An Economic Analysis of Removing the Canadian Wheat Board's Single Desk Authority and Rail Deregulation in Western Canada

by

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Abstract

Wheat is the most common cereal crop grown by farmers in Western Canada and is mainly used for export. The marketing structure for wheat in Western Canada is unique. The Canadian Wheat Board (CWB), a statutory marketing board, is mandated to sell all wheat grown by farmers for human consumption in Manitoba, Saskatchewan, Alberta and the Peace River region of British Columbia. Using historical price and basis data, this research attempts to quantify the economics of the current marketing structure for wheat in Western Canada. Simulations are developed to determine the economic profits and risk that could have been realized in an open market considering scenarios for three potential changes in the grain handling and transportation system (GHTS) and four alternative marketing strategies. Each are evaluated using a utility-based risk model to ascertain the most preferred marketing environment in terms of expected profit and risk.

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Table of Contents

List of Figures

List of Tables

Chapter 1: Introduction

1.1 Problem Statement

In grain marketing, the primary objective of farmers is to extract the highest possible returns. Grain farmers in Western Canada rely on uncontrollable forces such as markets and costs when selling grain internationally. The price received for grain, the costs of marketing grain and the risk involved are three main factors that affect farmers' profits. The price received is determined by the market and the price at which the grain is sold for. The costs associated with bringing grain to market are accumulated in the logistic system or the chain of processes involved in moving grain from farm to port (the basis). The risk involved in marketing grain is given by price and basis volatility.

For farmers in Western Canada, the Canadian Wheat Board (CWB) is the sole marketer for wheat, barley and durum (CWB grains) and holds over 20 percent in the international market (Informa Economics 2008). The price farmers receive for their grain is therefore determined by the CWB. Out of the wide range of crops that are grown, these three cereals represent 70 percent of total grain production in Western Canada. The global demand for Canadian wheat requires the CWB to bring 15-24 million tonnes of grain to export position annually for customers in 70 different countries (The Canadian Wheat Board 2011a). Canada's economic development largely depends on international trade, therefore there is a domestic need for marketing, handling and transporting grain to facilitate the flow of commodities. The CWB plays a pivotal role in marketing and transportation. Most importantly, it was established to act as the farmers' agent in the marketplace. As the sole marketing agent, the CWB may be able to leverage market power on the side of prices, freight rates, and railway service. Roles the CWB undertakes include, but are not limited to, processes such as finding customers, calling in grain, ordering rail cars, and determining costs (Transport Canada 2009a). Therefore, the CWB directly affects the financial return, or netback, received by farmers through several dimensions.

The CWB marketing system is important for many reasons including finding a large customer base. Moving grain and transportation costs are significant components of farm profitability. Farmers pay 600 to 750 million dollars annually to move product to port position. Ensuring every farmer has access to the logistic system is the first step to acquiring a pay cheque (Pugh and McLaughlin 2007). Without a transportation system, grain does not reach the market, and farmers do not get paid. The costs of moving grain in the system are borne by farmers, which in turn affect their profit for bringing grain to market.

The export basis consists of the sum of direct costs accounted for in the logistic system, such as elevation, grading, storage, inspection and transportation costs. Once farmers deliver their grain for market, the transportation costs are deducted from their payment in the form of a basis. It represents approximately one third of the price received by farmers for their grain in port position on average.

Grain is one of the few bulk products in which producers have very little bargaining power because they are geographically dispersed and there are long distances away from the customer. For years producers have been concerned about market power in the marketing sector and have lobbied for government intervention. In agriculture, the CWB and rail regulation are examples of government response to market power. Two railways operate in western Canada and are basically compulsory for moving grain to export position at a reasonable cost. The demand for the railway services coupled with the small number of firms provides both railways with market power. Very few markets have received as much attention and experienced such extensive government intervention as the railways (Schmitz et al. 2002).

The current role of the CWB is to exhibit rent seeking behaviour and use its market power and advocacy voice to extract price premiums, minimize costs and minimize risk. Previous research exists on the single desk in terms of price and costs, yet it remains to be seen how the CWB impacts producers in terms of return and risk. As agriculture progresses, new research is needed to explore how agents will respond to new environments and investigate how the industry will develop. More recently, the government has proposed changes in the way Western Canadian farmers market their wheat, which will significantly affect market regulation, the administrative fiat and the entire grain handling and transportation system (GHTS). Bill C-18 was introduced on October 18, 2011 to remove the CWB as the sole seller of wheat produced in Western Canada. The changes that are about to occur are major and will have widespread impacts on farmers producing wheat in Western Canada and other major players in the grain marketing industry (Fulton 2011).

1.2 Objectives

The objective of this research is to explore the removal of the CWB's single desk authority and deregulation of the rail system and investigate how these changes affect expected profit and risk for wheat farmers in Western Canada. Historical wheat price and export basis will be used to calculate expected profits and risk involved in selected marketing strategies considering producers could have marketed their grain in an open market environment between 2006/2007 and 2009/2010. It will explore risk preferences between those marketing strategies and the current CWB pool system.

Deregulation will be based on an open market scenario considering a form of full CWB deregulation, which is expected to change the price and export basis, in terms of expected value and variability. The open market scenario considers movements towards a free or more competitive market where there are no price or revenue control and no barriers to entry in the transportation industry. The price farmers receive for their grain and the export basis are major components of profit. Risk is also an important dimension of marketing decisions in agriculture. Unlike previous studies, this thesis will incorporate the notion that changes in the marketing structure can also affect the risk involved in grain marketing. Today risk related to marketing, transportation and price are managed with the CWB pooling system. Risk is a less tangible benefit of the CWB and its impact is harder to quantify because producers have different levels of risk aversion. Hence this dimension will be explored using different levels of risk aversion for farmers.

An expected utility framework is adopted to explore how these changes in expected value and variability of the export basis and price affect producers. The price and basis values in the open market scenario for wheat are incorporated into a utility function which measures producer satisfaction using both expected profit and risk. The utility function is then used to calculate certainty equivalents which are adopted to compare open market alternatives to the current system.

This research contributes to the literature by providing a better understanding of the impacts of changes in market structure on wheat farmers in Western Canada. The framework adopted in this study considers the effects of these changes on profit and risk, and their combined effect on farmers' preference between expected profit and risk for given levels of risk aversion.

1.3 Outline

The remainder of this manuscript is divided into six chapters. The current chapter has introduced the study. The second chapter provides a background on the wheat marketing system in Western Canada. Chapter 3 discusses the theory supporting this research. The fourth chapter contains a literature review discussing previous studies, which investigated changes in market structure and their impact on prices. Literature is also reviewed on agricultural risk. The fifth chapter presents the research method, specification of the empirical model, and data. Chapter 6 discusses the results of the open market simulations and the sensitivity analysis. The final chapter includes a summary of the results, a discussion of their implications and limitations, and raises questions for further research.

Chapter 2: Background

This chapter presents the background of the agriculture industry that has been influenced by the wheat marketing network of Western Canada. For the purpose of this research, the components of the marketing network discussed are wheat prices received by farmers and costs associated with marketing grain. The chapter begins by reviewing the farming community, elevator and rail systems within Western Canada. Then the logistics processes from moving grain from farm to port are discussed. The following two sections present the importance of the export basis and how it is calculated. Next, the influence of the Canadian Wheat Board on export basis and price is summarized.

2.1 Farm level

The demographics of the Prairie Provinces in Western Canada have evolved since the early 1940s. A reduced number of farmers in rural communities are farming a larger number of acres. In 1931, there were 728,624 farms with an average size of 224 acres in Canada (Statistics Canada 2006). Producers adjusted to the industrial organization of farming and by 2009 there were 75,000 farmers cropping an average of 1,170 acres (Transport Canada 2009a). Thus, farmers have invested in larger trucks and trailers for hauling long distances. The implication of these changes affects farmers by increasing storage and trucking costs.

2.2 Elevator system

The elevator system in Western Canada has changed over the years, shifting to large corporate companies owning the elevators and reducing the number of facilities. In 1971, 4,545 primary elevators were in use totalling 10.8 million tonnes of capacity (Tyrchniewicz et al. 1998). In 1999-2000 the number of elevators dropped to 1,004. In

2008-2009 this number declined to 366, capable of holding 5.2 million tonnes of grain (Transport Canada 2009a). Although the number of elevators and total capacity has decreased, capacity per elevator has increased as well as the number of grain deliveries. The elevator system also includes terminal elevators for export. Not all companies with primary elevators own a terminal. Cargill, Richardson International, Viterra, and Alliance Grain Terminal[1] each have terminal assets on the West Coast, and own a series of primary elevators across The Prairies. The implication on logistic costs is that the larger, more efficient facilities are able to offer more services to the buyer such as blending wheat. This leads to potential savings in grain handling from the larger elevators. Also, with fewer elevators, the rail lines make fewer stops to load grain. With the CWB acting as a marketing agent, grain is moved through the terminals independent of the owner and what elevator it is shipped from. For example, not all grain shipped from Viterra's elevator systems is put through the Viterra terminals. The flow of grain depends more on availability and the most efficient plan for the movement than facility ownership.

2.3 Rail lines

Grain in western Canada moves to port via rail transportation, thus producers have a vested interest to ensure that rail services are affordable (Schmitz et al. 2002). The Canadian National (CN) and The Canadian Pacific Railway (CP) are the two main line rail carriers operating in Western Canada. The CN and CP operate on 25,675 miles of rail line with almost 2,000 more miles listed for abandonment. As small primary elevators are destroyed, the connecting branch lines are being removed (McLandress

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[1] Alliance Grain Terminal is owned by Patterson Global Foods, Parish and Heimbecker, Great Sand Hills Terminal, North West Terminal, Weyburn Inland Terminals and Prairie West Terminal

2009). In 2008-2009, 73.3 miles of branch lines with light traffic were removed (Transport Canada, 2009a). In conjunction with destruction of elevators, producers in Western Canada are forced to haul grain longer distances to an elevator via road transportation. Therefore, road transportation costs increase. The opportunities for loading out of a producer car sites diminishes as lines are abandoned.

Shortly after confederation in 1867, there was a need for east-west transportation which provided incentive to build the railway. The rail lines were constructed with a large amount of public money and regulatory support due to the nation still developing and grain economy being an important part of Canada. Along with early public support, government restrictions limited market power once the railways were developed (Fulton et al. 1998). In the last 20 years, the logistic system in Western Canada has experienced many changes. Pressure for rail deregulation began in the early 1980s when grain prices were low, and input costs and interest rates were rising. The changes were set in motion when the Western Grain Transportation Act (WGTA) came in to affect in 1984. The WGTA was a transport subsidy provided by the Canadian federal government to assist the rail transportation of grain and grain products to export position. Upon elimination of the WGTA in 1995, a rate cap was introduced under the Canadian Transportation Act (CTA) to alleviate the effects of rising rail rates (Pugh and McLaughlin 2007). Since then, the removal of the WGTA has led to further federal government review of the transportation and handling system. In 1999 the CWB also adjusted their governance structure which now means management is directly accountable to a farmer elected Board of Directors. As a result, the objective of the CWB is to maximize the economic rent of farmers. Along with these legislative changes, rail and elevator infrastructure has been restructured. After the WGTA was gone, restrictions to branch line abandonment were removed. In the 2007-2008 crop year alone 516 miles of branch line were removed and currently more lines are targeted for destruction. Elevator infrastructure also fell, dropping 63 percent from 1999-2009 leaving 371 licensed country elevators (Transport Canada 2009a). Deregulation and other changes in the grain handling and transportation system are likely to affect the logistic costs. Rail regulation began in 1897 in Western Canada when the Canadian Pacific (CP) Railways agreed to transport grain at the fixed "Crow Rate". By 1925 all railways were moving grain at the statutory rate (Fulton and Gray 1998). By 1970, the CP and Canadian National (CN) were losing money at the "Crow Rate" and discontinued investing in transportation infrastructure such as rail cars and branch lines. The WGTA (1994) act was informally called the Crow benefit where the federal government paid a share of the freight cost to the railways to preserve the basic features of the Crowsnest Rates while ensuring the railways would earn a fair return (Fulton and Gray, 1998). The WGTA was replaced in 1995 by a rate cap under the Canadian Transportation Act (Pugh and McLaughlin 2007). The rate cap is the maximum rate charged by railways for grain movements used to determine freight rates on the western rail system (Estey, 1998). Justice Estey (1998) conducted a comprehensive review for prairie grain and developed recommendations for the grain handling and transportation system based on his findings. One recommendation was to change the freight rate cap to a railway revenue cap, which was passed under Bill-34 in 1999. The revenue cap limits the amount of revenue railways capture from moving grain providing them with the flexibility of differential rates. The revenue cap currently remains in place, however the discussion on further deregulation continues. Ian McReary

(2006) claims the legislative change to the revenue cap gave the CN and the CP additional monopoly power to exploit farmers in Western Canada (Pugh and McLaughlin, 2007). Fulton et al. (1998) look into how the export basis would change under deregulation. These studies focus on the 1980's and 1990's and show that in an agriculture environment with different logistic structures there can be large changes in the export basis. Fulton et al. (1998) reinforce that the industry has seen substantial deregulation of the grain handling and transportation system since 1995 when the Western Grain Transportation Act ended. Their study also explored rail and CWB deregulation and found the current structure to have the most narrow export basis. However, these studies focus only on one dimension of the problem. Changes in the export basis are calculated, but the variability of the export basis and how it could be affected by modifications in the logistic system is not discussed. The variability of the export basis is an important component of the discussion because it is related to marketing risk and hence the uncertainty in the net price received by producers. Fulton et al. (1998) simulate the market affects of removing the freight rate cap. Under deregulation, freight rates for wheat are predicted to increase, while local and terminal elevator charges fall. The increase in freight rates is larger in regions where only one railway is operating. For example, southwest Saskatchewan has only one railway in operation while central Saskatchewan has both railways operating. Rates are predicted to increase by $39.16 per tonne in southwest Saskatchewan compared to $34.83 per tonne in central Saskatchewan. In regions where local consumption is large, such as in the Peace River region, freight rates rise much less. In these areas, exports are relatively sensitive to changes in the basis, thus railways limit the magnitude of the increase in freight rate.

Therefore, the total basis rises less than in other regions. Fulton et al. (1998) notice the pattern of higher freight rates combined with lower elevator charges is the same pattern observed in the United States (ATKearney 1994; IBI 1994).

Rail rates have always been a large cost and common running rights is an alternative approach often presented in order to attempt to lower the rates. The CN and CP operate in duopoly form in Western Canada and a monopoly in areas where there is access to only one line. The introduction of common running rights, allowing more carriers on the rail line will increase competition and is predicted to lower rail costs. Concern over railways' market power has long been included in public policy. Public policy has been shifting away from regulation and realizing new approaches are needed to limit the market power of railways. Fulton and Gray (1998) suggest common running rights encourage entry into the rail industry, thus limiting railways market power. Common running rights are used in other industries such as telecommunications, electrical utilities and airways. In the telecommunication industry, the cost of long distance services was reduced dramatically from new competition entering the market. Competitors are allowed to use the same phone lines as the existing companies and the same idea can be employed for the existing railways. The simulation used by Fulton et al. (1998) considers different degrees of competition. The model examines the impact on grain export basis given two, six and unlimited number of carriers using the rail lines. For wheat, the introduction of common running rights resulted in higher local elevator and terminal tariffs and changes in freight rates depending on the degree of competition. For Western Canada, freight rates increase from the current scenario given two and six carriers, but decrease when the number of carriers is unlimited. For example, the rail rate under the current scenario for central Saskatchewan is $37.89 per tonne. The simulated rates with two, six and unlimited number of carriers are $69.79 per tonne, $52.66 per tonne and $30.80 per tonne, respectively.

2.4 Grain handling and transportation system

In agriculture, the Grain Handling and Transportation System (GHTS) is a major component of logistics (Pugh and McLaughlin 2007). The GHTS encompasses the logistic processes of the physical distribution of grain, including grain sales, calling in grain to the system, transporting grain to port, port coordination and clearance. The flow of grain from producer to consumer can vary depending on location of customer and method of delivery. Grain sales are often priced at the terminal position where the buyer charters the vessel (Transport Canada 2009a). Truck transportation is used when delivering to an elevator or local mill/processor. Otherwise, railways are used for longer distances, either to ports or exporting inland to Mexico or the United States (Schmitz and Furtan 2000). In the GHTS for Western Canada, the CWB markets non feed wheat and barley and provides farmers with returns (Dyck 2009).

Producers in Western Canada use a single desk to market wheat, durum and barley to export markets through the Canadian Wheat Board. Figure 1 shows the logistics supply chain for Western Canadian grain. Under delivery contracts, farmers deliver their grain to a primary elevator when called in, and then receive an initial payment upon delivery based on tonnage and grade. The Canadian Grain Commission (CGC) establishes quality standards and oversees delivery at elevators and terminals to ensure standards are met for export. Railways are considered to be suppliers in the country by the CWB. The CWB selects origins based on product availability and value proportion. Farmers are free to haul their grain to an elevator of their choice or alternatively they can load producer cars. The farmer contract for volume follows the delivery system they select. The cost the farmer faces to elevate and truck grain influences what option he selects. The CWB is the largest shipper of producer cars, because this is a lower cost option for farmers. Producer car volumes in the last decade have grown from 3,000 cars per year to over 12,000 cars per year today. The grain is then shipped to the ports for export.

Figure 1. Logistics of wheat in Western Canada

Farmers' Grain For Export

↓

Local Handling
(storage, elevation, grading)

↓

Rail Transportation

↓

Terminal Handling
(elevation, cleaning, inspection)

↓

Grain at Export Position

2.5 The export basis

Studies analyzing the logistic of Western Canada's Grain Handling and Transportation System (GHTS) find distinct results on the calculation and dynamics of the export basis. The export basis encompasses all costs from moving grain from farm to port. It includes costs of elevation (primary and terminal), elevator services, rail freight, Freight Adjustment Factor, Churchill Storage Program (previously Churchill Freight Adjustment

Factor), CWB pool account costs for operations, execution costs of marketing products and CGC fees as discussed below. The basis is made up of the following:

a) Trucking rates are based on average short hauls from the farm to the elevator.[2] Individual producer costs per mile vary depending on equipment used to haul and distance hauled, thus some values need to be assumed in the calculation.

b) Elevation charges are in place for the use of the elevator system at local elevator (primary) and at port (terminal). Primary elevation costs typically used in the calculation of export basis are provincial averages determined from elevators across the prairies. Terminal elevation is levied for grain moving to export position. Both primary and terminal elevation charges are deducted from growers' payments at the elevator site.

c) Elevator services refer to dockage, cleaning, storage and related services provided by the elevator. Producers are deducted for dockage and cleaning at the elevator level. The CWB pays storage once grain is delivered.

d) Rail freight rates are charged to producers for transporting grain from the elevator to port position.

e) The Freight Adjustment Factor (FAF) is implemented by producers paying the lesser of the rail freight to Vancouver or the freight to Thunder Bay plus FAF. FAFs are subject to change and are adjusted to reflect expected production, market factors and port shipping capacities (GOA 2004).

g) CGC fees are based on determining grades and the standards for each grain sample brought to market. GrainCo's[3] either add these fees to primary elevation or deduct the amount off producers' cash tickets.

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[2] Transport Canada adopts a 40-mile haul in the calculation of trucking rates, but the distance, and hence trucking rates, can be different in other sources.

The value of the export basis is dominated by rail freight, accounting for 55 to 63 percent of the total basis between 1999/00 and 2008/09 (Table 1). Primary elevation has the second largest share, remaining around 20 percent of the total basis. Trucking also has an important share of the export basis, representing 11 to 12 percent of its total basis. CWB fees represented 10 percent of the export basis in 1999/00 and its share increased to 15 percent in 2008/09. CWB fees showed the largest average annual growth among all direct costs in the export basis during this period, rising from $5.40 per tonne in 1999/00 to $10.14 per tonne in 2008/09 (Table 1) (Transport Canada 2009b).

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[3] GrainCo's is a term used for grain companies.

Table 1. Components of the wheat export basis for Western Canada– 1999/00 to 2008/09 A

	Direct costs ($ per tonne)						Producer savings ($ per tonne)			Export basis ($ per tonne)
	Freight	Trucking	Elevation	Dockage, cleaning	CGC fees	CWB fees	CFAR	Trucking premiums	transp. premiums	
Dollars/tonne										
1999/00	31.87	5.94	9.75	3.56	0.38	5.40	0.0	2.32	0.00	54.58
2000/01	30.21	6.10	9.91	3.56	0.38	5.75	0.09	3.01	0.61	52.20
2001/02	31.75	6.10	10.90	3.74	0.38	3.61	0.07	3.62	2.47	50.32
2002/03	34.73	5.94	11.22	3.93	0.38	7.72	0.11	3.96	2.70	57.04
2003/04	33.32	5.94	11.53	4.01	0.38	7.79	0.07	4.25	3.14	55.44
2004/05	33.74	6.54	11.64	4.19	0.38	6.50	0.05	3.68	1.49	57.72
2005/06	34.80	7.24	11.76	4.43	0.38	9.16	0.08	4.56	1.32	61.73
2006/07	37.18	7.76	12.07	4.68	0.38	8.14	0.07	5.15	1.79	63.13
2007/08	37.57	7.98	12.52	4.93	0.38	11.64	0.06	5.55	1.76	67.57
2008/09	37.83	8.09	13.02	5.15	0.38	10.14	0.00	6.17	1.70	66.74
Avg. annual change	1.9%	3.5%	3.3%	4.2%	0.0%	7.3%	0%	11.5%	14.5%	2.2%
Participation of direct costs in export basis (%)										
1999/00	58.4	10.9	17.9	6.5	0.7	9.9	0.0	-4.3	0.0	100
2000/01	58.5	11.5	18.7	6.7	0.7	10.9	-0.17	-5.7	-1.2	100
2001/02	63.5	12.0	21.4	7.4	0.7	7.1	-0.14	-7.1	-4.9	100
2002/03	60.8	10.4	19.6	6.9	0.7	13.5	-0.19	-6.9	-4.7	100
2003/04	60.0	10.7	20.8	7.2	0.7	14.0	-0.13	-7.7	-5.7	100
2004/05	58.4	11.3	20.2	7.2	0.7	11.3	-0.09	-6.4	-2.6	100
2005/06	56.3	11.7	19.0	7.2	0.6	14.8	-0.13	-7.4	-2.1	100
2006/07	58.8	12.3	19.1	7.4	0.6	12.9	-0.11	-8.2	-2.8	100
2007/08	55.5	11.8	18.5	7.3	0.6	17.2	-0.09	-8.2	-2.6	100
2008/09	56.7	12.1	19.5	7.7	0.6	15.2	0.0	-9.2	-2.6	100
Avg. participation	58.5%	11.5%	19.5%	7.2%	0.7%	12.7%	0%	-7.1	-2.9	100

Source: Transport Canada and calculations of the author

2.6 Calculation of the export basis

The concept of the export basis is fairly well established, but there are different approaches to its calculation. Transport Canada (2009), Fulton et al. (1998) and Kraft et al. (1996) use different methods to calculate export basis and reach different results. Transport Canada (2009b) and Fulton et al. (1998) divide Western Canada into the same 9 regions, but include different variables when determining logistic costs borne to producers. Transport Canada (2009b) breaks the export basis down into two components: direct costs and producer savings, as can be seen in Table 1. Direct costs include freight, elevation, dockage and cleaning, CGC fees, CWB, and Freight Adjustment Factor (FAF). The applicable freight rate is a weighted average of the area plus the FAF. Transport Canada does not include terminal elevation costs. The second component—producer savings—incorporates CWB transportation premiums. In the calculation of export basis, producer savings are deducted from direct costs because they represent gains to producers. Trucking premiums are equivalent to extra payments offered by GrainCo's in order to attract deliveries to their facilities. CWB transportation savings accrue from efficiency gains achieved by the CWB in the logistic system, such as financial returns generated from the car tendering process, freight and terminal rebates and any penalties for non-performance.

Fulton et al. (1998) use the same components as Transport Canada (2009b) but they do not consider trucking and CFA. Data on trucking is difficult to determine since hauling costs are producer specific. Several items such as length of haul, equipment used and ownership of equipment affect trucking costs. Transport Canada, for example, specifies that its trucking costs are based on short haul rates with a 40 mile average. The

CFAR and CPS were not incorporated in Fulton et al. (1998) as they were introduced after the study was concluded. Table 2 exhibits the export basis calculated by Fulton et al. (1998). As opposed to what Transport Canada (2009b) found for the period 1999/00 to 2008/09, Fulton et al. (1998) show CWB costs decreasing at an average rate of 3.8 percent per year while other direct costs were increasing. Consequently, the participation of CWB costs in the export basis dropped from 49 percent in 1980/81 to 11 percent in 1996/97.

Table 2. Components of the wheat export basis for Western Canada– 1999/00 to 2008/09 B

Year	Freight		Direct Costs Elevation & Dockage		CWB Costs		Export Basis
	$ per tonne	participation in export basis (%)	$ per tonne	participation in export basis (%)	$ per tonne	participation in export basis (%)	$ per tonne
1980/81	4.85	21.98	6.33	26.68	10.89	49.34	22.07
1981/82	4.85	22.57	6.83	31.78	9.81	45.65	21.49
1982/83	4.85	26.46	7.24	39.50	6.24	34.04	18.33
1983/84	5.23	26.47	7.38	37.35	7.15	36.18	19.76
1984/85	7.57	30.30	7.53	30.13	9.89	39.58	24.99
1985/86	5.90	25.91	7.76	34.08	9.11	40.01	22.77
1986/87	5.87	30.64	7.94	41.44	5.35	27.92	19.16
1987/88	6.23	33.46	7.94	42.64	4.45	23.90	18.62
1988/89	7.15	33.75	8.82	44.10	4.03	20.15	20.00
1989/90	8.86	34.12	9.31	35.85	7.80	30.03	25.97
1990/91	10.03	35.68	10.24	36.43	7.74	27.53	28.11
1991/92	10.37	41.68	10.67	42.89	3.84	15.43	24.88
1992/93	11.23	41.64	10.67	39.56	5.07	18.80	26.97
1993/94	12.86	44.45	10.67	36.88	5.40	18.67	28.93
1994/95	13.37	43.85	10.98	36.01	6.23	20.43	30.49
1995/96	33.01	67.18	10.98	22.34	5.15	10.48	49.14
1996/97	35.37	66.60	11.89	22.39	5.85	11.01	53.11
Avg. Annual Growth	13.2%		4.0%		-3.8%		5.6%

Source: Fulton et al. 1998

Kraft et al. (1996) calculate the cost of moving grain from farm to port. They use all the major items included in the export basis as Fulton et al. (1998) and Transport Canada (2009), but refer to them as logistic costs rather than export basis. Kraft et al. (1996) consider elevation, dockage and cleaning, and rail freight costs between 1980/1981 and 1996/1997. They exclude FAF, CFAR (which had not been created yet) and CWB costs. Kraft at al. (1996) also include storage and carrying costs which Transport Canada (2008) and Fulton et al. (1998) do not specify in their analysis. These methodological differences in the calculation of logistic costs can lead to distinct results. For example, in 1993/94 Kraft et al (1996) calculate a basis of $33.31 per tonne for wheat. If CWB costs of $1.40 per tonne and demurrage at $1.13 per tonne are also considered in the calculation, basis would be $35.84 per tonne.[4] In the same period Fulton et al. (1998) calculate an export basis of $28.93/tonne, a $4.38/tonne difference from Kraft et al. (1996).

2.7 Influence of the Canadian Wheat Board

2.7.1 Export Basis

While the CWB does not control every aspect of wheat logistics, its industry presence influences several dimensions of grain transportation from farm to port. Most cost items of the export basis are either influenced or determined by the CWB, as discussed below.

a) The CWB does not have direct authority on rail freight or elevation rates. Nevertheless, the CWB can use its advocacy voice to challenge the rail lines and GrainCo's to lower rates and litigate on issues of inequitable rail service provided for grain transportation. An example of this is the CWB's current push to have a rail review

[4] Kraft et al. (1996) mention CWB costs and demurrage even though they do not consider them in the calculation of logistic costs.

conducted which would lower freight rates to farmers by $200 million per year. The CWB does the rail car ordering for its grains.

b) FAF is determined by the CWB. As previously discussed, the Freight Adjustment Factor (FAF) is an adjustment to rail rates determined by the Canadian Wheat Board. Non-Board grains do not have this weighted averaged cost system.

c) CWB costs are the operational fees associated with each pool account. So this component is entirely determined by the CWB.

d) CGC fees are not affected by the CWB, although the CWB works closely with the CGC to ensure high quality standards for Canadian grain. The CGC fees affect logistic costs in terms of the grade farmers receive for their grain based on CGC grade and quality control standards.

2.7.2 Price

The history of the CWB began when farmers wanted greater power and protection when marketing grain. The Canadian government supported farmers' wishes for an agency, formalizing the involvement of the CWB in grain marketing. In 1935, the Canadian Wheat Board Act came into force. All annual sales revenues less the operating costs are returned directly to farmers pockets.

The Canadian Wheat Board (CWB) currently plays a prominent role in marketing and logistics of wheat, durum and barley in Western Canada. As a single desk operator, the CWB holds more market power than individual farmers in the sale of Western Canadian wheat, durum and barley. The market power allows the CWB to market grain as a premium product in global markets, which is a significant benefit of the CWB. Non-CWB grains do not extract such premiums because multinational corporations marketing the commodities trade grain based on margins, attempting to buy low from farmers and sell high in the market place. Through single desk marketing, the CWB derives a premium on agricultural exports that farmers would not be able to extract acting alone. From 1984-1998, an average premium of $13.34 per tonne for hard red spring wheat was applied, contending that this premium would be dissipated by arbitrage in an unregulated market (Veeman 1998).

The CWB allows farmers to exercise various pricing options when marketing Board grains. Farmers need to sign a pricing contract in order to receive payment for grain delivery. In addition to the CWB pool, four producer payment options (PPO) are provided to farmers allowing them to spread out their risk. The PPOs Fixed Price Contracts, Basis Price Contracts, Futures First, and FlexPro.

a) Price pooling offers producers a total net pooled return from grains sold that crop year. Price spreads are used to determine the relative value for each grade. The pooling option spreads out producers` market risk by ensuring fair payments to all farmers for equal quality of grain throughout the crop year while providing the opportunity to meet market highs. Farmers who participate in the Price Pooling option share the risk of price and basis volatility with other farm managers. The pool works by putting all the wheat that is delivered to the CWB into a pool account. As the wheat is sold to customers, the profits are placed in the pool account and accumulate for that crop marketing year. The sales of wheat that come from marketing all different class, grades and protein levels to various customers around the world are put into a single pool account. The relative average sales for each protein and grade are tracked over the year using a series of price differentials (Unterschultz et al. 1999). Upon delivery, producers receive an initial upfront payment based on grain quality and deduct transportation costs as they are not pooled by the CWB (CWB, 2011c). As more wheat is sold throughout the year, the revenues become more certain and farmers are given an upward adjustment in pay. A final payment is made to farmers when all sales from the pooled grain delivered in that crop year are complete (Unterschultz 1999). The CWB provides a pooled return outlook (PRO) which is a price forecast from the pool to give farmers knowledge of the expected pool price (CWB 2011c).

b) Fixed Price Contracts use a daily trading price and work on a base grade number 1, 13.5 protein. The spreads vary monthly depending on demand and sales. Producers can lock in a base price and can deliver 100 percent of their contract to the elevator of their choice. This option ensures farmers are paid 100 percent on delivery. Producers' gross profit on delivery is their fixed price less elevator deductions. Farmers can use the PRO to compare to the fixed price.

c) Basis Price Contracts allow farmers to lock in a basis first and then are given almost a year to lock in a futures price before the contract expires. A positive or negative adjustment factor is included in deductions for late signups subject to the level of risk in the market. High market risk imparts a positive adjustment factor, thus widening the basis. The adjustment factor changes daily and depends on current prices and previous sales.

d) Futures First is the mirror image of Basis Price Contracts, where producers take the futures prices and do not lock in a basis.

e) FlexPro offers producers a flat daily price for wheat with combined futures and basis pricing. This option is similar to the Fixed Price Contract

Chapter 3: Theory

The purpose of Chapter 3 is to discuss the theoretical framework adopted in the analysis of how changes in the marketing system affect producers. This study looks at the impact of deregulation of the Canadian Wheat Board and focuses on the theory behind those dimensions. The first section discusses competition and barriers to entry. It outlines the market structures and discusses theory behind market regulation on wheat price and export basis, and how it can change as more competition is allowed in an open market environment. The second section defines risk, particularly for the agricultural sector in Western Canada. The last section discusses how risk can be addressed in decision making models, providing a framework to explore the trade-off between risk and return in decisions under uncertainty such as when producers have to choose between different marketing strategies. The focus will be on expected utility theory and the concept of certainty equivalents.

3.1 Market structures and competition

Market structure refers to the number of buyers and sellers, their size distribution, the degree of differentiation, and the ease of entry into an industry. These structural characteristics are used for classifying market competitiveness. Markets are broadly classified as competitive (many buyers and sellers), oligopolistic (few firms), or monopolistic (single firm). Similarities among all market structures are the equilibrium price where quantity demanded equals quantity supplied, and firms want to maximize utility and profits. In economics, perfect competition is characterized as the most efficient form of competition in equilibrium state (Tomek and Robinson 1995). Perfectly competitive markets can be defined as markets in which there is perfect information about prices, and every economic actor is a price taker. Perfectly competitive markets are rare in today's global economy. In perfect competition, the price of a good or service is equal to the marginal cost. This market structure is used as a benchmark to evaluate actual market structures. Oligopoly and monopoly are market structures, which do not follow the same assumptions as perfect competition, essentially incorporating the notions that firms can set prices and there can be barriers to entry.

When a firm is not a price taker and exhibits market power, it has the ability to alter the price of a good or service higher than the marginal cost (Fulton et al. 1998). Prices are lowest in a perfectly competitive market and tend to increase as the number of competitors in the market decrease.

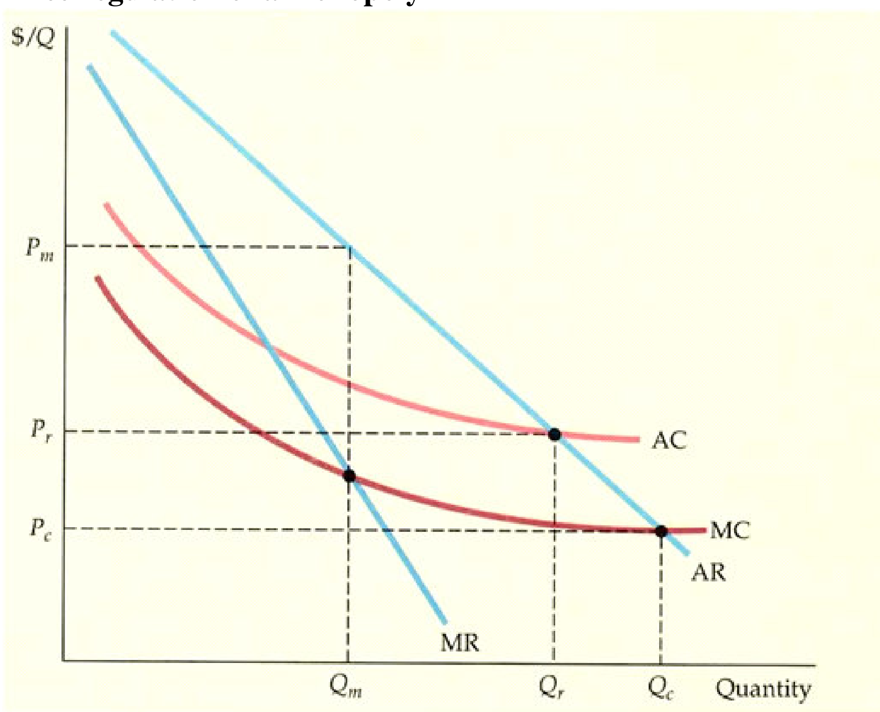
In an oligopoly market, firms do not take price or market demand as given because firms set price or output based on strategic consideration of competitors' behaviour. Nash equilibrium is an important concept applied to the analysis of oligopolistic markets (Pindyck and Rubinfeld 2006). Norwood and Lusk (2008) outline that a Nash equilibrium exists when all players are employing their best strategy given the strategies of all other players. There are three primary types of competition models that are used by economists to describe markets of imperfect competition: Cournot, Bertrand and Stackelberg competition models. Cournot competition describes a market structure in which firms compete on quantity produced. In Cournot competition firms do not collude, but act strategically by choosing output simultaneously. It is assumed that the number of firms is fixed, products are homogenous and firms do not participate in any form of collusion (Norwood and Lusk 2008). The Bertrand model is an economic model that describes a market structure in which firms compete by setting prices simultaneously. The Bertrand model assumes homogeneous products among firms while competing purely on price. The Stackelberg model is an economic model that describes a competitive situation in which the leader moves first and the follower moves sequentially. In this leader-follower model, it is advantageous to be the leader. Firms compete on quantity and it is assumed that the leader knows ex ante that the follower is observing its actions. A duopoly is a type of oligopoly where two firms exist in one market. In general, these two firms have dominant control over a market. If all firms in an oligopoly collude, the final outcome in terms of price and quantity will be the same as in a monopoly (Tomek and Robinson 1995).

A monopoly is a market structure exhibiting a form of market power in which one firm dominates the market by assuming the entire market share. The distinguishing characteristic of a monopoly is the demand curve facing the monopolist coincides with the industry demand curve. To maximize profits, a monopoly chooses to produce that output level for which marginal revenue is equal to marginal cost. Figure 2 illustrates this decision, where MC is the marginal cost curve, AC is the average cost curve, MR is the marginal revenue curve, and AR is the average revenue curve. Q_m in Figure 2 represents the point where marginal cost and marginal revenue are equal, resulting in price P_m, given by the demand curve, at which a monopoly firm can charge customers. In equating marginal cost, output level is produced where price exceeds marginal cost. Price does not equal marginal revenue as in perfect competition, but is greater than marginal revenue whenever the demand curve for the individual firm is negatively sloped. Mathematically, marginal revenue, which holds for any market structure, is expressed:

(1) $$MR = P\left(1 - \frac{1}{|E|}\right)$$

where E is the price elasticity of demand. The more inelastic the demand curve, the greater the difference between price and marginal revenue. Marginal revenue is positive only if $|E|$ is –greater than 1 (elastic demand). Marginal revenue is 0 if $|E|$ is 1. Marginal revenue is negative if $|E|$ is less than 1 (inelastic demand). Thus a rational monopolist will not set price in the range of demand that is elastic (Tomek and Robinson 1995).

Figure 2. Price regulation of a monopoly



Source: Tomek and Robinson 1995

Norwood and Lusk (2008) develop an example of how prices and quantities change under different market structures using a Cournot model, where price is determined as: $p = a - \frac{N}{N+1}(a-c)$, a is fixed cost, b is the slope of the demand curve, $q = \frac{a-c}{(N+1)b}$, N is the number of firms, and c is marginal cost (Table 3). Market output is $Q = Nq$ and profits per firm is determined by $\pi = (p - c)q$. As more firms enter the market the term N/(N+1) increases, reducing the market price. For example, if a = $100, b =$1 and c = $10 a single monopoly firm (N=1) charges a price of $55. The market price falls to $40 when a second firm enters the market forming a duopoly (N=2). When a third firm enters the market forming an oligopoly with 3 firms, the price drops lower to $33. This pattern continues as the number of firms entering increases until N=100.

Table 3. Cournot price as number of firms rise

Number of Firms (N)	Cournot Price	Cournot Quantity	Market Output	Profits per Firm
1, monopoly	$55	11.25	11.25	$506.25
2, duopoly	$40	7.50	15.00	$225.00
3, oligopoly	$33	5.63	16.88	$126.57
4, oligopoly	$28	4.50	18.00	$81.00
5, oligopoly	$25	3.75	18.75	$56.25
100, competitive market	$11	0.23	22.28	$0.20

Source: Norwood and Lusk 2008

3.1.1 Market power affect on price

The Western Canadian wheat industry poses a barrier to entry. Government legislation allows only the CWB to market Western Canadian wheat. Barriers to entry are anything that prevents an entrepreneur from instantaneously creating a new firm in a market. The term barrier to entry is often described by both the costs and time for entry into a market. If many firms have identical cost curves and face identical prices, only by having some advantage over new entrants can a firm earn higher profits than other potential firms. The firm that first entered the market has a first-mover advantage. This occurs when the firm has lower marketing costs because it faces no rivals. Examples of a barrier to entry are a patent which creates a legal monopoly, large start-up costs or public policy. Bain (1956) established three barriers to entry:

1) Absolute cost advantage allows a firm to produce more cheaply than potential entrants.

2) Economies of scale for large-scale production that require large capital expenditures.

3) Product differentiation occurs if firms produce similar, but not identical products. Consumers' purchase habits toward established brand names may make it more difficult for a new brand to be successful.

The impact of barriers to entry on markets is to limit competition. When a specific market faces barriers to entry, new firms can not easily enter the market, and thus the degree of competition remains unchanged. Depending on the number of firms in the market, barriers to entry can lead to firms with high market power and even to a monopoly. For example, the CWB acts as the only entity buying and selling Western Canadian wheat. If barriers to entry are eliminated allowing other firms to buy and sell, the competition increases, removing any strong market powers the CWB has in the global market. One option upon removing the single desk in an oligopoly structure is that large Grain Companies or other existing commodity trade organizations will market grain. Based on competition theory, as more firms enter the market, grain prices will go down.

Non-uniform pricing is often used by firms in markets that are not perfectly competitive in order to maximize profits. Non-uniform pricing refers to charging customers different prices for the same product or charging a single customer a price that varies depending on the quantity of the product purchased. Price discrimination applies to a non-uniform pricing policy used by a firm with market power (Carlton and Perloff 2005). Carlton and Perloff (2005) describe three conditions needed for successful price discrimination:

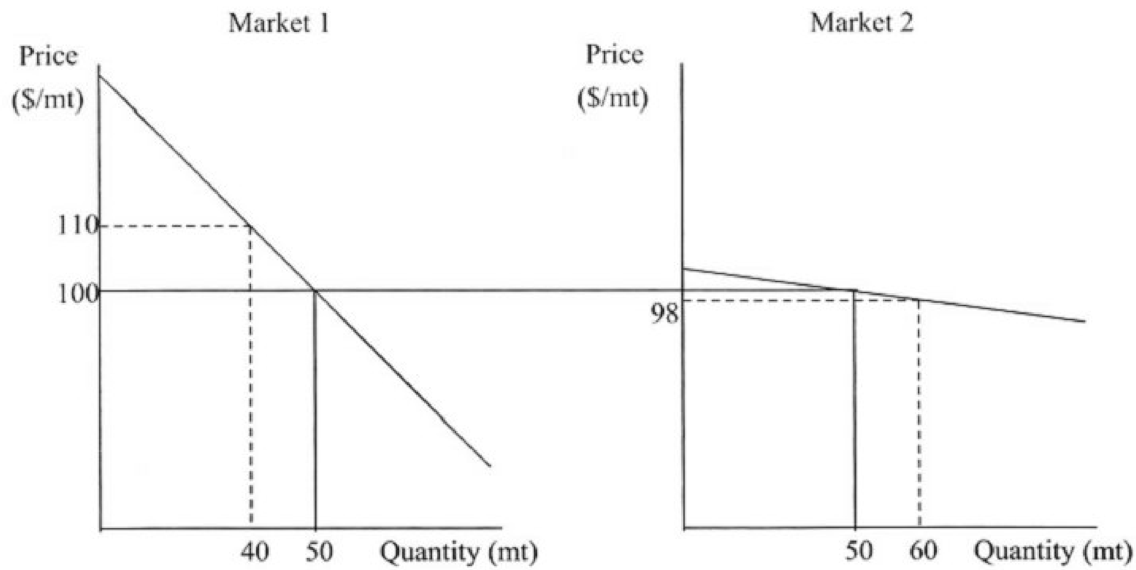
1) A firm must possess market power to set price above marginal cost

2) A firm must be able to identify consumers' willingness to pay for each unit, which will vary across consumers

3) A firm must be able to prevent or limit resale of the product by customers who pay the lower price.

The Canadian Wheat Board imposes a form of price discrimination to maximize profits. The CWB is a single desk seller of Canadian wheat, signifying market power in the global market. As the single seller for Canadian wheat, the CWB is able to charge customers higher prices to specific customers who demand high-quality Canadian wheat. Large market power gives the ability to set prices above perfect competition along with the ability to price discriminate. Schmitz et al. (1997) review the barley market to the extent that the CWB price discriminates to customers with varying demand curves. As a single desk seller, the CWB is not concerned about price competition by another firm selling Canadian barley. Thus the CWB can price discriminate and charge different prices to different customers. The CWB adjusts quantities on each demand curve to maximize revenue across all markets. Using an example from Schmitz et al. (1997) assume there are two buyers for Canadian barley and each requires 50 tonnes at $100 per tonne. Buyer in Market 1 has a more inelastic demand curve than buyer in Market 2. The demand curves are defined where a 10 tonne shift from Market 1 to Market 2 results in a $10 per tonne price increase in Market 1 and only a $2 price reduction in Market 2. Market revenue from price discrimination is $110.00 per tonne for 40 tonne (Market 1) plus $98.00 per tonne for 60 tonne (Market 2). The average price received per tonne changes from $100 per tonne to $102.80 per tonne as shown in Figure 3.

Figure 3. Returns from price discrimination



Source: Schmitz et al. 1997

3.1.2 Market power affect on basis

Upon removal of the CWB, barriers to market entry are removed and farmers will be able to sell grain to more than one firm. In an oligopolistic market, only a few firms account for the total production. It is assumed that grain companies such as Cargill or Viterra or other existing commodity marketing firms would market wheat in the open market environment[5]. The market encompassing these firms would be considered an oligopoly. Because only a few firms are competing for farmers' grain, each firm must carefully consider its pricing strategy and how its competition will react. For farmers, the price these firms charge for their elevator services affects their overall profit.

In the agriculture industry in Western Canada, these models are distorted by government intervention under the current rail revenue cap and barriers to entry. For

[5] The level of competition will depend on the local marketing options. For example, in many local regions farmers will have access to only one or two grain companies.

example, the revenue cap imposes a cap to the price charged to producers for transportation services, disallowing the duopolies (or monopoly in certain areas) to charge prices based solely on market structure in the industry. This affects the wheat basis as rail charges are included in the basis. A price ceiling is a government imposed limit on the price charged for a product or service. The purpose of price ceilings is to protect consumers from price increases that could make the product or service unattainable. Figure 2 in the previous section illustrates an example of a monopoly under price regulation (Pindyck and Rubinfeld 1998). In Figure 2 AC is average costs, MC is marginal costs, AR is average revenue and MR is marginal revenue. Unregulated, the firm would produce quantity Q_m where marginal revenue is equal to marginal cost. From that quantity point, monopoly price (P_m) is determined using the average revenue curve. The government regulatory agency would ideally like to put the price cap at P_c, but the firm would not produce at that point because it is lower than its average cost. The price is set at P_r where the average cost curve intersects average revenue. The price cap is applied through government regulation to prevent firms with market power from raising prices to P_m. In order to protect consumers, the cap forces restrictions on price limiting it to P_r. As shown in Figure 2, P_r is lower than P_m, thus without the cap, prices would rise to P_m. In the context of the current study, this price increase would widen the basis and lower farmers' profit. The railways possess strong market power because of the demand for their services. Rail lines are the primary form of moving grain from inland elevators to port or the United States for market. Trucking can be considered an alternative mode of transportation, but only for shorter distance and smaller quantity hauls because of costs and road weight restrictions associated with road transportation. With only two major rail lines in operation in Western Canada, the CN and CP form a duopoly. In certain areas of the Prairie Provinces, such as the Peace River area, farmers have access to only one railway, in which rail line in operation is a monopoly. Thus, as in Figure 2, the prices the railways can charge is at P_m, or close to P_m in areas with both railways in operation. However, the freight revenue cap that is currently in place prevents the railways from using their strong market position to charge high rates to everyone. In an open market situation, the revenue cap is assumed to be removed in conjunction with the CWB. The cap removal will result in the railways regaining the ability to charge monopoly and duopoly prices.

3.2 Risk

Risk is characterized as deviations from the expected value of an event. In agriculture, risk is often present in every decision, task and environment to which farmers are exposed. Hardaker et al. (2004) present six specific risk types in agriculture farmers are exposed to: production risk, price risk, institutional risk, personal risk, business risk, and financial risk. All risks directly impact the logistic system and farmers' profits in Western Canada. Production risk comes from the uncertainty of crop performance and results, thus affecting the yield. In turn, the quantity of bushels to be shipped is uncertain. Institutional risk results from government intervention of rules and policies. The Western Canadian logistic system is highly influenced by government policies, such as the Canada Transportation Act capping the grain rail rates that railways can charge and their annual revenue. Personal risk comes from the humans involved in farming operations. This risk category extends from death and illness to carelessness. Personal risk develops within the individuals involved in the farming operations. The succession of personal risk chains through the logistic system includes all people in the industry responsible for moving grain from farm to port. Rail cars are allocated based on quality and competition for farmers' volume. The goal of the CWB rail car policy is to increase competition among grain companies. Business risk is the amalgamation of production, market, institutional and personal risk. It is generated on the business and economic side of farming affecting business performance. For example, business risk affects farm profits, which is affected by the magnitude of the export basis. Financial risk differs from business risk as it refers exclusively to financing the farm operation. Operating profits of the CWB and GrainCo's change based on borrowed funds. Large costs go into operating these organizations and are needed to ensure operations run efficiently. There is financial risk when interest rates become exclusively high or the lender calls in a loan when funds are needed. This impacts the logistic system by obstructing companies to perform services cost-effectively. Thus, farmers can either be over charged for a service such as elevation or freight, or not be provided the service at all (Hardaker et al. 2004).

3.3 Choices involving risk and expected utility theory

Expected utility theory is traditionally adopted in economics to study choices involving risk. Utility is the pleasure or satisfaction individuals get from consuming goods or services (Nicholson and Lipnowski 2004). The concept of utility represents consumers' preferences and is employed when individuals are presented with choices. In economics, it is often assumed that individuals want to maximize utility. Mathematically, this assumption is represented by individuals maximizing a utility function, which is the makeup of an individual's system of preferences. For example, consider a utility function u(q,z), where q is the quantity of commodities consumed and z represents environmental and personal characteristics, subject to a budget constraint y.

Expected utility theory deals with the analysis of choices when risky prospects are involved. The basis of modern utility theory is formed around the subjective expected utility (SEU) hypothesis established by John Von Meumann and Oscar Morgenstern (1940) (Hardaker et al. 1997). The subjective expected utility hypothesis is the first axiomatic treatment forming modern utility theory and is the most commonly used theory for decision analysis involving risk. There are four axioms applied to SEU theory:

a) Ordering states that an individual either prefers one of two risky prospects (a_1 and a_2) or is indifferent between them.

b) Transitivity implies that if an individual prefers a_1 to a_2 and a_2 to a_3, then the individual will also prefer a_1 to a_3. The same ordering applies when the individual is indifferent between the risky prospects.

c) Continuity assumes that when an individual with the opportunity to choose between two risky prospects, one with a favourable outcome and the other with an unfavourable outcome, the individual will only take the risk if the probability of getting the good result is high enough.

d) Independence infers that the preference between risky prospects is independent from all other risky prospects. For example, the preference between a_1 and a_2 is independent of a_3.

A utility function can be created if the decision-maker behaves according to all four axioms. The utility function is based on preference and subjective probability. A utility function, u, with risky prospects (a_j) is written as u(a_j). Utilities can be used to categorize the risky alternatives, thus it is assumed that the highest utility is the preferred option. If an individual's preference is a_1 over a_2, it is represented as:

(2) $$u(a_1) > u(a_2)$$

The expected utility is the weighted sums of the utility values calculated by the utility values of individual consequences multiplied by the respective probabilities. The expected value is determined using utilities and the corresponding subjective probabilities. Furthermore, the utility of a risky prospect a_j is the expected utility for that prospect:

(3) $$u(a_j) = E[u(a_j)]$$

Consider a decision problem in which a choice, $a_{1,}$ with consequences of 1000 or 0 depending on which equally likely uncertain event occurs. The expected utility is calculated as:

(4) $$u(a_j) = 0.5u(1000) + 0.5u(0)$$

3.3.1 Risk preferences

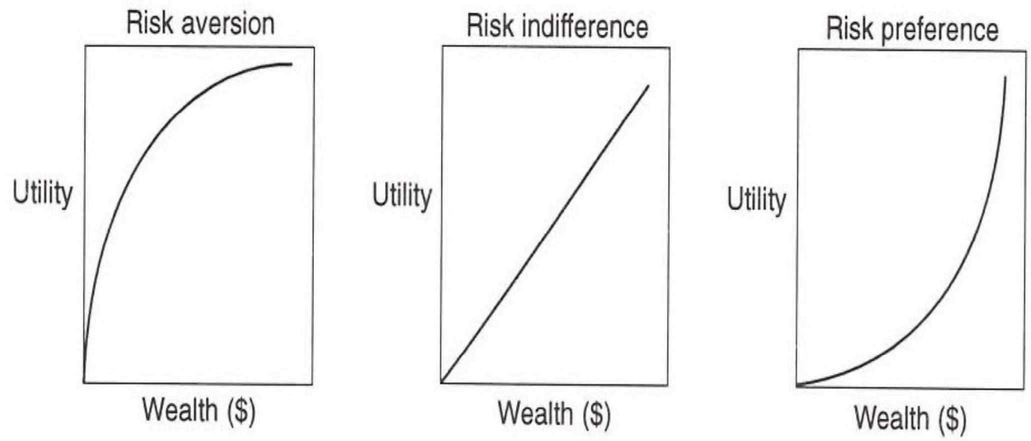
Risk preferences vary among individuals and are generally categorized into risk aversion, risk neutrality and risk seeking (Pindyck and Rubinfeld 2006). Risk aversion is the unwillingness to accept fair gambles. An individual exhibiting risk aversion is characterized as someone who prefers certainty over uncertainty with the same expected value. For example, a decision-maker would prefer a level of income that is certain to a riskier income with the same expected value. Risk aversion can be described by the willingness to pay to avoid risk. A risk averse person is willing to give up a percentage of income to avoid taking a risk. Similarly, the individual is willing to pay a percentage of income to reduce risk or avoid it completely (Nicholson and Lipnowski 2004).

Hardaker et al. (1997) observe the behaviour of farmers and conclude that the majority of farmers are risk averse.

Individuals are risk neutral when they are indifferent between a certain level of income and an uncertain prospect with the same expected value. Risk neutral individuals base their decisions on expected return and not on risk. Finally, individuals are risk preferring when they choose an uncertain income over a certain income with the same expected value. Risk preferring individuals are willing to "pay" to take risk (which is the opposite of what risk averse people do).

The shape of the utility function illustrates the level of risk aversion through its curvature (Figure 3). An individual with a concave utility function is said to be risk averse, while an individual with a convex utility function is risk preferring. A linear utility function demonstrates a risk neutral individual. However, a quantitative analysis is more relevant in terms of accuracy when distinguishing between various levels of risk aversion. The intensity of risk preferences can vary across individuals. Two people may both be risk preferring, but one more risk preferring than the other. Risk preferences are typically measured by the curvature of utility functions, and can be expressed graphically as shown in Figure 4.

Figure 4. Measuring risk preference



Source: Hardaker et al. 1997

The magnitude of risk preferences can be measured using the Arrow-Pratt coefficient of absolute risk aversion (ARA). The mathematical expression (5) represents the degree of risk aversion (RA) using the first (u') and second (u'') derivatives of the utility function. The expression is also known as the coefficient of absolute risk aversion shown by,

(5) $$RA_a = -\frac{u''}{u'}$$

The absolute risk aversion coefficient is used as a local measure of risk aversion. For example, it is the actual amount an individual holds in risky assets given a certain level of wealth. Recently, constant relative risk aversion (CRRA) is being employed in agriculture research. CRRA functions (power functions) are more commonly being used to explore risk analysis in agricultural economics because the results from a CRRA function are more consistent with observed behaviour (Nelson and Escalante 2004). CRRA is a measure related to the percentage of wealth held in risky assets. The coefficient of relative risk aversion (RRA) can be defined in a similar manner using initial wealth. The coefficient of RRA is defined as:

(6) $$R_r(w) = \frac{-wu''}{u'}$$

where R_r represents the coefficient of relative risk aversion and *w* represents wealth.

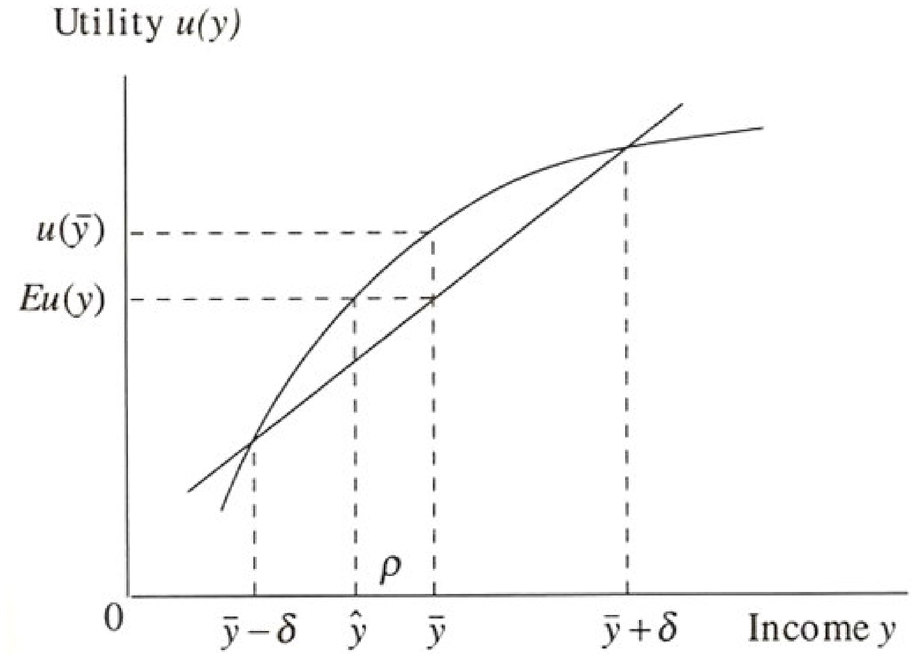
3.3.2 Certainty Equivalents

Certainty equivalents (CEs) represent the cost of risk in monetary terms (Sadoulet and Janvry 1995). The certainty equivalent of $F(\cdot)$,denoted c(*F,u*), is the amount of money in which an individual is indifferent between a gamble (more risk) and the certain amount of money shown in (equation 7). In a lottery example, *c(F,u)* represents the amount of money an individual is indifferent between getting a certain pre determined amount of money or owning a ticket for the chance of winning the lottery:

(7) $$u(c(F,u)) = \int u(x)dF(x).$$

When decisions analysis is primarily based on financial outcomes it is valuable to compare expected values of each scenario in terms of the corresponding CE (Hardaker et al. 1997). The satisfaction of the inequality c(*F,u)* ≤ x*dF(x)* for all $F(\cdot)$ is analogous to the decision maker being a risk averter (Mas-Colell et al. 1995). The difference between certainty equivalents in different scenarios portrays preference in dollar value when maximizing utility. Figure 5 is used to provide a graphical representation of CEs and explain risk attitude. Note that c*(F,u)* is shown as $\hat{y}$ in the example below.

Figure 5. Certainty equivalent



Source: Sadoulet and Janvry 1995

Figure 5 displays a concave utility curve u defined over income y of a risk averse individual. The sure income is represented by $\overline{y}$ and a risky prospect with two outcomes is presented in the figure: $\overline{y}$ - δ with probability 0.5, and $\overline{y}$ + δ with probability 0.5. Consequently, the expected value of the risky prospect is $\overline{y}$. For example, let's say $\overline{y}$ - δ is $1,000 and $\overline{y}$ + δ is $5,000 with equal probabilities. The expected value of the risky prospect is $3,000 shown by $\overline{y}$. The weighted average of utility levels of these two outcomes is the expected utility of the risky prospect, Eu(y), which is lower than the utility u($\overline{y}$) of the same sure income $\overline{y}$. The certainty equivalent, $\hat{y}$, is established using the utility function and depends on both the shape of the function and the probability distribution of y. The certainty equivalent is determined by drawing a line connecting the risky prospect values on the utility curve. Following the same example, the CE is $2,400, the point where the decision maker is indifferent between the two choices. The coordinates at the middle of this line are shown as (Eu(y), $\overline{y}$). The certainty equivalent is then established by drawing a line from this point to the utility curve and is defined by the amount of $\hat{y}$ such that:

(8) $$u(\hat{y}) = Eu(y).$$

Chapter 4: Literature Review

This chapter discusses previous studies on topics related to the current research. Section 4.1 focuses on studies exploring how price and export basis could change in a market structure without the CWB. Discussion on the changes in the export basis is more extensive because the three scenarios for the export basis used in this research are based on previous studies. Section 4.2 presents the effects of deregulation on wheat prices and basis in Australia and United States. Section 4.3 offers a general discussion of how market power and price uncertainty can affect marketing margins (i.e. the difference between price received by producers and their marketing costs). Finally, section 4.4 provides examples of risk analysis in agricultural markets.

4.1 Previous Canadian studies

4.1.1 Prices

The investigation of how changes in the Western Canadian grain marketing system affect producers is based on one scenario: an open market for wheat, which includes removal of single-desk powers from CWB and also removal of revenue cap. An open market for wheat assumes changes in both the price and basis for farmers. The degree in which these two factors would change is unknown because wheat has been marketed in a regulated environment for several years. Some research predicts the price will increase if wheat is marketed in an open market because of competition and not being able to extract premiums. Contrasting research exhibits the price premiums the CWB obtains such as Kraft et al. (1996). Veeman (1998) researched that the CWB sells Canadian wheat at a premium price of over $13.00 per tonne. This would not be attainable if the single-desk market structure were removed. Kraft et al. (1996) also estimated premiums between

$14.00 and $22.00 per tonne with the single desk. Pugh and McLaughlin (2007) focus on the CWB's ability to price discriminate to explain how premiums are extracted from the customers willing to pay a higher price, and calculate the premium for wheat to be between $7.00 and $12.00 per tonne. A similar idea is supported by Fulton (2006), who argues that the single-desk selling powers allow the CWB to market to countries that are willing to pay a premium for Canadian grain because of quality and consistency. As the only company supplying Canadian grain, the CWB is able to extract monopoly rent, a higher price for Canadian wheat. If the CWB were removed, so is the ability to price discriminate and thus wheat would be sold by few, large exporters, removing any premiums that would otherwise be captured. However, since there would be relatively few sellers, some rents can be expected, but will not exceed the premiums obtained by the CWB. Along with lower rents generated, a lower proportion of rents generated would be returned to farmers. The amount of rents returned to farmers is based on degree of competition at the elevator level (ie. how wide the margin is to split profits among farmers and elevator) and overall supply of high quality grain that is in demand.

On the contrary, Carter et al. (1998) suggest the CWB is a price taker in the international market and if any premiums are extracted, they are not reaching the farm gate. Their research shows the Canadian pooled price for wheat is an average of only $1.00 per tonne greater than the United States.

4.1.2 Export basis (grain handling and transportation system)

Fulton (2006) provides a general discussion of how the removal of the Canadian Wheat Board's single-desk selling powers would affect the grain handling and transportation system. First he discusses the reduction of competition among grain companies. The primary grain handling in the Prairies is reasonably concentrated. Disbanding the CWB would remove the ability of the CWB to bring additional competition to the primary grain handling sector through a tendering process. Secondly, he claims that terms from the railways will be less favourable. The CWB plays an important role in addressing issues with the railways. The railway industry is described as a duopoly with only two main firms competing for transportation services. Railway market power is a concern because of the high demand for their services to move grain to export position. The CWB is able to negotiate better freight rates and service than a grain company could if acting independently. A third impact discussed by Fulton (2006) is the elimination of an advocacy voice. The CWB is comprised of farmer-elected directors who are vocal and raise concerns regarding policy issues affecting grain farmers. Issues the CWB have been involved in include rail revenue cap, railway service issues, the merger between CN and B.C. Rail, international trade challenges, and the merger between Agricore United and UGG. Lastly, Fulton (2006) expects the freight cap to be removed if the single-desk selling powers are taken away from the CWB.

In a more recent piece Fulton (2011) offers again an overview of the challenges facing the grain handling and transportation system (GHTS) in Western Canada in a post CWB environment. Fulton (2011) suggests there is considerable evidence for the lack of a well-functioning GHTS upon removing the CWB’s single desk authority. The grain handling and railway industries are concentrated with few large firms that dominate the industry which in the past has been linked to problematic rail service. The CWB provides farmers with positive externalities in various forms including promotion of grain quality, defence against trade disputes, and ensuring regulatory tools such as the revenue cap can and service requirements remain in place. The revenue cap is a distinctive feature of the Canadian Grain Handling and Transportation System where the freight rate cannot exceed a specific amount. Upon deregulation Fulton (2011) expects there will be pressure to remove the rail cap to let market forces price and allocate grain cars. Therefore, railways will have more latitude when pricing rail costs and determining car allocation.

Analysis of the current GHTS investigating specific dimensions of the system has also been done using various theories and methods. Transport Canada (2009a) monitors the GHTS and presents its analysis in quarterly reports, which are prepared by the Quorum Corporation. The reports include an industry overview, an analysis of commercial relations, system efficiency and service reliability and producer impact. The section on producer impact is the most relevant for this research as the total system costs unfold at producer level in the form of the export basis. The methodology employed by Transport Canada is used to estimate the financial return to producers after deducting the export basis in order to determine if producer impacts stem from alterations in the GHTS. Producer impact is calculated for 9 regions in Western Canada. Quorum Corporation breaks down the export basis into its individual costs, and shows differences in determining the export basis for CWB grains and non-CWB grains. It is indicated that the wheat basis includes components such as CWB costs and a Freight Adjustment Factor and Churchill Storage Program, which are implemented by the CWB and therefore are not part of the export basis for non-CWB grains. Since the CWB determines some components of the export basis for grains under its system, there is an important difference in the dynamics of export basis for CWB and non-CWB grains.

Fulton et al. (1998) study the impact of deregulation on the export basis in the Canadian GHTS. The model focuses on how freight rates and elevator charges are determined in a deregulated environment and how they affect the export basis. They use a simulation model which divides Western Canada into 9 regions similar to Quorum Corporation. Their model uses a baseline scenario based on the current regime, and an additional three scenarios considering West Coast capacity constraint, removal of freight cap and common running rights. Under the current regime, rail and elevator rates are determined under the existing regulatory system with the established rail cap[6] and CWB costs, as previously discussed in the section on market structures.

The first alternative scenario uses the capacity constraint at the West Coast to determine the effects on the basis in a deregulated environment. The West Coast ports are not large enough to completely absorb all exported grain, thus the CWB directs grain away from the West Coast to Thunder Bay. Funds which help pay for shipping grain to Thunder Bay are generated by taking approximately $4.00 per tonne from the pool accounts. This value depends on the amount per tonne needed to raise funds to a point where prices received by farmers shipping east or west is equivalent. Upon deregulation, Fulton et al. (1998) predict a charge for growers selling grain through the West Coast of $8.45 per tonne shared between railways and elevators. This should ensure grain shipments to the West Coast do not exceed its capacity by restricting volume through higher prices to the West Coast. However, the $4.00 CWB charges are removed as the transportation system is deregulated. Producers only pay the capacity constraint if they

[6] The rail cap was introduced in 1995 in the Canadian Transportation Act to provide rate relief provisions to Western Canadian farmers from high rail transportation costs.

are shipping to the West Coast. Fulton et al. (1998) conclude the final result upon deregulation is, on average, a higher export basis for Western Canada.

The second alternative scenario simulates the freight cap removal. Fulton et al. (1998) claim that, without the freight cap, rail lines would take advantage of their market power and increase rates, which would rise to a point where trucking becomes competitive. As discussed in Chapter 3, when a price or freight rate cap is set through government intervention, the prices do not rise above the cap. Without this price ceiling in place, railways would use their market power to raise the prices above the cap, thus increasing the total export basis. Fulton et al. (1998) also predict local and terminal elevation costs to decrease if the system is deregulated, but they do not discuss the reasoning behind this outcome. For example, Central Saskatchewan local and terminal elevator tariffs are predicted to be \$8.07 and \$8.27 per tonne respectively, down from the \$11.48 and \$13.39 per tonne with the current freight cap system. Overall, Fulton et al. (1998) expect the export basis will increase to \$89.06 from 66.76 in Central Saskatchewan if the freight cap is removed. This shows that the increase in freight rate is larger than the decrease in elevation costs. The direction of the basis change is consistent with all other regions. In an open market, they predict the Western Canadian average basis would rise to \$82.29 per tonne for 1997-98, a \$33.30 per tonne increase compared to the current regime.

The third alternative scenario considers common running rights as an alternative to the current structure. As discussed in the previous chapter, the motivation would be to encourage entry into the rail transportation industry, increase competition as more firms offering the same service are in operation, and hence lower railway costs. In theory, increasing competition lowers prices for goods and services. Fulton et al. (1998) assume no barriers to entry in the railway market, but carriers must pay a regulated access fee to the owners of the track for use of the infrastructure. Fulton et al. (1998) examine the effect of common running rights on the export basis for two, six and unlimited number of carriers. Results show that railways market power impacts the basis in a deregulated environment. For wheat, common running rights with two carriers (which is the same number as in the current market) result in rail rates between the current rates with freight cap and the estimated rates without freight cap. As estimated in the previous scenario, this result suggests that removing barriers to entry and the rate cap, but still keeping the same number of carriers as in the current market, would increase freight rates. However, the increase in export basis would be smaller than in the scenario without the rate cap. As six and then an unlimited number of carriers are assumed, market power is reduced and thus rail rates decline accordingly. However, for both two and six carriers, elevator tariffs and terminal charges rise as the number of carriers increase, yet remain lower than in the current regime as the increase in elevator tariffs is not large enough to offset the decrease in rail rates. The increased competition in the rail industry leads to lower freight rates and higher elevator tariffs. Overall, the total basis estimated for common running rights is predicted to be higher than in the current regime, unless an unlimited number of carriers enter the industry.

Therefore, in the first two alternative scenarios Fulton et al. (1998) generally predict a combination of higher freight rates and lower elevator charges, leading to an increase in the export basis. The third alternative scenario, common running rights, shows distinct results. When only two carriers are considered, export basis is also expected to increase. However, when a larger number of carriers are assumed the predicted export basis is lower than in other scenarios except the current with freight cap scenario. Thus, Fulton et al. (1998) conclude that the current system with freight cap has the lowest logistical costs (basis) for producers in Western Canada unless common running rights are implemented with an unlimited number of carriers entering the industry. Overall, Fulton et al. (1998) predict the basis to increase anywhere between 4 and 46 percent depending on the type of deregulation.

Kraft et al. (1996) analyze the economic performance of the CWB and their role in marketing wheat. The section on the cost of marketing grain discusses the economic and institutional framework for grain marketing services. They estimate the cost of marketing grain from primary elevation to port for wheat, canola and flax. The cost of marketing grain estimated by Kraft et al. (1996) includes similar costs to those included in the export basis. They found the logistic costs for wheat have changed from $24.61 per tonne in 1980 to $33.31 in 1994. The study also includes administrative costs, demurrage and pool deficit costs, when combined equal an average of $3.85 per tonne for wheat from 1980/81 to 1993/94. Kraft et al. (1996) conclude it is cheaper to move grain from farm to port in a regulated environment under the Canadian Wheat Board, which is consistent with Fulton et al. (1998).

Carter et al. (1998) adopt a different approach compared to the previous studies, and provide evidence that producer profits in a competitive open market would be higher than under the current CWB system, which contrasts with previous findings. They provide current estimates of cost factors associated with the CWB and the producer impact of each cost. Some cost factors included are CWB administration, pool account charges, storage and interest, excessive cleaning and handling, port congestion, and opportunity costs. They conclude these costs are currently higher than they would be in a competitive market, and are borne by the producer in the form of price deductions at the elevator. Carter et al. (1998) further analyze data on wheat handling charges from the U.S. to compare to Canadian CWB and non-CWB grains. They find handling CWB grain between the elevator and port costs an extra $3.00 to $5.00 per tonne compared to non-CWB grain, and an extra $8.00 to $13.00 per tonne compared to U.S. handling fees.

Carter et al. (1998) also use the oats market after it was removed from the exclusive marketing rights of the CWB as additional evidence that market deregulation can affect the export basis. Following deregulation, Carter et al. (1998) report oat marketing costs decreased 33 percent. Lastly, they suggest demurrage, excess cleaning and port constraints cost farmers more than necessary. The total demurrage charges over an 11-year span amounted to $0.18 per tonne for wheat. Excess cleaning costs develop from over cleaning at port (to less than the allowable dockage), costing farmers additional cleaning fees. Cleaning grain at port also reduces the grain capacity in the transportation system as grain is hauled with dockage. If all cleaning happened at the local elevator, producers would only pay for one cleaning at the elevator and end up shipping less tonnes once the dockage is removed. Therefore the transportation costs would be reduced, lowering the export basis. They explain that grain is not cleaned to the same degree in the U.S. as in Canada because the net gain from doing so is less than the additional cleaning costs. Carter et al. (1998) support their findings with calculations from Wilson et al. (1993), who suggest that over cleaning negatively affects producers' profit. This is applicable to the Canadian system as the additional cleaning is approximately a $2.25 per tonne costs to producers. Overall, Carter et al. (1998) conclude that logistic costs for CWB grains are greater than those of other commodities in all of North America mainly due to the influence of the Canadian Wheat Board on logistic costs.

4.2 Open markets

Australia's and the United States' grain industries both operated under a regulated environment similar to the Canadian Wheat Board. Grain marketing was controlled by the Australian Wheat Board (AWB) in Australia and the rail system was regulated by the Interstate Commerce Commission (ICC) in the U.S. Since deregulation of their statutory marketing system, changes have occurred in producers' costs for marketing grain to export position.

The Australian Wheat Board was established in 1939 to market wheat for growers as a single desk and eventually transitioned to an open market over the course of 30 years. In 1989 the AWB lost its statutory authority for human consumption due to pressure for deregulation. This was prompted by farmers and the agriculture industry, especially when the Australian Royal Commission reporting that the grain handling and transportation system was not cost effective and efficient. In addition, the AWB underwent a pool deficit in the 1986-1987 crop year. At this time, the Wheat Industry Fund was also established to provide a capital base for marketing procedures and to accrue infrastructure (Cockfield and Botterill 2007). The Australian single desk in the wheat export market was removed through the Wheat Export Marketing Act 2008. Subsequently the single desk has been replaced with a comprehensive set of government and industry regulations. At this time 70 percent of the grain handling market was controlled by AWB, Co-operative Bulk Handling (CBH), ABB, GrainCorp and Cargill (Giesbrecht 2011). AWB, ABB and GrainCorp operated under a dual class shareholdings structure. A dual class structure is arranged with two distinct and separate groups of shareholders. A Class grower held shares are used to control the direction of the company and maximize net pool returns while B Class listed shares are used to fund the operation (Bushell and MacAulay 2011). Over the last few years the Australian grain handling system as been volatile in terms of facility ownership. The AWB is no longer in operation and was first bought out by Agrium, later to be purchased by Cargill. ABB was purchased and is owned by Viterra. The only grower owned and cooperative remaining in Australia is CBH. CBH continues to be a regulated grain handling monopoly in Western Australia.

Lobb and Fraser (2005) studied policy development and transportation changes and their influence on the logistic system while the Australian Wheat Board was losing its single desk. The policy changes in the AWB's marketing organization provided opportunities for large GrainCo's such as Cargill, Conagra and Louis Dreyfus to enter the Australian domestic wheat market. The generalization from Lobb and Fraser's (2006) research is that wheat prices in both domestic and export markets have increased since deregulation. However, it was also found that commercialization of the AWB resulted in world market uncertainty on the overseas price set by the AWB. Australia exports 85 percent of its wheat using road, rail and sea transportation. Producers in Australia move grain at their own expense to elevators averaging 17 km from farm storage. Grains moving to export position travel farther distances and use all three modes of transportation. After market deregulation the Australian grain industry tried to lower costs by increasing efficiency such as lower average costs per tonne for waterfront operations. Changes in both rail and port have led to lower logistic costs since deregulation. The reported national average rail freight price for wheat from 1996/97 to 2000/01 is a 15.3 percent decline. In general, the cost of grain transport has been lowered by efficiency improvements in Australia's railways. Australia port costs decreased from an average of $2.18 per tonne to $1.97 per tonne, a 9.63 percent drop from 1992 to 2002 due to a combination of deregulation of AWB Ltd.'s structure and increased system efficiencies. Transport costs and port costs are absorbed by the producer. Overall, the results show that the demand to lower costs suggests deregulation inaugurated the introduction of new efficiencies. In the case of Australia one reason for rail prices to not rise is that trucking is a feasible alternative form of transportation because of the shorter distance to port (compared to Canada). Grain is moved to the port by both rail and truck as the average distance from farm to port is within driving distance. In the first year of deregulation, truck transportation accounted for 30 percent of overall grain movement to port and rail market share continues to slowly fall (KPMG, 2009). Therefore, firms had to improve their cost structure to charge lower rail prices and be competitive with the trucking industry.

Wait et al. (1996) evaluate the impact of deregulation of the Australian Wheat Board (AWB) by analyzing the market structure before and after it occurred in 1989. Prior to deregulation, the AWB was the sole marketer of Australian wheat. Deregulation has provided wheat producers with choices on marketing their wheat to either sell directly to an end user, or through the marketing agent of their choice. Movement away from a pooling system has occurred in which farmers are paid for the quality of their grain specifically and not from the pool. They claim that deregulation has led to cost savings stemming primarily from changes in the storage, handling and transportation system. The key finding of the study is that there is a correlation between deregulation and reductions in freight and handling charges. On average, freight and bulk handling deductions decreased 15.6 percent within the first two years after deregulation. This is largely due to the increased competition with other forms of transportation to lower the freight charges. While rail is still a major form of transportation, the use of road transport has increased in the competitive market. As discussed in the theory section, as competition (or the threat of competition) in a market increases, prices go down.

Boyer (1987) explores movements of rail rates and market share subsequent to rail rate deregulation in the U.S. Deregulation in the United States occurred in 1980, when the Motor Carrier Act and Staggers Act granted railroads rights to adjust rate levels in areas where carriers do not dominate the market. Rate regulation forced railroads into excessive traffic by keeping rates at lower levels. Upon deregulation, rates increased and rail market share dropped (Boyer 1987). Railroads share of freight traffic has declined consistently since deregulation, and railroads experienced a loss of market share in individual commodities. This means other transportation modes are now being used more intensively. After deregulation, railways most likely tried to use their market power to raise prices. However, farmers turned to other modes of transportation, such as trucking.

Mac Donald (1989) researches the effects of deregulation on grain transportation in the United States. In theory, if government subsidizes rail lines, prices should increase upon deregulation. Although Mac Donald (1989) predicted deregulation would allow companies with more market power to increase rates, he concludes rail rates have declined overall. Lower rail costs are due to increased efficiency from the incline in multi-car shipments and reduction of single car trains. Deregulation also led to increased competition in the rail industry. After deregulation, railways increased efficiency by lowering the costs per train and negotiated lower rates with farmers in the short run. These affects are stronger in areas where rates may initially be raised to a monopolistic level from the high market share of railways in grain transportation.

4.3 Market Power and Price Uncertainty

Brorsen et al. (1985) analyze the effects of output price uncertainty on price spreads (marketing margin) in an agricultural marketing channel. The authors employ theory from Sandmo's treatment of uncertainty to Gardner's price spread determination model. The model suggests that if utility-maximizing marketing firms are competitive and assume decreasing absolute risk aversion (DARA), then an increase in output price risk should result in higher expected marketing margins. The analysis includes farm-wholesale and wholesale-retail margins and begins with a production function $y = f(x,z)$, where x is a raw material input and z is a vector of other inputs (capital, labour, etc.). Margin (M) is defined as the difference between the output price and the price of the raw material input. The expression used to analyze the expected margin under aversion is

$$(9) \qquad \overline{M} = \overline{p} - kr = M(w,q,\sigma,Y)$$

where M is margin, p is output price, k is a positive constant, w is initial wealth, q is quantity, σ is the uncertainty and Y is supply. Brorsen et al. (1985) then follow the Rothschild-Stiglitz mean-preserving spread of price to define that an increase in price uncertainty always increases the expected margin:

$$(10) \qquad \frac{\partial \overline{M}}{\partial \sigma} > 0$$

Price uncertainty thus affects marketing margins by widening the margin as the amount of uncertainty amplifies.

In order to analyze the price transmission mechanism under risk in the wheat marketing channel, price equations are formed for a farm-mill margin and mill-retail margin. The expected wheat margins are then measured using the above equation for $\overline{M}$. Brorsen et al. (1985) determine price risk variables using a measure of annual price risk and annual average output price. Their results suggest a positive relationship between the marketing margin and a measure of price risk. By studying the U.S. wheat-milling industry empirical evidence supports the theoretical model, shown by an increase in wheat marketing margins for both farm-mill and mill-retail when price variability increases. From the period 1964-1972 to 1974-1981, the mill flour price uncertainty increased implying a margin increase of $0.31 per hundredweight of flour. In the same time period, retail flour price uncertainty increased implying a margin increase due to risk of $0.35 per hundredweight of flour. Most of the price increase may have been passed on to the consumer because retail wheat demand is price inelastic. Overall, the results suggest consumers may have paid up to $0.033 more for a 5 pound bag of flour due to increase price uncertainty. The theory and results from Brorsen et al. (1985) research on marketing margins relates to the wheat export basis, as the export basis is the value differential or margin between the price at the port position and the price received by the farmer. The similarity between the marketing margin and wheat basis is that they both represent a spread of price differentials. The same theory can be applied to wheat farmers to determine how the basis changes with price uncertainty. Based on the results from Brorsen et al. (1985), an increase in price variability and uncertainty will lead to a wider wheat basis.

Schroeter and Azzam (1991) investigate marketing margins, market power and price uncertainty. The authors analyze marketing margins using a time series of spreads between wholesale pork prices and farm prices of market hogs. Margins were observed reflecting marginal cost of the processing industry, oligopoly/oligopsony price distortions and an output price risk component. Schroeter and Azzam (1991) explore the connection between output price uncertainty and marketing margins in which oligopoly/oligopsony settings may exercise market power over price. The analysis approach differs from Borsen et al. (1985) by forecasting changes in price instead of measuring output price risk on past changes. The model implies a single homogenous agricultural input to produce a single homogenous agricultural output. The production process requires non-agricultural inputs such as labour, energy and transportation. There is uncertainty with input decisions because the output price is unknown. Firms that possess market power do not know the realized output price but are assumed to know the marginal effects of changes in their inputs and expected price. Based on this theory, the margin can be expressed using the sum of marginal processing cost, oligopoly/oligopsony price distortions, and a firms' optimal adjustment to price risk. The expected margin is determined using a profit and expected utility function where the firm's objective is to maximize utility of profit assuming constant absolute risk aversion (CARA). The equation is written as

$$(11) \qquad E(M_j) = C_{ij} - Q\eta^{-1}\theta_{1ij} + Q\varepsilon_j^{-1}\theta_{2ij} + Q\delta_{ij}\vartheta_p^2$$

where M_j is the margin faced by firms in region *j*; C_{ij} is the marginal processing cost of firm *i* in region *j*; η is the slope of the expected product demand curve; ε_j is the slope of input supply curve in region *j* times the inverse of region *j's* market share; θ_{1ij} is the output market conjectural elasticity of firm *i* in region *j*; θ_{2ij} is the regional input market conjectural elasticity of firm *i* in the region *j*; δ_{ij} is the coefficient of absolute risk aversion multiplied by the national market share for firm *i* in region *j*. Q_j is the total national input or output quantity. Conjectural elasticities indicate a firm's input and output market power with a value of 0 meaning a firm is a price taker, and a value of 1 reflecting a pure monopoly or monopsony. The margin $E(M_j)$ is affected by all variables included in the calculation. The conjectural elasticities are indices of the firm's market power. If the firm is a price taker in both regions, conjectural elasticities θ_{1ij} and θ_{2ij} would be 0. If the firm reflects a pure monopoly, conjectural elasticities θ_{1ij} and θ_{2ij} would be 1. As market power increases, margin increases.[7] Risk affects the margin through the value of the coefficient of absolute risk aversion δ_{ij}. When the value of δ_{ij} increases it creates a larger margin than a firm with low risk aversion and a less significant δ_{ij} value. Results from the price spread illustrate how decision makers' risk aversion affects output price risk component ($Q\delta_{ij}\vartheta_p^2$). This component is suggested to be significant throughout the empirical analysis and is important in margin determination. Schroeter and Azzam (1991) present the implied margin decompositions and its components for selected quarters. The price spread and standard errors were determined for oligopoly component, oligopsony component, output price risk component and cost component. Throughout the sample period, the oligopoly component does not achieve

[7] Note that η is typically negative since it reflects the slope of a demand curve, therefore there is actually a positive relationship between the second term in the right-hand side of equation (13) and expected margin.

statistical significance and thus hog packers` output market has a limited ability to exercise market power. As an oligopsony, capabilities to exercise market power are only significant in the first quarter of the sample period. Based on the empirical framework used, the principal finding is that while margins are more consistent with competitive performance than they have been in the past, the output price risk component persisted through the whole sample. The findings of market power and output price risk components of the spread equation attest to the importance of considering both factors in the marketing margin analysis.

Overall, the theoretical model developed by Schroeter and Azzam (1991) suggests the marketing margin tends to increase as marketing firms gain more market power and output price uncertainty increases. These findings are in line with studies discussed previously which claimed that, upon deregulation of the CWB, companies within the grain handling and transportation system will raise the export basis (marketing costs) for wheat in Western Canada.

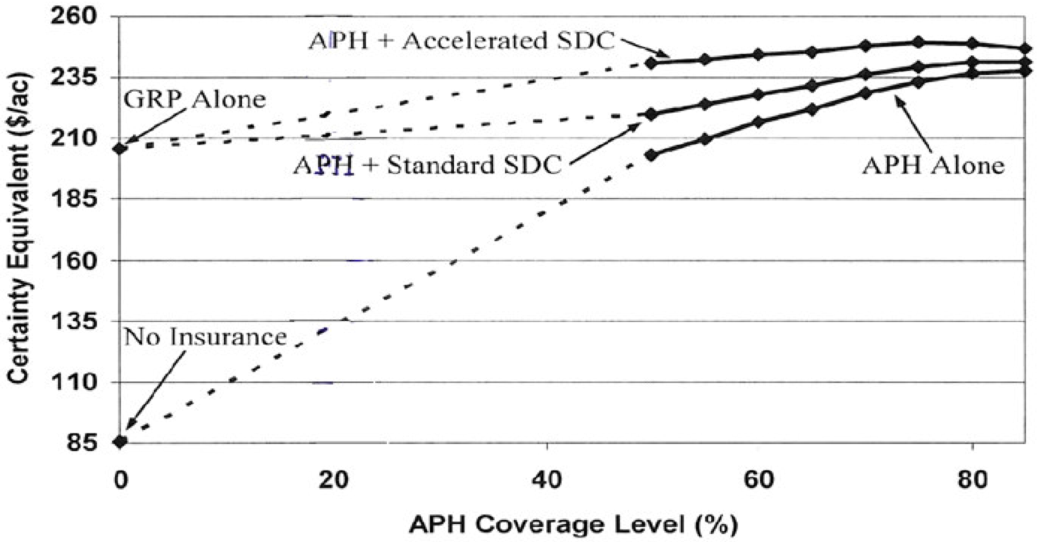
4.4 Agricultural risk analysis methods

This last section illustrates the use of certainty equivalents by briefly discussing other studies which investigate agricultural decisions under risk. Mitchell and Knight (2008) utilize a stochastic model to determine the resulting benefits to agricultural producing from a proposed change in crop insurance. The forms of crop insurance considered in the study include a supplemental deductible coverage (SDC), group risk plan (GRP), and actual production history alone (APH). SDC is a concept that provides farmers the option to add to their existing APH yield insurance. GRP policy states coverage is provided when the actual county yield falls below a certain percentage of the expected country yield. Farmers can combine a GRP with individual APH coverage. Using profit, mean and standard deviation, and a power utility function, they employ an expected utility framework to determine farmer satisfaction of the proposed change compared to the current coverage at that time. The optimal expected utilities were converted into the associated optimal certainty equivalents to illustrate the expected utility for each scenario in dollars per acre:

$$CE = [EU(\pi_i)]^{1/(1-R)} - \pi_B \quad (12)$$

where CE is the certainty equivalent, $EU(\pi_i)$ is expected utility of profit, R is the coefficient of relative risk aversion and π_B is the current profit. Results for the coverage policies at different coverage levels for Tripp County, South Dakota, are presented in terms of certainty equivalents . Figure 6 illustrates those certainty equivalents, and the vertical gap between the lines is the increase in farmer certainty equivalents when a farmer switches his crop insurance coverage. This type of empirical analysis of choices under uncertainty is useful as it provides a monetary value to the trade-off between risk and return and allows comparisons between different alternatives.

Figure 6. Certainty equivalent returns for corn in Tripp County



Source: Mitchell and Knight 2008

Adhikari, Knight and Belasco (2010) researched yield guarantees and the producer welfare benefits of crop insurance in the U.S. The actual production history (APH) yields are critical in determining the coverage offered to producers. The authors examine the impact of sampling error in APH yields and their findings indicate the potential to reduce producer welfare. First they look at the indemnity at various coverage levels and, secondly, determine certainty equivalent differences with two scenarios: yield substitution and yield floors. The analysis uses an expected utility framework to calculate the certainty equivalent for the individual farm at different levels of crop insurance coverage. The authors assume farmers' risk preferences are represented by a power utility function which implies constant relative risk aversion (CRRA). Let initial wealth be w, p is price, y is the realized farm yield, c is cost of production, I is the insurance indemnity, β is a yield adjustment factor, and γ is the premium paid. Farm revenue (π) with insurance is calculated by:

(13) $\pi_i(\beta) = w + p \cdot y + I(\beta) - \gamma - c$

And the CRRA utility function is:

(14) $U_i(\beta) = -\pi(\beta)^{1-R}$

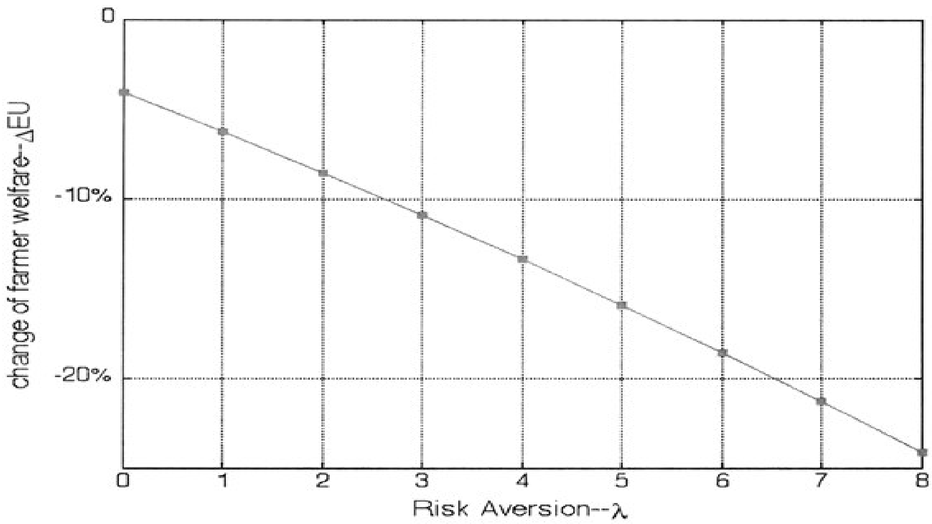
where, R > 1 is the coefficient of relative risk aversion and π is the revenue per acre. The maximized expected utilities are converted into certainty equivalents as given by (equation 12). The certainty equivalent differences with and without insurance provide the basis for the producer welfare analysis. Using the certainty equivalents, the authors conclude sampling error has no impact on producer welfare at a 50 percent coverage level, but the effect is more pronounced as the level of coverage increases. The certainty equivalents reflect willingness to pay for insurance at each level, which is congruent with the level of welfare received. The certainty equivalents which represent profit gain for wheat from sampling error range from $31.45 per acre to $39.98 per acre depending on level of coverage. The second analysis of determining differences with yield substitution and yield floors also uses certainty equivalents. The certainty equivalents for each scenario are shown relative to the uninsured case. The authors conclude that based on the certainty equivalent differences, gains from using yield substitution and yield floors are substantial compared to no crop insurance, and thus increase producer welfare. For example, the welfare effects of yield floors, assuming that yield substitution provisions are also in effect show profit gains ranging from $46.52 to $75.87 per acre for cotton.

Chenguang and Sexton (2009) determine the impacts of retailers' pricing strategies for produce commodities on farmer welfare. This study evaluates producer welfare of the diversified pricing strategies that retailers utilize. Four retail pricing regimes are considered and compared to the baseline markup pricing behaviour. Using markup pricing behaviour as a base case, 10 000 simulations of welfare comparison for each alternative price regime was carried out. Chenguang and Sexton (2009) determine alternative-pricing regimes can lead to higher expected farm income than under the markup pricing regime, however it evokes higher income volatility. They use a mean-variance function to represent expected utility and measure farmer welfare under risk aversion. The function imposes constant absolute risk aversion (CARA) and increasing relative risk aversion (IRRA). The mean-variance function is shown below where μ is the expected farm income, σ_R is the standard deviation (volatility) of the farm income and λ is the farmers' risk aversion parameter.

(15) $$V(\mu, \sigma_R) = \mu - \frac{\lambda \sigma_R^2}{2}$$

The percentage difference between the alternative pricing regimes is then computed. Chenguang and Sexton (2009) do not use certainty equivalents, but analyze farmers' welfare under risk aversion by measuring changes in expected utility. Results from the analysis show that as farmers become more risk averse, they experience higher relative utility loss under alternative pricing behaviors shown in Figure 7. This is due to the large volatility in farm income compared to the base case.

Figure 7. Total welfare and risk aversion



Source: Chenguang and Sexton 2009

4.5 Summary

The results of all studies discussed in this chapter relate to how changes in prices, uncertainty, market power and costs, among others, affect the export basis. One commonality among the studies discussed here indicates that revenue cap removal and more market power in the hands of railways will increase freight costs and hence the export basis up to as much as 46 percent (Fulton et al. 1998). In an open market environment, without the CWB to influence costs and margins and with more price uncertainty and market power within the grain handling and transportation system, costs tend to increase from reasons such as rail companies trying to extract higher margins. Research on removing AWB's single desk in Australia shows decreased costs based on increased efficiencies in the logistic system. Competition forced firms to increase efficiency along with more regulation. These efficiencies are not necessarily a direct result from deregulation. These changes were made upon the realization for the need of an improved logistic cost structure such as using longer unit car trains and regulated access to competitors' grain handling and transportation systems.

Chapter 5: Research method and data

The investigation of how changes in the Western Canadian grain marketing system affect producers relies on data between 2006/2007 and 2009/2010 and is based on several scenarios which assume an open market for wheat. There are four scenarios based on assumptions on how farmers would have priced their wheat in an open market, and three scenarios based on how the export basis would have changed in an open market. The combination of scenarios for prices and export basis generates 12 overall scenarios with distinct combinations of expected prices and risk in an open market, which will be compared to a base scenario considering the current structure with the Canadian Wheat Board. Expected utility framework will be adopted to ascertain producers' preference between the current wheat market structure and an open market.

An open market for wheat assumes changes in both the price and basis for farmers. The degree in which these two factors would change is unknown because wheat has been marketed in a regulated environment for years. The next sections will discuss the assumptions adopted to calculate expected values for price and export basis in an open market scenario, and the procedures used in the calculations.

5.1 Prices

5.1.1 Base scenario (CWB pool price)

The base scenario considers the current structure with the CWB and its pool pricing. Producers in Western Canada who grow wheat receive a total payment from the CWB at the end of the crop year for the quantity of wheat brought to market. Every farmer receives the same price at the end of the year–the pool price–regardless of the time of the year when the grain was delivered. The historical CWB pool price between 2006/2007 and 2009/2010 is used to reference the total payment each year to farmers marketing through the CWB. Therefore, the price received by farmers in the base scenario is simply the pool price. Following standard marketing literature, this research considers that risk is given by price volatility, i.e. the standard deviation of a price series. Since farmers receive the pool price regardless of the time when they deliver the grain, the standard deviation in this scenario is zero.

5.1.2 Alternative scenarios (open market)

In an open market, farmers are assumed to price wheat off the futures market at the Minneapolis Grain Exchange. However, every farmer has a different marketing strategy or technique in selling his or her grain. For example, one grower may want to sell all of his/her wheat immediately upon harvest, while another may want to sell it periodically over the next ten months. Thus, four strategies are considered to determine the average price a farmer would receive when pricing his wheat off the Minneapolis futures market. In all strategies Minneapolis futures prices are converted to Canadian dollars using the Bank of Canada noon exchange rate[8]. The four marketing strategies were determined through conversations with experts on wheat marketing from the industry and academia. They reflect distinct combinations of timing and share of crop sold during a crop year, which goes from August to July. In Strategy 1 the farmer sells equal portions of his or her crop on four dates during the crop year. So 25% of the crop is sold on each of the following days: September 15, November 15, March 15, and June 15. In Strategy 2 the farmer sells equal portions of his or her crop on ten dates during the crop year, thus 10% of the crop is sold on each 15th day of every month from September to June. In Strategy 3 it is assumed a single sale in the fall. In this scenario the farmer sells his or her whole

[8] Bank of Canada noon exchange rate represents the exchange rate at noon. Source: www.bankofcanada.ca

crop on October 15. Finally, in Strategy 4 the farmer makes only one trade in the Spring, selling the whole crop on March 15.

Expected prices were generated through random simulations of each marketing strategy from 2006/2007 to 2009/2010. In each strategy 1,000 simulations were run for each year used in the calculation. In those simulations the 15th day of the month is used as a reference. This research actually considers that the farmer would sell his or her crop during a 20-day period around the middle of the month. Therefore, it is assumed a marketing window starting 10 days before and ending 10 days after the 15th day of the month. The 20-day range provides a set for a more confident average value of prices near the 15th of the month rather than a single point in time. For example, Strategy 1 assumes wheat is sold on four days during the crop year, with 25% of the crop being sold on the 15th day of September, November, March and June. This strategy is simulated 1,000 times as follows. In the first simulation a business day is randomly selected in the period between September 5th and September 25th, then a second business day is randomly selected between November 5th and November 25th, a third business day is randomly selected between March 5th and March 25th, and finally a fourth business day is randomly selected between June 5th and June 25th. On each of these four days the closing Minneapolis futures price of the day is recorded (converted to Canadian dollars as explained before), generating a set of four prices during the crop year. The weighted average of these four prices is the average price received by the farmer who adopted strategy 1 in a given year.[9] The same simulation is repeated another 999 times for the same year. At the end of this procedure there will be 1,000 prices that a farmer would have received on a given year if strategy 1 were adopted, creating a distribution of

[9] The weights are the proportion of grain sold on each day.

possible prices for this strategy. The expected price for strategy 1 in a specific year is the mean of this distribution. The same procedure is repeated for each crop-year between 2006/2007 and 2009/2010, generating expected prices for each year. Marketing strategies 1 and 2, which involve respectively four and ten sales over the crop-year, are simulated as described above. But marketing strategies 3 and 4 involve one single sale during the crop-year, therefore their expected prices were just the average price between October 5th and October 25th (strategy 3) and between March 5th and March 25th (strategy 4).The price distribution generated from the 1,000 rounds of marketing simulations will also be used to address the risk involved in each strategy. Following standard marketing literature, this research considers that risk is given by price volatility, i.e. the standard deviation of a price series. Hence risk of a given strategy in a given year will be the standard deviation of the price distribution generated for that year. The standard deviations for each year calculated in respect to the mean are calculated by:(16).

(16) $$Stdev = \sum[(P_{\pi} - \mu_{\pi})^2 / n - 1]$$

where P_{π} is the random simulated price, μ_{π} is the mean price for the crop year, and n is the number of simulations, 1,000 in this case. The standard deviation is calculated for each crop-year from 2006/2007 to 2009/2010 to represent the price volatility each year.

5.2 Export Basis

5.2.1 Base scenario (CWB basis)

The base scenario is the current market structure with the CWB, thus the export basis is determined as previously discussed. However, data on export basis under the CWB are not readily available. The expected values and risk for the export basis in the base scenario are approximated using the location of Trochu, Alberta, and the Volume-

Related Composite Price Index (VRCPI). Trochu, Alberta, was chosen as the reference location because it was possible to obtain a precise value of the export basis in that location for the 2010-2011 crop year (CWB 2011b). There was still no historical data on the export basis for Trochu or any other location, so it was approximated using the VRCPI. This index is computed by the Canadian Transportation Agency (CTA) and captures costs of energy, labour, material, capital, hopper car lease rates, amortization, among others. The VRCPI reflects the inflation factor of forecasted price changes for the above materials purchased by the Canadian National Railway Company (CN) and the Canadian Pacific Railway Company (CP) for use in their transportation operations. The index is the only source for this type of information and is used by the CTA and the Government of Canada in establishing the revenue cap for CP and CN. These costs for transportation are the largest component of the basis and the primary cause of changes in the basis. As discussed in chapter 2, the average freight costs between 1999 and 2009 represent 58.5 percent of the average export basis for the period.

The observed export basis obtained for 2010-2011 in Trochu was $46.14/tonne. The values for the export basis in previous years were approximated following the percentage change in the VRCPI. For example, the VRCPI changed by 7.01% from 2009-2010 to 2010-2011. Thus the estimated export basis for 2009-2010 is $43.12/tonne, such that it also reflects a change of 7.01% from 2009/2010 to 2010/2011. Therefore a historical series of export basis for Trochu was built using the value of $46.14 per tonne in 2010-2011 (the only actual value obtained from current market sources) as a starting point, and then previous values were approximated according to the annual percentage change of the VRCPI. Table 4 shows the values of the VRCPI between 2000-2001 and

2010-2011, its corresponding percentage change in each crop year, and the estimated values for the export basis in Trochu following the procedure described above. In 2007-2008, Transport Canada changed the VRCPI by including more cost items. The adjustment to the price index reflects the inclusion of embedded hopper car maintenance and actual hopper car maintenance costs. The revised index now includes nine primary components, each exhibiting its own weight (Canadian Transportation Act 1997). The index series in Table 7 is based on the "new" index and thus extended to reach 2000-2001 based on the values of the "old" series (Canadian Transportation Agency 2011).

Table 4. Volume-related composite price index (VRCPI) and estimated export basis for Trochu, AB

Year	VRCPI (old structure)	VRCPI (new structure)	% change in "new" index	Estimated export Basis, Trochu ($/tonne)*
2000-2001	1.0000	0.9163		37.14
2001-2002	1.0352	0.9485	3.50	38.44
2002-2003	1.0442	0.9568	0.88	38.78
2003-2004	1.0195	0.9342	-2.36	37.86
2004-2005	1.0108	0.9262	-0.86	37.54
2005-2006	1.0553	0.9670	4.41	39.19
2006-2007	1.1252	1.0310	6.62	41.79
2007-2008	1.1611	1.0639	3.19	43.12
2008-2009		1.1493	8.03	46.58
2009-2010		1.0638	-7.44	43.12
2010-2011		1.1384	7.01	46.14

Source: CWB 2011b

(*) The value of the export basis for Trochu in 2010-2011 was observed. The values for the export basis in previous years were estimated using the change in the VRCPI.

The series for the export basis in Table 4 is used to obtain the basis value adopted in the calculation of the profit in the base scenario (CWB pool). It is assumed the export basis has the same value for all dates in the four marketing strategies, hence the risk (standard deviation) of the export basis is zero in the base scenario.

5.2.2 Alternative scenarios (open market)

Three scenarios are simulated to illustrate the effects on the export basis of deregulation of the wheat handling and transportation system in Western Canada. The determination of the change in export basis and its components are largely based on Fulton et al. (1998) findings.

Scenario 1 is based on complete deregulation of the grain handling and transportation industry. This involves removal of both the CWB and the freight revenue cap. Elevation charges are expected to decrease according to Fulton et al. (1998). As the rate cap is removed, the rail rates are expected to increase to a point where trucking becomes an economically viable option as an alternative mode of transportation. This is used as an upper bound to where rail prices will rise as indicated by Fulton et al. (1998), who find an 89.4 percent increase for freight rates. Adjusting to the current structure, the costs are expected to change in the same direction as the CN and CP continue to dominate the rail industry in western Canada. Since the rise in freight rates is greater than the fall in elevator charges, the total export basis rises by 46% as a result of deregulation. This same pattern of higher freight rates and lower elevator charges was observed in the U.S. following rail deregulation (ATKearney 1994; IBI 1994). The change in rates subsequent to rail deregulation can be used as a benchmark for western Canada because of the similar market structure and location.

Scenario 2 is based on removal of the CWB with the freight revenue cap remaining in place. Fulton et al. (1998) concludes removing the CWB decreases elevation charges by 4 percent and increases rail costs by 20 percent as a Western Canadian average. The overall change in the export basis is a rise of 4 percent. The results from this simulation illustrate the impact the CWB had on rail rates to keep them at a lower level. The primary affect on rail is the CWB's subsidization of the costs for moving grain though the St. Lawrence Seaway. Eliminating the CWB from the grain handling and transportation industry removes the subsidy and thus increases transportation costs.

In Scenario 3 the changes are based on removal of the CWB while also removing barriers to entry in the rail industry and allowing for common running rights. Six carriers are used for the model. Fulton et al. (1998) finds rail rates increase 27 percent while elevation rates decrease 8 percent when six carriers operate in the rail industry. As a result, the export basis increases 7 percent.

The magnitude of the changes for elevation, rail and CWB employed in each of the three scenarios is shown in Table 5. The results from the scenarios are used to determine the magnitude of the expected values for the export basis upon deregulation. The expected value for the export basis in each scenario will be calculated by multiplying the expected value of the export basis in the current structure (CWB basis) by the percentage change in the export basis in each scenario as indicated in Table 5. Note that the three scenarios address changes in individual components of the export basis as an illustration of how the basis is expected to change in an open market. However, the empirical analysis in this thesis will focus on the total change of the export basis, not in its individual components.

Table 5. Simulation of tariffs for wheat under deregulation of the grain handling and transportation system in Western Canada – expected percentage changes with respect to current structure

SCENARIOS	Elevation	Terminal Costs	Rail Freight	Total Export Basis
1 –CWB and freight cap are removed	-25 %	-33 %	90 %	46 %
2 –CWB is removed but freight cap remains	-4 %	-8 %	20 %	4 %
3 – removal of CWB and introduction of more carriers	-8 %	-1 %	27 %	7 %

Source: Fulton et al. (1998)

Finally, the risk in the open market is assessed using the standard deviation of historical series of export basis data. Since wheat has been traded through the CWB for a long time, there is no data on Canadian export basis in an open market environment. Therefore it is assumed that an open market in Canada would exhibit variability in the export basis in a similar manner to what is observed in the U.S. The risk assessment of the export basis in an open market in Canada is based on export basis in the U.S. Historical data on DNS 14 PNW[10] from August 1, 2006 until July 30, 2010 are used to assess the volatility pattern assumed to approximate what could be expected in a Canadian open market. Historical origin basis data is difficult to find and may not exist in a published form, therefore the U.S. basis data refers to the specific destination of Portland, Oregon. The daily basis quotes are based on a daily market survey conducted by the CWB. The destination basis is assumed to follow a similar pattern of volatility and distribution as an origin basis (The Canadian Wheat Board 2011b).

Similarly to the procedure adopted to address price risk, basis risk in an open market is determined for each specific marketing strategy discussed in section 5.1.2. The idea is that the estimated variability in the export basis in an open market should be

[10] DNS 14 PNW refers to Dark Northern Spring wheat with 14 percent protein in the Pacific Northwest region of the United States.

generated using the same method adopted to generate the variability in the expected price for each marketing strategy previously discussed. So export basis risk will be generated for each marketing strategy following the same simulation technique discussed earlier. In the first strategy it is assumed that a farmer would sell his or her grain on the 15^{th} day of September, November, March and June. The final export basis for a given year is calculated by randomly selecting a business in the 20-day period around the 15^{th} of each of these four months, recording the export basis value for those days, and then averaging the four values. This procedure is repeated 1,000 times for each crop-year and the export basis value for each crop-year will be the average of all 1,000 simulated values. The standard deviation of this series will be used as a measure of export basis risk. Note that distributions of export basis values in the open market scenarios are generated only to find the standard deviations, which are used as a measure of risk. As discussed before, expected values for the export basis in the open market are entirely based on the study by Fulton et al. (1998).

Since expected values and standard deviations for the export basis in the open market do not come from the same distribution, the standard deviation described above is not used directly as the export basis risk in the four marketing strategies. The coefficient of variation (standard deviation divided by the mean) is calculated for each distribution generated for the Portland export basis according to the procedure described above. It is assumed that the export basis in Trochu, AB, would have this same coefficient of variation in an open market. Then the standard deviation (risk) of the export basis in Trochu in the open market is calculated by multiplying this coefficient of variation by the expected value for the export basis generated from the three scenarios in Table 5.

5.3 Expected utility analysis

The comparison between the current structure under the CWB and alternative scenarios considering an open market will be performed using the expected utility framework. The power utility function in equation (17) is adopted, where π, the argument of the function, is the profit of a farmer and R is the coefficient of relative risk aversion (Sadoulet and Janvry, 1995). Profit is defined as the difference between the price received for wheat and the export basis.

(17) $$u(\pi) = \frac{\pi^{1-R}}{1-R} \quad ;$$

This utility function implies constant relative risk aversion (CRRA), which is given by R as shown in equations (18) through (21). Equation (18) simply shows the definition of relative risk aversion (RRA) as the ratio of the second and first derivatives of the utility function multiplied by the argument of the utility function. Equations (19) and (20) present the calculations of the first and second derivatives, respectively, of the utility function from equation (17). Equation (21) exhibits the final calculation of the coefficient of relative risk aversion, demonstrating it is equal to the parameter R in equation (17).

(18) $$RRA = -\pi \frac{u''}{u'}$$

(19) $$u' = \frac{(1-R)\pi^{1-R-1}}{1-R}$$

(20) $$u'' = \frac{(1-R)(-R)\pi^{-R-1}}{1-R}$$

(21) $$RRA = -\pi \frac{[(1-R)(-R)\pi^{-R-1}]/(1-R)}{[(1-R)\pi^{1-R-1}]/(1-R)} = R$$

Gollier (2001) concludes a range for R is between 1 and 4, with R = 2 a moderate level of risk aversion. Farmer's expected utility is the expected value of (17), which can be expressed as in (22):

$$(22) \qquad EU(\pi) = \frac{E[\pi^{1-R}]}{1-R} = \frac{\int_{\pi} \pi^{1-R} dF(\pi)}{1-R}$$

where *F(π)* is the cumulative distribution function of profit π.

Following Nelson and Escalante (2004), if the argument of a utility function follows an elliptically symmetric distribution[11], then expected utility can be expressed in terms of the mean and variance of this variable. In this study it is assumed that the distribution of profit-the argument of the utility function represented in (17)-is elliptically symmetric, therefore the CRRA mean-variance representation of expected utility proposed by Nelson and Escalante (2004) can be used. Equation (23) shows this mean-variance representation, where u_π and σ_π^2 are the mean and variance of the profit distribution, and R is the coefficient of relative risk aversion.

$$(23) \qquad EU(\pi) = -\frac{1}{u_\pi^2 - R \cdot \sigma_\pi^2}$$

Since profit is defined as price received by producer minus the export basis, by definition the mean and variance of the profit distribution can be calculated as in equations (24) and (25), where u_p and σ_p^2 are the mean and variance of the price distribution, u_{EB} and σ_{EB}^2 are the mean and variance of the export basis distribution, and $\sigma_{p,EB}$ is the covariance between price and export basis.

[11] The normal distribution is the most famous example of distributions that fit in the broader group of elliptical symmetric distributions, i.e. a variable that follows a normal distribution also follows an elliptically symmetric distribution.

(24) $$u_{\pi} = u_p - u_{EB}$$

(25) $$\sigma_{\pi}^2 = \sigma_p^2 + \sigma_{EB}^2 - 2\sigma_{p,EB}$$

The covariance between price and export basis for each marketing strategy in the open market is based on the U.S. market. It comes from the simulation which generated price series based on Minneapolis futures prices and export basis series based on Portland, OR. The covariance between those simulated prices and export basis is assumed to hold in an open market in Western Canada. Values of expected utility for all open market scenarios are calculated based on expected values and variance (risk) for price and export basis as discussed in the beginning of this chapter. For example, substituting equations (24) and (25) in equation (23), expected utility for a given open market scenario is expressed as:

(26) $$EU(\pi) = -\frac{1}{\mu^2 - R \cdot \sigma^2} = -\frac{1}{(\mu_p - \mu_{EB})^2 - R(\sigma_p^2 + \sigma_{EB}^2 - 2\sigma_{p,EB})}$$

where μ_P and μ_{EB} are expected values for the price and export basis, σ_P σ_{EB} are the standard deviation (risk) for the price and export basis, and $-2\sigma_{p,EB}$ is the covariance between price and export basis. The values used in this calculation are obtained using the simulation values for each year explained in sections 5.1.2 and 5.2.2.

Expected utility is then converted into certainty equivalent (CE) so that different scenarios can be compared in monetary terms. Utility constitutes a non-monetary measure of producer well being or satisfaction. Certainty equivalent is the corresponding monetary measure. The values of CE indicate the level of return that generates an equal level of utility i.e. that makes the individual indifferent between an uncertain outcome and a certain one. In this research, the open market scenario offers the uncertain outcome with an expected profit and its associated risk, while the CWB pool provides the certain outcome with the pool price and its export basis without any variability. The certainty equivalent can be calculated by finding the value CE (in $/bu) that needs to be added to the pool profit (π_{CWB}) in order to make the utility of the CWB system equal to the expected utility generated by the expected profit (π_{OM}) in an open market scenario (equation 27). In other words, CE in equation 27 represents the monetary value which makes producers indifferent between the pool system and a given market strategy in the open market.

(27) $$EU(\pi_{OM}) = \mu(\pi_{CWB} + CE)$$

Following equation 27, the mathematical calculation of CE adopting a power utility function (equation 17) is given by equation (30).

(28) $$CE = \{(1-R)\cdot EU(\pi)\}^{\frac{1}{1-R}} - \pi_{CWB}$$

The most significant variable in the study is the certainty equivalent, as it represents a value that can be used in comparative analysis. The resulting data is compared and analyzed. A positive value for CE would show that producers require an extra payment in order to make the pool equally attractive as the open market strategy, indicating they would initially prefer the expected profit-risk combination offered by the open market rather than the CWB pool. On the other hand, a negative certainty equivalent means that producers would be need to give up a portion of the pool profit to make the open market equally desirable, which suggests they have an initial preference for the pool as opposed to the open market. These calculations will be adopted to generate certainty equivalents for each of the alternate scenarios. There are 12 alternative scenarios (three scenarios for changes in the export basis and four marketing strategies), in which expected values and variances used for each scenario are obtained from the procedures discussed in sections 5.1.2 and 5.2.2.

Chapter 6: Results

The results of the model are presented in this chapter. First, risk and profit obtained in each strategy are discussed, providing a comparative analysis about the risk-profit trade-off between an open market and the CWB pool. Second, the results from the twelve overall scenarios are introduced summarizing farmers' certainty equivalents. Next, results are discussed considering various levels of risk aversion. Lastly, results from the model are also explored using a measure of downside risk.

6.1 Overview of wheat market in 2006/2007-2009/2010

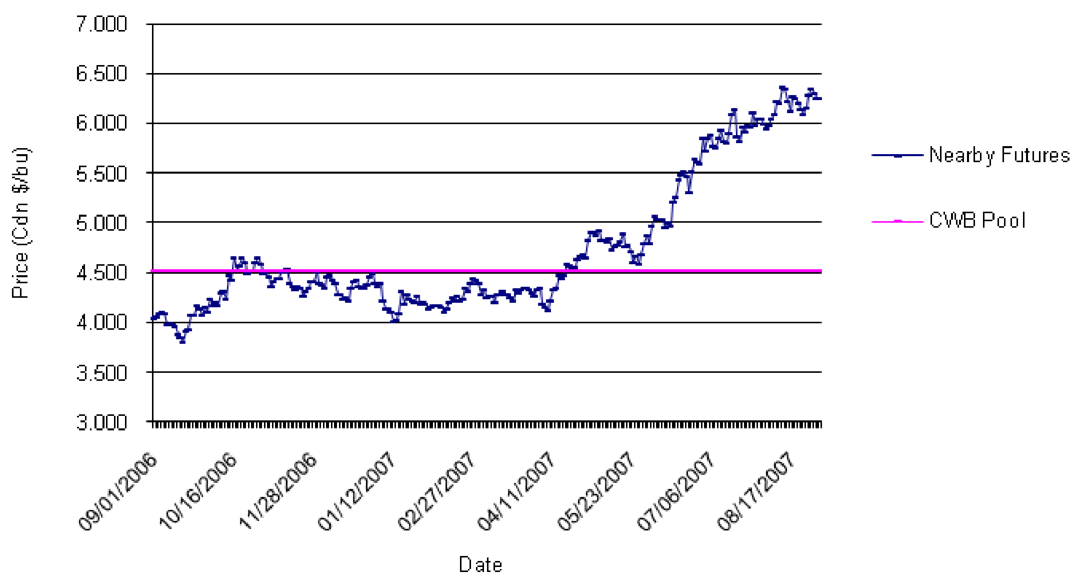
The wheat market over the last four years in Western Canada has provided profit to farmers who used the CWB pool. The CWB pool is the price received by all farmers in the pool, representing an average of all wheat sales from the crop year. The open market, as in the United States, does not provide farmers with the option of marketing wheat in a pool, therefore farmers would sell grain using the futures markets.[12] In an open market scenario, the Minneapolis wheat futures prices are adopted to portray the price movements of the wheat futures for the year. Figures 8-11 illustrate the open market price movements and the CWB pool price for each crop year.[13] In the 2006/2007 crop year the open market closely followed the CWB pool price with values slightly under until the end of April, when the wheat futures price rose until the end of the crop year. The wheat market in 2007/2008 continued to rise, peaking at the end of February at $24.482 per bushel. Then it began a decline and finished the crop year around the same value as the CWB pool price, $8.866 per bushel. In 2008/2009 crop year, the CWB pool price of $7.214 per bushel is higher than the futures price for most of the year. The

[12] Farmers could either use futures contracts directly or negotiate contracts with grain elevators based off futures prices.
[13] Crop year goes from September 1st to August 31st.

futures price in 2008/09 declined in October and remained below the CWB pool price through the crop year. The 2009/2010 crop year illustrates a futures price that moved below and above the CWB pool price for most of the year. It was not until the end of the crop year when the futures price rose over $2 per bushel above the CWB pool price.

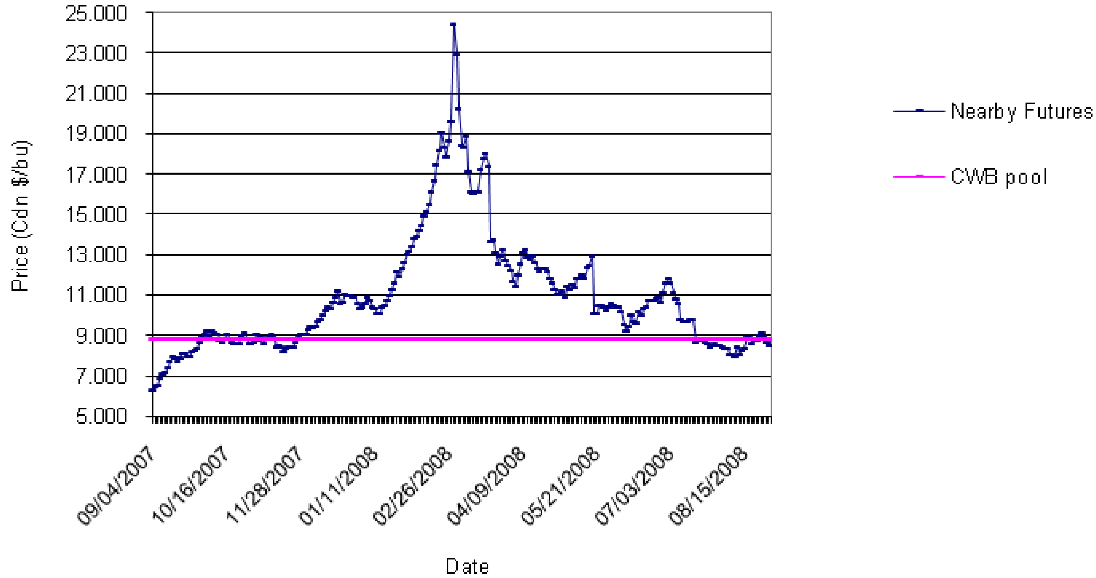
Therefore, this simple preliminary analysis offers no clear pattern on whether futures prices are consistently above or below the pool price. It suggests, however, that futures prices can exhibit large variability. Futures prices ranged between $3.815 and $6.370 per bushel in 2006/2007, $ 6.335 and $24.482 per bushel in 2007/2008, $4.443 and $8.211 per bushel in 2008/2009, and $4.353 and $7.624 per bushel in 2009/2010.

Figure 8. Wheat market prices 2006/2007 crop year



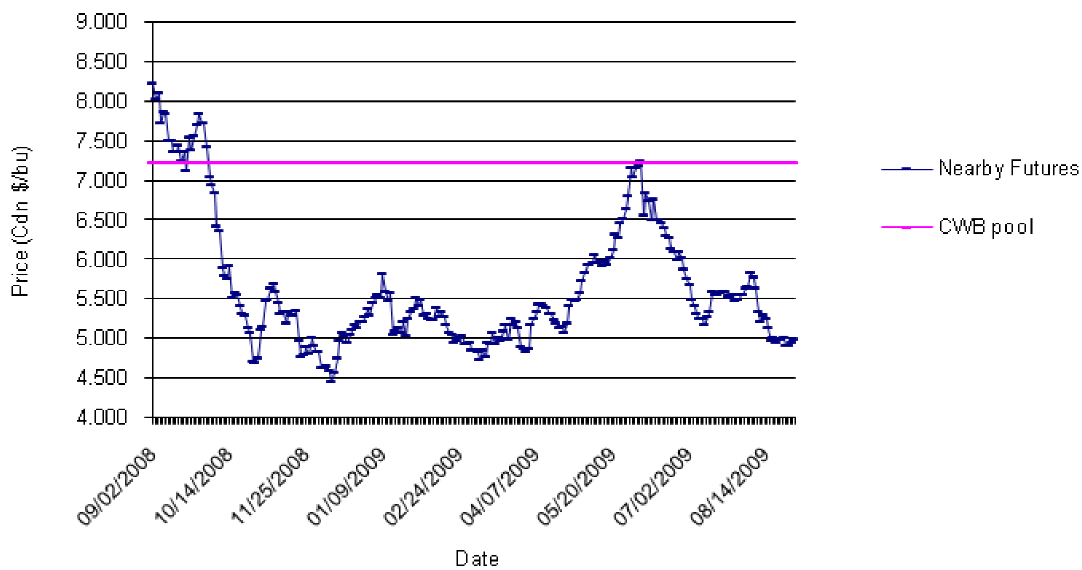
Source: CRB 2011

Figure 9. Wheat market prices 2007/2008 crop year



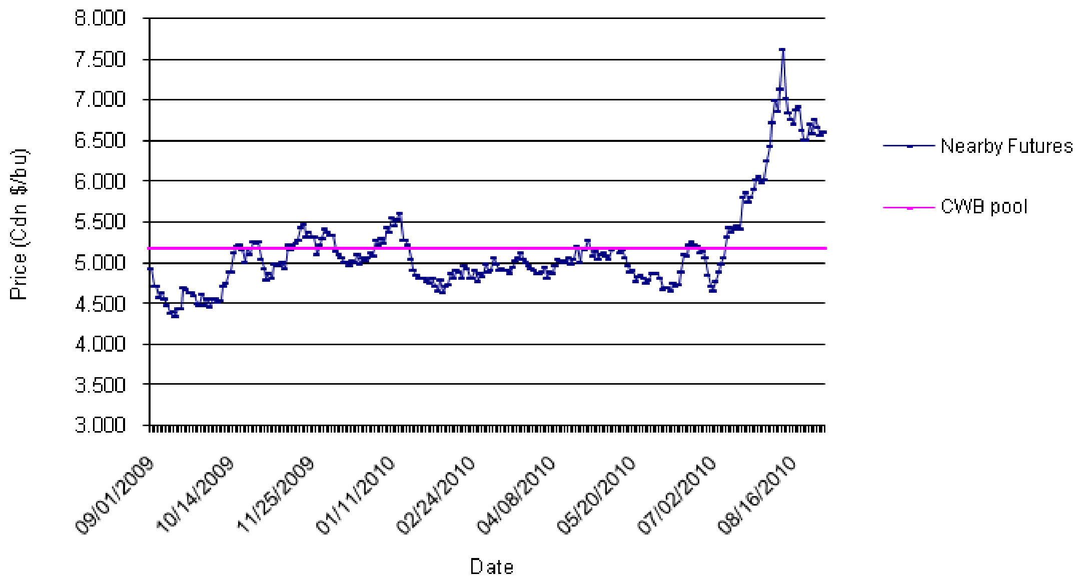
Source: CRB 2011

Figure 10. Wheat market prices 2008/2009 crop year



Source: CRB 2011

Figure 11. Wheat market prices 2009/2010 crop year

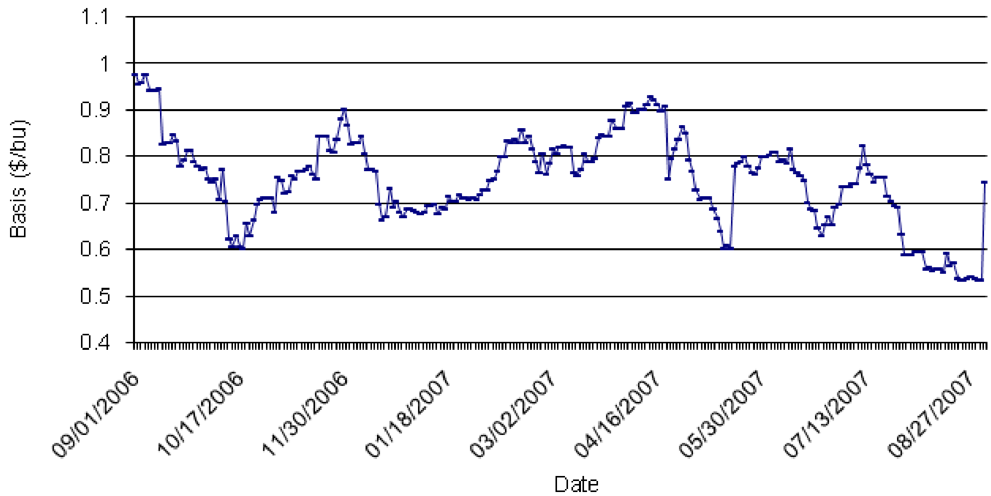


Source: CRB 2011

Similar to futures prices in an open market, the export basis also fluctuates throughout the crop year. Using basis levels of Dark Northern Spring (DNS) wheat from Portland, OR, Figures 12-15 illustrate movements in the export basis in the U.S. open market.[14] During all four crop year, the export basis in the U.S. open market also exhibit large variability. Basis values ranged between $0.536 and $0.978 per bushel in 2006/2007, $0.294 and $5.382 per bushel in 2007/2008, $0.771 and $1.846 per bushel in 2008/2009, and $0.771 and $2.442 in 2009/2010. Conversely, given the current market structure in Western Canada, there is no variability in the export basis under the CWB.

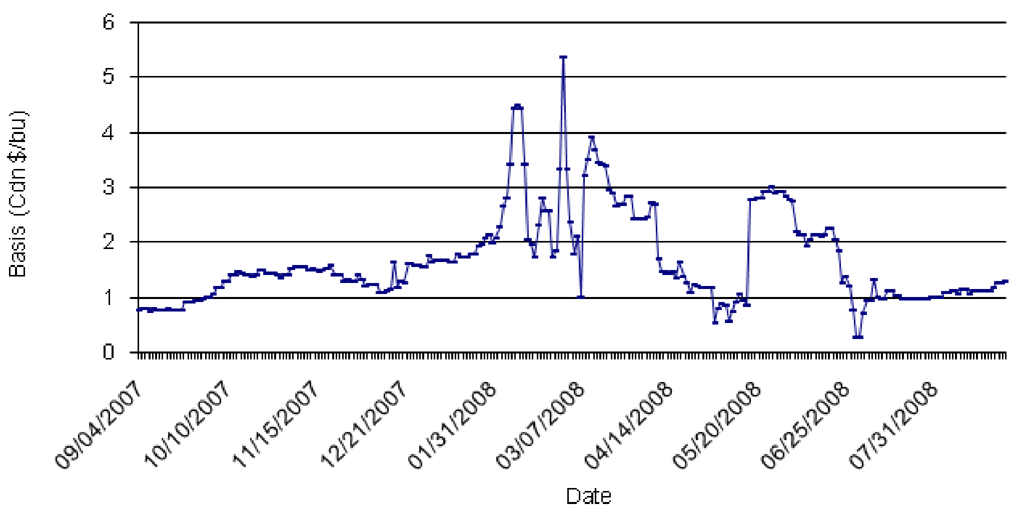
[14] Values are converted to Canadian dollars. They are collected daily by the Canadian Wheat Board sales team

Figure 12. DNS wheat export basis in 2006/2007 (Portland, OR)



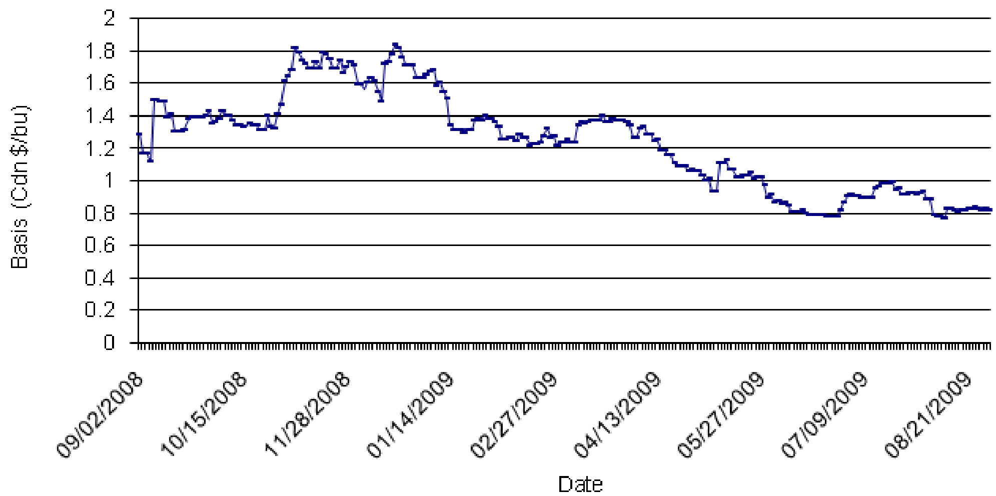
Source: The Canadian Wheat Board 2011b

Figure 13. DNS wheat export basis in 2007/2008 (Portland, OR)



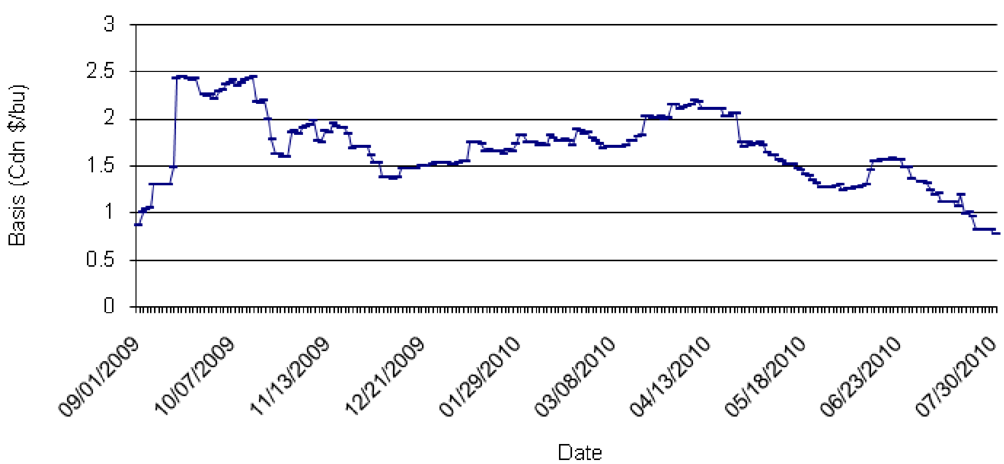
Source: The Canadian Wheat Board 2011b

Figure 14. DNS wheat export basis in 2008/2009 (Portland, OR)



Source: The Canadian Wheat Board 2011b

Figure 15. DNS wheat export basis in 2009/2010 (Portland, OR)



Source: The Canadian Wheat Board 2011b

6.2 Risk and expected profit for each marketing strategy in 2006/2007-2009/2010

Prices and basis presented in the previous section will now be used to discuss risk and expected profit in each marketing strategy considered in this research.

The level or risk in each scenario is measured in terms of price and basis volatilities. Fluctuations in price and basis create risk because there is uncertainty in the final profit farmers receive. The price and basis volatilities are encompassed in the standard deviation of profit for each particular scenario. A low standard deviation indicates the values are all close to the mean, whereas a high standard deviation suggests values are more spread out. The analysis is carried out for the three scenarios individually and within each crop year. Expected profits, risks (standard deviations) and coefficients of variation (cv) are given for each marketing strategy. The cv is determined as:

$$cv = \frac{\sigma}{\mu} \tag{29}$$

where σ is the standard deviation and μ is the mean of the distribution of profits. The calculation normalizes the standard deviation and allows direct comparisons between multiple distributions. The cv is a dimensionless number useful for comparing data sets with different mean values. The cv is calculated to negate the effects of the common variable (the mean) to allow the actual characteristics of each data set to be observed (Poon and Weersink 2011). In this case, each year of data has a different mean and standard deviation. Since standard deviations are calculated with respect to the mean of the distribution, a higher standard deviation by itself does not necessarily imply more risk is involved. The coefficient of variation normalizes the standard deviation by removing the affects of the mean, thus creating a measure of dispersion which is independent of the unit of measurement and allowing for comparisons across different distributions.

6.2.1 Scenario 1 (export basis increases by 46 %)

Expected profits, risk and coefficients of variation for each marketing strategy in scenario 1 are presented in Table 6. In this scenario, expected profits for all marketing strategies are smaller than the CWB pool profit in three out of four crop years.[15] The only exception is 2007/2008, when three open market strategies considered in this study would have allowed farmers to capture the high prices observed in the futures market between February and April of 2008 (Figure 8). In particular, marketing strategy 4 (single sale in March) would have yielded a much higher profit compared to other strategies and the CWB in 2007/2008, since it would have allowed farmers to sell their whole crop at one of the highest prices of the crop year. Marketing strategy 4 would also have resulted in higher risk compared to other strategies in 2007/2008 (Table 6). Its coefficient of variation was 12.914%, indicating that a farmer's profit could be 12.914% smaller than expected if his profit fell one standard deviation below the mean of the distribution.

In general coefficients of variation indicate large dispersion in the distribution of profits across marketing strategies, ranging from 1% to 7% in 2006/2007, 3% to 13% in 2007/2008, 2% to 12% in 2008/2009, and 3% to 14% in 2009/2010. Overall, it appears that marketing strategy 3 tends to exhibit more risk than the other strategies over the four crop years in this first scenario.

[15] A two-tailed t test is used to test the null hypothesis that the difference between expected profit in the open market and the CWB pool profit is equal to zero (Ho: $EP_{OM} - P_{CWB} = 0$). The null hypothesis is rejected for all marketing strategies at 10%.

Table 6. Expected profit, risk and coefficient of variation for each marketing strategy in scenario 1

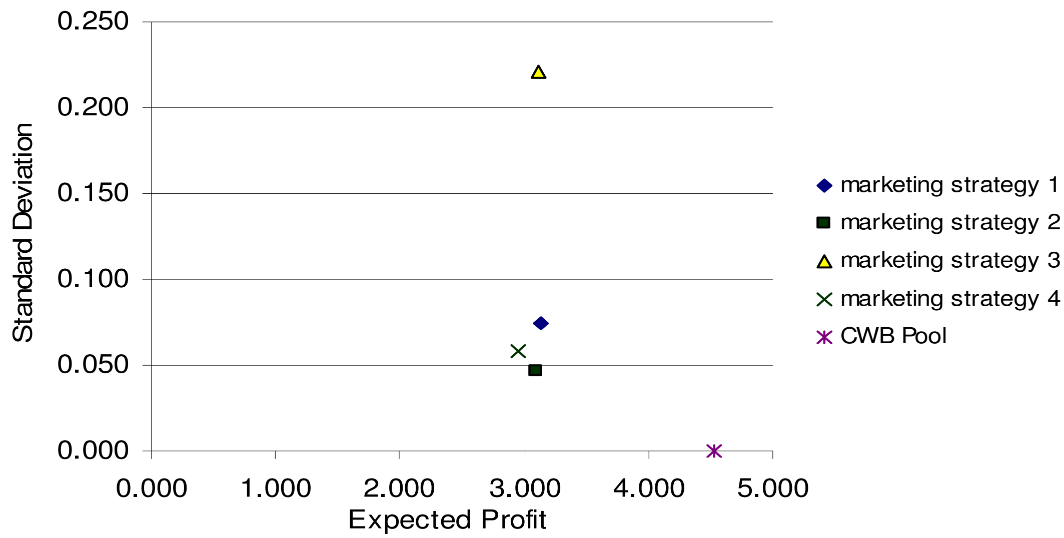
	2006/2007	2007/2008	2008/2009	2009/2010
Expected profit ($/bu)				
Marketing strategy 1	3.138	9.258	4.191	3.253
Marketing strategy 2	3.089	9.880	3.801	3.318
Marketing strategy 3	3.108	7.470	3.861	3.241
Marketing strategy 4	2.945	15.007	3.118	3.323
CWB Pool	4.534	8.866	7.214	5.185
Risk (standard deviation,$/bu)				
Marketing strategy 1	0.074	0.487	0.140	0.215
Marketing strategy 2	0.047	0.299	0.082	0.085
Marketing strategy 3	0.221	0.259	0.478	0.452
Marketing strategy 4	0.058	1.938	0.294	0.114
CWB Pool	0.000	0.000	0.000	0.000
Coefficient of variation (%)				
Marketing strategy 1	2.358	5.260	3.329	6.622
Marketing strategy 2	1.151	3.027	2.147	2.567
Marketing strategy 3	7.126	3.471	12.376	13.937
Marketing strategy 4	1.982	12.914	9.420	3.437
CWB Pool	0.000	0.000	0.000	0.000

Source: Author's calculations

* Marketing strategy 1: four equal sales over the crop year (September, November, March, June); Marketing strategy 2: ten equal sales over the crop year (September to June); Marketing strategy 3: single sale in October; Marketing strategy 4: single sale in March.

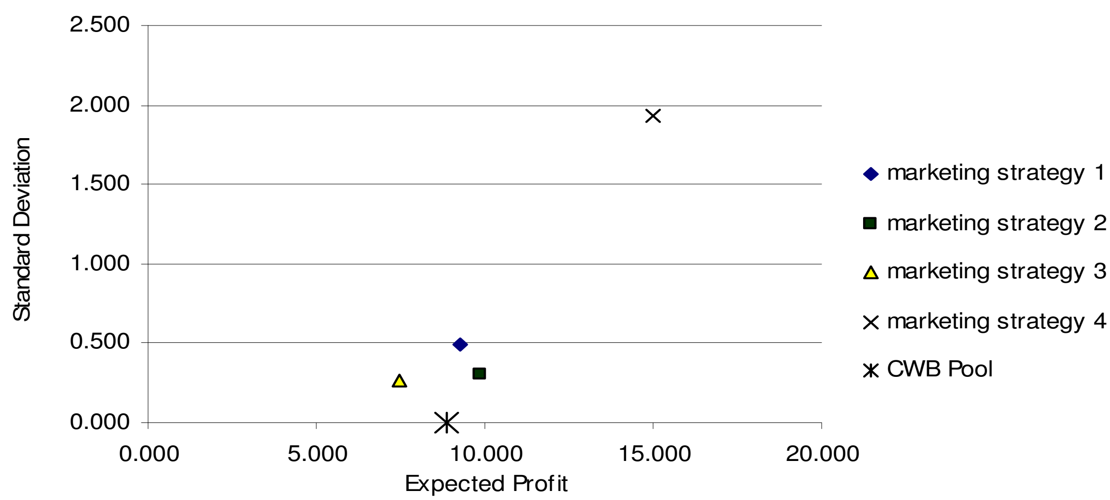
The scatter plots below illustrate the risk-expected profit trade-off between open market strategies and the CWB pool (Figures 16-19). Each scatter plot shows the standard deviation (risk) and expected profit for each market strategy (as presented in Table 6) which represents the differences in risk and return between the open market and CWB pool. Better combinations of expected profit and risk are obtained towards the bottom-right corner of the graphs, indicating larger expected profit and lower risk. On the other hand, worse combinations of expected profit and risk are located as we move towards the top-left corner of the graphs, denoting lower expected profit and higher risk.

Figure 16. Expected profit and standard deviation of marketing strategies in scenario 1-2006/2007



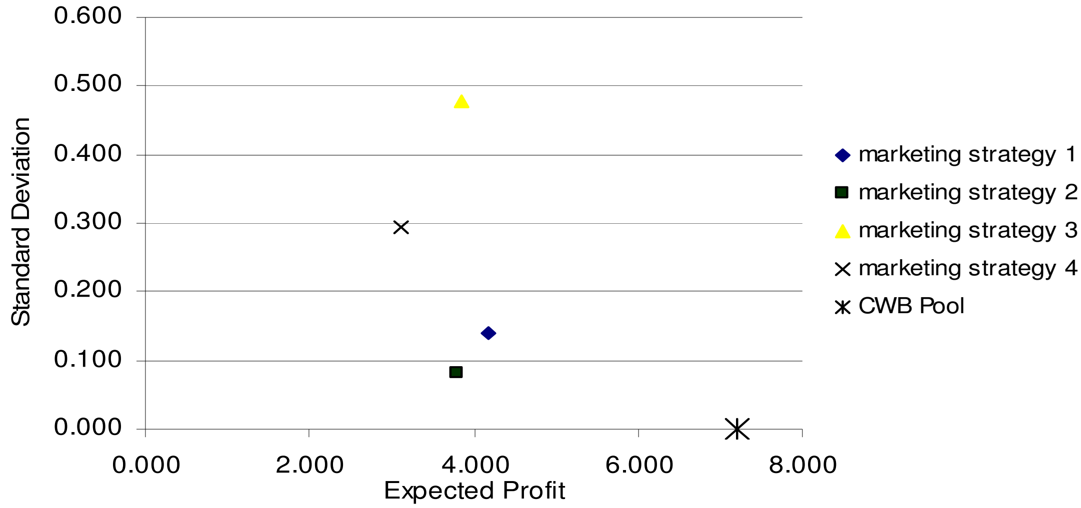
Source: Author's calculations

Figure 17. Expected profit and standard deviation of marketing strategies in scenario 1-2007/2008



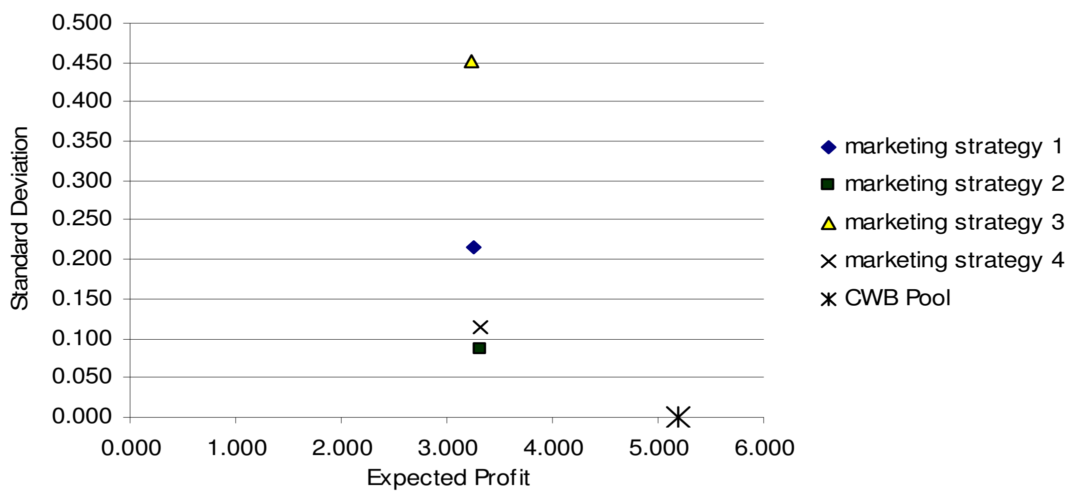
Source: Author's calculations

Figure 18. Expected profit and standard deviation of marketing strategies in scenario 1-2008/2009



Source: Author's calculations

Figure 19. Expected profit and standard deviation of marketing strategies in scenario 1-2009/2010



Source: Author's calculations

6.2.2 Scenario 2 (Export basis increases by 4 %)

Expected profits, standard deviation and coefficient of variation are given for each marketing strategy in Table 7. As in Scenario 1, expected profits for all marketing strategies are smaller than the CWB pool profit for all crop years with the exception of 2007/2008[16]. In that specific crop year, three out of four marketing strategies considered would have allowed farmers to capture higher profits than the CWB pool due to the high futures prices observed between February and April where futures prices rise as high as $24.482 per bushel. Marketing strategy 4 (single sale in March) futures prices range from $13.175 to $18.366 per bushel, but has the highest risk compared to other strategies.

In terms of risk, large dispersion in the distribution of profits across marketing strategies is indicated by the coefficient of variation in Table 7. The coefficients of variation range from 1% to 10% in 2006/2007, 3% to 13% in 2007/2008, 2% to 11% in 2008/2009 and 2% to 12% in 2009/2010. Overall, marketing strategies 3 and 4 exhibit more risk than the other strategies in scenario 2.

[16] A two-tailed t test is used to test the null hypothesis that the difference between expected profit in the open market and the CWB pool profit is equal to zero (Ho: $EP_{OM}-P_{CWB} = 0$). The null hypothesis is rejected for all marketing strategies at 10%.

Table 7. Expected profit, risk and coefficient of variation for each marketing strategy in scenario 2

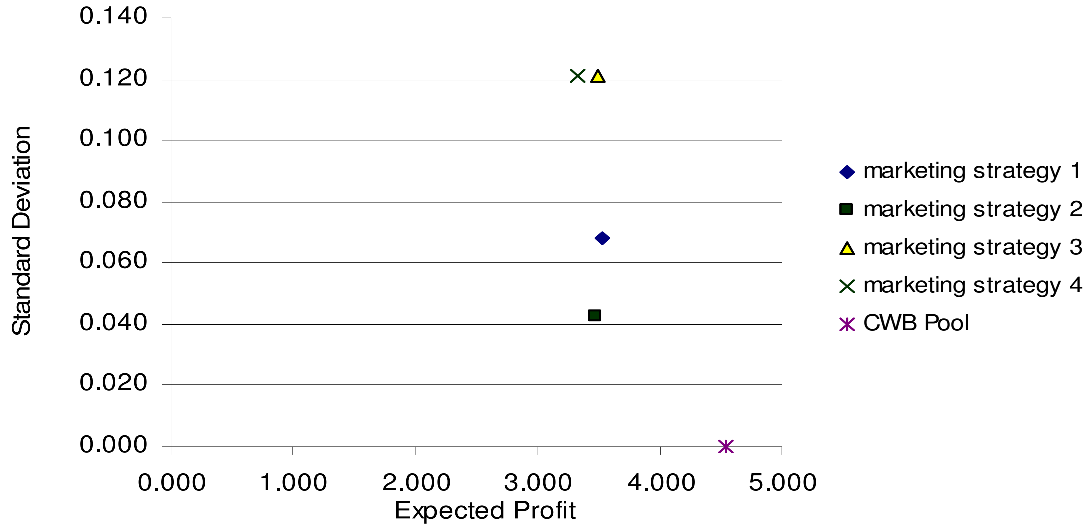
	2006/07	2007/08	2008/09	2009/10
Expected profit ($/bu)				
Marketing strategy 1	3.523	9.668	4.722	3.729
Marketing strategy 2	3.475	10.291	4.332	3.794
Marketing strategy 3	3.493	7.881	4.392	3.717
Marketing strategy 4	3.330	15.418	3.649	3.799
CWB Pool	4.534	8.866	7.214	5.185
Risk (standard deviation, $/bu)				
Marketing strategy 1	0.068	0.481	0.139	0.228
Marketing strategy 2	0.043	0.293	0.080	0.089
Marketing strategy 3	0.349	0.257	0.477	0.459
Marketing strategy 4	0.121	1.930	0.255	0.126
CWB Pool	0.000	0.000	0.000	0.000
Coefficient of variation (%)				
Marketing strategy 1	1.930	4.978	2.934	6.117
Marketing strategy 2	1.223	2.851	1.855	2.341
Marketing strategy 3	9.980	3.256	10.871	12.341
Marketing strategy 4	3.635	12.518	6.975	3.322
CWB Pool	0.000	0.000	0.000	0.000

Source: Author's calculations

* Marketing strategy 1: four equal sales over the crop year (September, November, March, June); Marketing strategy 2: ten equal sales over the crop year (September to June); Marketing strategy 3: single sale in October; Marketing strategy 4: single sale in March.

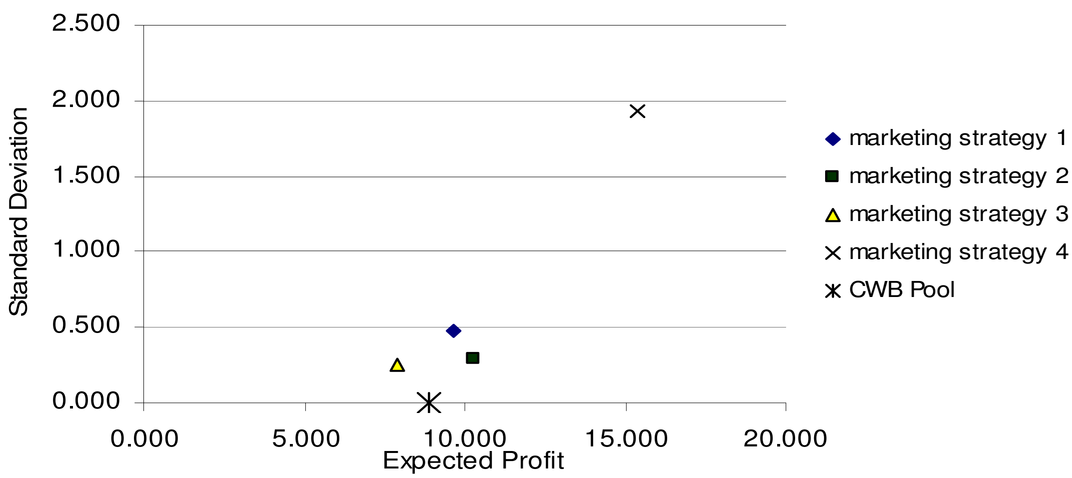
Differences in risk and return can be used as a preliminary reference in determining how the CEs will result. Figure 20 to 23 illustrate the expected profit and risk (standard deviation) for each marketing strategy and crop year. In three out of four crop years, the CWB pool exhibits a better combination of profit and risk because of higher profits and no risk.

Figure 20. Expected profit and standard deviation of marketing strategies in scenario 2-2006/2007



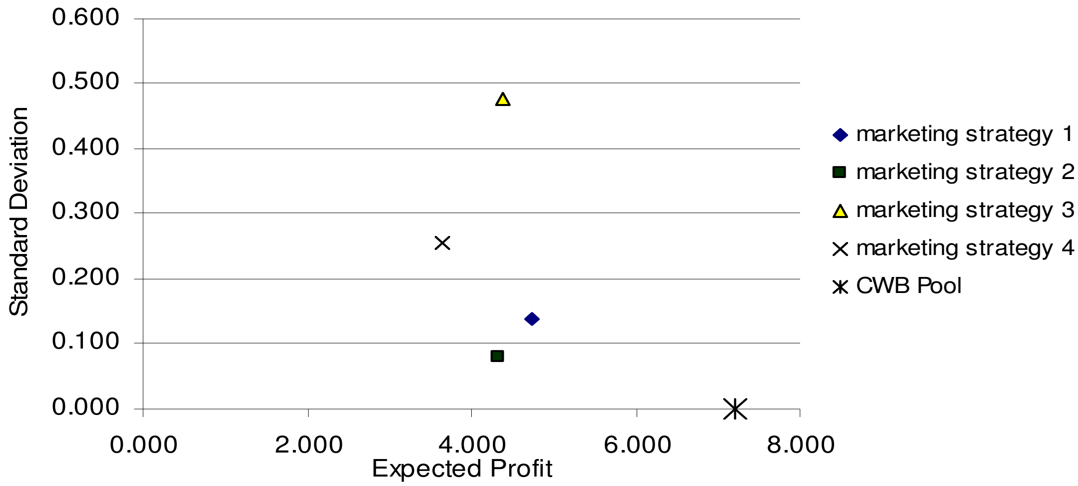
Source: Author's calculations

Figure 21. Expected profit and standard deviation of marketing strategies in scenario 2-2007/2008



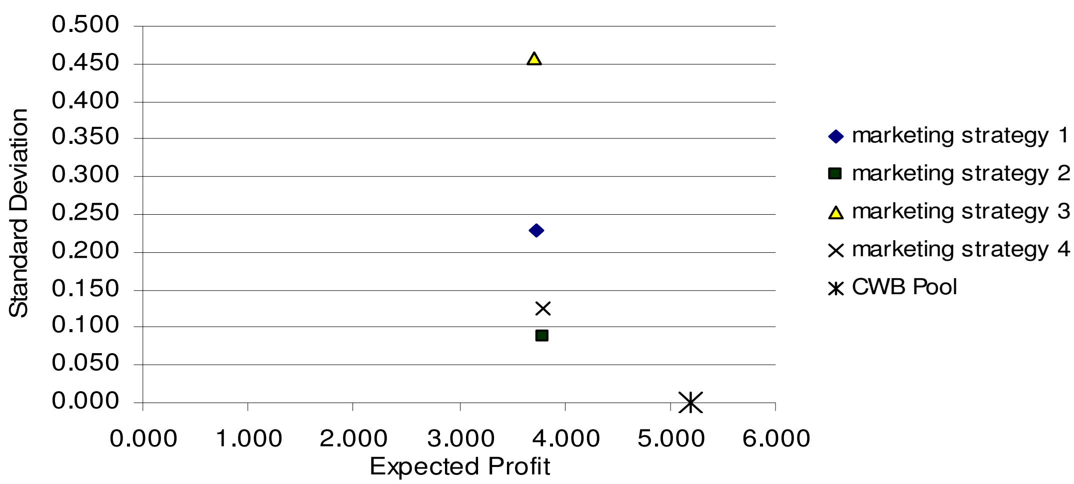
Source: Author's calculations

Figure 22. Expected profit and standard deviation of marketing strategies in scenario 2-2008/2009



Source: Author's calculations

Figure 23. Expected profit and standard deviation of marketing strategies in scenario 2-2009/2010



Source: Author's calculations

6.2.3 Scenario 3 (Export basis increases by 7 %)

Scenario 3 risk and return analysis is consistent with the first two scenarios. Table 8 presents the expected profits, risk and coefficients of variation for each marketing strategy in scenario 3. In terms of expected profit the CWB pool captures the highest profits with the exception of 2007/2008.[17] Since farmers sell their whole crop in a single sale in marketing strategy 4, the high prices observed in the futures market would have allowed farmers to earn a much higher profit than other strategies and the CWB pool in 2007/2008.

In three out of four crop years, marketing strategy 2 tends to exhibit higher risk than other strategies shown by their higher coefficients of variation. Overall, there is large dispersion in the distribution of profits across marketing strategies in all crop years ranging from 1% to 6% in 2006/2007, 3% to 13% in 2007/2008, 2% to 11% in 2008/2009 and 2% to 12% in 2009/2010.

[17] A two-tailed t test is used to test the null hypothesis that the difference between expected profit in the open market and the CWB pool profit is equal to zero (Ho: EP_{OM}-P_{CWB} = 0) . The null hypothesis is rejected for all marketing strategies at 10%.

Table 8. Expected profit, risk and coefficient of variation for each marketing strategy in scenario 3

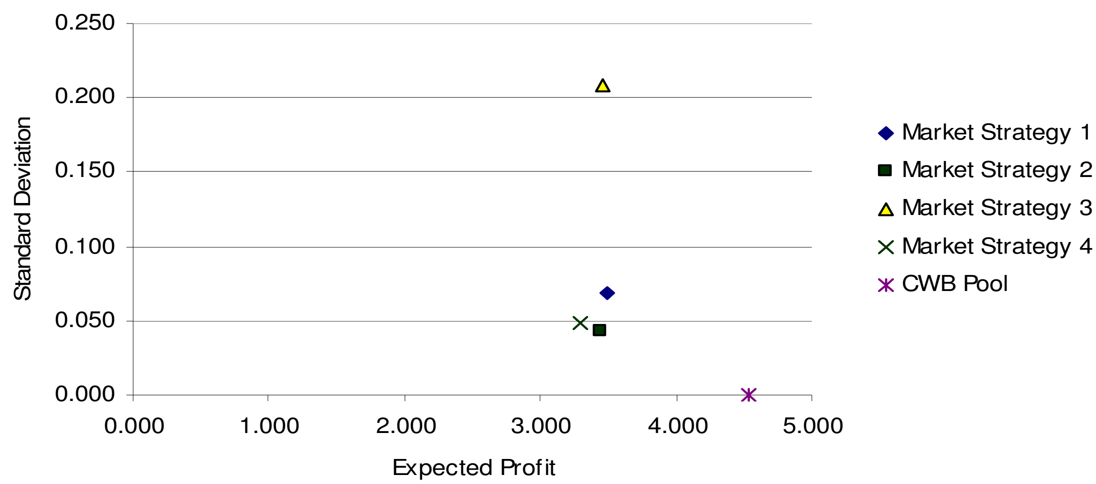
	2006/07	2007/08	2008/09	2009/10
Expected profit ($/bu)				
Marketing strategy 1	3.496	9.639	4.684	3.695
Marketing strategy 2	3.447	10.261	4.295	3.760
Marketing strategy 3	3.466	7.851	4.354	3.683
Marketing strategy 4	3.303	15.388	3.612	3.765
CWB Pool	4.534	8.866	7.214	5.185
Risk (standard deviation, $/bu)				
Marketing strategy 1	0.068	0.482	0.139	0.227
Marketing strategy 2	0.043	0.294	0.080	0.078
Marketing strategy 3	0.208	0.257	0.447	0.458
Marketing strategy 4	0.049	1.931	0.258	0.125
CWB Pool	0.000	0.000	0.000	0.000
Coefficient of variation (%)				
Marketing strategy 1	1.956	4.998	2.959	6.149
Marketing strategy 2	1.241	2.863	1.873	2.355
Marketing strategy 3	6.001	3.271	10.965	12.441
Marketing strategy 4	1.484	12.545	7.130	3.330
CWB Pool	0.000	0.000	0.000	0.000

Source: Author's calculations

* Marketing strategy 1: four equal sales over the crop year (September, November, March, June); Marketing strategy 2: ten equal sales over the crop year (September to June); Marketing strategy 3: single sale in October; Marketing strategy 4: single sale in March.

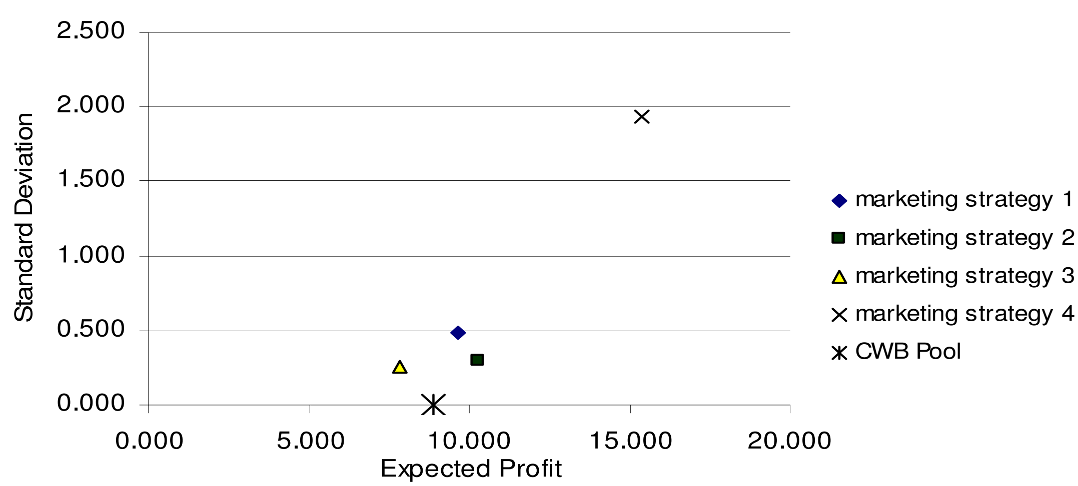
Figures 24 to 27 illustrate the risk-expected profit trade-off between open market strategies and the CWB pool for scenario 3. Each scatter plot shows the differences in risk and return between the open market and the CWB pool using expected profit and standard deviation.

Figure 24. Expected profit and standard deviation of marketing strategies in scenario 3-2006/2007



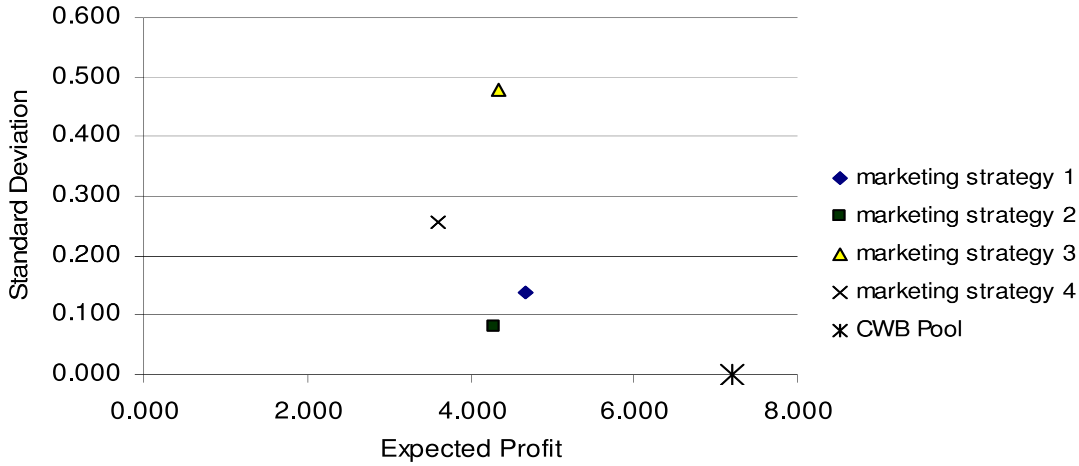
Source: Author's calculations

Figure 25. Expected profit and standard deviation of marketing strategies in scenario 3-2007/2008



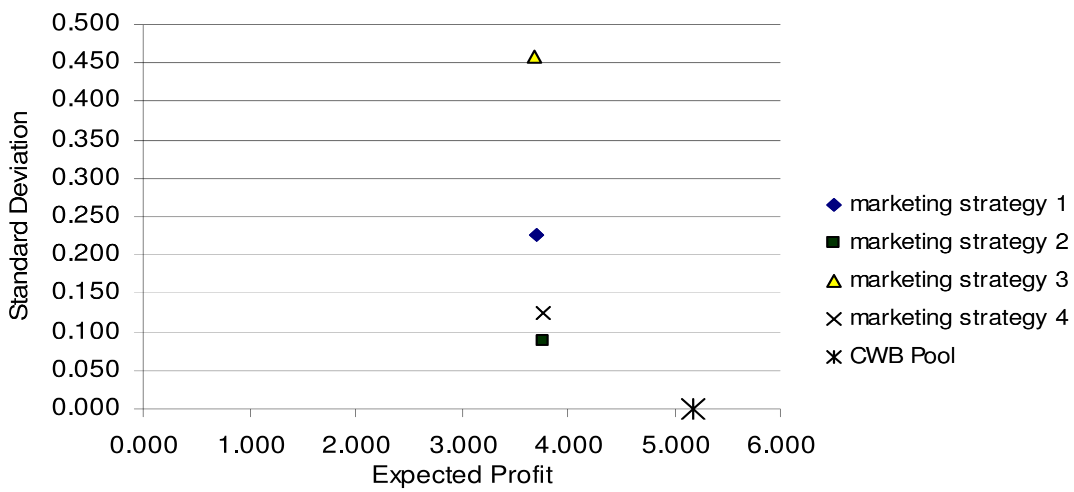
Source: Author's calculations

Figure 26. Expected profit and standard deviation of marketing strategies in scenario 3-2008/2009



Source: Author's calculations

Figure 27. Expected profit and standard deviation of marketing strategies in scenario 3-2009/2010



Source: Author's calculations

Given the data used in this research, expected profit and risk are not corresponding in a consistent pattern together. As risk or standard deviations increase, profit will either go up or down and is not predictable. In an open market with such deviations, farmers can be left dumfounded on how and when to market their grain. In order to observe how the standard deviation and expected utility can affect farmers' marketing decisions, expected utility is determined to reflect farmers' preference. These standard deviation/expected utility comparisons relate to expected utility. Depending on the amount of risk, it is expected that higher profits lead to higher expected utility. However, if the price volatility fluctuates enough to create an augmented standard deviation, expected utility will be reflective of the amount of risk involved. Although expected profit and standard deviation provide information about each scenario and strategy, it is important to analyze utility and certainty equivalents.

6.2.4 Summary of risk and profit profiles

Expected profit and risk provide a general idea of what to expect for certainty equivalents. Farmers are assumed to prefer higher profits and less risk. The previous analysis indicates that, in three out of four crop years, different marketing strategies in an open market would have generated lower expected profits and higher risk compared to the CWB pool. In general, those numbers would suggest that farmers would have chosen to stay in the CWB pool as opposed to sell in the open market. However, high risk levels in the open market reflect the notion that large losses can occur and also that there are more possibilities to obtain high profits. Therefore the level of risk aversion also needs to be considered in the analysis. Farmers with low aversion to risk might choose to sell in the open market in an attempt to achieve higher profits, while highly risk averse farmers might prefer to stay under the CWB even if that means giving up the possibility of higher profits. The next section of this research explores farmers' preferences in terms of expected profit and risk by calculating certainty equivalents for different levels of risk aversion.

6.3 Certainty equivalents for each marketing strategy in 2006/2007-2009/2010

An expected utility framework is adopted to explore farmers' preferences in terms of risk and expected profit of marketing strategies in an open market vis-a-vis the CWB pool system. The discussion in this section tries to answer one of the following two questions for each marketing strategy for all three scenarios. If a farmer preferred the risk-expected profit combination of a marketing strategy in the open market, how much more profit would the CWB pool need to generate in order to make this farmer indifferent between the open market and the pool? Or, if the farmer preferred the risk-expected combination of the CWB pool, how much of his profit in the pool would he need to give up in order to be indifferent between the open market and the pool?

The answers to those questions are expressed in certainty equivalents. Following up on chapter 5 (equation 30), a positive certainty equivalent (CE) signifies that producers would only stay under the CWB if they were paid a certain amount of money. In this case the certainty equivalent would represent the minimum amount of money producers would require to stay in the CWB pool. A negative CE indicates that producers are willing to give up (or "pay") a certain amount of money to remain the CWB pool. In this case the certainty equivalent represents the maximum amount they would be willing to give up.

In this section certainty equivalents are calculated based on a coefficient of relative risk aversion equal to 3, which is chosen as an "average" risk aversion following the marketing literature. Lence (1996) adopts three levels of relative risk aversion–1, 3, and 10–classifying them as low, moderate and high, respectively. Nelson and Escalante (2004) estimate relative risk aversion for Illinois farmers based on historical financial attributes and find that it lies within the interval [0.27, 4.95]. Mattos et al. (2008) adopt a range between 1 and 5 for relative risk aversion. Table 9 present certainty equivalents considering farmers with risk aversion equal to 3 who could choose between different marketing strategies and CWB pool in the three scenarios between 2006/2007 and 2009/2010. For example, the certainty equivalent for marketing strategy 1 in scenario 1 for 2009/2010 is -2.90, which implies farmers were willing to give up $2.90 per bushel to remain marketing their grain in the CWB pool rather than adopting strategy 1 in an open market. As shown in Table 9, CEs are negative for all marketing strategies with the exception of marketing strategy 4 in 2007/2008. Certainty equivalents were generally close to -$2.00 per bushel in 2006/2007, between $1.80 and -$3.60 per bushel in 2007/2008, between -$4.00 and -$5.00 per bushel in 2008/2009, and between -$2.00 and -$3.00 per bushel in 2009/2010. Therefore, the CWB pool method of marketing is more preferred than the open market environment.

Table 9. Certainty equivalents ($/bu) for each scenario and strategy with risk aversion level 3

RA = 3	**2006/2007**	**2007/2008**	**2008/2009**	**2009/2010**
Scenario 1				
Marketing Strategy 1	-2.317	-2.347	-4.255	-2.900
Marketing Strategy 2	-2.350	-1.889	-4.528	-2.841
Marketing Strategy 3	-2.353	-3.593	-4.547	-2.961
Marketing Strategy 4	-2.453	1.477	-5.039	-2.839
Scenario 2				
Marketing Strategy 1	-2.044	-2.055	-3.879	-2.563
Marketing Strategy 2	-2.077	-1.598	-4.152	-2.504
Marketing Strategy 3	-2.101	-3.302	-4.164	-2.617
Marketing Strategy 4	-2.184	1.777	-4.652	-2.503
Scenario 3				
Marketing Strategy 1	-2.063	-2.076	-3.906	-2.587
Marketing Strategy 2	-2.097	-1.619	-4.178	-2.528
Marketing Strategy 3	-2.097	-3.323	-4.191	-2.642
Marketing Strategy 4	-2.199	1.755	-4.680	-2.527

Source: Author's calculations

As previously mentioned, the only positive certainty equivalents in Table 9 are found for marketing strategy 4 in all three scenarios in 2007/2008. In our model a positive certainty equivalent implies that farmers would require an extra payment in order to stay in the CWB pool. Those three situations might reflect the larger expected profit in strategy 4 in 2007/2008 (Tables 6-8), since the single sale in March assumed in this strategy would have allowed farmers to capture some of the highest prices in history (note that 2007/2008 exhibited a wide price range, between $7.00 per bushel and $24.00 per bushel, as can be seen in Figure 9). Even though risk was also greater in that year (Table 6-8), the larger expected profit appears to have outweighed the greater risk level. To get a better understanding on how much of the pool profit farmers are willing to give up, the CEs as a proportion of the pool profit are calculated (Table 10). These values provide a broader sense of magnitude of the value they are willing to give up to continue marketing grain in the CWB pool. For example, in 2006/2007 farmers would be willing to give up $2.317 per bushel of their pool profit in order to avoid marketing strategy 1 in Scenario 1. Since the pool profit in that year was $4.524 per bushel, it means farmers would be willing to give up 51% of their pool profit. In other words, even if the pool profit was cut by half, they would still prefer the pool as opposed to strategy 1.

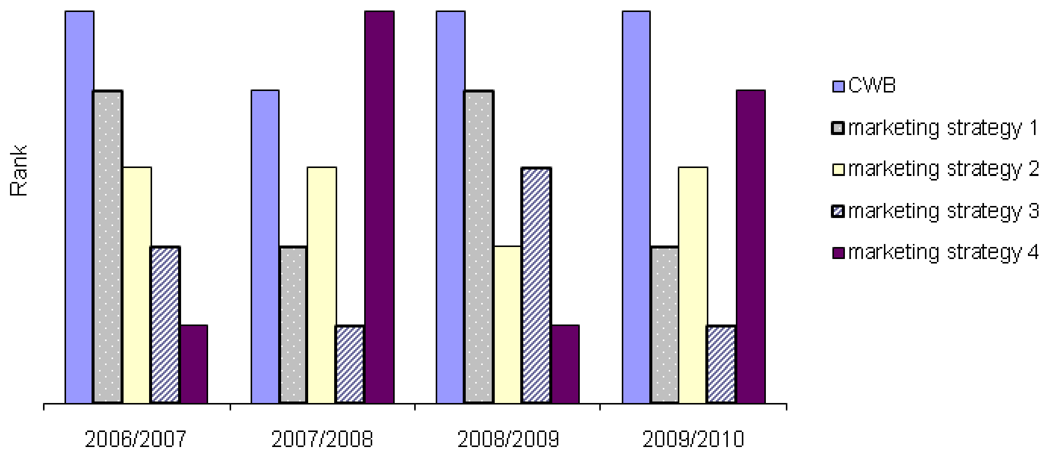
Table 10. Certainty equivalents as a proportion of the pool profit

	2006/2007	2007/2008	2008/2009	2009/2010
Scenario 1				
Marketing Strategy 1	-51.1%	-26.5%	-59.0%	-55.9%
Marketing Strategy 2	-51.8%	-21.3%	-62.8%	-54.8%
Marketing Strategy 3	-51.9%	-40.5%	-63.0%	-57.1%
Marketing Strategy 4	-54.1%	16.7%	-69.8%	-54.8%
Scenario 2				
Marketing Strategy 1	-45.1%	-23.2%	-53.8%	-49.4%
Marketing Strategy 2	-45.8%	-18.0%	-57.6%	-48.3%
Marketing Strategy 3	-46.3%	-37.2%	-57.7%	-50.5%
Marketing Strategy 4	-48.2%	20.0%	-64.5%	-48.3%
Scenario 3				
Marketing Strategy 1	-45.5%	-23.4%	-54.1%	-49.9%
Marketing Strategy 2	-46.2%	-18.3%	-57.9%	-48.8%
Marketing Strategy 3	-46.2%	-37.5%	-58.1%	-50.9%
Marketing Strategy 4	-48.5%	19.8%	-64.9%	-48.7%

Author's calculations

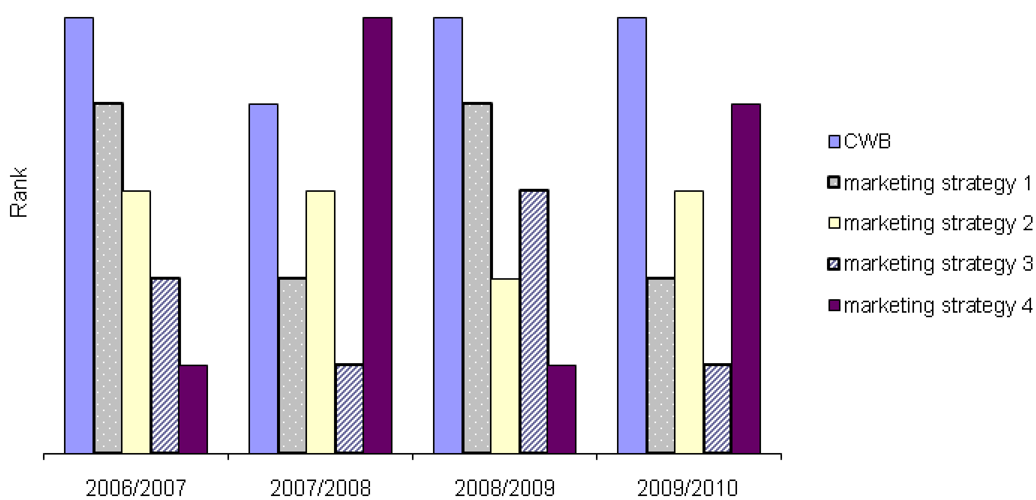
The CE values are ranked in order that distinguishes producers' preference in marketing strategy. This is done for each crop year and each scenario, including the pool. Together, expected profit and risk determine farmer preference. Compatible with Table 10, Figures 28-30 show the ranking of marketing strategies under each crop year and scenario. Based on the CEs, the preferred marketing strategies are determined in order of preference. As the CEs provide a better idea of the magnitude of preference, this ranking illustrates whether producers prefer the pool or not. The figures clearly illustrate that the CWB pool is the more preferred method for marketing wheat compared to all open market options analyzed.

Figure 28. Marketing strategy ranking in scenario 1 for each crop year (risk aversion = 3)



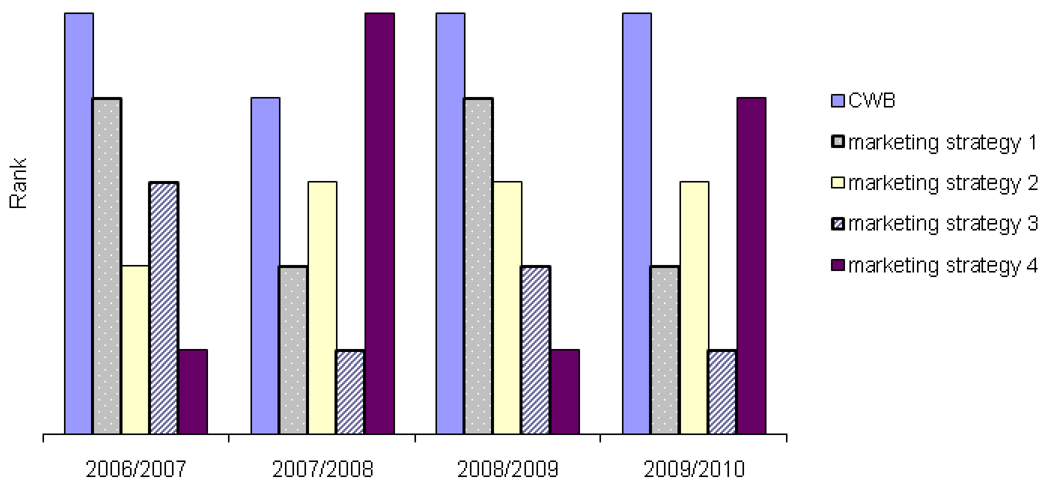
Source: Author’s calculations

Figure 29. Marketing strategy ranking in scenario 2 for each crop year (risk aversion = 3)



Source: Author’s calculations

Figure 30. Marketing strategy ranking in scenario 3 for each crop year (risk aversion = 3)



Source: Author's calculations

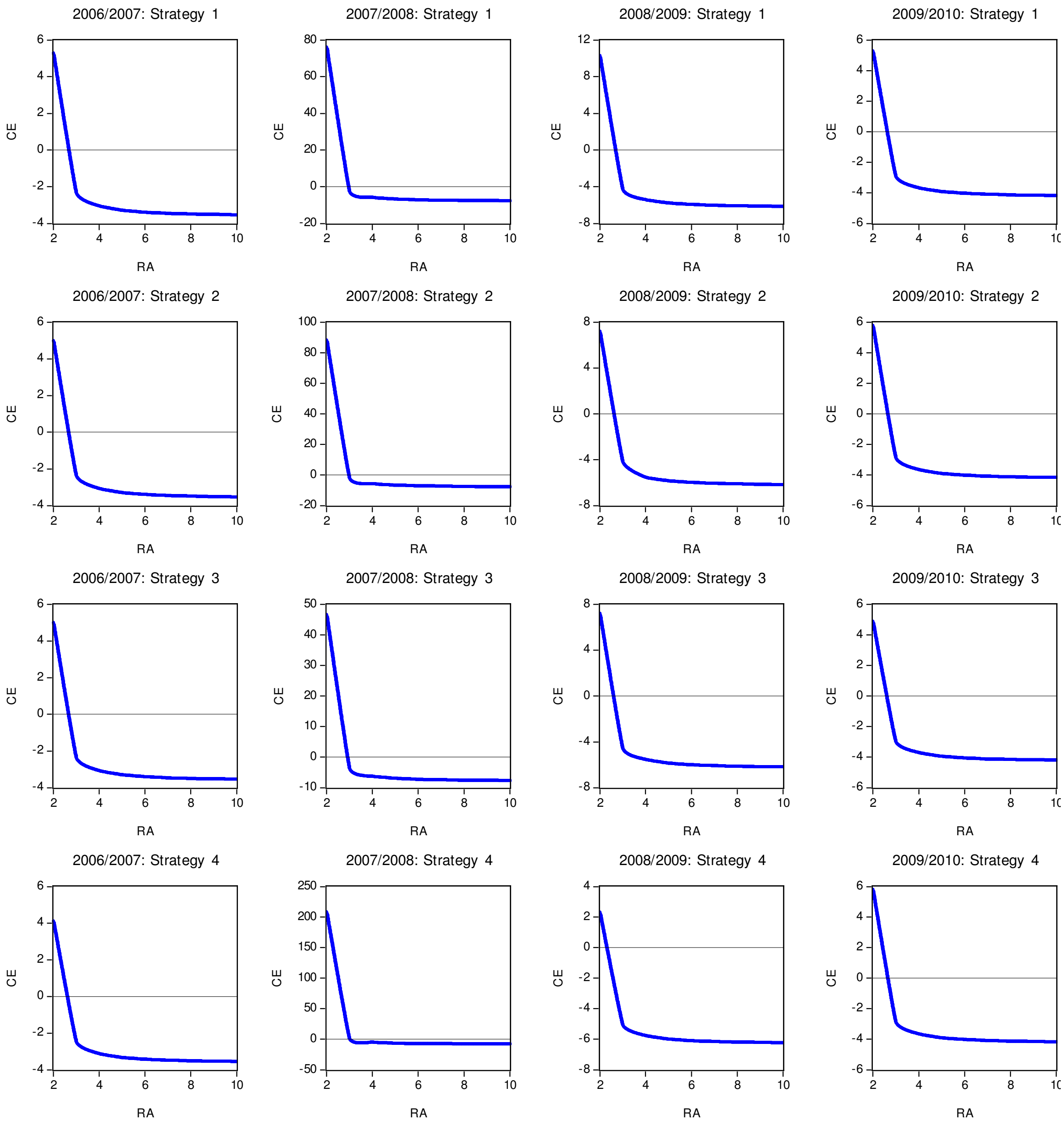
The previous analysis was done using risk aversion equal to 3. All farmers are individualistic and employ their own marketing strategy but also exhibit varied levels of risk aversion. The next section discusses how individual risk aversion levels alter producer preference for an open market environment or the CWB pool.

6.3.1 Certainty equivalents for different levels of risk aversion

Individual farmers function and operate in their own unique way. Each producer's level of risk is differentiated from one another. Therefore, it is important to assess farmers' preferences in the study based on a range of risk aversion levels.

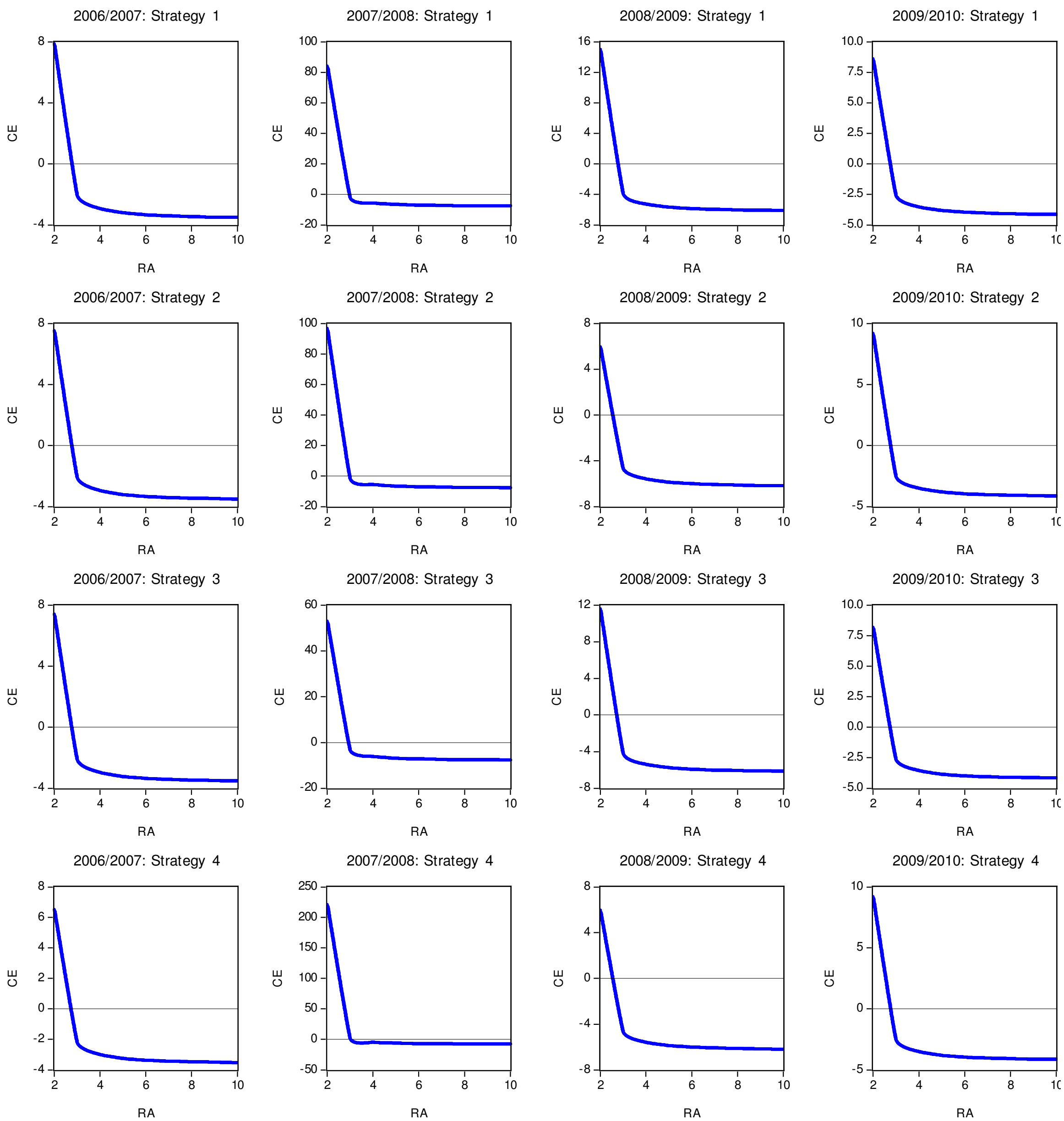
The analysis employs a wider interval of risk aversion levels in order to compare producers with distinct risk preferences. Figures 31-33 exhibit the calculated certainty equivalents for relative risk aversion ranging from 2 to 10 in each scenario. Starting at risk aversion equal to 3 as adopted in the previous analysis, results generally show that higher levels of risk aversion lead to more negative certainty equivalents. This finding means that more risk averse farmers would be willing to give up larger portions of the CWB pool profit in order to avoid marketing in the open market. This is consistent with the notion that increasing levels of risk aversion implies that individuals are relatively more concerned with risk and thus would be more inclined to sacrifice more of their return in order to avoid risk. Certainty equivalents show relatively larger changes up to risk aversion equal to 4 or 5. As risk aversion grows above 5 the magnitude of the changes in certainty equivalents become smaller and the curves in Figures 31-33 become flatter. On the other hand, certainty equivalents exhibit large sensibility for risk aversion levels smaller than 3. When relative risk aversion is equal to 2 all certainty equivalents become positive, indicating farmers would require to receive an extra amount of money to market their wheat using the CWB pool. This extra profit required by farmers to use the pool ranges mostly between $4.00 per bushel to $10.00 per bushel in 2006/2007, 2008/2009 and 2009/2010. However, those values tend to be much larger in 2007/2008 because of the higher prices observed in that year in the open market, making certainty equivalents reach as high as $221.00 per bushel as found for marketing strategy 4 in scenario 2. Certainty equivalents were also calculated for risk aversion equal to 1.5, showing highly positive values (in hundreds and even thousands of dollars per bushel) which are not shown in Figures 31-33 because such large numbers would affect visual clarity. Overall, positive certainty equivalent for small values of risk aversion are consistent with the notion that farmers exhibiting little aversion to risk would prefer to market their grain in an environment which allows them to obtain higher profits (even though risk would also be greater), or else would require a larger certain profit in order to operate in a pool structure.

Figure 31. Certainty equivalents (CE) for different levels of risk aversion (RA) in scenario 1



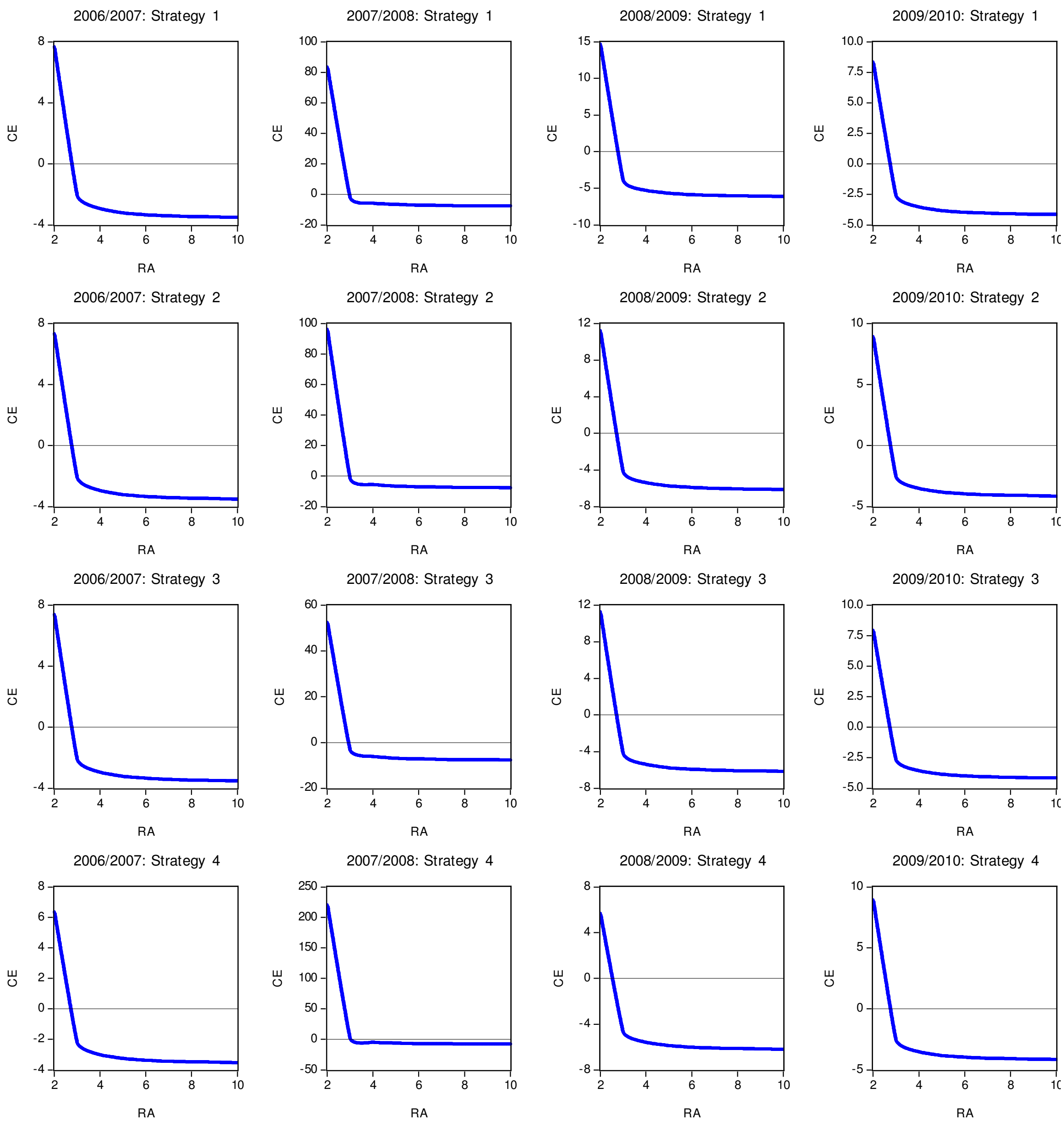
Source: Author's calculations

Figure 32. Certainty equivalents (CE) for different levels of risk aversion (RA) in scenario 2



Source: Author's calculations

Figure 33. Certainty equivalents (CE) for different levels of risk aversion (RA) in scenario 3



Source: Author's calculations

In conclusion, the CWB pool strategy for marketing wheat in Western Canada is the most preferred by farmers who have a risk aversion level of at least 3 or greater. The data describes that risk-loving farmers exhibit a higher utility in the open market, thus prefer to market wheat in a volatile environment. Combined, the CWB pool profit and zero risk prove to be preferable to producers with higher risk aversion levels.

6.3.2 Analysis considering a downside risk measure

Risk is typically analysed in terms of volatility, which is given by the standard deviation or variance of a distribution. The previous analysis discussed risk in an open market environment in terms of the standard deviation of futures prices and basis. By definition, measuring risk with standard deviation means that deviations above and below the mean over time are considered in the calculation. This implies that both upside and downside deviations are equally seen as undesirable events. However, Unser (2000) argues that individuals often perceive risk as the failure to achieve a certain level of return, while Chen et al. (2003) claim that one-sided risk measures are consistent with the risk perceived by agents. Thus downside risk measures, which consider that only returns below a certain reference level represent risk and returns above this reference level embody better investment opportunities, can be relevant in risk analysis (Grootveld and Hallerbach, 1999).

In this context, price and basis variations can be analyzed in a different framework to measure risk. There are movements in futures prices and basis levels that do not affect farmers negatively and can be exempt from being measured as risk. From a wheat producers' perspective, only deviations below the mean price represent undesirable prices, whereas deviations above the mean price can be seen as opportunities to increase profit. Similarly, only deviations above the mean basis (i.e. larger export basis) represent undesirable basis, while deviations below the mean basis (i.e. narrower basis) can be seen as opportunities to increase profit.

In the downside risk framework discussed in this section, risk is by the semi-standard deviation. This risk measure still assumes the mean of the distribution as the reference level, but only considers undesirable deviations from the mean in the calculation of risk. Futures prices that move above the mean are not considered risk because they give farmers the potential to price wheat at a higher value. Therefore, price deviations above the mean enter with a value of zero in the calculation of the semi-standard deviation of price, as can be seen in equation (30).

(30) $$SSD_{price} = \sqrt{\frac{\Sigma \sum_{i=1}^{n} \delta_i^2}{n-1}}$$

where $\delta = \begin{cases} p_i - \overline{p} & if\ p_i - \overline{p} < 0 \\ 0 & if\ p_i - \overline{p} > 0 \end{cases}$, p_i is the simulated price received by the farmer and $\overline{p}$ is the mean of the price distribution.

The same idea but with opposite movements are used to measure basis risk. Basis levels below the mean (narrower basis) are not considered risk because they represent a lower cost for farmers, giving them the opportunity to achieve higher profits. Therefore, export basis deviations below the mean are considered with a value of zero on the calculation of the semi-standard deviation for the basis, as can be seen in equation (31). Finally, the semi-covariance between price and export basis follows from the previous discussion and is given by equation (32).

(31) $$SSD_{basis} = \sqrt{\frac{\sum_{i=1}^{n} \Delta_i^2}{n-1}}$$

where $\Delta = \begin{cases} 0 & if\ b_i - \bar{b} < 0 \\ b_i - \bar{b} & if\ b_i - \bar{b} > 0 \end{cases}$, b_i is the simulated export basis and $\bar{b}$ is the mean of the basis distribution.

(32) $$SCOV_{price,basis} = \frac{\sum_{i=1}^{n} \delta_i \Delta_i}{n-1}$$

where the variables are as defined in equations (30) and (31).

Once the semi-standard deviations and semi-covariances are calculated, the analysis is repeated and risk-expected profit trade-offs in each crop year are investigated using the new risk measures. Table 11-13 show expected profits, risk (semi-standard deviations) and coefficient of variation for each marketing strategy in all scenarios. Expected profits are the same as before, since only the risk measures are calculated differently now. With regards to semi-standard deviations and coefficients of variation in Tables 11-13, they are generally smaller than the standard deviations and coefficients of variation previously presented in Tables 6-8. The only exceptions are marketing strategy 1 in 2008/2009 in scenarios 1 and 2, marketing strategy 2 in 2006/2007 in all scenarios, and marketing strategy 4 in 2006/2007 in scenario 1.

Table 11. Expected profit, risk and coefficient of variation for each marketing strategy in scenario 1

	2006/2007	2007/2008	2008/2009	2009/2010
Expected profit ($/bu)				
Marketing strategy 1	3.138	9.258	4.191	3.253
Marketing strategy 2	3.089	9.880	3.801	3.318
Marketing strategy 3	3.108	7.470	3.861	3.241
Marketing strategy 4	2.945	15.007	3.118	3.323
CWB pool	4.534	8.866	7.214	5.185
Risk (semi-standard deviation, $/bu)				
Marketing strategy 1	0.052	0.374	0.200	0.130
Marketing strategy 2	0.070	0.217	0.059	0.056
Marketing strategy 3	0.192	0.233	0.250	0.229
Marketing strategy 4	0.083	1.724	0.172	0.088
CWB pool	0.000	0.000	0.000	0.000
Coefficient of variation				
Marketing strategy 1	1.659	4.039	4.764	4.002
Marketing strategy 2	2.274	2.201	1.556	1.693
Marketing strategy 3	6.192	3.113	6.470	7.079
Marketing strategy 4	2.805	11.486	5.529	2.639
CWB pool	0.000	0.000	0.000	0.000

Source: Author’s calculations

Table 12. Expected profit, risk and coefficient of variation for each marketing strategy in scenario 2

	2006/2007	2007/2008	2008/2009	2009/2010
Expected profit ($/bu)				
Marketing strategy 1	3.523	9.668	4.722	3.729
Marketing strategy 2	3.475	10.291	4.332	3.794
Marketing strategy 3	3.493	7.881	4.392	3.717
Marketing strategy 4	3.330	15.418	3.649	3.799
CWB pool	4.534	8.866	7.214	5.185
Risk (semi-standard deviation, $/bu)				
Marketing strategy 1	0.048	0.367	0.157	0.102
Marketing strategy 2	0.070	0.208	0.056	0.048
Marketing strategy 3	0.183	0.230	0.248	0.218
Marketing strategy 4	0.062	1.716	0.140	0.056
CWB pool	0.000	0.000	0.000	0.000
Coefficient of variation				
Marketing strategy 1	1.353	3.801	3.326	2.732
Marketing strategy 2	2.022	2.017	1.304	1.272
Marketing strategy 3	5.244	2.924	5.655	5.856
Marketing strategy 4	1.859	11.132	3.830	1.472
CWB pool	0.000	0.000	0.000	0.000

Author's calculations

Table 13. Expected profit, risk and coefficient of variation for each marketing strategy in scenario 3

	2006/2007	2007/2008	2008/2009	2009/2010
Expected profit ($/bu)				
Marketing strategy 1	3.496	9.639	4.684	3.695
Marketing strategy 2	3.447	10.261	4.295	3.760
Marketing strategy 3	3.466	7.851	4.354	3.683
Marketing strategy 4	3.303	15.388	3.612	3.765
CWB pool	4.534	8.866	7.214	5.185
Risk (semi-standard deviation) ($/bu)				
Marketing strategy 1	0.048	0.368	0.160	0.104
Marketing strategy 2	0.070	0.208	0.057	0.049
Marketing strategy 3	0.184	0.231	0.248	0.218
Marketing strategy 4	0.063	1.717	0.142	0.058
CWB pool	0.000	0.000	0.000	0.000
Coefficient of variation				
Marketing strategy 1	1.371	3.817	3.414	2.809
Marketing strategy 2	2.038	2.029	1.319	1.297
Marketing strategy 3	5.302	2.936	5.706	5.930
Marketing strategy 4	1.918	11.156	3.930	1.549
CWB pool	0.000	0.000	0.000	0.000

Author's calculations

The trade-offs between risk and expected profit might change once risk in the open market appears to be generally smaller when a one-sided measure is used (semi-standard deviation). A new set of certainty equivalents is calculated in order to explore whether the new trade-offs presented in this section can also change farmers' choices with respect to the CWB pool and the open market. Table 14 displays the certainty equivalents calculated for a risk aversion level of 3. Results are qualitatively the same as the ones obtained in Table 9. Out of 48 certainty equivalents calculated between four marketing strategies, three scenarios and four crop-years, 45 of them are negative and only three are positive. The only positive certainty equivalents are again found in marketing strategy 4 in 2007/2008. The numerical difference between certainty equivalents calculated with standard deviation as the risk measure and the ones calculated with the semi-standard deviation as risk measure is generally about $0.2/bu or less. Therefore, the one-side risk measure adopted in this section seems to have little impact on producers' preferences between the CWB pool and the open market in terms of certainty equivalents.

Table 14. Certainty equivalents ($/bu) for each scenario and strategy with a risk aversion of 3

	2006/2007	2007/2008	2008/2009	2009/2010
Scenario 1				
Marketing Strategy 1	-2.316	-2.336	-4.261	-244%
Marketing Strategy 2	-2.351	-1.884	-4.527	-248%
Marketing Strategy 3	-2.349	-3.591	-4.501	-248%
Marketing Strategy 4	-2.454	1.534	-5.019	-259%
Scenario 2				
Marketing Strategy 1	-2.043	-2.044	-3.880	-303%
Marketing Strategy 2	-2.078	-1.594	-4.151	-308%
Marketing Strategy 3	-2.074	-3.300	-4.123	-314%
Marketing Strategy 4	-2.180	1.832	-4.639	-324%
Scenario 3				
Marketing Strategy 1	-2.063	-2.065	-3.907	-297%
Marketing Strategy 2	-2.098	-1.614	-4.178	-302%
Marketing Strategy 3	-2.094	-3.321	-4.150	-302%
Marketing Strategy 4	-2.200	1.810	-4.666	-317%

Author's calculations

6.4 Sensitivity analysis

The three scenarios for changes in the export basis adopted in this research are based on the assumptions and calculations of Fulton et al. (1998). Nevertheless, there is uncertainty in the exact value the export basis could change upon the removal of the CWB and rail deregulation. This section explores how different assumptions about the change in the export basis would affect the calculated certainty equivalents presented in Table 9. Note that the coefficient of relative risk aversion considered in this sensitivity analysis is also equal to 3, as the one assumed for the calculations in Table 9.

6.4.1. Export basis unchanged

The first sensitivity analysis considers the impact of an unchanged export basis on the certainty equivalents (CEs). As previously discussed, CEs were negative in all situations with the exception of marketing strategy 4 in 2007/2008, indicating producers would have preferred to stay under the CWB to marketing their wheat in an open market (Table 9). The current analysis recalculates the CEs assuming the export basis would not change in an open market (i.e. it would be the same value as in the current system with the CWB), but all other variables change in the same way as in the initial analysis (export basis volatility and price levels and volatility are assumed to follow the U.S. market). The unchanged export basis analysis provides a sense of how the certainty equivalents change based on the magnitude of the export basis and due to its variability. Table 15 presents the resulting certainty equivalents for this analysis. In line with previous results, all certainty equivalents are still negative with the exception of marketing strategy 4 in 2007/2008. However, the certainty equivalents are less negative than the ones calculated in Table 9. This result suggests producers would still prefer the CWB to the open market even if the export basis does not increase, but the strength of this preference for the CWB would be less than before. This is consistent with the lower export basis used in the current analysis compared to the previous one, since making the value of the export basis in the open market the same as under the CWB makes the open market relatively less undesirable.

Table 15. Certainty equivalents with an unchanged export basis

	2006/2007	2007/2008	2008/2009	2009/2010
Scenario 1				
Marketing Strategy 1	-2.019	-2.029	-3.696	-2.528
Marketing Strategy 2	-2.053	-1.572	-3.969	-2.469
Marketing Strategy 3	-2.052	-3.276	-3.977	-2.582
Marketing Strategy 4	-2.155	1.804	-4.465	-2.468
Scenario 2				
Marketing Strategy 1	-2.019	-2.029	-3.696	-2.528
Marketing Strategy 2	-2.053	-1.572	-3.969	-2.469
Marketing Strategy 3	-2.077	-3.276	-3.977	-2.582
Marketing Strategy 4	-2.159	1.804	-4.465	-2.468
Scenario 3				
Marketing Strategy 1	-2.019	-2.029	-3.696	-2.528
Marketing Strategy 2	-2.053	-1.572	-3.969	-2.469
Marketing Strategy 3	-2.052	-3.276	-3.977	-2.582
Marketing Strategy 4	-2.155	1.804	-4.465	-2.468

Source: Author's calculations

As for the positive certainty equivalents for marketing strategy 4 in 2007/2008, they become more positive when the change in the export basis is assumed to be zero, indicating a stronger preference for the open market as opposed to the CWB. This result was also expected in this situation. If producers already preferred the open market when the export basis was assumed to increase, their preference for the open market would only strengthen if it is now assumed that the export basis would not change.

Overall, the certainty equivalents in Table 15 and Table 9 only differ in that the former assumes the export basis would remain constant in the open market while the latter assumes it would increase. Although the calculated values for the certainty equivalents change with distinct assumptions about the export basis, the difference between them in each scenario is relatively small. Therefore it appears that the actual magnitude of the export basis has relatively little impact on producers' preferences compared to the volatility of the export basis or to changes in the magnitude or volatility of prices.

6.4.2 Changes in the export basis

The second sensitivity analysis revisits the previous point by exploring a different dimension. As previously discussed, calculated certainty equivalents in Table 9 are negative for all situations but marketing strategy 4 in 2007/2008. This section investigates how the export basis would have to change in order to make those certainty equivalents switch from negative to positive. All parameters in the model remain constant except for the value of the export basis, so the volatility of the export basis and the level and volatility of price remain the same as before in the open market scenarios. Tables 16 through 19 exhibit the values of the export basis and the resulting expected profits in each crop year that would be necessary to make the certainty equivalents change from the negative values in Table 9 to a positive value equal to 0.00001 (which would indicate a slight preference for the open market). Considering all other assumptions remain the same as in Table 9, in all situations presented in Tables 16 through 19 the export basis in the open market would generally have to decrease between 300% to 400% in order to make producers choose the open market as opposed to the CWB. More specifically, the values for the export basis would have to be negative in order to switch producers' preferences towards the open market.

Table 16. Minimum percent change in the export basis to make producers' preference switch towards the open market in 2006/2007

2006/2007	Expected Price ($/bu)	Export Basis ($/bu)	Expected Profit ($/bu)	Change in export basis
Scenario 1				
Market Strategy 1	4.478	-1.936	6.414	-244%
Market Strategy 2	4.429	-1.983	6.413	-248%
Market Strategy 3	4.448	-1.979	6.427	-248%
Market Strategy 4	4.285	-2.128	6.413	-259%
Scenario 2				
Market Strategy 1	4.478	-1.936	6.414	-303%
Market Strategy 2	4.429	-1.983	6.413	-308%
Market Strategy 3	4.448	-2.041	6.489	-314%
Market Strategy 4	4.285	-2.139	6.424	-324%
Scenario 3				
Market Strategy 1	4.478	-1.936	6.414	-297%
Market Strategy 2	4.429	-1.983	6.413	-302%
Market Strategy 3	4.448	-1.979	6.427	-302%
Market Strategy 4	4.285	-2.128	6.413	-317%
CWB pool	5.794	1.260	4.534	

Source: Author's calculations

Table 17. Minimum percent change in the export basis to make producers' preference switch towards the open market in 2007/2008

	Expected Price ($/bu)	Export Basis ($/bu)	Expected Profit ($/bu)	Change in export basis
Scenario 1				
Market Strategy 1	10.685	-1.876	12.561	-231%
Market Strategy 2	11.307	-1.239	12.546	-187%
Market Strategy 3	8.897	-3.647	12.544	-356%
Market Strategy 4 *	16.434	3.437	12.997	141%
Scenario 2				
Market Strategy 1	10.685	-1.876	12.561	-285%
Market Strategy 2	11.307	-1.239	12.546	-222%
Market Strategy 3	8.897	-3.647	12.544	-459%
Market Strategy 4 *	16.434	3.437	12.997	238%
Scenario 3				
Market Strategy 1	10.685	-1.876	12.561	-279%
Market Strategy 2	11.307	-1.239	12.546	-218%
Market Strategy 3	8.897	-3.647	12.544	-449%
Market Strategy 4 *	16.434	3.437	12.997	229%
CWB pool	10.13	1.260	8.866	

Source: Author's calculations

(*) Marketing strategy 4 in 2007/2008 already showed a positive certainty equivalent, so the current analysis calculates the minimum change in the export basis which would be needed to switch the sign of the certainty equivalent from positive to negative.

Table 18. Minimum percent change in the export basis to make producers' preference switch towards the open market in 2008/2009

	Expected Price ($/bu)	Export Basis ($/bu)	Expected Profit ($/bu)	Change in export basis
Scenario 1				
Market Strategy 1	6.041	-4.163	10.204	-325%
Market Strategy 2	5.651	-4.551	10.202	-346%
Market Strategy 3	5.711	-4.524	10.235	-345%
Market Strategy 4	4.968	-5.205	10.173	-381%
Scenario 2				
Market Strategy 1	6.041	-4.163	10.204	-416%
Market Strategy 2	5.651	-4.551	10.202	-445%
Market Strategy 3	5.711	-4.524	10.235	-443%
Market Strategy 4	4.968	-5.205	10.173	-495%
Scenario 3				
Market Strategy 1	6.041	-4.163	10.204	-407%
Market Strategy 2	5.651	-4.551	10.202	-436%
Market Strategy 3	5.711	-4.524	10.235	-433%
Market Strategy 4	4.968	-5.204	10.172	-484%
CWB pool	8.47	1.260	7.214	

Source: Author's calculations

Table 19. Minimum percent change in the export basis to make producers' preference switch towards the open market in 2009/2010

	Expected Price ($/bu)	Export Basis ($/bu)	Expected Profit ($/bu)	Change in export basis
Scenario 1				
Market Strategy 1	4.908	-2.444	7.352	-248%
Market Strategy 2	4.973	-2.361	7.335	-243%
Market Strategy 3	4.896	-2.489	7.385	-250%
Market Strategy 4	4.978	-2.361	7.340	-243%
Scenario 2				
Market Strategy 1	4.908	-2.444	7.352	-307%
Market Strategy 2	4.973	-2.361	7.335	-300%
Market Strategy 3	4.896	-2.489	7.385	-311%
Market Strategy 4	4.978	-2.361	7.340	-300%
Scenario 3				
Market Strategy 1	4.908	-2.444	7.352	-301%
Market Strategy 2	4.973	-2.361	7.335	-295%
Market Strategy 3	4.896	-2.489	7.385	-305%
Market Strategy 4	4.978	-2.361	7.340	-295%
CWB pool	6.44	1.260	5.185	

Source: Author's calculations

Chapter 7: Discussion and conclusions

7.1 Conclusions

Wheat is the most common cereal crop grown in Western Canada and has been marketed through the Canadian Wheat Board since 1935. Many farmers feel the unique pool system earned profits and shared risk. More recently many have challenged the monetary value the CWB provides. This research uses data from the U.S. open market to analyze potential alternative open market marketing options for wheat. Using comparative analysis, this study considers whether Western Canadian farmers would prefer the open market to the CWB pool. The results of the analysis suggest that producers in Western Canada with moderate to high levels of risk aversion would prefer the CWB pool as it is currently operated to open market scenarios.

The first part of the model investigates 12 open market scenarios for crop years 2006/2007, 2007/2008, 2008/2009 and 2009/2010. More specifically, the model considers the trade-off between expected profit and risk in an expected utility framework to investigate farmers' preferences between the CWB pool and the open market. Assuming relative risk aversion of 3, results of the simulation procedure rank the CWB as the most preferred marketing option overall. In the four years analyzed, there are three base scenarios and 4 marketing strategies which accumulate to 48 open market comparisons. In 45 of those comparisons, the CWB is the most preferred by farmers This result is mainly due to the fact that the pool provides smaller risk and profits above or only slightly below expected profits in the open market.

However, the results should be interpreted with care as the risk attitude of farmers is individualistic. Even though a relative risk aversion of 3 can be seen as an "average" level of risk aversion (Lence 1996; Nelson and Escalante 2004; Mattos et al. 2008), individual farmers can exhibit a large range of risk preferences. In the sensitivity analysis risk aversion levels of 2 through 10 are also considered in order to portray the varying levels of farmers' risk aversion. The results of the risk aversion analysis suggest that farmers exhibiting more aversion to risk (risk aversion greater than 3) tend to have a stronger preference for the CWB pool. Conversely, farmers exhibiting less aversion to risk (risk aversion smaller than 3) would start choosing the open market rather than the CWB pool.

The next part of the sensitivity analysis employs the same model but uses a measure of downside risk. Profits remain unchanged from the first analysis, but risk changes as only volatility below the average futures price and above the average basis is measured. In general, risk measured by the semi-standard deviations are smaller and farmers experience less risk in the open market using this specific risk measure. Thus, the CE values are higher (less negative) when downside risk is used as a measure of risk, but the changes in magnitude are relatively small and still lead to the same qualitative results as in the initial analysis.

7.2 Implications

The results of the research have implications for producers in Western Canada who do not possess a risk aversion level of 3. These producers are either more risk averse or are risk-loving which affects their preference of marketing strategy (as shown in the sensitivity analysis). Risk-loving farmers prefer to sell their wheat in the open market, while more risk averse farmers prefer the CWB pool.

The Marketing Freedom for Grain Farmers Act passed November 28, 2011 which removes the CWB's single desk and enables all farmers to market grain in an open market. However, this legislation will render implications for risk averse farmers who prefer the CWB pool option. In an open market environment, the CWB will continue as a voluntary board which will impact their operations and affect farmers' profits who choose to market through them. For example, the CWB pool option will be distorted as the number of participants won't be guaranteed. This can affect the CWB's overall sales volumes and profits to customers buying in large quantities. The more risk averse farmers may also need assistance marketing wheat because the process will be new to most of them and they will most likely want to find ways to minimize risk. The results show that the CWB pool is preferred by farmers, which is most likely due to the pool and its risk reduction. Therefore, in an open market many farmers may be seeking more risk management tools. Contracts that reduce risk may be more appealing, rather than speculating to try and market at the highs of the year.

7.3 Limitations

Wheat has been marketed through the CWB since 1935 and operates differently than in an open market. Therefore, obtaining a current data set the closely reflects open market environments is difficult. Data on the export basis is not readily available and, consequently, this study was based on the export basis from one specific location, namely Trochu, Alberta. The analysis for other regions in Western Canada might not necessarily yield the same numerical results found in this study. Even though the general qualitative conclusions may hold for all Western Canada, regional dynamics of prices and export basis can generate distinct expected profits, export basis and risk. Additionally, the analysis considers four years of data, but only the one basis value is known. To determine the previous three years data the Volume-Related Composite Price Index (VRCPI) is used as an approximate measure of annual changes of the export basis. Albeit the VRCPI reflects price changes largely attributable to changes in the export basis, the values used in this study do not necessarily represent the exact export basis for each crop year.

Another dimension of the analysis is the expected change in the export basis in an open market. The percent changes adopted in the research are based on the simulation model by Fulton et al. (1998), which estimated grain handling and transportation rates that would be set by railways and elevator companies under various scenarios. For example, Fulton et al. (1998) assume that railways and terminals know how local elevators will react to changes in freight rates and terminal charges and thus a the model assumes railways and terminal elevators are leaders in a two period game. The results may be affected if another pricing strategy is assumed. Overall, these changes in the export basis could be different depending on the assumption of the model that generated the changes. This research also implicitly assumes the export basis changes by a certain percent for each scenario and then follows the same changes over time as in the current environment under the CWB. However, in an open market the export basis may vary differently since the wheat market will be operating in a distinct structure. A related point is the export basis volatility. In this research it is assumed that in an open market the volatility of the export basis will be the same in Western Canada as in the U.S, which depends on whether the Canadian market will adjust in an open market environment similar to what exists in the U.S.

Finally, it is also assumed that the price of wheat and risk in the open market are derived from farmers marketing grain from Minneapolis wheat futures market. However, upon removal of the CWB's single desk, other alternatives with distinct price and risk dynamics may appear. For example, ICE Futures Canada is scheduled to launch a new futures contract on wheat which could be used as the standard price reference for farmers in Western Canada.

7.4 Recommendations for future research

This research contributes to the ongoing studies regarding grain marketing and the Canadian grain handling and transportation system. Future research could follow the same methodology but use new and more accurate data is as it becomes available upon the development of a new market structure. Further studies might look into the different demographics of the farming population. For example, risk aversion of farmers of different age groups could be explored, providing a better understanding of the trade-offs between expected profit and risk within different age groups and their preferences in terms of marketing strategies. Other demographics could have implications for risk attitude and preferences between risk and profit, and it would be interesting to consider variables such as farm location, size and wealth, and use of market advisory services, among others. Future research could also analyze open market scenarios based on different zones or region of Western Canada. According to Fulton et al. (1998), each region will have varying transportation costs. Fulton et al. (1998) note two patterns observed in their research. First, where only one railway is operating, the increase in freight rates is greater than areas where both rail lines are accessible. The same is expected to occur under the current market structure as railways will use their market power to raise rail costs. Secondly, the increase in freight rates is much less in regions where local consumption is large because the exports are sensitive to changes in costs (the basis). If changes in rates increase too high, exports decrease because local markets are more appealing due to a lower cost of transportation. In these regions, the rail lines must compete with local end users thus forcing the rail prices to remain at a certain level in order to compete in the local market. This research does not address these issues in the simulation. Finally, another dimension to be considered for further research is the alternate marketing contracts provided by the CWB (generally known as Producer Payment Options). This research only considers that farmers would choose between the CWB pool and some open market strategies between 2006/2007 and 2009/2010, whereas in those years they could have also chosen to use CWB contracts such as FlexPro, Basis Price Contracts, Fixed Price Contracts or the Grainflo storage program.

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