the properties associated with forward contracts. Delivery on these contracts would occur earlier in the crop year rather than later. However, there are no conceptual reasons why forwards could not be offered that specified delivery later in the crop year. This discussion begins by examining issues surrounding forward contracts.

3.2.1. FORWARD CONTRACTS

Forward contracts and futures contracts are closely related. A brief description on forward contracts and how they are valued in theory is presented. The following section then relates the definition of forwards to designing a usable forward contract.

A forward is defined as an agreement to buy or sell a clearly described asset for delivery at a specified time in the future for a prespecified price. Unlike futures contracts, forwards are not traded on an exchange. One agent in the forward assumes the long position (agrees to buy - CWB) and one agent assumes the short position (agrees to sell -farm manager). Most forward contracts are designed to lead to the physical delivery of the product. It is usual for a forward contract to have a single delivery date specified in the contract. Unlike a futures contract which only locks in price, a forward contract locks in a price and a basis.

Forward contracts are used for hedging (risk management) and for price speculation. Thus agents may enter into forward contracts to manage price risk (hedge), add to price risk in expectation of making a profit (speculate) or a combination of both.

The essential feature of a forward as a hedge instrument is that over a long time period the expected payoff from using forwards is about zero. Agents who use forwards for contracting should expect zero profits from the use of forwards.

Agents entering into forward contracts for purposes of speculation do so in the expectation of making a profit. This implies that these agents have price forecasts on the future value of the asset that differ from the price built into the forward contract. Based on this different price forecast the agent expects to make a profit by entering into a forward contract. The agents profit from their activities if their price forecasts are superior to the other market participants.

Theory has defined how forwards are valued on storable products such as wheat. Essentially the forward price on a commodity such as wheat, is based on the current cash price of the commodity and all the storage costs to store the commodity to the forward delivery. An important valuation point is that the agreed to forward price in the contract is that price such that the forward contract has zero value on the day the contract is opened.

The simplest forward pricing models states that the forward price on a contract opened at time t is the compounded price of the current cash price with allowances made for storage costs.

$$F_T = (S_t + U)(1+r)^{(T-t)}$$

where F_T is the forward price in the contract, S_t is the current cash price, U is the present value of storage costs, r is the risk free discount rate and T-t is the time remaining in years or fractions of years to maturity[4]. This model of course does not make any allowance for the price pooling under the CWB but it does give a quick look at how the simplest forward contracts are priced in theory. In reality the forward price will be some discounted value of the expected pooled price. The discussion can now focus on what is required for a successful forward.

3.2.2. DESIGNING USABLE FIXED PRICE CONTRACTS (FPC)

Many factors enter into the design of a successful contract. The following points provide a basis for discussing contract design. The essential requirements for a forward are:

1. Willing buyer and seller. At the time the contract is opened both parties must essentially view the contract as having zero value.

2. Asset values that fluctuate. Unless the asset value has significant fluctuations then the risk management component of the contract has little value. With low asset value fluctuations, the demand for the contract may come from access to delivery issues.

3. Asset to be delivered can be adequately described in terms of quality with quality discounts and premiums specified in the contract. The discounts for different grades of CWRS must be included in the contract. These discounts may also have to be extended to the protein levels.

4. Fixed quantity.

5. Known delivery date and specified delivery locations. The known delivery period may conflict with the access issue under CWB pooling. The simple theory model discussed above shows that the value of a forward is directly related to the time remaining to maturity. Uncertainty over the delivery time creates uncertainty about the value of the forward price in the contract and this reduces the value of the forward as a planning and risk management tool. Uncertainty over delivery time may have to be offset with slightly higher forward prices in the contract.

6. Easy to understand and use.

[4] This simple model often includes a convenience yield component. Convenience yield is the benefit to the holder of the commodity that allow the owner to sell the product into local markets if markets offer especially favourable prices or to maintain a production process. The CWRS 1 and 2 wheat owner has no alternative markets and thus has no convenience yield.

7. Access to public information on prices. The information on which the forward contract is based must be available to both sides in the contract and if possible information provided independently from the two parties. The PRO is provided by the CWB and thus is not independent of the CWB. This may negatively impact on the acceptance of forward contracts by farmers if the contract is based exclusively on the PRO. A simple example of the importance of information is provided by the CWB and its policy for evaluating any derivative products offered to the risk management group by banks or other financial companies. As stated by CWB personnel, the CWB will not purchase any derivative product if the CWB cannot value the contract itself. That is, the CWB requires the information to value the product. The values used in the products offered to the CWB are often based on prices from public risk markets such as the Chicago Board of Trade (CBOT) or Minneapolis Grain Exchange (MGE).

All of the points mentioned above have an important role in the use and success of forward contracts. A comparison can be made to canola forward contracts used extensively by farm managers. Futures prices on canola and other oilseeds are publicly available to the farm manager along with supply-demand information. Canola forward contracts are offered by virtually all major grain companies and crushing plants in Western Canada. These contracts are easy to enter into. The farm manager simply phones the company and agrees to the contract. The price, quantity, delivery period, delivery location and quality terms are included in the contract. There is no uncertainty surrounding whether the farm manager has entered into a contract or not. There is no waiting period to determine if the forward is accepted by the canola buyer. Access to the forward contracts are on a first come first contracted basis. That is, the company will enter into contracts as long as it takes to meet the company objectives and then it quits offering forwards for specific delivery times (or changes the basis).

Several risk issues arise for the CWB if it provides a forward contract. These issues are price risk, basis risk and default or counter party risk. The CWB accepts all the price risk and basis risk by offering these contracts. The value of these price and basis risks need to be measured and priced and this is discussed below. The final risk is counter party risk whereby farm managers may not honour the contract obligations. The reasons for counter party risk may range from crop failure to deliberate non-compliance with the contract terms by the farm manager. The latter situation is most likely when the prevailing market conditions offer expected sale prices above those agreed to in the forward contract. Handling counter party risk becomes more a matter of administration and enforcement of contract terms which specify the penalties for non-compliance. This report will not deal any further with the issue of counter party risk.

There are two access issues of importance to farm managers. The first issue is access to forward contracts. The second issue is access to delivery on the forward contract. A related issue is how the forward contract price is managed during a sign up period.

Two proposals on farm access to prespecified forward contracting periods are examined. Access to forwards would be limited to specific one week periods. After the one

week window, no further contract offers would be accepted. The price of the forward would be fixed during the period of the sign up. One method is to take bids on forward contracts, let the CWB evaluate the quantities contracted. If the quantities offered are greater than required by the CWB under its forward program, acceptance would be prorated, similar to the process used under the current system for offering of delivery contracts. This form of access management is familiar to wheat farmers. This method allows the CWB to manage the batch contracting period implicit in this type of arrangement without placing high stress on the administration of the system. There are several CWB risk management issues related to this form of access to forwards that are discussed below.

Managing access on a prorated basis is different from the standard forward contracts described above. The farm manager has quantity uncertainty during the sign up period for the forward contract. Only after the contracting period for that month closes and the sign up is evaluated by the CWB will the farm manager learn what quantity was contracted. One proposal suggests giving the farm manager the option to opt out of the contract if the quantities accepted are not acceptable to the farm manager[5]. This gives the farm manager an extended time period to evaluate the market and only stay in the contract if prices have dropped. This is detrimental to any CWB risk management program for FPC. The quantity uncertainty is also detrimental to the success of the program simply based on some of the points discussed previously. If the quantities offered under the forward program are usually prorated, then farm managers may adjust the quantity offered by increasing the quantity offered.

An alternative access method is a fixed sign up period, with contracting on first come first contracted basis. The contract price is still fixed during the period of the sign up. This removes any uncertainty for the farm manager as to the amount that has been contracted and the price of the contract. This makes the sign up similar to the process used in the canola market where access is controlled by first in line.

Logistic problems for the CWB occur with the first come first contracted type of option. If there is heavy demand for the contract, it may be difficult for the CWB to physically manage the contracting program on the daily or hourly basis required under such a system. Part of this challenge arises from fixing the contracting period to specific time periods such as the one week period. This changes the forward pricing program to a batch processing system versus a flow processing system. This may put demands on the forward contracting system that the CWB and its agents are unable to handle since these programs involve all wheat farmers in Western Canada.

Issues related to forward pricing and CWB price risk management arise under either farm manager access to forwards system. The first issue is the fixed forward price during the

[5] This opt out on the part of the farm manager would be similar to the current procedure with the delivery contracts signed with the CWB.

contracting period. The second issue is the CWB's ability to off load risk during the sign up period. The third issue is the public futures market's response to the CWB sign up period.

During the contracting week the forward price is fixed. However, the market prices (futures prices) on which the PRO is based fluctuate. Substantial price moves during the one week sign up period will affect participation. A significant market price drop would increase the participation in the forward contract. A significant price rise would decrease participation. The CWB is taking on price risk changes during the period the contract is offered. While the actual value of the forward contract at the beginning of the week had zero value for all participants, the forward contract may have a positive value for either the CWB or the farm manager by the end of the week[6]. Recall that the value of forward contract should be zero at the time the contract is opened. The short term sensitivity of the forward contract value to PRO or other prices used to value the forward price needs to be measured. A brief discussion on measuring sensitivities is in Chapter 5.

While price risk management issues are addressed in Chapter 5 several points are discussed here. Under the one week contracting prorated method, the risk managers with the CWB will not know how much grain is contracted until well after the contracting period[7]. Thus they will be continually guessing how much of the contracted amount to hedge in the relevant futures markets. Do they hedge fully the quantity of grain allowed under the forward program at the beginning of the contract period or in the period leading up to the contract period? Thus, all the grain that can be forward priced has been priced ahead of time in the markets to remove as much risk as possible from the CWB. However if the sign up is below the total quantity allowed under the forward program, then the CWB is exposed to price risk on the over hedged short positions. If only a portion of the allowed quantity is hedged at the beginning of the sign up week, then the CWB has risk exposure on the unhedged portion of the forward priced grain if there is a "complete" sign up. Then the rest of the hedges must be placed after the final quantities are determined which may be several days or weeks after the closing of the contracting week. By this time the markets may have moved substantially negating the advantages of placing any more hedges on the futures markets. Either way, under the pro-rated batch sign up system, the CWB has to forecast forward price contract demand and determine how much and when to place its hedges. It must be emphasized here that even with complete hedging on public futures exchanges the CWB cannot remove all price risk.

The CWB has a similar problem of risk management under the first come first signed up contracting program. Continual monitoring of the sign up on a daily or hourly basis is

---

[6] This risk increases substantially if farm managers are allowed to opt out of the contracts under a pro rated contract acceptance system.

[7] With the prorated method, one suggestion has been to give farm managers the option after the sign up period to either accept or reject the quantity the CWB is willing to fix price contract. This is not a viable solution since this now allows the farm manager to opt out of the contract if the fixed price contract now has a negative value and to stay in contract if the contract has a positive value to the manager. Again the CWB risk managers will not know how much grain to hedge under the program until well after the contracting period is closed.

required for the risk management group. However since information is flowing into the CWB on a daily or hourly basis, the risk management group can effectively place hedges to match the quantities contracted each day. This limits the CWB price exposure to price changes during the week of contracting. The time period of price exposure is reduced versus the prorated contracting system. The CWB could also place hedges at the beginning of the week for a fixed quantity and then adjust their positions during the week as sign up information and quantities are received.

CWB risk exposure during the sign up period is in part derived from the fixed price. An alternative for avoiding this price risk under the first come first signed up alternative is allowing the forward price to fluctuate during the week of the sign up. Thus each day the price is changed such that the contract value is reset to zero and the CWB risk management group is dealing with a significantly shorter time period within which to place hedges. Allowing the forward price to fluctuate implicitly means that the PRO is also fluctuating. The feasibility of such a strategy needs to be evaluated by the CWB since it would simplify the risk management activities associated with the program.

The one week contracting period places constraints on the CWB risk management activities. Since the CWB is a major player in the futures wheat market the entire industry will know when these sign up periods are taking place and will watch the market activity. The market will also know when the CWB must place a series of short hedges to cover their risk exposure under the forward pricing program. These hedges generally need to be placed in new crop months which will have the lowest trading volumes. If the quantities are substantial relative to the liquidity in the futures contracts, the market can place short positions ahead of the CWB in expectation that the CWB will drive the market price down. CWB hedging activities related to the contracting program could have short term negative price impacts on wheat futures due to their predictable nature. The depth (or liquidity) of the futures markets contracts used by the CWB need to be carefully evaluated to control this form of price risk. Of course the CWB does not need to place hedges at exactly the same time period as the contracting period, however then the CWB may be accepting too high a level of risk exposure given the constraints under which FPPAs must operate.

The market reaction to CWB activities under a FPC need to be considered. Since the CWB is placing offsetting positions in the market, the number of contracts signed and the quantity may be important information if volumes increase to significant levels over time. This is valuable market information that can be used to the detriment of the CWB. This suggests that the CWB needs to implement this contracting program directly with farm managers rather than through current grain companies. This reduces the ease of access to the FPC.

One possible solution to forward contracting is to offer contracts daily for a period of four or five months with a fixed total quantity that will be accepted during the sign up period. The sign up period would be closed without notice when the total quantity limit is reached or if the total quantity is not reached it would be closed at the end of the period. Unlike commercial companies in the canola market where the contracting is in part controlled by varying the basis built into the contract, the CWB would simply have a publicly known fixed quantity

that it would accept. The CWB would not have to release the quantities signed up until the program was closed. The forward price would fluctuate daily based on the PRO model. The benefits would be:

1. Longer time period for the farm managers to evaluate the market and sign up.
    a) This would reduce the ability of the market to forecast the hedge activities of the CWB.
    b) Unless there was an extremely high demand for the contracts at the beginning of the contracting period[8] this would:
        i) reduce the pressure for farms to sign up in a one week period
        ii) reduce the pressure on the CWB risk management group to place a large quantity of hedges in a very short time period.
        iii) allow the CWB to match their hedge program almost exactly with the sign up on the forward contracts.
        iv) Allow the CWB to change the delivery period on the forwards as the sign up proceeds
            a) It must be recognized that changing the delivery period would signal to the market the approximate quantities signed up under the program.

The drawbacks to such a program are:

1. The CWB would have to be pricing the forward on a daily basis and this requires pricing models that can be updated daily. This may present problems in terms of the CWB objectives for fairness in pricing and the current system of only updating the PRO monthly.
2. There may still be short periods of high sign ups that places stresses on the ability of the system to handle the signings and risk management activities. (but the market will not be able to forecast this.)
3. Grain companies if directly involved in the forward sign up, may gain some "inside information" that could be used for speculative purposes in wheat futures markets.

Access to delivery is another issue that needs to be addressed. Ideally forward contracts specify the delivery period for the contract. The manager signing these contracts needs to have reasonable assurances as to when the grain will be delivered and paid for. If the delivery period is too uncertain, then this negates many of the benefits of forwards as tools for managing cash flow. The ideal situation is that delivery occur within a specified month similar to canola forward contracts. If the system is unable to accept the grain during this month then the CWB needs to address what penalties they are willing to pay to the farm manager. (This would be a part of the contract). Presumably the forward contract quantities would be included for delivery as part of the very first contract series with the added restriction that the farm manager must make deliveries during the specified month.

Management of the deliveries is not trivial since the CWB objectives are to maximize the overall efficiency of the system. Fall congestion in the grain system and local area

[8] An extremely high demand for forwards might indicate that the forward is over priced.

concentrations of forward contracts may strain the ability of the system to accept the forward priced grain. Since presumably fixed price contract grain will be given delivery priority (as it is for canola) managers may value these contracts more for their access rights to the grain handling system than as any price risk management tool. Discussion now switches to the expected users of FPC.

3.2.3. EXPECTED USERS OF FPC

It is difficult to predict the demand for these fixed price contracts. Demand will depend on the construction of the contract as discussed above, farm manager's price expectations relative to the forward price in the fixed price contracts, access to the grain handling system implicit in the contract and the value of the government guarantee (if this guarantee is not dropped) for the initial payment. The more valuable the government guarantee (that is the higher the expected initial payment) the less demand that we would expect for the fixed price contract since the fixed price contract gives up all claims to the put option implicit in the government guarantee.

The most likely first time users of fixed price contracts may depend on how the contracts are constructed. If the contracts are similar to the contracts for canola, then the first time users may be experienced canola growers or specialty crop growers that are used to entering into forward price contracts on a portion of their expected production. If the contracts are quite different from contracts that farm managers are familiar with, then the expected usage may well be very low while farm managers evaluate the usefulness of these contracts.

Direct discussions with grain companies might give a better handle on how farmers tend to price their canola prior to harvest. Our observations are that experienced canola marketers price smaller quantities over several different times based on their assessment of the market and the price level offered. Rarely does the manager contract all the grain they plan to forward contract in one time. Prior to harvest most managers are reluctant to commit a substantial portion of their crop to a forward contract. For example if one assumes that all open canola contracts on the WCE for new crop (Sept. and Nov.) are hedged quantities, only about 2.5% of 1997 expected production is hedged[9] as of January 1997.

This simple analysis to forecast FPC demand based on canola can be extended to other months using data form 1996 and 1995. Table 3 and Figure 1 provide some rough guidelines on the upper bound of the percentage of canola crop that is hedged. The range starts off between 2.7% and 4.5% in January prior to seeding and reaches a range of 10.8% to 16.5% in July. These estimates are upper bound figures. A rough upper bound on the CWB FPC program after a trial period would be 3% of wheat production for CWRS 1, 2 and 3 in

[9] A possible upper limit on the amount of contracting might be derived as follows using the outstanding futures contracts on the WCE. Assume that all open canola contracts in new crop month as of January 20 1997 are covering short hedges, total expected canola acres are 11 million and expected yields are 0.5 tonnes per acre. Then expected canola production is 5.5 million tonnes. Open contracts on Jan. 20 1997 for September and November are 6646 contracts or 132,920 tonnes. As a rough upper estimate 2.5% of the expected 1997 canola production is hedged as of January, 1997. (source: Financial Post Jan 21 1997.)

February. Using the mean production from Table 1, this would be approximately 420,000 tonnes. Using a figure of 9% by May would be a total tonnage under the FPC of 1.3 million tonnes.

These estimates on potential usage for fixed price contracts based on the canola futures markets are most likely upper bounds on the potential level of contracting . First, this canola proxy also measures net speculative positions in the market and long hedge positions. Secondly, the price variability is greater for canola than for the pooled wheat price. The lower price variability on the pooled wheat price should reduce the demand for fixed price contracts.

3.2.4. IMPACT OF GOVERNMENT GUARANTEES IN INITIAL PAYMENTS

The presence or the absence of a guarantee on the initial payment has implications for valuing the FPC. Under most circumstances the initial payment would be determined after the period for FPC was closed but farm managers from prior history will have expectations regarding the size of initial payment that will be offered. Based on the put option value of a guarantee, the CWB must recognize that guarantees have some value and it is provided for free to the farm manager. If guarantees continue as part of the CWB pricing pooling system, then this would in theory reduce the FPC participation. Managers participating in the FPC give up the guarantee. The guarantee limits the downside price risk on the pool and leaves open the upside on pooled price potential. If the guarantee has little value, an historical and empirical question, then this will have little impact on the FPC. Once the initial payment is announced, a FPC will be compared to the benefits of retaining a cash position (unpriced) combined with the guarantee (put). This issue is revisited in Chapter 4 when financial models for valuing FPPAs are explored. The alternative FPPA, early pool cash out is discussed next.

3.3. EARLY POOL CASH OUT (EPCO)

Early pay out of final payments is the second flexible pricing alternative considered. The crop year ends on July 31. Wheat delivered after this date is priced in the next crop year's pool. However, the final pool value for the crop year ending July 31 is still not finalized. Wheat delivered late in the crop year remains to be priced and/or delivered to customers. The farm waits (historically) until the following January to receive the final pool pay out[10]. The question of interest is how could this pay out to the farm be done in August (or earlier) before all sales in the pool have been finalized? This discussion assumes that the Federal government continues to guarantee the payments to the CWB and participation by the farm in early pay outs are voluntary.

[10] The Agriculture and Agriculture Canada policy statement (1996) stated that this pay out timing on the final pool return will be more flexible in the future.

3.3.1. DEFINITION OF THE PRODUCT

There are two separate situations under the EPCO payment system. The first situation is essentially paying out the farm manager prior to the end of the crop year. A payment is made by the CWB to the farm. The farm no longer participates in the final payment. This pay out, could in principle occur at any time during the crop year. The CWB still has quantity and grade uncertainty as well as price risk. The second alternative is to pay out the farm manager at the end of the crop year when all quantities and grades in the pool are finalized.

Under either situation, the CWB is essentially purchasing back the farm's call option on the remaining pool value. The value of the call depends on the priced grain in the pool, the expected price for unpriced grain and all initial and interim payments up to that point in time . Delivery access issues are not relevant to this product if the EPCO is based on grain delivered under the current contracting system. The issues are pricing the call and managing the residual price risk to the CWB.

3.3.2. DESIGNING USABLE EARLY POOL CASH OUT CONTRACTS

This is a simpler product to provide and manage than FPC. From the farm perspective the main issues are the price of the early pay out contract compared to the expected final payment. The CWB has issues of timing, whether the price should fluctuate daily and access to this contract. The farm manager requires unbiased price information and information on the value of the pool at decision time to evaluate these contract options.

3.3.2.1.End of Crop Year Contracts

Contracts provided right at the close of the crop year will remove any quantity and quality risk in the pools from the view point of the CWB. Thus, this is the easiest situation for the CWB to handle. Similar to the FPC, the CWB has risk associated with offering a single price for a fixed time period and then attempting to offset the contract offers with positions in the relevant futures markets. The risks to the CWB are much smaller. Most of the pool is already priced and small changes in the current market prices will have very small changes on the final pooled price. This is illustrated in Chapter 4 using financial models. The futures contracts traded to mitigate the price risk on the unpriced portion of the pool will be the nearby contract months. These months will have much higher volumes than the contracts used under the FPC and it is less likely that the CWB will be moving the market price.

Allowing the pay out to vary during the contract offer period would remove the risk associated with offering a fixed price. This risk may not be large in any case. The CWB risk management group will still have challenges matching their risk management activities with the contract sign-up unless the information flow is daily and contract value is allowed to vary if market prices change.

Farm manager access issues to a contract offered at the end of the crop year should not be a major issue. There should be unlimited access. If this is not feasible from the CWB's perspective, then the access should be based on the contracting with those managers first in line to sign up.

3.3.2.2.During Crop Year Pay Outs

Pay outs on the final pool value offered prior to the end of the crop year have similar issues as the FPC. Does the CWB accept all participants, is the price fixed for a specified time period, and how is the risk managed?

These points are already discussed under the FPC alternative and the early pay out alternative at the end of the crop year. The issues are the same and the levels of risk are somewhere in between the two alternatives. If this pay out is offered near the end of the crop year, it is similar to the end of crop year alternative. If it is offered early in the crop year it is similar to the FPC alternative.

Also, the CWB has the power to influence the final pay out on these contracts depending on their sales program and acceptance of wheat from farms. The valuation of this product is not independent of the buyers (the CWB). For example, if ex post the pay out was too high relative to the current market prices, would the CWB change the marketing program on the remaining wheat to influence the pool value? These are important questions since most futures and options contracts try to base their value on a price or prices that cannot be influenced by a single buyer or seller. Where some short term market influence might occur products are structured to reduce or eliminate the possibility of market influence[11].

3.3.3. ASSESSMENT OF POTENTIAL USERS AND VOLUME

The Early Pool Cash Out (EPCO) comes at a point during the crop year where part of the uncertainty has been removed from the pool. Much of the pool is priced, quantity and grade estimates are reasonably accurate and the CWB has better estimates on the remaining sales values. The further into the crop year these are offered, the less the price fluctuation in the pool. This removes incentives for entering into these contracts for speculation or even for risk management if the contracts are fairly priced. The primary reason a manager might use these programs, especially at the end of the crop year, are for cash flow management.

The EPCO has call option properties implicit in its description. The farm manager receives the greater of zero or the final payment (and interim payments). If the pool account value for that grade of grain ends up below the amount already paid out there is no final payment. The government guarantee has provided a floor price. If the pool value is above all previous pay

[11] An example might be where one investor could possibly move the market for one or two days. Then the product might be structured and valued on the average asset value for the last two weeks of the contract.

outs, then there is a "final" payment. The conceptual framework for this product has been described earlier and the framework is used in Chapter 4 to evaluate EPCO.

3.4. NEGOTIABLE PRODUCER CERTIFICATES (NPC)

Negotiable producer certificates (NPC) allow farm managers to trade their rights to all future interim and final payments. There are several benefits of such a program to the CWB but there also several problems that must be addressed.

NPC do not require the CWB to implement any strategies to manage risk associated with the pool. The largest requirement would be the administrative aspects associated with tracking the NPC and making the final pay outs to the correct parties. On the administrative side, the CWB or a CWB agent would be acting as a clearing house for this market.

3.4.1. CREATING A VIABLE MARKET

The success of NPC may be limited by the CWB's ability to create a viable market. A viable market requires public information and the perception that the CWB is unbiased. The NPCs have to be valued if they are to be traded. This requires information on more that just the PRO or EPR. The farm managers would need information on the priced portion of the pool, the portion of the expected pool that is not priced and possibly some idea as to the future sales program. Will price discovery be open and transparent? Without some information along these lines it is difficult to foresee active trading in NPCs. Since there is uncertainty regarding their value, they may not be readily negotiable and the uncertain value may not be enough to attract speculators.

A market will have to be created that brings together buyers and sellers so that the certificates can be easily traded. Who is going to create this market and where is it going to be located[12]? Market transactions will be driven by farm manager's willing to sell their rights to all remaining payments. Unless someone "long" the producer certificate is willing to sell there will be no transactions.

To improve liquidity should non farm participants be given the opportunity to write early pool cash out contracts? This raises issues of counter party risk which is managed on public

[12] This may be an opportunity for electronic trading however there are individual identification issues and transactions costs. Such a system may actually require the CWB to create and run the electronic market for such a system of traded assets. If trade volumes are small, the costs of the system may out weigh any possible benefits to the farm manager. To facilitate anonymous trading the units (tonnage) may have to be standardized to 20 or 100 tonne contracts. This still leaves the problem of providing enough information to value the contracts and avoiding the perception that the CWB is influencing the contract value. Conceptually there is no reason why the idea of an electronic market for the fixed price contracts could not also be examined. This would allow market participants to trade both the early pool cash out contracts and the fixed price contracts. The role of the CWB might be that of market facilitator and possibly market maker. The problem as stated earlier is that the CWB is the market and determines the final value of these contracts through its delivery and sales program. Speculators may not be attracted to such a market due to its lower volatility. This is an interesting alternative and creating an electronic trading market might be worthwhile exploring further. This is an alternative to using the over-the-counter market.

risk markets using margin and a central clearing house. This adds to the administrative burden. These are all issues that need to be examined. Given some of these considerations, such a market may not be viable. However, from the CWB's perspective, such a market is the simplest for handling CWB risk. Essentially the CWB would have no direct price risk.

3.5. SUMMARY

Any product that is designed under FPPA needs to be easy to use and based on as much public information as possible. The lower the information available to the farm manager the lower the expected participation. The government guarantee may be a critical issue in determining the success of FPPA. A valuable guarantee will reduce the incentive to participate in any FPC or EPCO. These products must also provide a real risk management role. Without these and other essential features outlined in this chapter, FPPAs may fail in their objective of providing farm managers with risk management alternatives. This concludes the discussion on the different FPPA products. The next chapter addresses valuation issues and ways to measure the risk associated with these contracts.

4. VALUATION MODELS FOR FPPAS AND SOURCES OF RISK

The pooling description and the different proposed FPPA's were discussed in the prior chapters. The questions remaining to be addressed are (1). how to value the proposed FPPAs, (2) measuring CWB risk and (3) managing CWB risk, the level of risk exposure the CWB inherits by offering FPPAs. Valuation issues and selected risk measures are analyzed in this chapter. Three different methods for examining FPPAs are presented.

The simplest model assumes the CWB is a risk neutral organization. Risk neutral simply suggests that the CWB is sufficiently diverse that it is only concerned with returns and not concerned with risk. Over a long enough time period the profits and losses on running the different FPPAs should average to zero. Discussion under risk neutrality provides an approximate estimation on the CWB's dollar risk from providing FPC and early pool cash outs under the assumption that no risk reducing management activities are undertaken. Examination of risk neutrality provides a lead in to the other two methods for valuing FPPAs. The second valuation method further evaluates the PRO and EPR for use in valuing FPPAs. The final method applies financial models to FPPAs valuation.

4.1. PRO: VALUATION OF FPPAS

The CWB has federal government guarantees that provide the organization with features similar to a risk neutral organization. Risk neutral refers to well diversified companies or institutions that are concerned with procuring higher returns but are relatively unconcerned with the associated risk. In particular, the CWB has preferential borrowing rates and loan guarantees from the Federal government[13]. The static PRO is a description of one valuation method. The description also allows some simple analysis of the potential errors (dollars) involved in providing FPPAs. This model is described as a lead in to alternative valuation models and as an introduction to the potential forecast error.

The following discussion assumes that the PRO/EPR is an unbiased forecast of the final pool value. The unbiased assumption implies that the chances of forecasting a final pool value greater than or less than the actual pool value are approximately the same. However over many years the average value of the PRO will equal the realized pool value. Observed positive forecast errors (PRO-Actual Pool Value>0) indicate the range for negative forecasts and vice versa.

Under the unbiased assumption the FPC is simply the discount of the PRO using risk free interest rates or the CWB's borrowing rate. The EPCO is the same format as the FPC, but the PRO is discounted to the relevant time period and the initial price plus interim payments is subtracted from the discounted PRO. There are two approaches to discounting the PRO. The two approaches are described with examples which apply to FPC but are easily extended to EPCO.

[13] These guarantees may be significantly changed under proposed changes to CWB legislation.

1. Discount the entire PRO from the date of the expected final pool sale to the contract specified delivery date using a risk free interest rate such as a t-bill or short term bond interest rate. For example, assume a FPC is opened in February with delivery specified early in the crop year in October. The last sale by the CWB in the pool is expected one year after delivery in the following October. As a first approximation, if the two year Canadian bond rate[14] is r, discount the PRO from October (after the crop year closes) to the October FPC delivery date and fix the value of the FPC to the discounted PRO value. That is: $FPC\ ContractValue = \left(PRO \big/ (1+r)^{(T-t)} \right)$. The PRO is discounted for slightly over one year[15]. For example using Table 4, assume the PRO is $200/t and the interest rate is r=4.45%. Then the discounted value of the PRO is $188.33/t which is then set equal to the FPC value. This method is appropriate for a risk neutral organization if the PRO calculations incorporate the timing of the cash inflows and adjust the values to a future value[16]. However if the PRO ignores the timing of the cash flows for the CWB then this method will on average provide a positive net benefit to the CWB under the unbiased PRO assumption. The timing of the CWB cash flows is incorporated in the next method.
2. Discount the PRO under the assumption that the cash inflows (sales) occur over the entire crop year. Divide the PRO by the number of periods (i.e. months) and use the monthly cash inflow to derive the present value of an annuity over the same time period. That is: $FPC\ ContractValue = \left[\frac{PRO}{TimePeriods} \right] \left[1 - \left(1 \big/ (1+r)^{(T-t)} \right) \right] \frac{1}{r}$. This is simply an annuity where all cash flows are received at the end of each period. The formula varies depending on the timing of the CWB sales and the delivery date for the FPC. For example, assume the PRO is $200/t as shown in Table 4. The sales payments for the pool may be spaced equally from October to October, a period of thirteen months. The annuity value of the cash inflows is $194.10. Notice that the $194.10 is greater than the $188.33 for method 1. The second method is more appropriate if the PRO calculation does not adjust the timing of the CWB cash inflows to a future value. A combination of either method may be the most appropriate method for discounting the PRO depending how the timing of the cash flows are incorporated into the PRO.

---

[14] Using the longer rates to approximate the correct discount rate is one way to derive the interest rate. Alternative hypotheses on expected future interest rates (Ingersoll 1987, chapter 18) would use different discount rates.

[15] The forward model used here is setting the $FPC = E[\overline{S}_T](1+r)^{-(T-t)}$ where $\overline{S}_T$ is the final pool value determined at time T and t is the delivery date specified in the FPC. In the example above (T-t)=13/12 which is the total time period in fractions of years. Since the wheat must be sold through the CWB, there is no relevant convenience yield and in the example given above there is very little if any storage costs.

[16] Similarly, if the PRO incorporates the CWB borrowing costs then the PRO is accounting for at least some of the cash timing of inflows and is implicitly including a future value in the PRO.

Thus far, the discussion has assumed the agency is risk neutral. An approximate dollar value may be placed on the possible size of the PRO error and the dollar amounts involved with FPC and EPCO when no risk mitigating activities are undertaken.

The two sources of PRO error are the price level forecast and the spread forecast between the different grades. The dollar value of these errors is also impacted by the total crop marketed by the CWB, the quantities in each grade and farm participation in the FPC and EPCO. The PRO forecast errors are analyzed next.

Historical data on the PRO is limited, however it is does indicate the potential PRO error or variance. Table 5 shows selected PRO projections by month of forecast for #1, #2, and #3 CWRS. Also included in the table is the final pool return. Figure 2 and Figure 3 profile the historical PRO absolute price error for #1, #2, and #3 CWRS[17] . This error is simply the difference between the PRO for a specified month and the final pool price. The error for #1 CWRS (Figure 2) has ranged as high as $80/t for 1995-96 crop year but gradually decreased as the wheat was delivered and sold. Even as late as March in the crop year, price errors have exceeded $10/t. Data on the other grades (Figure 3) was limited and price errors could not be calculated for early PRO months but price errors still ranged over $10/t in March of the crop year. Figure 4 and Figure 5 translate these errors into percentage of final pool value. The errors are sizeable with errors over 30% for #1 CWRS for the early year PRO forecasts.

Spread forecast errors, the difference between prices for different grades are smaller than the absolute price error. Figure 6 and Figure 7 track the PRO spread between #1 CWRS and #2 CWRS and between #1 CWRS and #3 CWRS. The spread in the PRO forecast for #1 and #3 (Figure 7) for December in the crop year 1993-94 is $25/t (see Table 5: $155-$130). The error in the spread forecast is presented in Figure 8. This is the difference between the PRO forecast spread (i.e. Figure 6 and Figure 7) and the actual spread between the final pool value for different grades. The spread error between #1 and #3 CWRS was over $6/t in September 1995-96. Data available to the authors limited the spread error analysis to months within the crop year, but it would be expected that spread error would increase the longer the forecast period. That is, the $6 error is on the low side for spread forecasts made in February prior to the beginning of the crop year.

Forecast price error has already been found to exceed $80/t and spread error has exceeded $6/t. Table 6 examines one scenario on the absolute dollar error surrounding a risk neutral organization using the PRO to price EPR and EPCO. Specific quantity and farm participation assumptions are:

1. The percentage of crop placed under FPC was derived from the canola data in Table 3.
2. FPC specifies the discounts for CWRS #2 and #3.

[17] The error was calculated as the absolute value of the difference between the PRO forecast and the final pool value in Table 5.

3. The EPCO crop participation is assumed to be 2% each month of the expected crop for the months indicated in the table. By March in the crop year 28% of the crop has been priced under FPC and EPCO.
4. The total quantities for each grade are the mean values from Table 1.
5. Time discounting was not included in the model.
6. The errors used are the absolute value of errors derived from Table 5 (Figure 4 and Figure 6) for the 1995-96 crop year and ignore the direction of the error since unbiasedness means the error could be to either side.
7. The price error for #1 CWRS is assumed to apply to all grades.
8. The price error and the spread error are assumed to be independent.
9. The spread error was not available for the early months so it is assumed that the first observed spread error is the error that existed earlier. This likely understates the spread error. Historical spreads between grades, adjusted for inflation are in Table 10.
10. No risk management activities such as hedging are undertaken by the CWB.

The error measured in Table 6 could either be to the "benefit" of farmers or to the "benefit" of the CWB and assumes all the errors used here occur in one direction during the year. The bottom line is that the error would be $171.0 M for price error, $10.4 M for spread error which combines to a total error of $181.4 M. Potentially, the CWB could be ahead or behind by $181.4 M in one year. Since data is limited and quantities contracted are not known, this may or may not be a reasonable number. If the *actual direction* of price and spread errors with mean quantities from Table 1 are applied to Table 6, the total error remains relatively unchanged at $181.2 M and this is to the benefit of the CWB. If the actual direction of price and spread errors with the actual quantities from 1995-96 are applied to Table 6, the total error, again to the benefit of the CWB, changes to $152.6 M shown in Table 7. The PRO underestimated the price and probably overestimated the grade spread for the 1995-96 crop year. Many different scenarios could be examined and a preliminary exploration is undertaken in the next section.

4.2. PRO: SIMULATIONS EVALUATING CWB RISK

A risk neutral assumption may not be adequate or desirable from the CWB's perspective. Over the long run, PRO forecast errors will average to zero but in the short run the CWB and/or the FPPA funding accounts may become insolvent. Simulation is added to the examples presented in the prior section as a method to evaluate risk. Suggestions for further research related to the PRO and methods for deriving a suitable PRO risk premium are presented. The models presented next are only suggestive of one method for evaluating risk and require further refinement.

The basic model presented here uses the data in Table 6 to develop a Monte Carlo model to measure the distribution of the CWB's total dollar risk under FPC and EPCO. Random elements are added to quantity, to price and to spread errors. The key assumptions used are:
1. Farm participation is based on the percentage of crop marketed by the CWB (Table 6) and not on a fixed total quantity accepted by the CWB.
2. Distribution analysis of the CWB total sales in Table 1 (not shown here) indicated it

can be approximated with a triangle distribution. The triangle distribution on the quantity risk allows the quantity to vary between the maximum and minimum tonnage shown in Table 1. Stochastic adjustments to approximate the different grade distributions[18] were added.

3. The price and spread errors in Table 6 are assumed to represent one side of a 95% confidence interval of a normal random variable. That is, 95% of the time, errors are expected to be less than the absolute value of the price and spread errors in Table 6. For example, the standard deviation for the February (prior to crop year) PRO error is approximately $40.5 tonne. Our judgement suggests that wheat markets exhibited "above average crop year price changes" in 1995-96. The possibility of bigger errors (in particular price errors) is relatively small.[19] Further analysis could use historical futures price data with a simplified PRO model to evaluate the possible range of price errors.[20] Price forecast error is examined further in the next section by using financial models.
4. Within the forecast period, the price and forecast error are modelled to follow a decreasing pattern within the crop year. The pattern is estimated using a linear regression of price error from 1995-96 on lagged price error from 1995-96. This regression estimated the trend in forecast error within a single crop year. In other words, the first forecast of the year determines the extent of the forecast error and error decreases linearly from that point in time.
5. Possible correlations as shown in Table 2 or Table 11 between grade price spreads and grade quantities were in general not modelled. These and other relationships should be incorporated into future analysis.
6. Results are based on 100,000 replications of the simulation.

Results of two Monte Carlo simulations are presented here. The first simulation assumes the same farm participation rate as shown in Table 6 (i.e. up to 28% of the crop) and the results are shown in Figure 9. The second simulation assumes the farm participation rate is 20% of that shown in Table 6 (i.e. 5.6% of the crop) and the results are in Figure 10. Figures 9 and 10 show the distribution of total dollar risk for the two different simulations when quantity, price and spread risk are combined together. Figure 9 shows that the majority of the pricing

[18] More sophisticated simulations should investigate other distributions. The total quantity is reasonably approximated by the triangle distributions used in this Monte Carlo however the grade spread distributions did not reasonably match the grade frequency exhibited in Table 1.

[19] Pooled wheat prices when adjusted for inflation may be indicative of possible price forecast errors. Table 10, wheat prices adjusted for inflation, have a price standard deviation of $94/t for #1 CWRS and there are price changes in the pool price exceeding $100/t (i.e. 75-76 versus 76-77) and several year to year changes exceeding $45/t. The ad hoc estimate of the standard deviation of the PRO forecast error used in the Monte Carlo may not be overly conservative. If commodity prices have a long term downward trend in price, then the standard deviation estimate in Table 10 over estimates the true standard deviation. The PRO error may not be related to the year to year changes in the final wheat pooled values, but in the absence of longer term data with which to evaluate the PRO, the data in Table 10 is suggestive of the potential error.

[20] Similar to the PRO calculation, historical futures prices at the time a PRO would first be calculated could be placed into a simplified PRO model to forecast price. Then the futures prices during the relevant part of the crop year could be averaged and compared the simulated PRO to measure the PRO error. A variation on this method is presented in the financial models.

errors lie between -200 M and +200 M when up to 28% of the crop is contracted under FPPAs. A substantially portion of the time the dollar risk exceeds plus or minus $60 M. The total price error has a mean of -$75,000 and a standard deviation of $65.2 M. The model is predicting that over 30% of the time the total error will exceed plus or minus $65.2 M. Figure 10 shows most of the errors lie between -25 M and +25 M when only 5.6% of the crop is covered under FPPAs but errors exceeding 40 million can still occur. These simulation models indicate the substantial dollar risks associated with FPC and EPCO when price risk, spread risk and quantity risk are combined in a simulation.

The objective of any CWB risk management program is to significantly reduce the dispersion of price errors measured by the above simulation. The residual dollar risk remaining after adding risk management to these models is one possible measure of the PRO risk premium required to insulate the CWB from a large portion of possible outcomes. This residual risk is the total dollar error surrounding the forecast. Different risk premiums could be simulated to evaluate the remaining dollar risk for the CWB. Similar Monte Carlo methodologies could be used directly with the PRO model to evaluate the distribution of risk for FPPAs. An alternative valuation model and risk measurement model, based on finance theory, is presented in the next section.

4.3. FINANCE MODELS: AN ALTERNATIVE VALUATION AND RISK ASSESSMENT APPROACH

Financial economics specializes in measuring risk, pricing risk and valuing assets. These financial models successfully value many types of derivative products. Derivatives are financial products whose value is based on an underlying asset. These includes futures contracts, forward contracts, options and other financial products; exactly the types of products proposed for FPPAs. Financial models developed for FPPAs provide a benchmark for comparison to the PRO model and also provide an alternative method for valuing FPPAs and their associated risk.

Using the pooling definitions developed in Chapter 2, finance models are built to evaluate FPPAs. The general numerical methods underlying the financial models specific to CWB FPPAs are presented first. Strengths and weakness of this method are incorporated into the discussion. Monte Carlo simulations using these financial models evaluate the forecast risk and illustrate an alternative FPPA valuation method. Similar to the PRO simulation, the models described here are meant to be illustrative of their potential use in future empirical research.

The wheat pooling process averages the prices received for grain throughout the sales period. When government guarantees are incorporated, wheat pooling exhibits features similar to average value (Asian) options. These issues were discussed in Chapter 2. A brief introduction to finance models used to price average value assets is presented next.

Monte Carlo, applied in a different fashion than in the PRO model above, is the general method used for valuing average-value financial instruments. Essentially, all possible

wheat price paths through time are sampled. For example, given a current market price today of $130/t (U.S. dollars), the model simulates the possible price path of this wheat price on a weekly or even daily basis for up to 20 months into the future. Prices for one week in the future, two weeks in the future and so on generated. At the same time another price such as the Canada-U.S. spot exchange rate is simulated on a week by week or day by day basis. All simulated U.S. wheat prices are converted into Canadian dollars. Wheat prices for the pool sales period are averaged over a prespecified time period to estimate the final pool value. U.S. wheat prices are used since most CWB sales are denominated in U.S. dollars and the public risk markets for milling wheat are based in the U.S. Since the Monte Carlo has a random component, many different price paths through time are possible. The complete price path needs to be simulated many thousands of times to arrive at the most likely asset value. Once the final value of the model is determined, it is discounted to the present time period to arrive at the asset's value. (Hull 1993, Kemna and Vorst 1990).

The information required to use these financial models are current market prices, correlations between returns for the different prices, volatility measures for each price, time to maturity, type of averaging in the model and interest rates. Except for the averaging, these are standard inputs in many financial models including the Black or the Black-Scholes option pricing models.

The financial models described here differ from the PRO simulation in several key areas. The financial model actually simulates the possible price paths through time to arrive at a FPPA value and also provides several other risk measures. Only information presently available in the market is used in the simulation which makes the valuation method more transparent than the PRO. The market price of risk is implicitly built into the financial models and is reflected in the resulting values[21]. The method provides a valuable tool for checking any results derived from the PRO model or estimating an appropriate risk adjusted discount rate for the PRO. For example, the financial model should in most cases generate a lower discounted pooled price than the PRO model[22]. The difference between the two values would allow calculation of a market based risk premia measure that could be used to discount the PRO forecast. The accuracy of this particular comparison will be an empirical issue tempered with expert judgement. These financial models may provide estimates on the effectiveness of a hedging strategy through the calculation of hedge ratios commonly called deltas. Other model sensitivities can be estimated. A finance model will be a useful check against the PRO model, provide an alternative basis for estimating historical risk, and provide further insights on FPPAs.

[21] The market price of risk is included in the models by using current market prices which are presumed to contain the risk premium of future possible outcomes. The price paths that are simulated are adjusted to account for this market price of risk. This method of valuation is a complex issue and interested readers are referred to Hull (1993).

[22] The financial model will not always be lower than the PRO due to CWB proprietary market information forecasting lower prices than currently observed in the public futures markets.

There are several drawbacks to using these financial models. In general, only market information is included which may be a positive feature when trying to involve other agents in the program risk management. CWB proprietary market information and total quantity risk are more difficult to incorporate. Futures market prices for the months of interest, inputs into the model, may not yet be trading when the FPC contracts are offered. The models are relatively complicated to custom build for a specific projection, require the inclusion of several different variables, relatively complex numerical techniques, and information on price correlations and volatilities (returns standard deviations). These model inputs are estimated using current market information. Distribution assumptions on prices are also required. That is, assumptions on the type of statistical price uncertainty are necessary.

The remainder of this section develops and presents financial models for valuing the FPPAs. The results are intended to be illustrative of the type of analysis that is possible and highlight many features and implications on valuation that arise from the financial nature of FPPAs. Many of these issues were raised in the earlier discussion on pooling in Chapter 2 and are further illustrated using these financial models. The discussion begins with the base assumptions incorporated into the Monte Carlo financial models. Applications to FPC, EPCO and NPC are then presented.

Financial models require inputs on current prices, volatilities, correlations and other data. Tables 8 and 9 contain data on returns[23] correlations and volatility (standard deviation of returns) for the Kansas Board of Trade (KBOT) and CBOT September and December 1997 wheat futures. Recent historical data suggests the volatility on the wheat futures returns ranges from 14% to 16.5% (Table 8). There are indications for the prior year that MGE had volatilities ranging to 28%. Implied wheat volatilities on the CBOT (i.e. the volatilities implied by current option values) are higher than the estimated historical volatilities with values in the 21% range (Table 9). The implied exchange rate volatility for a similar date is 3.8%. The returns correlation between wheat on the CBOT and KBOT is 0.65. Other data suggest the correlation between returns on the exchange rate and wheat values is very close to 0. This data is used to guide inputs into the Monte Carlo.

A Monte Carlo financial model was built that incorporated three wheat prices and one exchange rate. Wheat futures prices in February 1997 for December 97 futures from CBOT, KBOT and MGE are included to simulate the multiple prices entering the wheat pool pricing. The model could be expanded to include other futures prices or different maturity contracts. The prevailing exchange rate is also included to convert U.S. wheat prices into Canadian prices. All prices are assumed to be log normal, a standard assumption in many financial pricing models. Distribution analysis of the prices provides some justification for using the log normal distribution especially for the wheat price variables. MGE parameters are assumed to be similar to the CBOT and KBOT parameters. The futures prices (average market futures price of $179.09/t Canadian) and parameters such as volatilities used in the base simulations

[23] Returns refers to the annual returns to buying a futures contract and holding the contract for specified period. These are not the same numbers as standard deviation of price and the correlation between prices. See Hull (1993) for a discussion on calculating returns.

are presented in Table 12. All these inputs can be varied as required and several different scenarios are analyzed by changing initial payment values and remaining time to final payment.

Two main Monte Carlo models were simulated. These are described next.

1. FPC with initial payment already announced with varying times to final sale and varying initial announcement price is the first financial model. The principal objectives of this model are to estimate the forecast risk (standard deviation of the final pool), value the government guarantee and value the FPC. The standard deviation surrounding the final pool price is another proxy for the PRO forecast error. Specific inputs related to Table 12 and this model are as follows.
    a) Twenty months to final sale is modelled. (i.e. equivalent to offering a FPC starting in March prior to the beginning of the crop year). This estimates the pool value when 20 months remain until the CWB makes the last sale out of the pool. A separate model is run assuming the start time is 19 months to the final sales (i.e. equivalent to offering a FPC in April). This estimates the pool value assuming only 19 months remain until the final pool sale. Separate models are run for 20, 19, 18, 17 and 16 months prior to last pool sale.
    b) None of the wheat in the pool is priced at the time of valuation. CWB pool wheat pricing (i.e. sales to wheat customers) are assumed to begin 15 months prior to the final sale in the pool.
    c) Initial price is varied for different model runs.
    d) Wheat prices in Table 12 are always used as the current market price for models estimated for different times to maturity.

2. The second model, simulated within the crop year, is similar to model one but it incorporates the sales already made in the pool and continues to vary the time remaining to the final pool sale by the CWB. Model 2 is applicable to EPCO and NPC. The objectives of this model are to value the call option implicit in the future "final payment", estimate the forecast risk as less of the pool remains to be priced and estimate the present value (discounted value) of the final pool price. Specific inputs related to this model and Table 12 are as follows.
    a) The period from 14 months to 1 month prior to last CWB pool sale are each run as separate models. The model is first run with 14 months remaining to the final sale. Then a separate model is run again with less time remaining to final sale. At the same time the percentage of grain already priced in the pool is increased. Separate models with 14, 12, 10, 8, 6, 5, 4, 3, 2, and 1 month to final pool sale were run.
    b) The average value of all CWB pool sales prior to the current date are $170/t. For example, a model run with 10 months remaining until the final pool sale assumes that 37.5% of the total pool has been priced and the average price of these sales was $170/t.
    c) Initial price is varied for different model runs.
    d) Current market futures prices are always the Table 12 prices which average to $179.09/t.
    e) Specific issues remaining to be resolved with this model (aside from more

closely simulating the pooling system) are the length of time to discount the final pool value or the option value.

The analysis on the different models first focuses on the forecast error. Both models estimate the range of possible final pool values. This is an alternative measure of the PRO forecast error and the total risk associated with FPPAs. Figure 11 presents the pooled standard deviations based on Table 12 inputs and output from financial models 1 and 2. Twenty months prior to the final sale (i.e. February or March before the beginning of the crop year) the standard deviation of the forecast is just under $35/t. About 68% of the time the pool price is expected to be within $35 dollars of the forecast pooled price. The standard deviation decreases to just under $10 per tonne two months prior to the last sale. At twenty months none of the pool has been priced. At two months remaining in the pool it is assumed that 88.75% of the pool is priced with an average price of $170/t. The twenty month financial model standard deviations (Figure 11) surrounding the pool forecast results strongly suggest that the PRO simulation in this chapter which used a PRO standard deviation of $40.5/t is not overly conservative.

These financial models are sensitive to current price levels and to the volatility estimates used. Two alternative simulations explored the sensitivity to changes in price levels or volatilities. The standard deviation of pool price with 20 months to final sale when market prices are increased by 40% (i.e. average futures market price is $250.72/t) is $52.74/t ($42.79/t with 16 months to final pool sale). If prices are held at the values in Table 12 ($179.09/t average) and wheat volatilities are decreased to 16.5%, 14% and 19% for CBOT, KBOT and MGE respectively, the standard deviation of the final pool value decreases to $24.68/t with 20 months to final sale ($19.38/t with 16 months to final sale). Forecast errors increase with the higher starting wheat prices and decrease with smaller volatilities. These results demonstrate that CWB risk associated with FPPAs will vary from year to year to depending on the current price levels and the uncertainty (volatility[24]) in the market.

Present value estimates of the pooled price were calculated from both models using the base case inputs from Table 12. These values are used in valuing FPC. The estimated pooled wheat values are discounted to the present values shown in Figure 12. Under the assumptions given in Table 12, the present value of the pool twenty months prior to the last sale in the pool is just over $164/t. This value steadily increases to $170/t with one month of CWB wheat sales remaining. The only variable changing here is the time to maturity. Figure 12 illustrates how the present value of the pool becomes less and less sensitive to prevailing market prices as more and more of the pool is sold. The assumption in Figure 12 is that the average price of any prior pool sales is $170/t.

FPC wheat prices are shown in Figure 13. The present value estimates from Figure 12 are adjusted for time value back to the FPC delivery date assumed to be 12 months prior to the

[24] It may be possible to add time varying volatilities to the model. The impact of this would depend on how these time varying parameters are included.

last pool grain sale. Given a prevailing futures market average price of $179.09, the FPC contract value is estimated at $168.84/t at twenty months prior to last grain sale. The grain is for a September or October delivery month. Decreasing the time to maturity to 16 months (i.e. offering a FPC closer to the start of the crop year) increases the value FPC wheat price to $169.80. This method for setting wheat price specified in the FPC is analogous to the method describe under the PRO model.

Valuing the government guarantee is also a component of these models and has implications for farm participation in FPPA. The farm wheat value with a price guarantee is the greater of the initial payment or the final pool price (equation 5, Chapter 2). Prior to delivery, the value of the grain in the bin is equal to $P[I,\bar{S}_t]+E_t(\bar{S}_T)$ where $P[I,\bar{S}_t]$ is the put premium with strike price I and value price S_t. The put premium is not paid by the farm and it is the farm value of the government guarantee. Table 13 and Figure 14 present the average value put premiums implied by the government guarantee. Even when initial prices are set at $140/t, which is $39/t below the prevailing average futures market model price, the guarantee still has a value of $1.62/t at twenty months prior to last sale. When the initial price is set at $190/t and the prevailing futures market price is $179.09, the possibility of the federal government having to pay out on the guarantee is high and this is reflected in the put value of $20.63/t. The put values decrease as time to maturity decrease and increase with higher price guarantees.

Farm manager participation in the FPC will be affected by the pattern of values in Figure 14. If initial prices are set relatively close to the prevailing market price (i.e. $10 to 30 below prevailing market prices) the government guarantee has value. In Figure 14, with 20 months to maturity and an initial guarantee of $160/t, the average value put premium is $5.98/t. Neither the CWB nor the federal government has received any compensating premium for the price guarantee yet this $5.98/t has real value to the farm manager. The $5.98/t value is all derived from the guarantee[25] in this particular example. There is a possibility that the pool price will end up below the initial price and this value is reflected in the calculated put premium. Rational farm managers should expect to be compensated for this guarantee in the FPC. Since the CWB does not receive any premium for the guarantee, the CWB is not in any financial position to compensate the farm for the value of the guarantee. Under this scenario of initial payment close to the market price, the uptake on FPC contracts will only be by the most risk averse farmers, those who place the most importance on managing cash flow or those farm managers that prefer to speculate. The value of the guarantee drops as the initial price decreases. A FPC program designed for risk management and encouraging farm participation will require that the initial payments be set well below the prevailing market prices and the FPC price.

The CWB's perceived pool value and the farm manager's perceived pool value diverge due to the guarantee. Figure 15 further illustrates the value of the price guarantee when it is combined with the expected pool value. Results from 20 months to maturity and 16 months to

[25] This is an out-of-the-money average value put option.

maturity are shown with varying initial price guarantees. The pool value to the farm manager is the combined expected final pool value (bottom section of the graph bars, Figure 15), discounted to the present time plus the average value put option (upper part of the bar). The CWB has to set the FPC price equal to or below the present value of the pool (with some slight time value adjustments). This is represented by the lower part of each bar. Depending on the initial payment guarantee, the value managers place on the grain can be substantially above the expected present value of the pool.

When the grain is delivered the farm manager exchanges the expected pool value plus the put value for a risk free bond equal to the initial payment and an average value call option with a strike price equal to the initial payment (Chapter 2). The average value call option represents the present value of the final payment. The EPCO and the NPC, both early pay outs of the final pay out can be valued based on this average call. Managers taking an EPCO or selling a NPC are giving up the benefit of the price guarantee. Figure 16 illustrates the average-value call option premiums under differing assumptions on initial price and time to final pool sale using financial model 2. All other input values such as average futures price, $179.09/t, are as given in Table 12. The values in Figure 16 are the risk adjusted present value of the expected final payment. The value of the final payment decreases as the crop year progresses and decreases with higher initial payments.

Figure 16 demonstrates the value of the guarantee to the farm manager who has delivered wheat, received an initial payment and is now considering an EPCO or selling a NPC. Even when the current market price is $179.09/t, the average value of wheat sold in the pool $170/t, the initial is $190/t, and there is 14 months to the final pool sale, the call still has a value of $3.22/t. This $3.22 value exists because there is a possibility that market prices may rise and the pool value may exceed the initial payment. The CWB would not be offering any EPCO in this situation since the expected pool value is below the initial yet farm managers may be willing to trade their rights to final payments using NPC. A NPC still has value despite a high initial payment relative to the current pool value and market prices.

Comparing the initial payment plus the call value to the present value of the pool without a price guarantee results in Figure 17. The present value of the pool (the bars on the figure) represents the CWB's value on the pool and the total value the CWB is willing to remit to a farm at delivery under an EPCO. The lines represent the value farm managers place on the initial plus the final payment when the federal guarantee is included. The different lines are for different initial payments. In all cases the farm value is above the CWB value. Even when the initial is $140/t with market prices at $179.09/t and the averaged sales value of the grain already sold is $170/t, the farm manager places a slighter higher value on wheat than the CWB. Where the initial price is below the final pool price, the CWB value and the farm value converge as the final pool sales period approaches.

The diverging valuations between the CWB and the farm manager when a government guarantee has significant value suggests that NPCs are more viable in these circumstances. Unless the CWB is compensated in some way for the farm manager's free guarantee, it cannot afford to pay for the guarantee that is built into the expected final payment. When the

guarantee has little value then the farm and CWB values converge and the EPCO is viable from the CWB's viewpoint. Further examination of this issue is warranted in future research.

Sensitivity of the average value call to different pool values is explored in Figure 18. This examines the responsive of the forecast pool final pool value to changes in current market prices. Initial prices and average pool price are varied with ten months to final pool sale. All other values are as given in Table 12. Since the prevailing market price is $179.09/t, a $200/t average value for wheat already priced represents a major market price decrease. Even with a $190/t initial and a $180/t average pool value, the expected final payment value to the farm exceeds $1/t. The average value call, the present value of the final payment, increases with the value of the existing pool sales and increases with lower initial payments.

Financial models provide another method for evaluating FPPA and evaluating price risk. These models use current market information and require estimates of the parameters of the price distributions. Extensions of these models can be used to evaluate the effectiveness of hedging activities and to measure the range of possible spreads between the prices. The importance of the government guarantee in valuing FPPAs was highlighted. If the guarantee is valuable, the farm valuation and the CWB valuation differ since the farm is provided the guarantee at no charge. Successful implementation of any FPPA needs to address these issues. The financial model analysis provides a framework for a detailed empirical analysis of FPPAs when done in conjunction with the PRO model.

4.4. SUMMARY

The PRO model and financial models examined in this chapter presented two ways to measure the total CWB risk. The models built and presented here, while based on market or historical information, are only intended to be suggestive of the total risk associated with FPPAs when no risk management activities are undertaken. The short historical data series on the PRO indicates that the PRO is subject to substantial forecast error. Analysis of the PRO indicated a potential $180 million dollar risk if farm participation in FPPA was similar to their participation in futures and forwards in the canola market. Financial option pricing models examined valuation issues and risk issues. Using market prices and exchange rates, expected pool values are simulated. Government price guarantees are an important consideration in valuing the EPCO or FPC. These financial models provided a forecast risk measure comparable to the result used in the PRO simulation. None of these models examined the risk management activities that can be used to reduce CWB risk. The next chapter examines risk management issues and highlights research directions to assess the effectiveness of these risk strategies.

5. MANAGING CWB RISK

The constraint placed upon any FPPA under the CWB pooling system is that the general pool must be insulated from the activities associated with FPPA. Earlier chapters highlighted the wheat price pooling system and the types of FPPA alternatives under consideration. Further analysis in Chapter 4 examined CWB FPPA risk. The CWB has several different risk management tools available to it to reduce risk. This chapter further examines the types of risk, possible strategies for removing the risk and the type of research that can be used to evaluate these strategies. The discussion starts by summarizing the sources of risk to the CWB.

5.1. SOURCES OF RISK

CWB risk associated with FPPAs depends on many factors including the specific type of financial product offered to farm managers. For example, under an EPCO, the CWB assumes the full risk of any short fall in the final pool value versus the pay out to the farm manager. Under a NPC, the CWB has no direct risk since trade is conducted between parties outside the CWB however the CWB may have some indirect risk depending on how a NPC market is structured. The following discussion ignores any counter party risk such as contract non-compliance by farm managers.

The risk, as presented in Chapter 4, can be split into three major components. The first component is overall price risk. The second component is the price spread risk between the different grades. The third component is the quantity risk. Each risk is briefly discussed.

Price risk is derived from two major sources. The first source is the price risk associated with the different wheat prices feeding into the wheat pool. The second source is exchange rates and in particular the Canada-U.S. exchange rate since much of the wheat is priced in U.S. dollars. Obviously the pool value is sensitive to both wheat price risk and exchange rate risk. When the FPC financial model (1) in Chapter 4 is used to measure the sensitivity of the final pool value (twenty months to final sale) to 1% changes in wheat prices or Canada-U.S. exchange rates, the pool shows approximately a corresponding 1% change in value. This is not surprising given the model assumptions. Within the crop year the financial models show the sensitivity of the expected pool value and the implied call values to 1% changes in wheat price. Figure 19 demonstrates how the pool becomes less sensitive to price changes as the crop year progress. However, the implied call option value (the farm value of the final payment) has much larger percentage changes.

A key question then becomes how likely is a 1% change in wheat prices versus a 1% change in exchange rates? The short answer is that in general it is much more likely to observe a 1% change in wheat prices versus a 1% change in exchange rates. The implied volatility parameters reported in Table 8, 21% for CBOT wheat and 3.8% for exchange rates, indicates that exchanges rates are less likely to have major short term major price moves than wheat prices. An alternative measure for comparing risk, the coefficient of variation (CV is

standard deviation divided by average price) using historical data on Canadian feed wheat and Canada U.S. exchange rates gives results of 2.2 and 0.5 for wheat and exchange rates respectively. The higher the CV, the higher the risk of larger short term movements. CV estimates vary by time period[26] so these risk measures can vary. Similarly, data in February 1997 on December CBOT wheat futures have contract high and lows of 470 and 355.5 and IMM Canadian dollar futures have contract high and lows of 0.7694 and 0.7348. This represents a 27% range in CBOT wheat versus a 2% range in currency.

Quantity risk and spread risk may be somewhat related. The correlations in Table 11 (or Table 2) are indicative of a negative relationship (but possibly insignificant) between the quantity of #1 CWRS and the grade price spreads. A decrease in #1 CWRS with a corresponding increase in the lower grades can increase the spread. The spread error, based on the PRO analysis in Chapter 4, is much lower than the overall price risk. Spread risk is also related to the international wheat market spread. The CWB, as a selling agent for Western Canadian farmers, also has risk surrounding the quantities of wheat that will be sold into different markets with different prices. The discussion now shifts to managing some of these risks.

5.2. DECREASING RESIDUAL RISK

Chapter 4 evaluated the total price risk assumed by the CWB under FPPAs (i.e. see Figures 9 and 10). These outcomes are the positive or negative dollar errors associated with offering FPPA. The CWB needs to be concerned with both sides of the error. If too many dollars accumulate in the contingency fund, this may decrease the incentive for farm managers to participate since it indicates overly conservative pricing by the CWB. If a CWB contingency fund must borrow large amounts of money then the CWB has solvency problems. The ideal situation is to have the outcome (price error) always equal 0. That is equivalent to having only one bar on Figures 9 or 10 centred on $0 with a probability of 1. The ideal cannot be achieved but strategies can be implemented that significantly reduce the range of dollar errors. The residual risk is the distribution of dollar error after risk management activities such as hedging are implemented. This residual risk will guide the additional risk premium that should be incorporated into any FPPA.

5.2.1. QUANTITY RISK

There is very little that can be done to directly limit the quantity risk. The quantity risk interacts with the price and spread risk. Every increase in quantity under FPPAs multiplies the price and spread risk. As discussed in Chapter 3, the CWB can set limits on the quantities of wheat that will be accepted under FPCs or EPCOs. However the CWB cannot limit the quantity of #1, #2 or #3 CWRS that is produced and sold in the pool. Exposure to total price risk and spread risk is examined next.

[26] CV measurements are not appropriate if in the statistical sense the price series are non-stationary. The mean and variance of the price do not exist since prices seem to wander randomly if they are non-stationary. If the series is non stationary, then the returns volatility would be the preferred measure.

5.2.2. PRICE RISK

5.2.2.1.Wheat Prices

The issues for managing wheat risk are similar for FPC versus EPCO. With the FPC the risk managers are concerned with the managing the risk over the entire period of the sale. Once a FPC price is set, the objective is to minimize the price risk on the entire contract quantity. For example, the discussion in Chapter 5.1 indicated the pool value under the financial model shifts one for one with changes in current wheat prices. With EPCO, the sensitivity of the final pool value decreases as more and more sales are made (Figure 19). Only a portion of any contracted grain under a EPCO needs to be hedged or price risk offset since the other portion is already priced by the existing sales in the pool.

There are three main public risk markets that have wheat contracts. These are CBOT, KBOT and MGE. The MGE trades wheat that most exactly matches the wheat grades under consideration for FPPA and EPCOs. The MGE has the lower volume of trading. The issues that need to be addressed with these markets are:

1) How should trade between the three different exchanges be allocated to most closely match the way prices vary in the CWB pool? CWB risk managers already have some information on this problem.
2) Contract volume is a major concern for liquidity and ease of trading. As discussed in Chapter 3, the CWB may have relatively high demands for certain contracts over a short time period. Without liquidity, the CWB may experience problems placing hedges in specific contract months.
3) Ideally the hedges should be placed with different contract months to match the expected sales program. The hedges are then lifted as the sales program gets under way and part of the pool is priced. Under the FPC, sales may start in 6 months but continue for a total of 20 months from the date of the FPC. There may not be contracts available far enough into the future to hedge the entire quantity through time. This will require the use of shorter term contract months and then rolling the hedge as the other contracts become available or more liquid. Some risks are associated with rolling hedges where short term hedges are used to protect longer term positions.

Even with wheat price hedging there is always some residual risk that cannot be hedge. The individual sales prices the CWB receives vary around the relevant futures markets. Hedging does not remove this basis risk. The more wheat the CWB prices based on basis contracts on the U.S. markets the higher the effectiveness of these risk management activities.

The alternative to futures are exchange traded wheat options. Several constraints limit option usefulness for this program. First, options are less liquid than the futures markets. If the CWB has liquidity problems on futures contracts this will be even more pronounced with options. Second, options as demonstrated in Chapter 4, incorporate a time value. This time value is more expensive the greater the maturity date of the option. The CWB needs a range of maturity dates extending up to twenty months into the future. The time value will be high.

This option premium can of course be included in valuing FPC but it may limit FPC participation.

The alternative market for managing risk is the over-the-counter market. Here the CWB either sells or buy contracts from major investment dealers or other institutions. In this situation the CWB can get contracts tailored to the CWB's specific needs. However, it is unlikely that the CWB can obtain contracts that exactly match the pool value since the CWB has some influence over the final pool value. This is discussed further below. The CWB should be able to get instruments based on wheat prices in public markets combined in any fashion desired. Financial models presented in Chapter 4 are an example of the type of model that could be used to price over-the-counter products designed for the CWB. Other products could be puts on puts to handle uncertainty on total quantity sign up when FPCs are offered. These could be combined with a portfolio of futures positions. The puts on puts would only be exercised if the FPC quantity sign up exceeded the CWB's futures positions. Many different portfolio approaches are possible.

If the CWB can convince investment banks or other funds that it is neutral in the way it handles the pool value then over-the-counter derivatives are possible that can perfectly offset the price risk (although possibly not the spread risk). The simplest might be to enter into direct swaps. The CWB accepts a fixed payment on a portion of the pool (i.e. the FPC price) and agrees to flow the final value of the wheat pool through to the other holder of the swap. In effect the other party to the swap acts as if they have delivered wheat into the pool. There may be variations on this that can be negotiated. Commodities tend to have good investment properties (i.e. zero returns correlation) when related to financial investments such as the stock market. Further research might investigate the risk correlation between pooled wheat and other financial assets. This could potentially be a selling feature of this type of swap.

Historical simulation using futures prices from the three different exchanges can be used to evaluate the use of wheat futures and options for risk management. This would provide an estimate of the cost of risk management to the CWB and on the amount of U.S.$ wheat price risk remaining. If all risk could be removed, the value of the FPC could for example equal the PRO discounted at the risk free rate less all risk management transactions and premium costs. These simulations are numerically intensive however in our experience they are very useful in measuring the remaining residual risk (Novak and Unterschultz 1996).

5.2.2.2.Exchange Rates

The market for over the counter exchange rates is huge and in major currencies it is very liquid. The CWB already has personnel that deal exclusively in managing currency risk. The CWB simply uses these forward currency markets to price the expected U.S. value of sales. The contracts are matched with the sales program. The effectiveness of this exchange program is directly related to the quantity of wheat that is priced in currencies that can be hedged. Spread risk is now addressed.

5.2.3. SPREAD RISK

The FPC or the EPCO set the price and possible discount for different grades. The price spread in the contract may differ from the final realized price spread in the pool. Price spread risk was examined in Chapter 4. While this is a relatively smaller risk it can still be in the millions of dollars.

Portions of the spread risk can be managed directly by using the wheat futures markets that correspond to different wheat grades. When hedges are placed they should be allocated to the different futures markets in proportion to the grade distribution expected under the contracts. Historical information such as Table 1 provides information on the expected grade distribution. 56.8% of the CWRS graded #1 over the past 20 years. The estimates may be further refined by knowledge about the geographic location of each FPPA contract and the historical grade distribution in these locations. Price spread changes that are driven by world markets, will be at least partially offset by using different wheat contracts. The extent of risk controlled in this fashion is an empirical question.

Quantity risk enters this spread risk as the crop grade spread becomes known. The grade spread may impact on the price spread as discussed above. A partial response can be made by adjusting positions between futures contracts based on the expected grade distribution. Even with all these risk management activities some residual risk will remain. This issue is briefly addressed next.

5.2.4. CONTINGENCY FUND

The empirical research suggested throughout this document would provide measures of the CWB's remaining residual risk. The size of the residual risk will suggest the size of the contingency fund that needs to be built up over time. Presumably this fund will be funded by the risk premium built into the FPPAs. FPPA risk premium cannot be overpriced or farm managers will not participate in the program. The mechanics of managing such a fund are not analyzed in this report.

At the beginning of the program the fund may end up in a negative or positive cash position. For example, such a fund would have ended up with a surplus in the 1995-96 crop year (i.e. see Table 7). It would likely have ended up with a negative amount (i.e. borrowing) in the 1996-97 crop. No amount of risk management can remove all of the risk of a contingency fund having to borrow funds.

5.3. SUMMARY

Wheat price risk is the largest source of risk under these FPPAs. Much of the risk can likely be managed using public risk markets in the United States however liquidity constraints may exist, especially when pricing FPC. Over-the-counter markets are worthwhile exploring as an alternative risk market. It may be difficult to tailor derivative products that exactly offset CWB wheat pool risk because the final pool value is not independent of the CWB actions.

However other arrangements may be possible and should be explored. Empirical work is required to evaluate the remaining residual risk after appropriate risk management activities have been introduced.

6. CONCLUSION

This report investigated flexible pricing and payment alternatives (FPPA) that can be incorporated within the CWB pooling system for wheat. FPPA are derivative products designed to manage individual farm wheat price risk and manage cash flow. FPPA allow the CWB to remove some or all of the price uncertainty within a crop year to participating farm managers and let them arrange cash inflows more suited to their business. Providing FPPA such as fixed price contracts (FPC) or early pool cash outs (EPCO) add risk to the CWB.

The risk attributes of price pooling were examined. Individual pooling can closely emulate CWB pooling as a tool for averaging prices over time but individuals will not capture any of the other benefits attributed to price pooling. The federal guarantee, provides a financial benefit to farms similar to an average value put option. This value must be considered in the design of FPPA.

Two main derivative products were considered. These were a fixed price contract (FPC) and an early pool cash out (EPCO). Negotiable producer certificates would be similar in design and value to the EPCO. Two key points are important in the design of any product. These derivative instruments need to be easy to use and based on as much public information as possible. The government guarantee will also be a critical issue in determining the success of FPPA. A valuable guarantee will reduce the incentive to participate in any FPC or EPCO. These products must also provide a real risk management role. Without these and other essential features, FPPAs may fail in their objective of providing farm managers with risk management alternatives.

The Pool Return Outlook (PRO) historical error and financial models were used to evaluate the total CWB risk associated with FPC and EPCO and provide ways to value these products. Model analysis showed substantial price risk exists for the CWB. The short historical data series on the PRO indicates that the PRO is subject to substantial forecast error with a potential $180 million dollar risk if farm participation in FPPA was similar to their participation in futures and forwards in the canola market.

Financial option pricing models examined valuation issues and risk issues. Using market prices and exchange rates, expected pool values were simulated to demonstrate future research directions. Total risk measures from these models confirmed that the PRO forecast error could be substantial. The issue of government price guarantees was explored further. If the government guarantee has value, the farm view of the pool value diverges from the CWB view of the pool value. This may limit participation in the FPPA program. Ways to value FPC and EPCO were further explored using these finance models and have potential as an alternative valuation method. The financial models built here also demonstrated the changing sensitivity of the pool value to price changes as the crop year progresses.

There are three main sources of risk for the CWB associated with FPPAs. These risks, price risk, spread risk and quantity risk have varying impacts on the CWB. The price risk

is composed of wheat price risk and currency risk. Wheat price risk is the largest source of risk. Part of the wheat price risk can be managed using public risk markets in the United States however liquidity constraints may exist, especially when pricing FPC. Over-the-counter markets are worthwhile exploring as an alternative risk market. It may be difficult to tailor derivative products that exactly offset CWB wheat pool risk because the final pool value is not independent of the CWB actions. Other arrangements in the over-the-counter market may be possible and should be explored.

The spread risk and the quantity risk are related. The price spread between grades in the final pool may differ from the grade spread specified in the derivative contracts. Part of the spread risk is related to world markets. Some of this can be managed using public risk markets. However, part of the risk may be directly related to the distribution of grades sold by the CWB. This risk, unique to the CWB, cannot be directly hedged. The total quantities that are priced under FPPAs directly impact on the total dollar risk the CWB assumes.

Empirical work is required to evaluate the CWB's remaining residual risk after appropriate risk management activities have been introduced. This requires further appraisal of the PRO and the financial models examined in this report. Monte Carlo and historical simulation can be used as part of this evaluation. Information derived from further evaluation of FPPA should greatly assist the CWB evaluate flexible pricing and payment alternatives.

7. BIBLIOGRAPHY

Agriculture and Agrifood Canada. 1996. Policy Statement - Changes in Western Grain Marketing (October 7).

Blank, S.C. 1989. Research on Futures Markets: Issues, Approaches, and Empirical Findings. Western Journal of Agricultural Economics. 14: 126-139.

Bowerman, B.L. and R.T. O'Connell. 1989. Time Series Forecasting. Duxbury Press Boston.

CWB. 1994, 1995. Internal Discussion Documents.

CWBa. 199. Grain Matters. (Grain Matters).

CWBb. 1995. Grain Matters. (November-December).

Fama U.E. and K.R. French. 1987. Commodity Futures Prices: Some Evidence on Forecast Power, Premiums and the Theory of Storage. Journal of Business. 60: 55-73.

Hull, J.C. 1989. Options, Futures, and Other Derivative Securities. Prentice Hall, Englewood Cliffs.

Hull, J.C. 1993. Options, Futures, and Other Derivative Securities. Second Edition. Prentice Hall, Englewood Cliffs.

Ingersoll, J. E. 1987. Theory of Financial Decision Making. Rowman and Littlefield, Bollman Place, Maryland.

Kemna, A.G.Z. and A.C.F. Vorst. 1990. A Pricing Method For Options Based On Average Asset Values. Journal of Finance. 14: 113-129.

Kraft, D.F., W.H. Furtan and E.W. Tyrchniewicz. 1996 (January). Performance Evaluation of the Canadian Wheat Board. Consultants report.

Merton, R. C. 1977. An Analytic Derivation of the Cost of Deposit Insurance and Loan Guarantees. *Journal of Banking and Finance*. 1: 3-11. Reproduced in Continuous-Time Finance by R. C. Merton, 1990. Basil Blackwell Inc. Oxford.

Merton, R. C. 1990. Continuous-Time Finance. Basil Blackwell Inc. Oxford.

Novak, F. and J. Unterschultz. 1996. Simple Risk Measures When Hedging Commodities Using Foreign Markets: A Note. 16(2) 211-217.

Western Grain Marketing Panel. 1996 (July). Final Report to Government of Canada.

Western Producer. 1993 (June). Orderly Marketing Special Report.

8. APPENDIX: TABLES

Table 1: Western Canadian Wheat CWB Quantity Receipts by Crop Year and Final Net Pool Value Per Tonne (Including Government Guarantees)

Crop YEAR	1 CWRS Tonnes	2 CWRS Tonnes	3 CWRS Tonnes	TOTAL Tonnes	1 CWRS Final Pool Value $/T	2 CWRS Final Pool Value $/T	3 CWRS Final Pool Value $/T
1975-76	2,882,970	4,286,059	2,031,555	9,200,584	146.27	141.42	132.78
1976-77	8,454,778	3,030,882	439,124	11,924,785	117.15	109.89	104.35
1977-78	7,432,993	1,759,451	3,183,950	12,376,393	120.3	113.81	107.17
1978-79	6,292,178	1,853,070	1,749,483	9,894,731	160.53	151.8	150.11
1979-80	7,406,366	2,986,198	2,677,458	13,070,022	196.43	187.64	179.18
1980-81	3,927,895	4,506,029	4,950,550	13,384,474	222.12	217.96	209.42
1981-82	10,630,755	3,580,319	1,559,625	15,770,699	199.62	197.03	187.76
1982-83	9,216,202	4,896,461	3,024,821	17,137,484	192.34	187.39	180.39
1983-84	11,522,103	3,371,000	3,230,046	18,123,149	193.98	190.23	178.56
1984-85	12,281,701	988,131	1,311,408	14,581,241	186.37	184.11	171.51
1985-86	3,197,975	3,729,669	4,486,528	11,414,172	160	154.21	146.21
1986-87	6,142,850	3,267,968	4,431,953	13,842,771	130	124.21	110.21
1987-88	4,855,577	6,680,442	3,101,605	14,637,625	134.02	127.87	115.78
1988-89	8,189,247	4,029,452	1,337,637	13,556,336	197.14	191.19	182.11
1989-90	6,495,428	4,526,378	4,968,945	15,990,751	172.11	168.08	161.13
1990-91	18,215,797	2,684,989	330,850	21,231,637	135	129.21	117.21
1991-92	16,240,700	1,265,253	386,389	17,892,342	134.14	127.22	122.67
1992-93	6,130,247	3,209,249	5,420,511	14,760,007	156.82	149.99	145.19
1993-94	2,349,618	5,101,435	4,055,697	11,506,750	164.01	155.46	142.82
1994-95	7,071,758	3,839,480	1,329,115	12,240,353	195.59	189.45	180.11
1995-96	8,493,288	2,937,650	682,081	12,113,018	254.16	251.17	247.6
mean	7,972,877	3,453,789	2,604,254	14,030,920	170	164	156
standard deviation	3,983,185	1,316,349	1,613,883	2,849,786	35	36	36

1. Source of data. Canadian Wheat Board and CWB Annual Report. The dollar figures have not been adjusted for inflation.

Table 2: Correlation between Grade Quantity Sales and Grade Price Spread on Final Pool (Using Table 1 Data)

	1 CWRS Tonnes[1]	2 CWRS Tonnes	3 CWRS Tonnes	#1-#2 Price Spread	#1-#3 Price Spread	#2-#3 Price Spread
1 CWRS T.	1.00					
2 CWRS T.	-0.56	1.00				
3 CWRS T.	-0.63	0.43	1.00			
#1-#2 Price Spread	-0.23	-0.01	0.05	1.00		
#1-#3 Price Spread	-0.10	0.31	0.18	0.35	1.00	
#2-#3 Price Spread	0.02	0.32	0.16	-0.22	0.84	1.00

1. Absolute value of correlations greater than 0.4 would be considered statistically significant at the 5% level. However any absolute value over 0.10 might be relevant for a Monte Carlo simulation and for projecting relationships between grades and price spreads. The price numbers have not been adjusted for inflation which would change the relationships estimated here.

Table 3: Comparing Canola Contract Open Interest to Expected Crop Tonnage to Show Upper Bound on Hedge Activities in Canola

Date of Obser-vation[1]	Contract Month Open Interest (OI) Numbers							
	Sept	Nov	Jan	March	May	Total Tonnes OI	% Expected Crop Given Crop Estimate Shown	
							5M T. Estimate	7M T Estimate
1995								
Jan-24	1352	8043				187900	3.8%	2.7%
Feb-22	1402	10376	358			242720	4.9%	3.5%
Mar-22	1316	13493	1055			317280	6.3%	4.5%
Apr-21	2268	12129	2351			334960	6.7%	4.8%
May-23	3908	17428	4897	409		532840	10.7%	7.6%
Jun-21	4194	22011	6473	3027		714100	14.3%	10.2%
Jul-21	4731	21640	6692	4899		759240	15.2%	10.8%
1996								
Jan-22	4067	5011	2055			222660	4.5%	3.2%
Feb-20	4099	7240	2279			272360	5.4%	3.9%
Mar-23	4337	10779	2655			355420	7.1%	5.1%
Apr-19	3949	12803	3007	203		399240	8.0%	5.7%
May-22	6879	18025	3935	357		583920	11.7%	8.3%
Jun-21	9191	17755	5717	2225		697760	14.0%	10.0%
July-22	9730	20307	6356	4050	735	823560	16.5%	11.8%

1. Source of Data: Financial Post (Various Issues). The actual canola tonnage for the 1995 crop was 6.368 M tonnes and the tonnage for 1996 was 4.991 M tonnes. (Source: Statistics Canada).

Table 4: Two Methods of Discounting the PRO using "Risk Free" Interest Rates

Action[1]	Time (Month)	PRO $/t	Method 1:. Discount PRO to Delivery Date	Method 2 (M2): Assumed Cash Inflow to CWB	(M2) Discount CWB Cash Inflow to Oct Delivery Date	(M2) Oct.1 Annuity Value of Discounted Cash Flows
FPC Signed	Feb	*FPC Value →*	188.33		*FPC Value→*	194.10
	Mar					
	Apr					
	May					
	Jun					
	Jul					
	Aug					
	Sep					
Delivery Date in FPC	Oct		188.33	15.38	15.32	194.10
	Nov			15.38	15.25	
	Dec			15.38	15.19	
	Jan			15.38	15.12	
	Feb			15.38	15.06	
	Mar			15.38	14.99	
	Apr			15.38	14.93	
	May			15.38	14.87	
	Jun			15.38	14.80	
	Jul			15.38	14.74	
	Aug			15.38	14.67	
	Sep			15.38	14.61	
	Oct			15.38	14.55	
	Nov					
Expected Pool Closure With Last Sale	Dec	PRO as of FPC Signing Date: $200/T		Total Expected Inflow: $200/T	Discounted sum: $194.10 (Annuity Value)	

1. The interest rate used was a 2 year Canadian Bond rate (January 1997) of 4.45%. Method 1 discounts a $200 PRO forecast from December to the Oct delivery date to get a value of $188.33 for the FPC. Method 2 discounts each expected cash flows to the CWB to arrive at an annuity value of 194.10 for Oct delivery date. The 194.10 is the FPC value. Different assumptions on FPC delivery dates, cash inflows, pool closure and interest rates will change the results.

Table 5: PRO and EPR for Wheat with Final Pool Value

PRO ($/T) [1]	1 CWRS																	
														ERP				
YEAR	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	MAY	JUN	SEP	Actual Return
1992-93	0	0	0	0	0	0	0	0	0	0	0	0	0	148	0	147	154	156.82
1993-94	0	0	140	136	132	132	140	140	145	150	155	155	152	148	0	157	164	164.01
1994-95	0	138	138	138	138	151	160	180	185	185	184	184	184	187	0	187	194	195.59
1995-96	173	178	182	191	198	220	220	231	234	234	234	237	243	250	258	257	254	254.16
1996-97	235	235	273	281	276	255	242	227	213	204	204	205	0					
	2 CWRS																	
1993-94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	155.46
1994-95	0	0	0	0	0	0	0	0	178	178	177	177	177	181	0	182	188	189.45
1995-96	0	0	0	0	0	0	0	225	228	230	230	232	238	248	256	255	251	251.17
1996-97	0	0	0	0	0	0	0	0	0	0	0	0	0					
	3 CWRS																	
1993-94	0	0	0	0	0	0	0	0	0	0	130	130	127	128	0	137	143	142.82
1994-95	0	0	0	0	0	0	142	162	169	166	165	165	165	170	0	173	179	180.11
1995-96	0	0	0	0	0	0	0	218	221	225	225	229	235	244	252	251	247	247.6
1996-97	0	0	0	0	0	0	0	0	201	189	193	194	0					

1. Source: Canadian Wheat Board. None of these numbers have been discounted for the time value of money.

Table 6: Example of Possible Absolute Dollar Error Using the PRO For Fixed Price Contracts (FPC) and For Early Pool Cash Outs in Selected Months

Month[1]	Cumulative % of Crop under FPC and EPCO	Price Error Per Tonne	Spread Error per Tonne #1-#2	Spread Error per Tonne #1-#3	$ Error From Price Error	$ Error From Spread #1-#2 Error	$ Error From Spread #1-#3 Error	Total $ Error
	FPC							
FEB	5%	81.16	6	6.44	55,279,455	1,005,964	814,151	57,099,570
MAR	6%	76.16	6	6.44	15,934,887	309,017	250,095	16,493,999
APR	7%	72.16	6	6.44	3,580,098	73,276	1,123,549	4,776,923
MAY	11%	63.16	6	6.44	35,071,971	820,123	663,745	36,555,839
JUN	14%	56.16	6	6.44	28,565,723	751,241	2,395,291	31,712,254
JUL			FPC	subtotal	138,432,134	2,959,621	5,246,830	146,638,585
AUG	EPCO							
SEP	16%	23.16	6	6.44	6,499,122	414,455	335,428	7,249,005
OCT	18%	20.16	3.01	6.44	5,657,267	207,918	335,428	6,200,613
NOV	20%	20.16	1.01	2.44	5,657,267	69,767	127,088	5,854,121
DEC	22%	20.16	1.01	2.44	5,657,267	69,767	127,088	5,854,121
JAN	24%	17.16	2.01	1.44	4,815,412	138,842	75,003	5,029,257
FEB	26%	11.16	2.01	1.44	3,131,701	138,842	75,003	3,345,546
MAR	28%	4.16	0.99	0.56	1,167,373	68,385	29,168	1,264,925
			EPCO	subtotal	32,585,409	1,107,975	1,104,204	34,797,588
Dollar Error					171,017,543	4,067,596	6,351,034	181,436,173

1. The following assumptions were made to create this table. The percentage of crop placed under FPC was derived from the canola data in Table 3. The EPCO crop was assumed to be 2% each month of the expected crop for the months indicated in the table. Quantities used are the mean quantities from Table 1. The PRO was not discounted such as was discussed in Table 4. The errors used are the absolute value of errors derived from Table 5 (Figure 4 and Figure 6) for the 1995-96 crop year and ignore the direction of the error since unbiasedness means the error could be to either side. The price error for #1 CWRS is assumed to apply to all grades. The price error and the spread error are assumed to be independent. The spread error was not available for the early months so it is assumed that the first observed spread error is the error that existed earlier. This likely understates the spread error. Thus this error measure could either be to the "benefit" of farmers or to the "benefit" of the CWB and assumes all the errors used here occur in one direction during the year.

Table 7: Example of Possible Dollar Error Using the PRO For Fixed Price Contracts (FPC) and For Early Pool Cash Outs(EPCO) (Selected Months Using 1995-96 Crop Year Quantities)

Month[1]	Cumulative % of Crop under FPC and EPCO	Price Error Per Tonne	Spread Error per Tonne #1-#2	Spread Error per Tonne #1-#3	$ Error From Price Error	$ Error From Spread #1-#2 Error	$ Error From Spread #1-#3 Error	Total $ Error
FEB	5%	81.16	6	6.44	47,723,246	855,632	213,234	48,792,112
MAR	6%	76.16	6	6.44	13,756,730	262,837	65,502	14,085,070
APR	7%	72.16	6	6.44	3,090,731	62,325	294,269	3,447,325
MAY	11%	63.16	6	6.44	30,277,945	697,563	173,842	31,149,349
JUN	14%	56.16	6	6.44	24,661,043	638,974	627,351	25,927,369
JUL			FPC	subtotal	119,509,694	2,517,331	1,374,199	123,401,224
AUG	EPCO							
SEP	16%	23.16	6	6.44	5,610,750	352,518	87,852	6,051,120
OCT	18%	20.16	3.01	6.44	4,883,969	176,847	87,852	5,148,668
NOV	20%	20.16	1.01	2.44	4,883,969	59,341	33,286	4,976,595
DEC	22%	20.16	1.01	2.44	4,883,969	59,341	33,286	4,976,595
JAN	24%	17.16	2.01	1.44	4,157,188	118,094	19,644	4,294,925
FEB	26%	11.16	2.01	1.44	2,703,626	118,094	19,644	2,841,363
MAR	28%	4.16	0.99	0.56	1,007,803	-58,165	-7,639	941,998
			EPCO	subtotal	28,131,274	826,067	273,924	29,231,265
Dollar Error					147,640,968	3,343,398	1,648,123	152,632,489

1. The following assumptions were made to create this table. The percentage of crop placed under FPC was derived from the canola data in Table 3. The EPCO crop was assumed to be 2% each month of the expected crop for the months indicated in the table. Quantities used are the 1995-96 quantities from Table 1. The PRO was not discounted such as was discussed in Table 4. The errors used are the absolute value of errors derived from Table 5 (Figure 4 and Figure 6) for the 1995-96 crop year and ignore the direction of the error since unbiasedness means the error could be to either side. The price error for #1 CWRS is assumed to apply to all grades. The price error and the spread error are assumed to be independent. The spread error was not available for the early months so it is assumed that the first observed spread error is the error that existed earlier. This likely understates the spread error. Thus this error measure could either be to the "benefit" of farmers or to the "benefit" of the CWB and assumes all the errors used here occur in one direction during the year.

Table 8: Relationship Between Two Wheat Futures Contracts (August 1996 to January 1997 Daily Data)

	Kansas Sept. 97 Wheat Futures[1]	CBOT Sept. 97 Wheat Futures	Kansas Dec. 97 Wheat Futures	CBOT Dec. 97 Wheat Futures
Price Correlation between Markets	0.98	----------	.98	---------
Returns Correlation Between Markets	0.65	----------	0.65	----------
Annualized Standard Deviation of Returns (Volatility)	14.5%	16.5%	13.9%	16.0%

1. Source of Data Used For Calculations: CWB. Analysis of the Kansas September and December 1996 futures showed an historical returns standard deviation of 28% over a 350 trading days or 22% over the last 100 days of trading data.

Table 9: Implied Wheat Futures Volatilities on CBOT Wheat June 97 Options (Using the Black Option Pricing Model)

	Put Implied Volatility Range[1]	Call Implied Volatility Range
At-The-Money Options	20.5-20.8%	20.4-20.7%
Out-Of-The-Money Options	20.3-20.5%	21.2-22.6%

1. Based on Jan. 29 and 30 1997 prices and data from the Financial Post and Data Transmission Network -DTN. One calculation for Sept. Wheat Call Options estimated an implied volatility of 21% (as of Jan 30, 1997). An implied volatility calculation for June 97 Canadian dollars on the IMM provided an estimate of 3.8% volatility (Financial Post). Data from weekly spot exchange rates provided a ten year historical annual volatility measure on the spot exchange rate of 4.2%. Also of interest, the returns correlation between Canadian feed wheat and spot exchange rate is essentially 0 (i.e. -.019).

Table 10: Western Canadian Wheat CWB Quantity Receipts by Crop Year[1], Final Net Pool Value Per Tonne and Grade Price Spread (Including Government Guarantees)Adjusted with CPI to 1995 Dollars

Crop YEAR	1 CWRS Tonnes	2 CWRS Tonnes	3 CWRS Tonnes	TOTAL Tonnes	1 CWRS Final Pool Value $/T	2 CWRS Final Pool Value $/T	3 CWRS Final Pool Value $/T	#1-#2 Price Spread	#1-#3 Price Spread	#2-#3 Price Spread
1975-76	2,882,970	4,286,059	2,031,555	9,200,584	433.92	419.54	393.91	14.39	40.02	25.63
1976-77	8,454,778	3,030,882	439,124	11,924,785	323.31	303.28	287.99	20.04	35.33	15.29
1977-78	7,432,993	1,759,451	3,183,950	12,376,393	307.35	290.77	273.80	16.58	33.55	16.96
1978-79	6,292,178	1,853,070	1,749,483	9,894,731	376.53	356.06	352.09	20.48	24.44	3.96
1979-80	7,406,366	2,986,198	2,677,458	13,070,022	422.13	403.24	385.06	18.89	37.07	18.18
1980-81	3,927,895	4,506,029	4,950,550	13,384,474	433.27	425.16	408.50	8.11	24.77	16.66
1981-82	10,630,755	3,580,319	1,559,625	15,770,699	346.28	341.79	325.71	4.49	20.57	16.08
1982-83	9,216,202	4,896,461	3,024,821	17,137,484	301.12	293.37	282.42	7.75	18.71	10.96
1983-84	11,522,103	3,371,000	3,230,046	18,123,149	287.00	281.45	264.18	5.55	22.81	17.27
1984-85	12,281,701	988,131	1,311,408	14,581,241	264.27	261.07	243.20	3.20	21.07	17.87
1985-86	3,197,975	3,729,669	4,486,528	11,414,172	218.26	210.36	199.45	7.90	18.81	10.91
1986-87	6,142,850	3,267,968	4,431,953	13,842,771	170.23	162.65	144.31	7.58	25.91	18.33
1987-88	4,855,577	6,680,442	3,101,605	14,637,625	168.15	160.44	145.27	7.72	22.89	15.17
1988-89	8,189,247	4,029,452	1,337,637	13,556,336	237.78	230.61	219.66	7.18	18.13	10.95
1989-90	6,495,428	4,526,378	4,968,945	15,990,751	197.72	193.09	185.10	4.63	12.61	7.98
1990-91	18,215,797	2,684,989	330,850	21,231,637	148.03	141.68	128.53	6.35	19.51	13.16
1991-92	16,240,700	1,265,253	386,389	17,892,342	139.27	132.08	127.36	7.18	11.91	4.72
1992-93	6,130,247	3,209,249	5,420,511	14,760,007	160.40	153.42	148.51	6.99	11.90	4.91
1993-94	2,349,618	5,101,435	4,055,697	11,506,750	164.72	156.14	143.44	8.59	21.28	12.69
1994-95	7,071,758	3,839,480	1,329,115	12,240,353	196.08	189.92	180.56	6.16	15.52	9.36
1995-96	8,493,288	2,937,650	682,081	12,113,018	254.16	251.17	247.60	2.99	6.56	3.57
mean	7,972,877	3,453,789	2,604,254	14,030,920	264.29	255.11	242.22	9.18	22.07	12.89
standard deviation	3,983,185	1,316,349	1,613,883	2,849,786	94.80	92.00	89.54	5.31	8.48	5.61

1. Source of data. Canadian Wheat Board and CWB Annual Report. Adjusted using CPI index to 1995 $(CPI for1995 estimated).

Table 11: Correlation between Grade Quantity Sales, Price and Grade Price Spread on Final Pool(From Table 10) (Data Adjusted For Inflation to 1995 $ using CPI)

	1 CWRS Tonnes	2 CWRS Tonnes	3 CWRS Tonnes	TOTAL tonnes	1 CWRS Final Pool Value $/T	2 CWRS Final Pool Value $/T	3 CWRS Final Pool Value $/T	#1-#2 Price Spread	#1-#3 Price Spread	#2-#3 Price Spread
1 CWRS T	1.00									
2 CWRS T	-0.56	1.00								
3 CWRS T	-0.63	0.43	1.00							
TOTAL T	0.78	-0.07	-0.11	1.00						
1 CWRS $	-0.27	-0.06	-0.05	-0.43	1.00					
2 CWRS $	-0.26	-0.05	-0.05	-0.41	1.00	1.00				
3 CWRS $	-0.26	-0.06	-0.05	-0.42	1.00	1.00	1.00			
#1-#2 Price Spread	-0.26	-0.18	-0.10	-0.51	0.55	0.51	0.51	1.00		
#1-#3 Price Spread	-0.27	-0.01	-0.02	-0.39	0.65	0.62	0.59	0.76	1.00	
#2-#3 Price Spread	-0.17	0.17	0.07	-0.11	0.46	0.46	0.41	0.21	0.79	1.00

Table 12: Financial Model Monte Carlo Base Case Input Variables

Variable description	Variable Value
Canadian risk free interest rate (2 year bond rate)	4.17%
U.S. risk free interest rate (2 year bond rate)	5.87%
CBOT Dec 97 wheat futures converted to U.S.$/tonne	$130.83/t (177.30 in Can. $)
KBOT Dec 97 wheat futures converted to U.S. $/tonne	$132.66/t (179.70 in Can. $)
MGE Dec 97 wheat futures converted to U.S. $/tonne	$133.03/t (180.28 in Can. $)
U.S. Canada exchange rate	.7379 $ U.S. to buy 1 Can $
Time to final sale in the wheat pool	varies: 20 months to 1 month
Time period when sales begin	varies depending on time to final sale
Initial price or current initial plus interim	varies
Current value of any wheat already sold in the wheat price pool	$170/t (Can) or varies depending on the simulation and the time remaining to final sale
Proportion of pool already price	varies from 0 to 100% depending on the time remaining to final sale
CBOT wheat returns volatility	21%
KBOT wheat returns volatility	20%
MGE wheat returns volatility	28%
Exchange rate returns volatility	.038
Returns correlation CBOT and KBOT	.65
Returns correlation between CBOT and MGE	.65 (assumed to be similar to CBOT and KBOT)
Returns correlation between KBOT and MGE	.65 (assumed to be similar to CBOT and KBOT)
Returns correlation between exchange rate and all wheat contracts	0.0
Portion of sales at CBOT simulated price	.33 (assuming equal sales each period when sales ongoing)
Portion of sales at KBOT simulated price	.33 (assuming equal sales each period when sales ongoing)
Portion of sales at MGE simulated price	.34 (assuming equal sales each period when sales ongoing)
Number of price paths in one run[1]	500 or 1000
Number of times run is repeated	100

1. The number of runs combined with the number of times the run is repeated give the total number of price paths simulated (i.e. 50,000 or 100,000). Some runs used fewer price path simulations due to the extensive computer time required to run the different scenarios. Future simulations could incorporate a higher number of price paths.

Table 13: Financial Model Monte Carlo Put Average Value Option With Known Initial Payment Prior to Beginning of Crop Year (Values as given in Table 12 with current market wheat futures at $179.09/t)

	Time	To Last	Sale		
Range of Initial Prices	20 Months	19 Months	18 Months	17 Months	16 Months
$140/tonne	$1.62/t	$1.31/t	$1.05/t	$0.83/t	$0.58/t
$150/tonne	3.30	2.87	2.46	2.06	1.67
$160/tonne	5.98	5.56	5.04	4.37	3.57
$170/tonne	9.58	9.14	8.60	7.73	7.00
$180/tonne	14.62	14.03	13.33	12.58	11.71
$190/tonne	20.59	20.04	19.21	18.53	17.82

9. APPENDIX: FIGURES

Figure 1: Canola Market Open Interest as Percentage of Crop

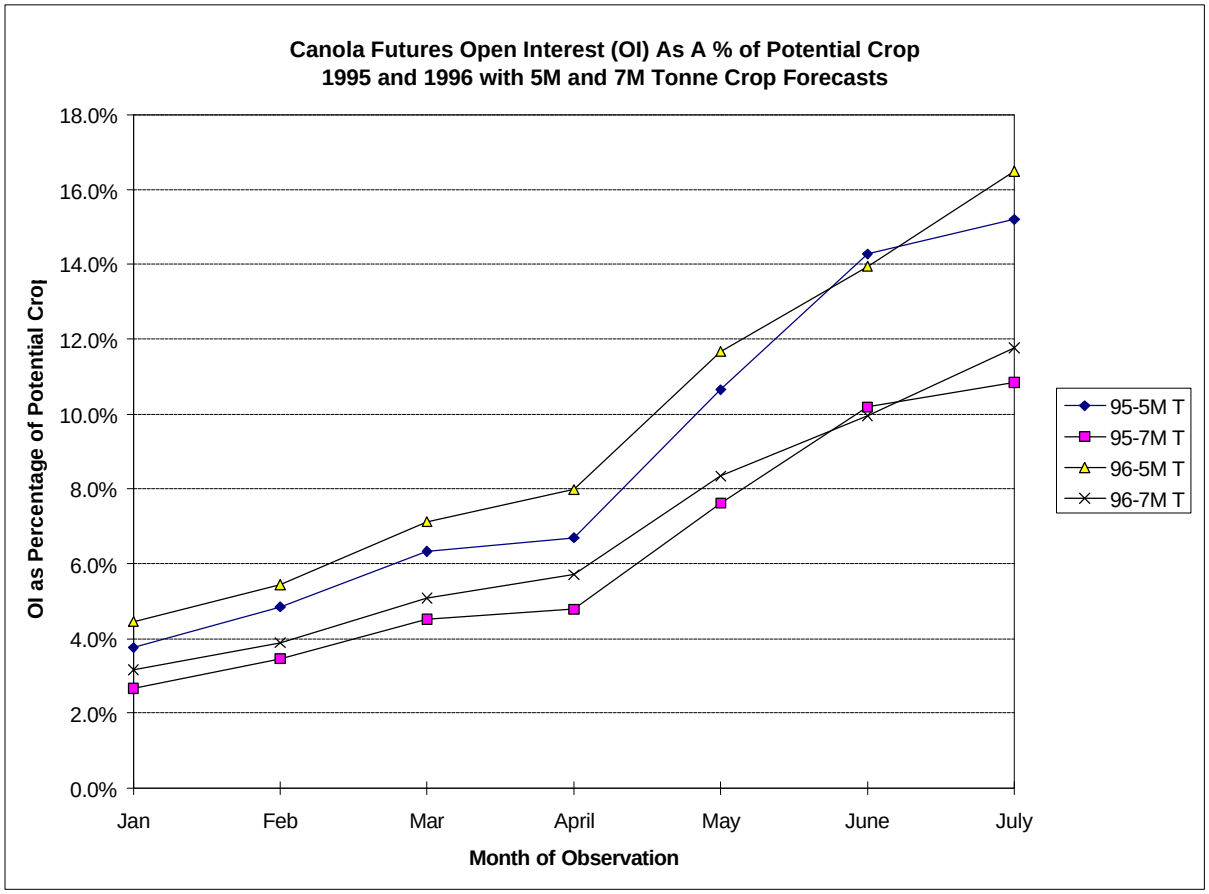


Figure 2: PRO Absolute Error for #1 CWRS

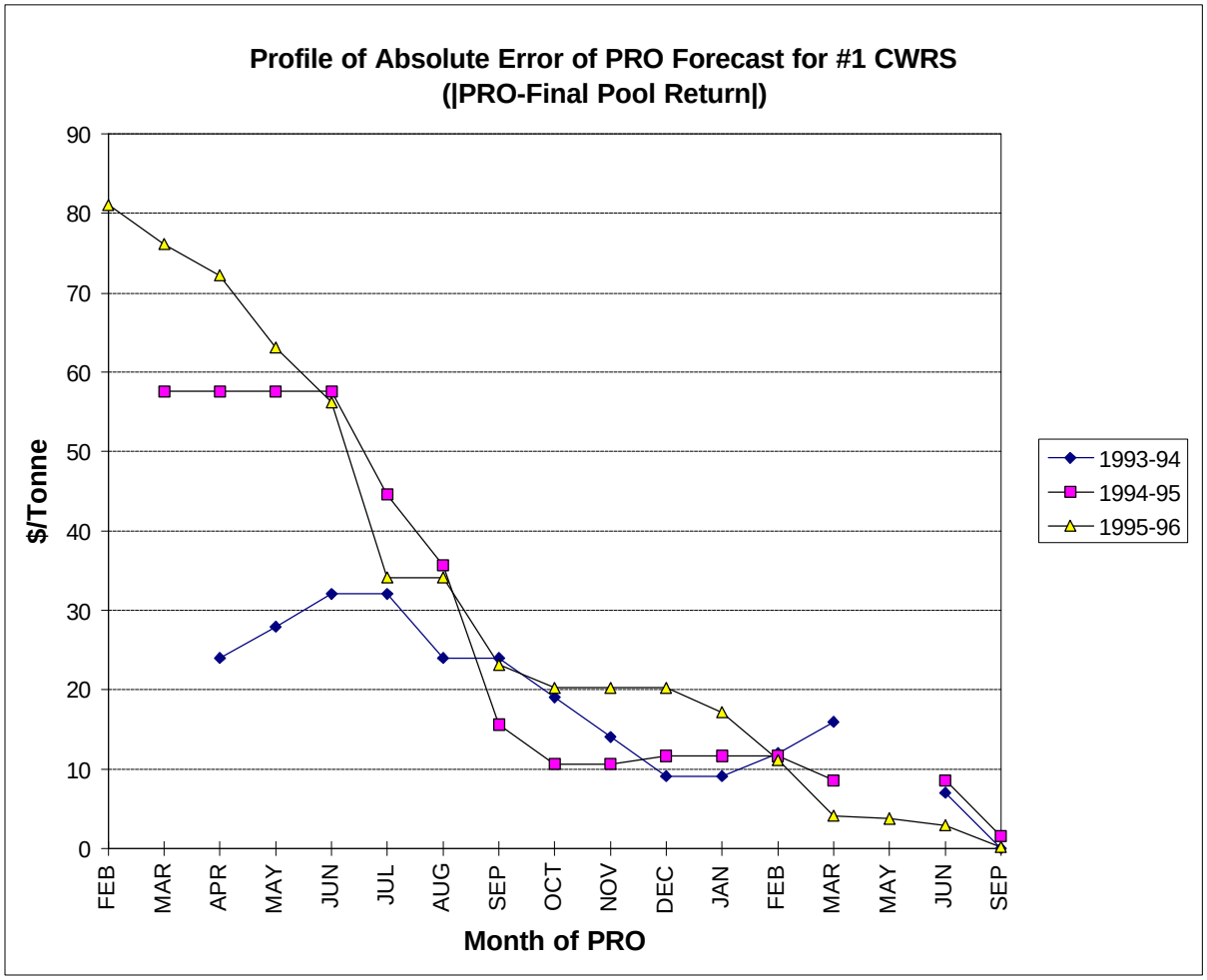


Figure 3: PRO Error for #2 and #3 CWRS

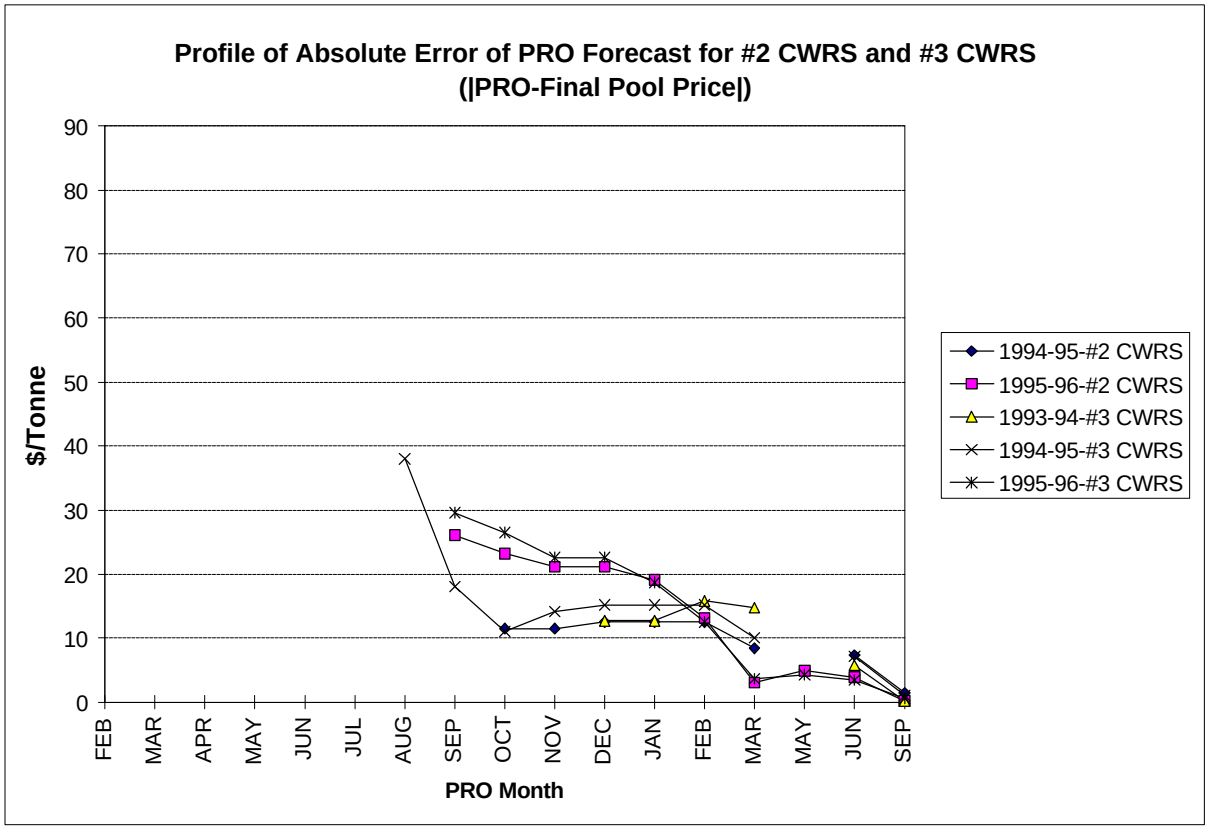


Figure 4: PRO Percentage Error for #1 CWRS

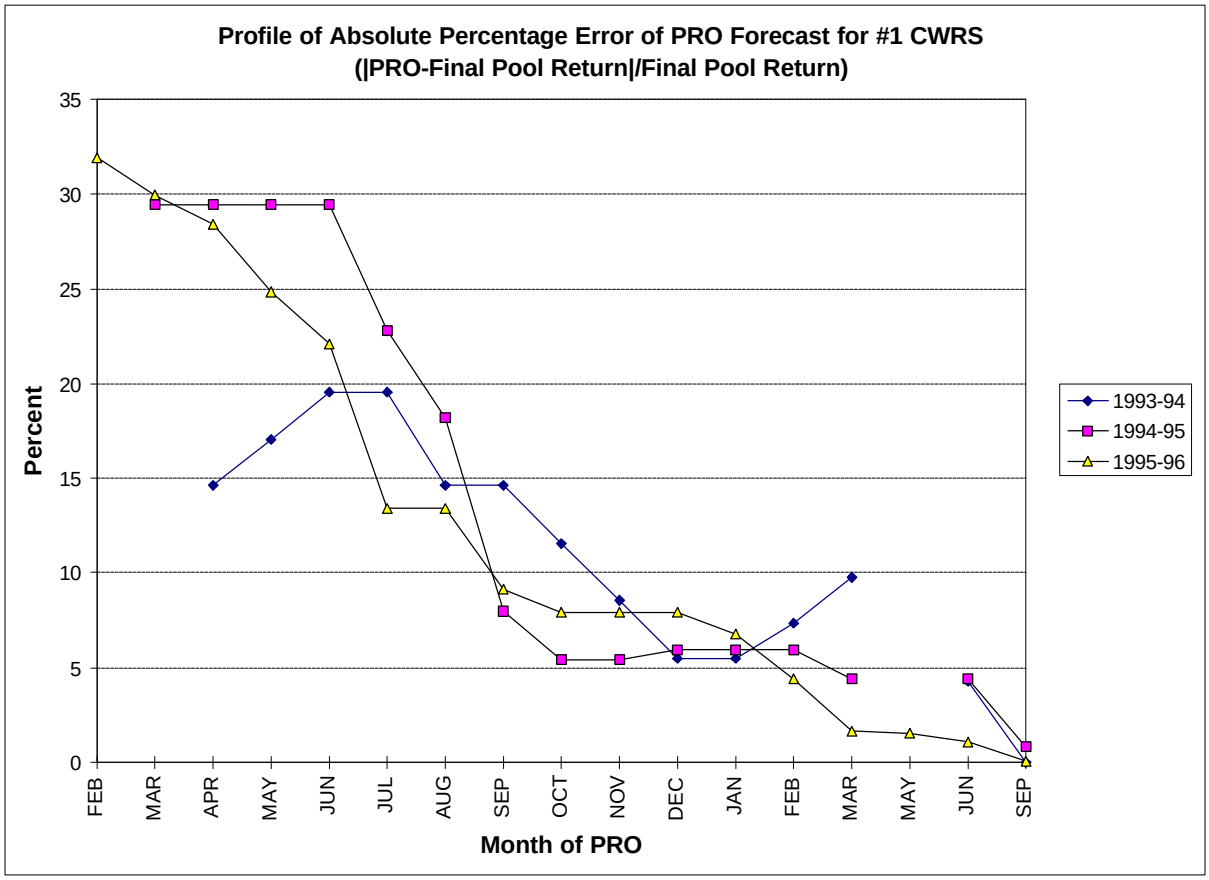


Figure 5: PRO Percentage Error for #2 and #3 CWRS

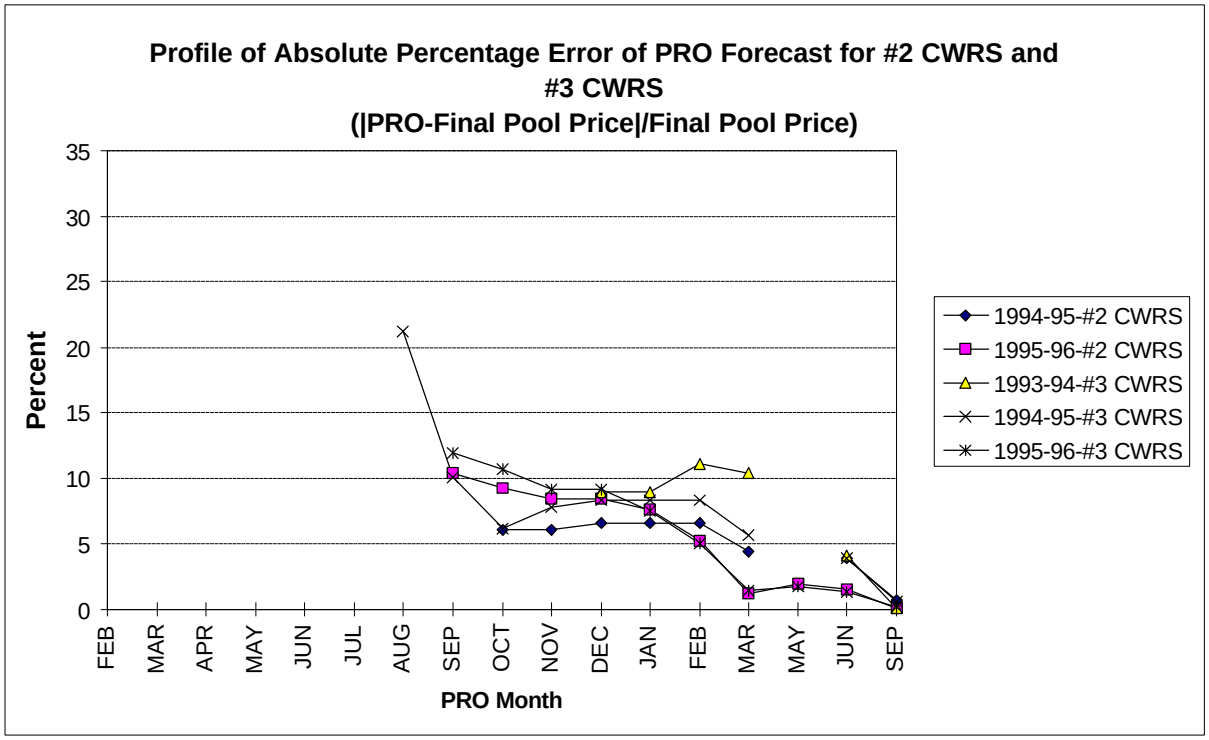


Figure 6: PRO Grade Spread Between #1 and #2 CWRS

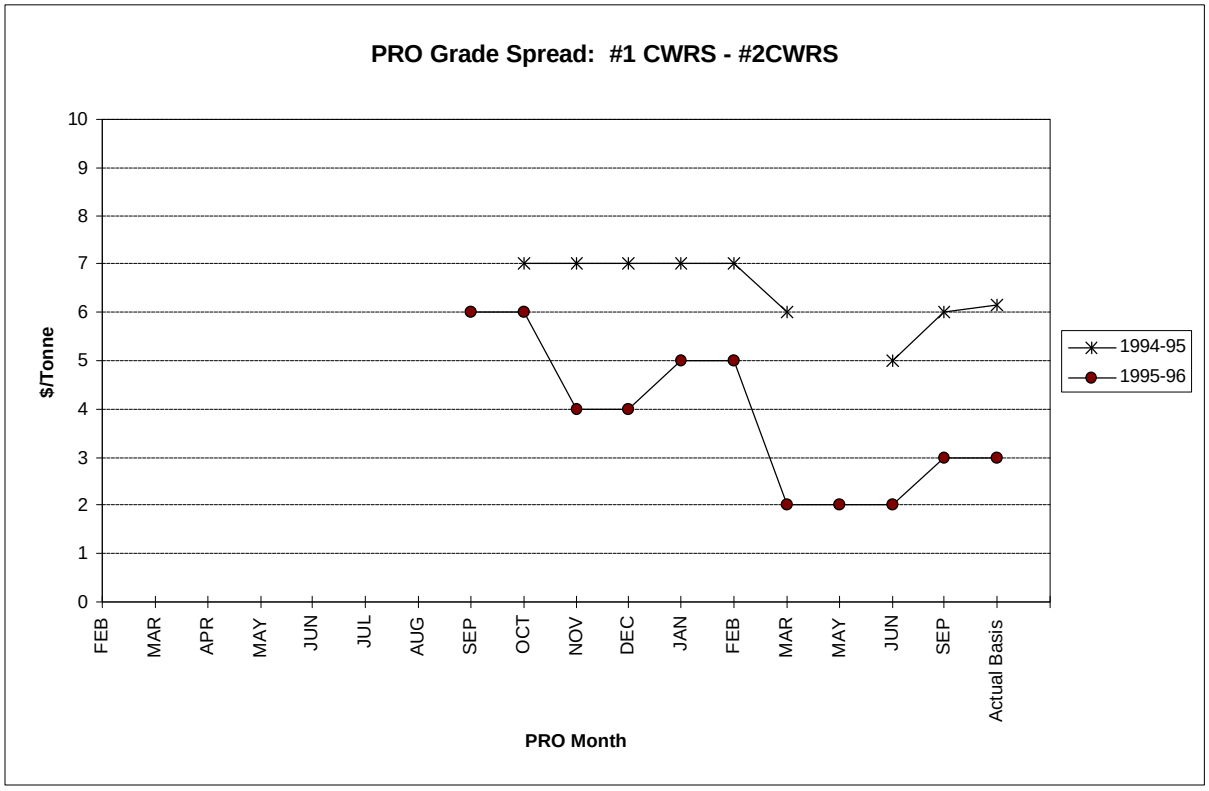


Figure 7: PRO Grade Spread For #1 and #3 CWRS

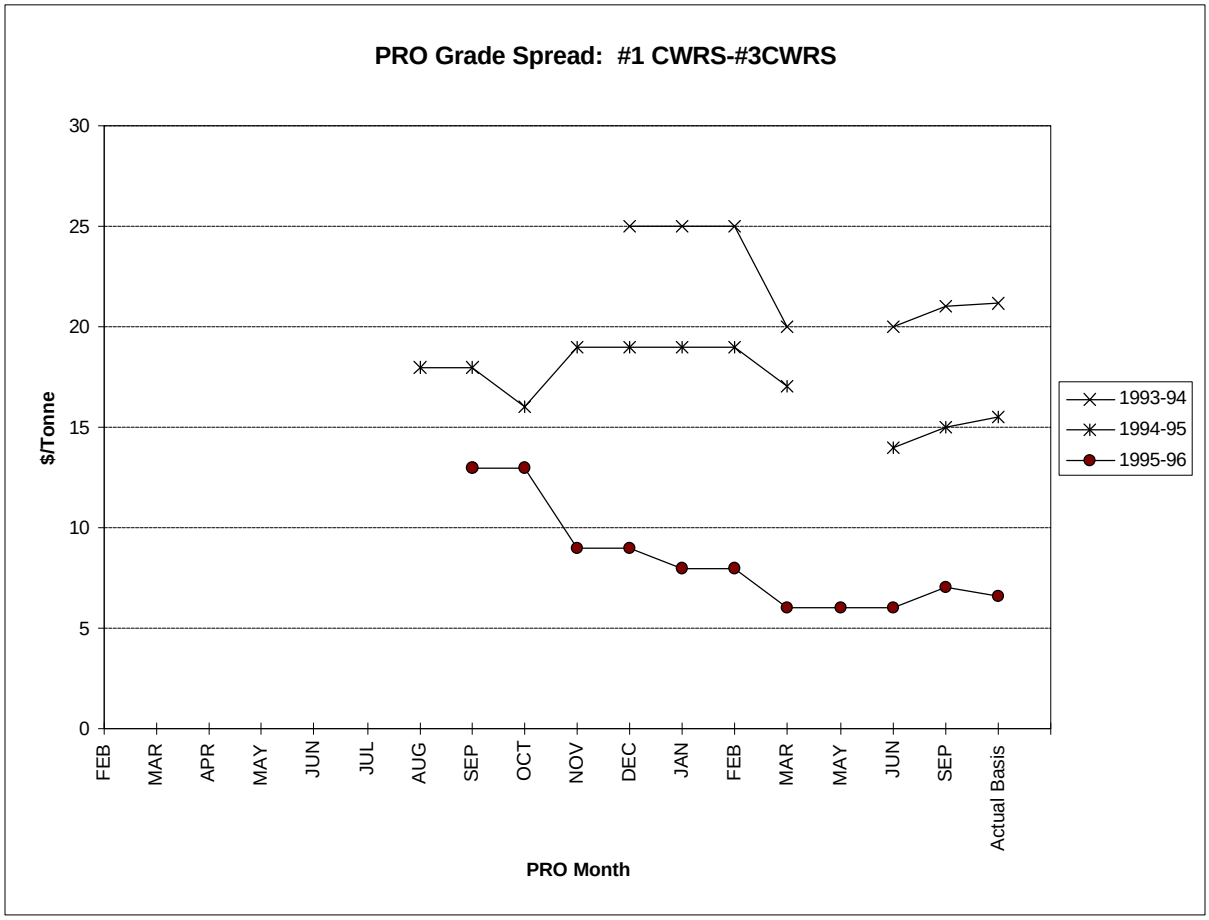


Figure 8: PRO Grade Spread Forecast Error

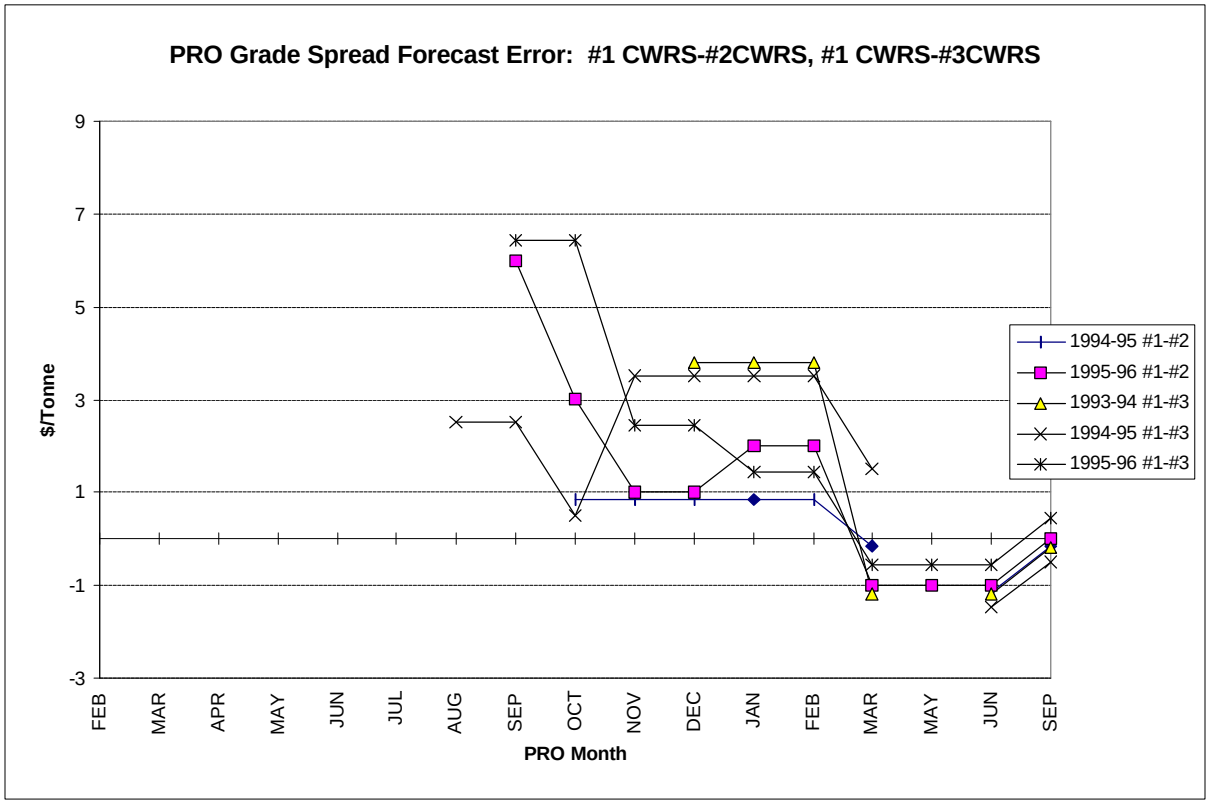
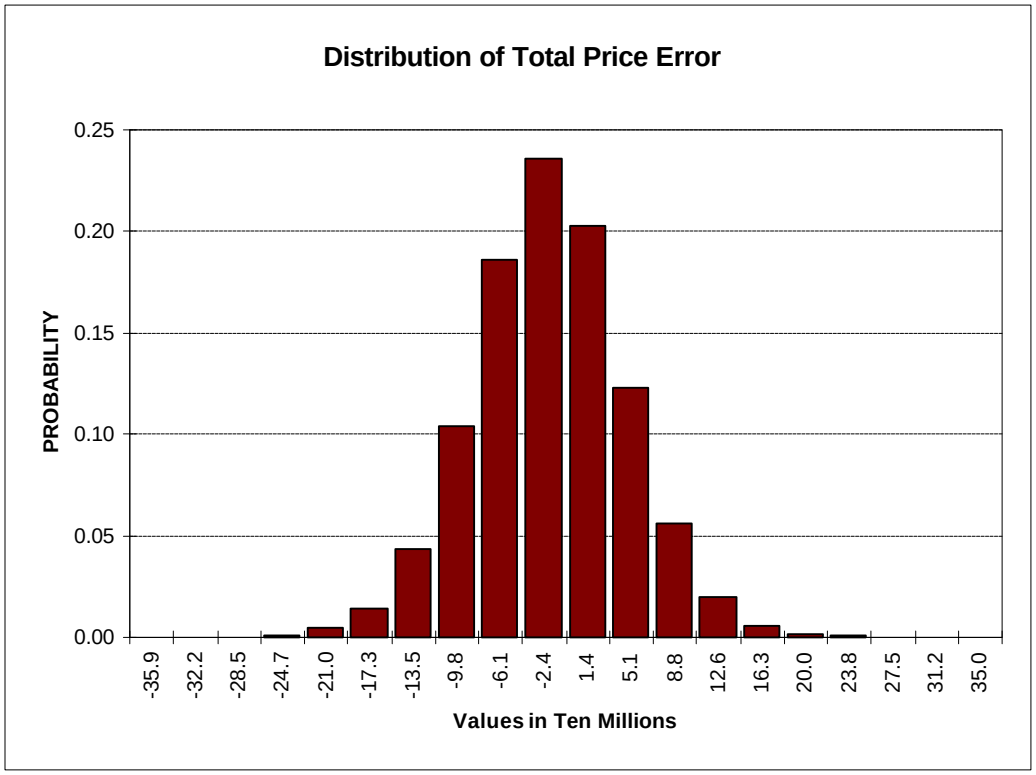
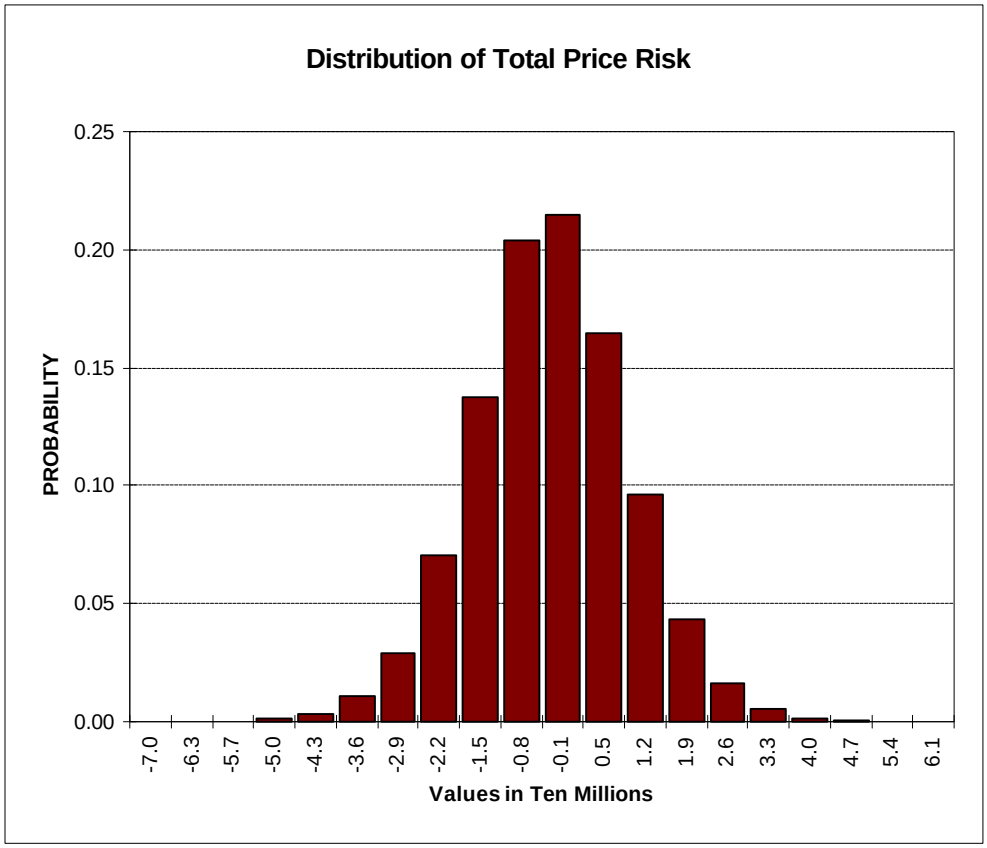


Figure 9: PRO Simulation With 100% of Table 6 Farm Participation Rate



(The mean is -$75,000 and the Standard Deviation is $65.2M)

Figure 10: PRO Simulation with 20% of Table 6 Farm Participation Rate



Mean equals -$19,600 and the standard deviation is $13.0 M

Figure 11: Financial Model Simulation: Standard Deviation of Possible Pool Price Outcomes under Monte Carlo

(Forecast Risk Under Financial Modelling Assumptions Without Discounting)

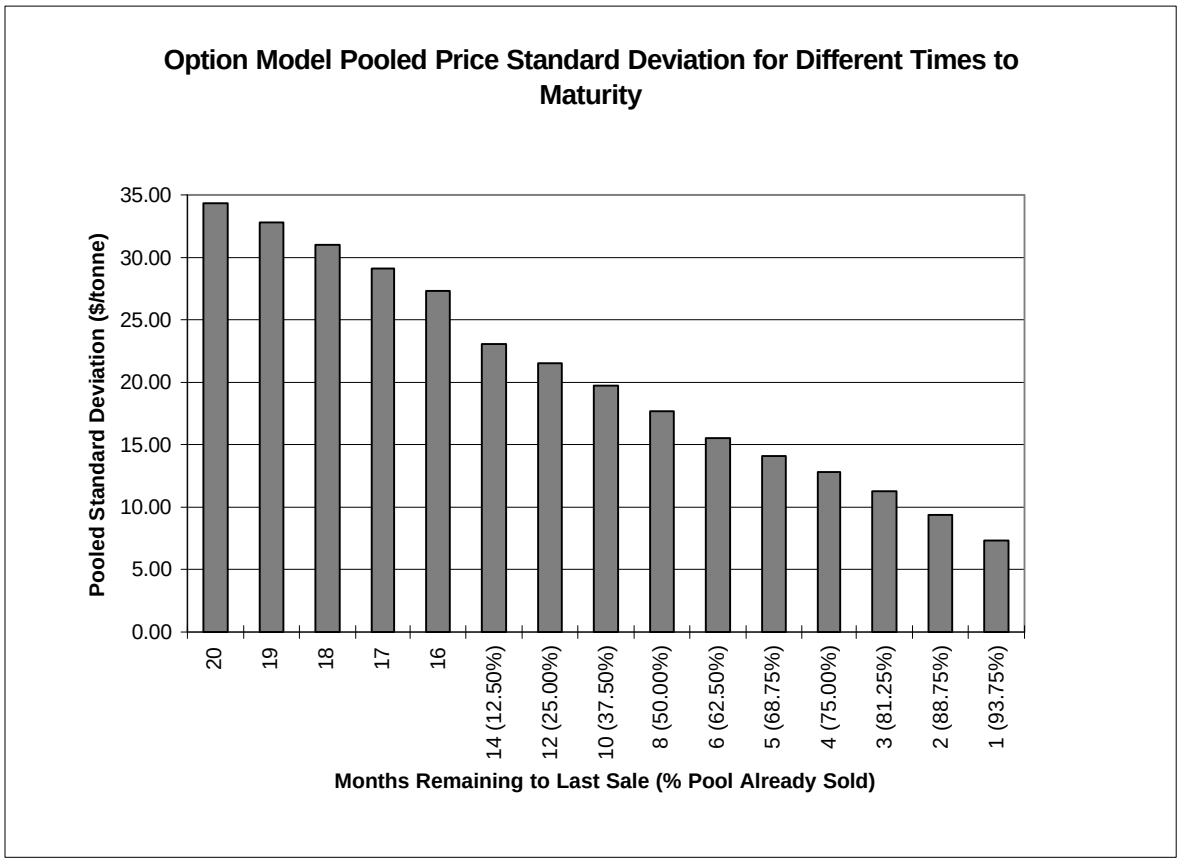


Figure 12: Financial Model: Present Value of Pooled Wheat For Different Times to Maturity

(From Model 1 and Model 2 Results)

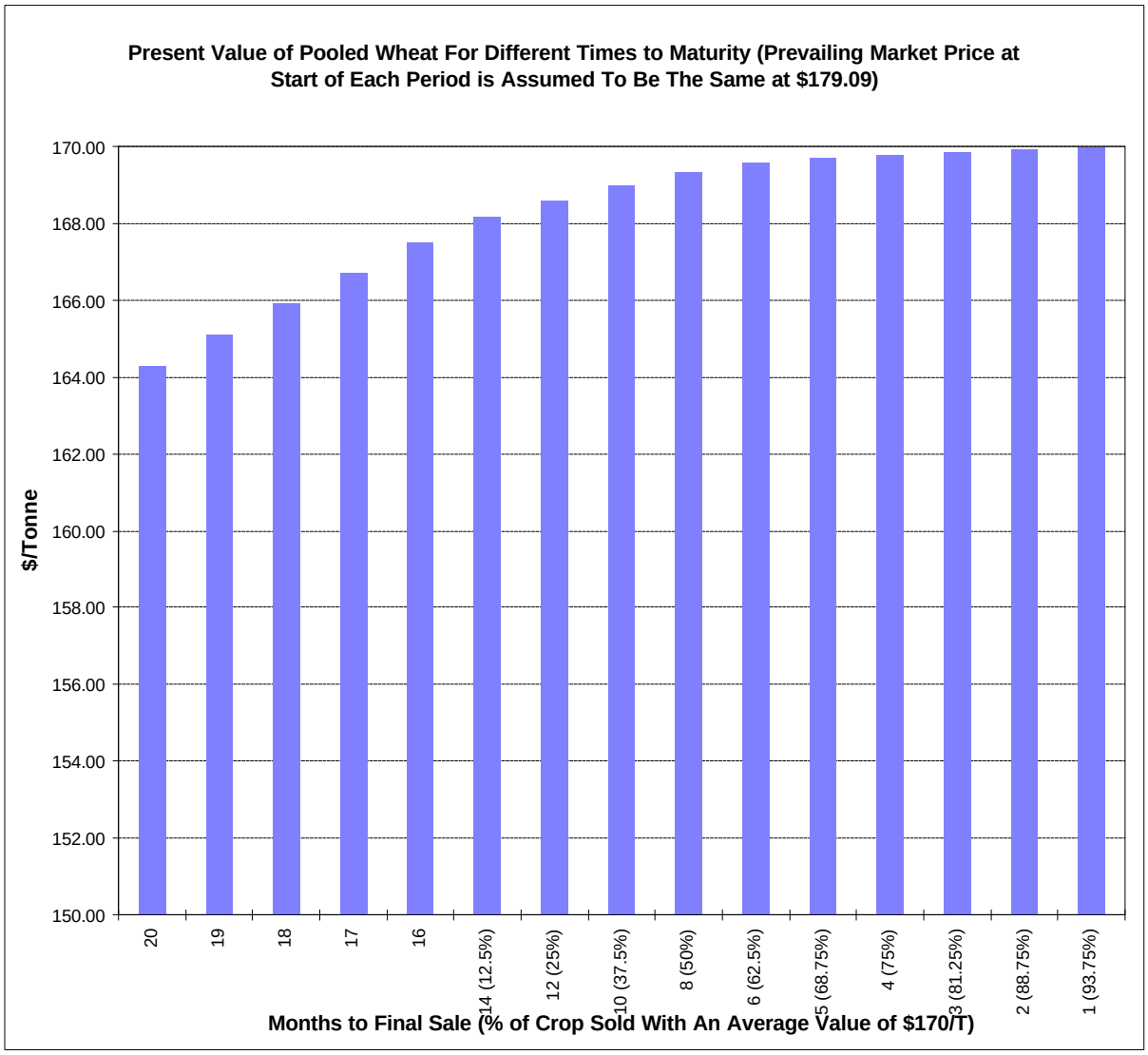


Figure 13: Financial Model: Value of the FPC Under Table 12 Assumptions

(Delivery at 12 Months Prior to Last Pool Grain Sale.)

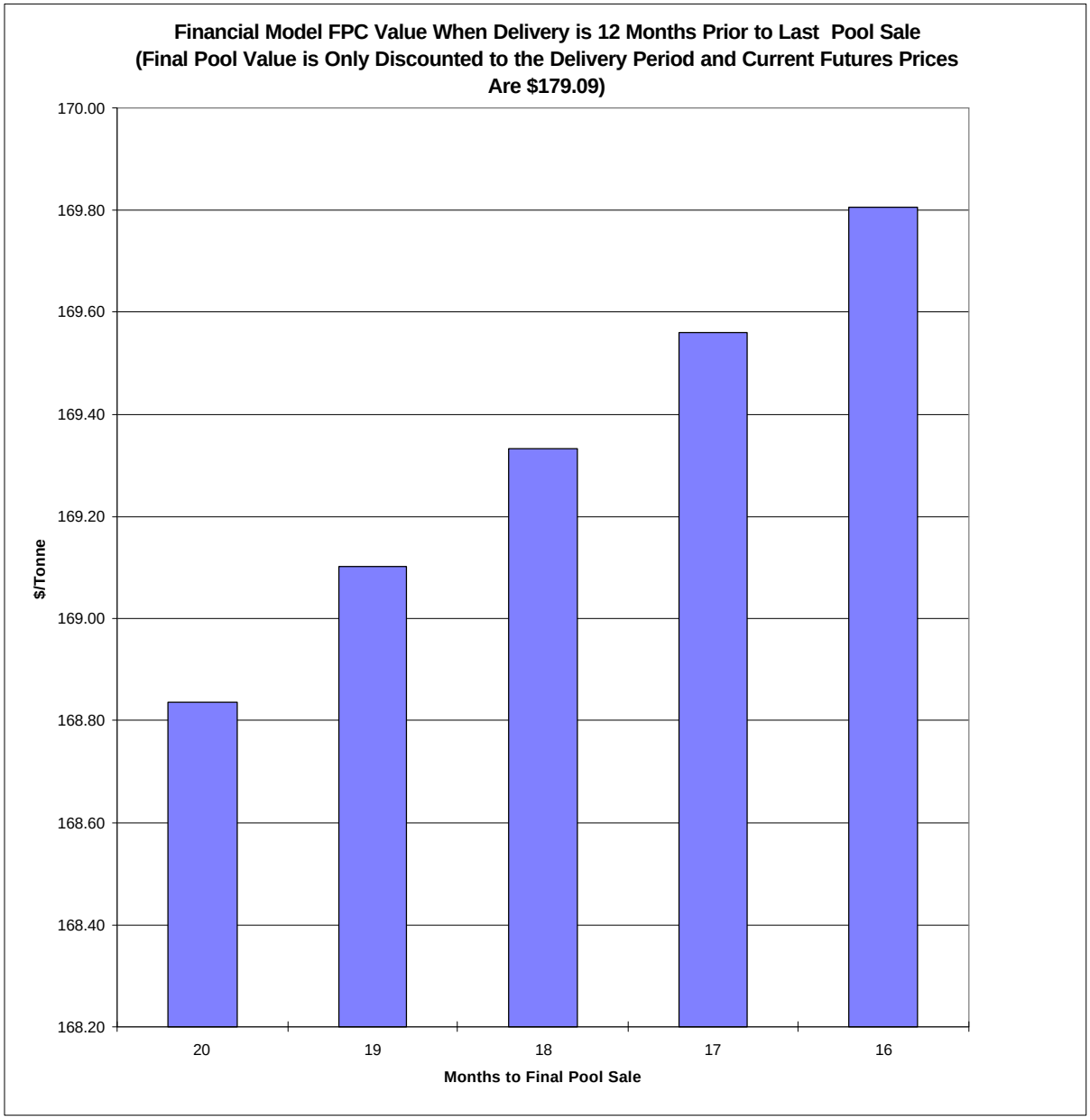


Figure 14: FPC Financial Model Simulation 1 - Average Value Put Option Premium (Government Guarantee Value)

(Initial Payment is Announced or Expected and the Current Market Prices are $179.09)

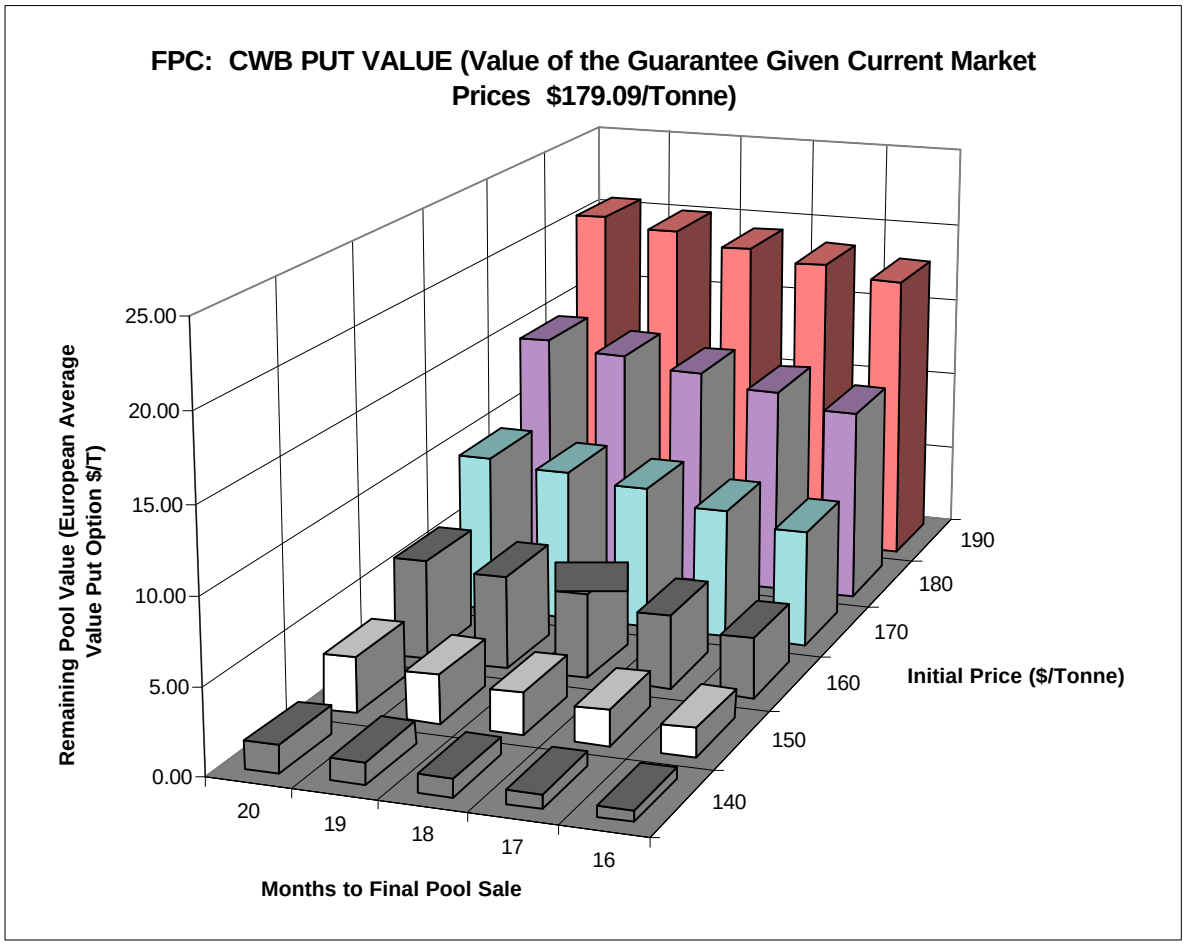


Figure 15: Combined Present Value of Expected Pool and Average Value Put Option

(Using Table 12 Inputs; Initial Payment Announced or Expected; Market Price=$179.09)

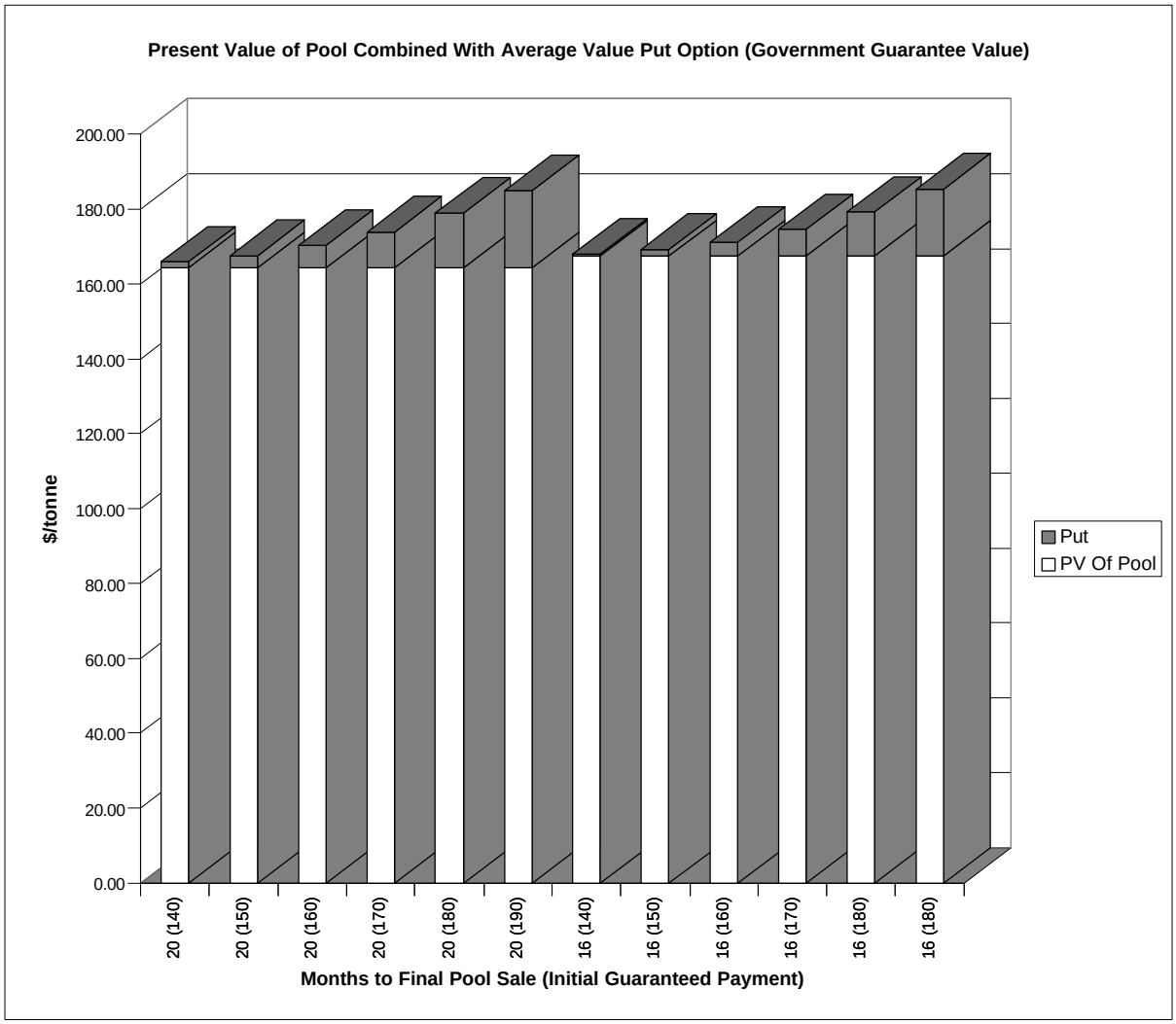


Figure 16: EPCO Financial Model Simulation: Average Value Call Option With Pooling and Government Guarantee

(Current Futures Market Price is $179.09 and the Average Value of Any Grain Already Sold in the Pool is $170/t.)

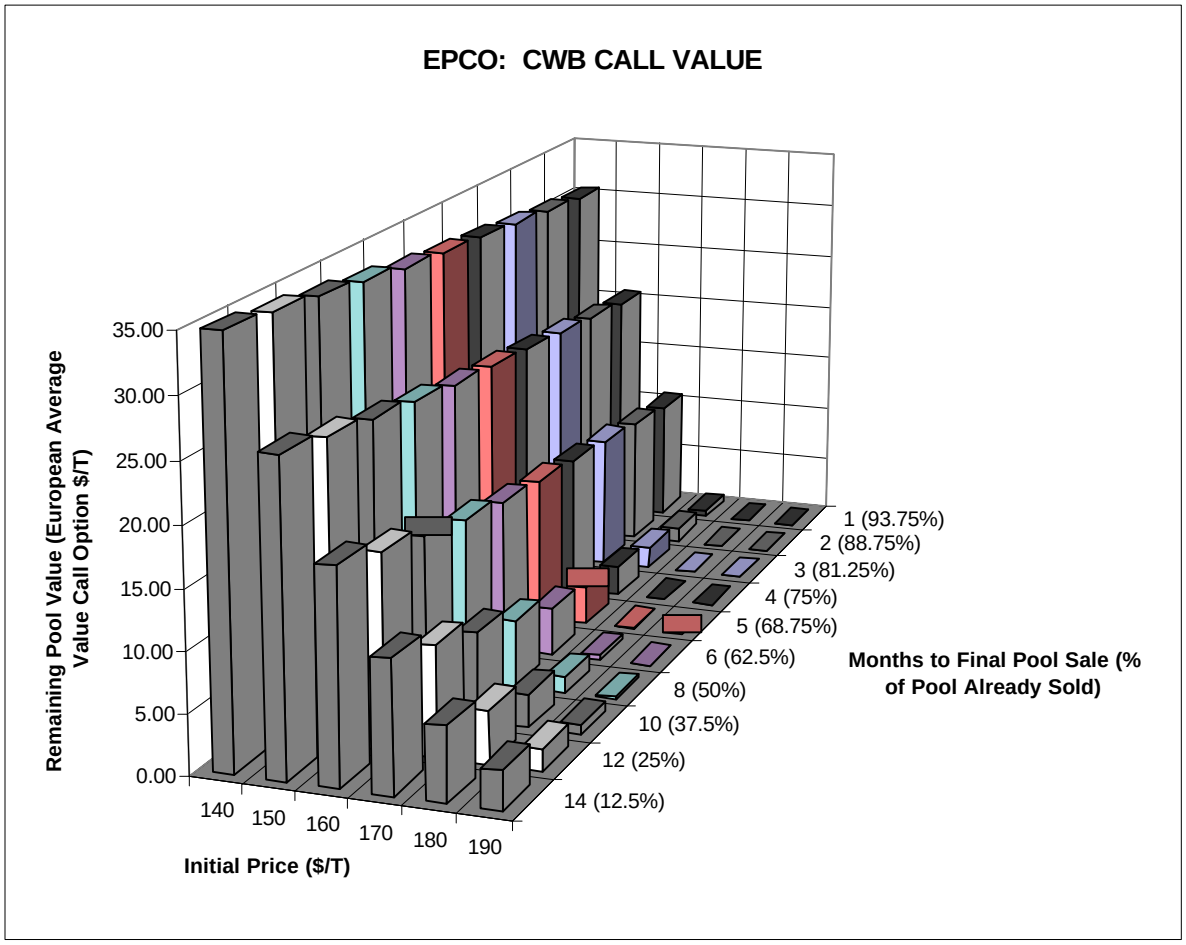


Figure 17: EPCO Financial Model Simulation: Comparing Initial Price Plus the Average Value Call Option to the Present Value of the Pool

(Current Futures Market Price is $179.09 and the Average Value of Any Grain Already Sold in the Pool is $170/t. The Call Value Is The Present Value of The Final Payment With the Government Guarantee)

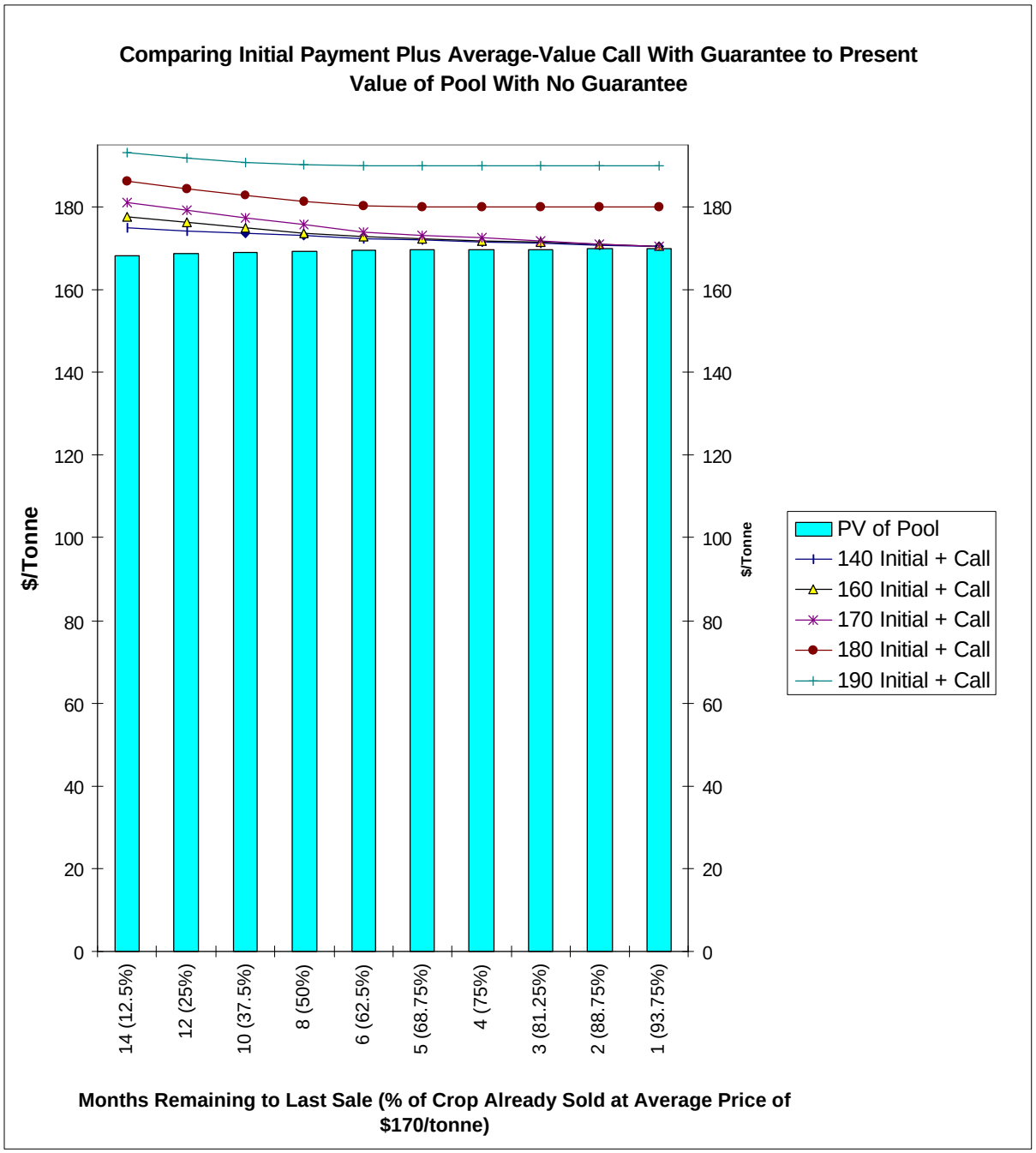


Figure 18: Financial Model Simulation - Average Value Call Option When Current Pool Average Prices Varied

(10 Months Remaining to Final Wheat Sale in the Pool With Current Market Price at $179.09/T)

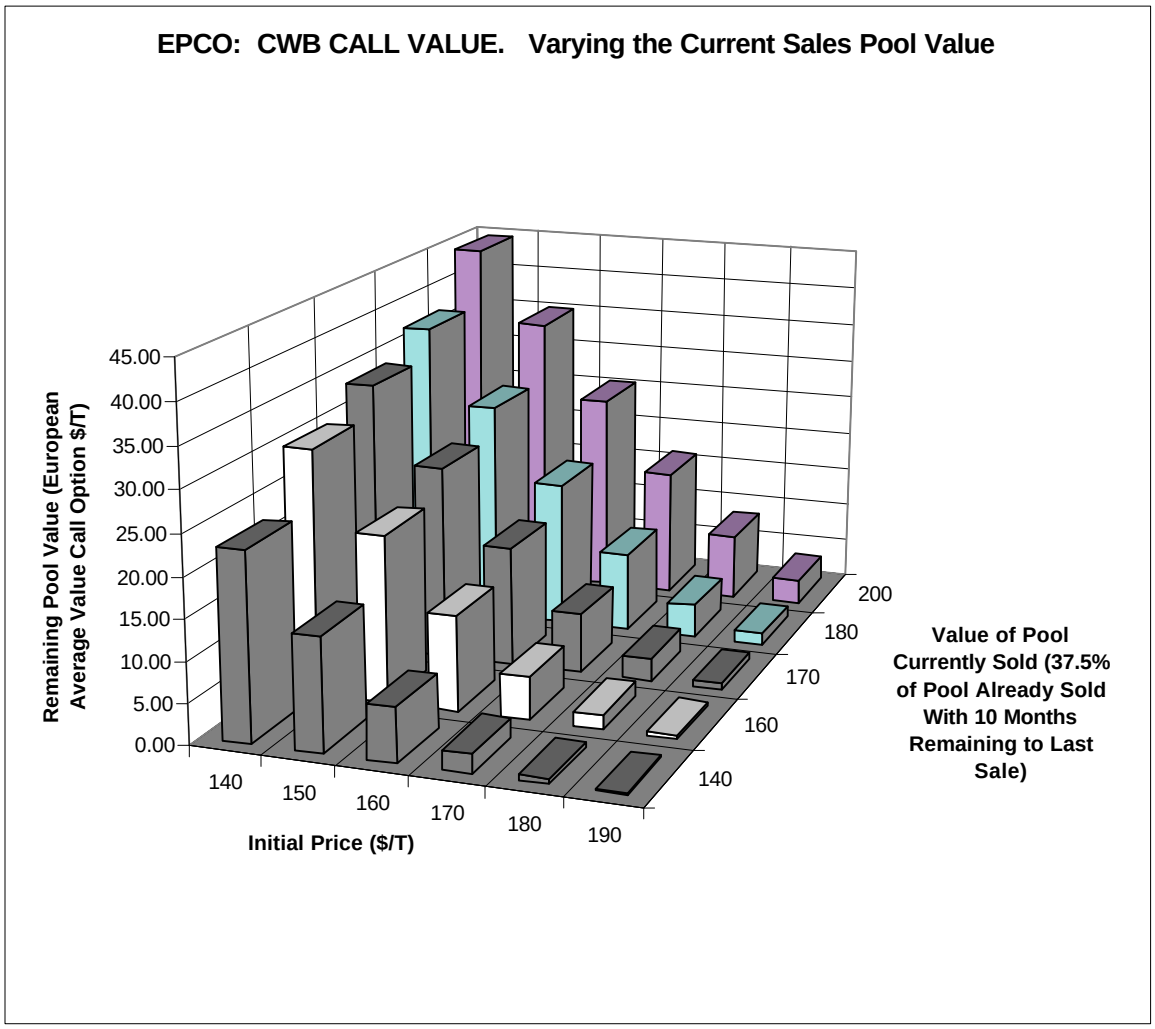


Figure 19: Percentage Change in Pool or Implied Call Value With a 1% Change in Wheat Price (Delta)