THE ECONOMIC IMPACTS OF THE CANADIAN WHEAT BOARD RULING ON U.S.–CANADA MALT BARLEY CONTRACTING

by

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ABSTRACT

The August 2012 termination of the Canadian Wheat Board's (CWB) monopsony and monopoly powers changed the market structure for Canadian grains. In this paper, we examine what this change means for North American malt barley markets. We develop decision–making models of Canadian barley producers and U.S. malt barley procurers (maltsters), and account for the relative costs of altering each party's existing contracting decisions. The contract decision model provides the foundation for an empirical simulation–based analysis of contracting decisions by Canadian and U.S. malt barley market participants in the new institutional environment. The simulation model is calibrated to jointly characterize the relationship among Canadian malt barley production factors such as yields and expected barley malting rates; transportation costs impacting U.S. firms; and relevant government policies and changes. The latter category includes termination of the CWB's single–desk authority and the continuing jurisdiction of the Canadian Grain Commission and the *Canadian Transportation Act (1996)*. Our model suggests that terminating the CWB's monopsony and monopoly powers may give U.S. brewers and Canadian farmers incentives to contract for malt barley and further deregulation of transportation rates and wheat variety controls could benefit North American malt barley farmers. However, those incentives are not so substantial as to guarantee U.S. maltsters will contract with Canadian farmers for the procurement of malting barley.

INTRODUCTION

The Canadian Wheat Board (CWB) shaped the structure of Canadian grain markets for nearly 70 years as the sole buyer and seller of Western Canadian grain. The Canadian single–desk marketing board affected farmers' production and marketing decisions; altered the structure of the grain acquisition, transportation and processing industries; and affected international trade and trade relations, especially between Canada and the United States. Canadian grain markets have also been regulated through restrictions on the types of grains allowed to be grown, caps on rail revenues from grain transportation, and license requirements for grain exports. These regulations affected the net costs to buyers of Canadian grains and net revenues to Canadian producers. Specifically, licensing regulations stopped technology adoption that could have increased wheat farmers' economic rents by 15%–25% (Ulrich et al., 1987) and without revenue caps on rail transport of grains, rail rates would be an estimated 4% higher (Vercammen, 1999). Estimates have shown that systemic costs associated with Canadian grain regulations are approximately C$16 per metric ton for barley (Carter et al., 1998).

In November 2011, the Canadian government voted to remove the CWB's single–desk powers through the *Marketing Freedom for Grain Farmers Act (2011)*, which became effective on August 1, 2012. The act established a competitive environment for marketing and procuring Canadian grains, enabling brewers to procure malt barley directly from Canadian farmers, rather than the CWB. Traditionally, a major concern for U.S. brewers has been the acquisition of adequate quantities of malt barley to meet beer production demands (Johnson et al., 2000). To maintain the quality of their product and ensure sufficient malt supplies, U.S. brewers (often through maltsters) contract with U.S. farmers to grow specific varieties and amounts of malt barley. The increased incidence of crop disease in the 1990s and decreasing malt barley production, has led U.S. buyers to geographically diversify their malt barley procurement (Johnson & Nganje, 2000). The recent Canadian policy change may provide such opportunities for U.S. brewers in markets to which, historically, access has been limited or closed. The existing literature on malting barley and the CWB has compared the costs of the CWB to a less regulated market and compared differences between quality and types of contracts in Canada and those in the United States. This study examines the conditions under which malt barley contracts will occur in a less regulated Canadian market. We model the contracting and planting decisions of Canadian farmers and the contracting and procurement decisions of U.S. brewers and malt firms (maltsters) in order to identify the conditions under which contracts between the two parties are likely occur.

We develop decision–making models of Canadian barley producers and U.S. malt barley procurers (maltsters) following the work of Goodwin and Schroeder (Goodwin & Schroeder, 1994), who analyze farmers' adoption of forward pricing techniques and account for the relative costs of altering each party's existing contracting decisions. Similarly our conceptual model of contracting incorporates conditions unique to malt barley markets. including a farmer's attitude towards risk and the quality and quantity concerns of both farmers and maltsters. The model addresses three important questions. First, how does the termination of the CWB's single–desk authority affect a Canadian farmer's contracting decisions? Second, what are the effects on U.S. maltsters' contracting decisions? And third, what circumstances are necessary to ensure favorable market conditions for contracting in Canada?

The conceptual contract decision model provides the foundation for an empirical simulation–based analysis of Canadian and U.S. malt barley market participants in the new institutional environment. The simulation model is calibrated to jointly characterize the relationship among Canadian malt barley production factors such as crop yields and expected barley malting rates, transportation costs impacting U.S. firms, and relevant government policies and changes. The latter category includes termination of the CWB's single–desk authority and the continuing jurisdiction of the Canadian Grain Commission (CGC) and the *Canadian Transportation Act (1996)*. Historical yield and price data were mainly collected from the Canada Grains Council and the Unites States Department of Agriculture. We do not have data from less regulated Canadian grain markets because the single–desk was only recently removed, so historical data were used to determine marginal price and yield distributions and their correlation structures. Then we performed Monte Carlo simulations using normal copulas. The model allows us to identify those prices for malting barley that Canadian farmers and U.S. maltsters are willing to accept in a less regulated market. The analysis also provides estimates of the probability that circumstances will be favorable to contracting in Canada: that is, the frequency with which market conditions occur under which both American maltsters and Canadian farmers are willing to offer and accept contracts for the production and acquisition of malting barley. Using this approach, we examine several market scenarios in which Canadian grain markets are further deregulated through less stringent varietal control and the removal of revenue caps for grain transportation.

We find that selection rates and relative distances for maltsters to ship grain to their facilities are important aspects of malt barley contracting decisions. Farmers in Saskatchewan and Manitoba are more willing to accept lower malt barley contract prices as selection rates increase, and the probability that conditions will be favorable for contracting also increases. Similarly, as the relative distance to ship grain decreases the probability that maltsters will contract in Canada increases. However, further deregulating Canadian grain markets by removing revenue caps on rail transport of grain does not seem to have much effect on contracting opportunities. On the other hand, removing varietal restrictions for spring wheat, a crop that competes for planted acres with malt barley, would make farmers less willing to accept relatively low malt barley prices that they might have previously accepted. This significantly decreases the likelihood that U.S. maltsters would find opportunities in Canada that are better than opportunities in the United States. In Manitoba the likelihood of contracting decreases by 5.3–5.7 percentage points and in Saskatchewan the likelihood decreases by more than 15 percentage points when varietal restrictions are removed. Alberta is found to be marginal with respect to the possibility for malt barley contracting by U.S. maltsters due to relatively long grain shipping distance compared to U.S. growing regions and other Prairie Provinces.

The results of this study suggest that terminating the CWB's monopsony and monopoly powers may give U.S. brewers and Canadian farmers incentives to contract for malt barley. Further, eliminating other regulatory policies still in place in Canada could benefit participants in North American malt barley markets. For example, the removal of revenue caps on grain transport could conceivably result in a more uniform and more competitive North American rail system. In addition, modifying Canadian varietal control standards of spring wheat could increase Canadian farm revenues but would reduce incentives to contract with Canadian farmers for malt barley.

CHANGING INSTITUTIONAL FRAMEWORK

In 2012 numerous regulatory changes were implemented with respect to the Canadian grains sector. Although there was substantial deregulation with regard to the CWB, the Canadian Grain Commission (CGC) took on some the CWB's previous activities. In August 2012, Part II of the *Marketing Freedom for Grain Farmers Act (2011)* went into effect. Consequently, the CWB now operates under the *Canadian Wheat Board (Interim Operations) Act (2011)* and changes to the *Canada Grain Act (1985)* have been made. This chapter first examines the historical role of the CWB and then describes its current status. A similar discussion concerning the CGC and Canadian rail regulation follows. Lastly, we summarize relevant trade agreements and trade disputes.

Canadian Wheat Board (CWB)

CWB History

The CWB was originally formed in 1919 as an agricultural marketing board in an attempt to guarantee farmers advantageous prices; however, it was dissolved the following year. In the early 1930s, the price of wheat fell below the cost of seed and farm incomes fell. This led to support for government action and the CWB was reestablished by the *Canadian Wheat Board Act (1935).* Until 1943, the CWB was a voluntary marketing agency for wheat grown in the Prairie Provinces. In 1943, sales of wheat through the CWB became compulsory and in 1949, sales of oats and malt barley through the CWB became compulsory as well. Although the *Canadian Wheat Board Act (1935)* had been subject to expiration, the act was amended in 1965 to renew and extend the CWB indefinitely (Magnan, 2011).

Historically, the primary role of the CWB has been as the sole buyer and seller of western Canadian grains. The CWB's operations included control of elevators, shipment of grain, and grain marketing. These roles were established by federal law and the CWB was involved with each of these aspects of grain handling and marketing. For example, the CWB negotiated rail rates on behalf of farmers, and also provided a service which allowed farmers to reserve rail cars for shipment to elevators. Additionally, the CWB managed a price–pooling system for the purpose of limiting farmers' exposure to intra–year price risk. The price pooling system was managed as follows: producers were paid an initial payment upon grain delivery, an interim payment, and a final payment after pooled accounts were closed and shipping and marketing costs had been deducted. Canadian farmers received different prices for their grain depending on where grain was delivered. But farm prices were based on the same price pool that was used as the basis for the point of delivery price, and price pools were guaranteed by the government. After buying grains, the CWB then marketed Canadian grain worldwide.

Since 1935, the main arguments in favor of government support for the CWB were that the CWB was able to minimize grain handling and marketing costs and had the ability, through monopoly and quality control, to exercise market power in the export and domestic market. In other words, the CWB was politically viable for half a century because many farmers believed that the CWB increased producer revenues. Table 2.1 presents recent events in CWB history that demonstrate declining political support and the CWB's attempts to modernize and stay politically relevant. However, public opinion eventually declined so much that the CWB lost political support.

Table 2.1: Recent CWB History

1980s	Farm income crisis: some areas, notably Saskatchewan, saw negative net farm incomes (Qualman, 2004). This increased opposition to the CWB's marketing mandate.
1986–1994	Uruguay round of General Agreement on Trade and Tariffs (GATT) negotiations: the World Trade Organization (WTO) made decisions regarding state trading enterprises (STEs). These decisions included minimum market access rules and gradual reduction of export subsidies. STEs were allowed under these agreements, provided that they did not distort trade. The United States complained that the CWB's practices were unfair, but the CWB claimed that they did not distort prices because they did not change world grain prices. However, during more recent negotiations Canada made some concessions. The Canadian government guaranteed CWB borrowings, but it was considered unfair for the CWB to borrow at the same rate as the Canadian government as this increased producer returns. Thus the CWB was no longer allowed to do so.
1990	Strategic review of CWB's operations revealed that, (1) the CWB needed to be modernized and provide more accountability to farmers (2) the CWB faced major challenges due to trade liberalizations and more stringent end user demands.
Early 1990s	Opposition to the CWB: notably there was a crisis of the CWB's political legitimacy. Domestic political support for agriculture declined which meant that the CWB became more of a farmer controlled entity. Even so, a minority of farmers viewed the CWB as an obstruction to a more efficient deregulated grains sector. In particular they were opposed to being forced to sell grains through the CWB.
1993	The federal government conducted a failed attempt to end the CWB through executive order.
1994	After the failed attempt to end the CWB, the federal government consulted with the Western Grain Marketing Panel about the board's future.
1996	Continued opposition to the CWB: the Western Grain Marketing Panel recommended partial deregulation of the CWB's marketing monopoly powers for barley. This was controversial and a referendum was called in order to retain the CWB's single–desk powers. Single–desk powers were retained but CWB governance was reformed through the re–writing of the *Canadian Wheat Board Act (1985).*
Late 1990s	Redefined relations with the federal government: farmers were allowed more marketing options, but still subject to collective marketing. There was a shift to more direct farmer control of the board which improved farmers' general opinions of the CWB. Also, producer payment options (PPOs) were introduced. These were specialized contracts that allowed farmers to use pricing instruments similar to those in an open market, even though the sales still went through pooled accounts.
1998	Revisions to the *Canadian Wheat Board Act (1985)* were passed: the new act introduced the principle of democratic farmer–control over the CWB. This meant that any major changes of the CWB's marketing mandate were subject to a farmer vote. Additionally, the CWB's board was restructured such that it comprised of 10 elected farmers and 5 government appointees.
2006–2007	More than 20,000 producers were using CWB producer payment options.
2008	Another attempt to end CWB's single–desk power in barley markets was struck down by executive order in federal court.
2012	The CWB's monopsony and monopoly powers are terminated and the *Canadian Wheat Board (Interim Operations) Act (2011)* went into effect.

Current Status of the CWB

The *Canadian Wheat Board Act (1985)*, which granted monopsony and monopoly rights to the CWB, was officially repealed on August 1, 2012 after several years of declining political support. The *Canadian Wheat Board (Interim Operations) Act (2011)* stipulated that the CWB continue operations as a corporation with the purpose of marketing grain but did not grant monopsony and monopoly rights to the CWB, creating a less regulated market for Canadian grain. Part I of the act specifies the commercial structure of the CWB, from how the president is appointed to details of the employee pension fund. Part II provides details of CWB marketing, namely price–pooling. Part III comprises of general regulations that include implementation of NAFTA requirements (*Canadian Wheat Board (Interim Operations) Act*, 2012).

The crux of the legislation is that the CWB is no longer a single–desk marketing monopoly and grain pools are voluntary. To aid this transition, the federal government, in June 2012, set aside C$349 million, over five years, to cover the CWB's "wind down" costs. "Wind down" costs include human resource costs, the costs of extinguishing fixed asset debt, and costs related to reducing operations. The money is not for routine CWB business expenses; rather it is only to be used for transitional costs. The purpose is that farmers will not have to bear the costs of the transition but will be subject to the costs of the open market ("Questions Farmers are Asking", 2012). There are also several less obvious subsidies written into the *CWB (Interim Operations) Act (2011).* The first is that Parliament will provide funds to cover losses on any pool (Sec. 19.3). The second is that the Government of Canada guarantees CWB debt (Sec. 26.5). In fact, the exact language of this guarantee has changed little from the original:

> The repayment with interest, if any, of money borrowed by the Corporation is guaranteed by the Minister of Finance on behalf of Her Majesty if the terms approved under subsection (4) indicate that it is to be guaranteed.

Although payments on debts are made directly from the CWB, they likely receive lower long and short run rates than they otherwise would have (*About us: Investor relations*, 2012).

Another transitional measure is the implementation of new check–off funds, which began in August 2012 and were previously collected by the CWB. The purpose of the check–offs is to fund research, grain marketing, technical assistance, and the administrative costs of these activities. Groups that directly benefit from the funds include the Canadian International Grains Institute, the Canadian Malting Barley Technical Centre and the Western Grains Research Foundation. The check–off, overseen by the Alberta Barley Commission, is automatically made on sales of wheat and barley when sold to licensed grain buyers in specified areas.[1] It does not apply to sales between producers or feed and exports that are not sold to licensed buyers. However, the check–off is voluntary and farmers may request a refund by writing to the Alberta Barley commission (*FAQ: Payments and Check-offs*, 2012) (*Regulations Respecting Research, Market Development and Technical Assistance (Wheat and Barley)*, 2012).

While we know that the CWB will continue to exist for the next five years, whether the CWB will exist beyond 2017 is uncertain. It is possible that the CWB will operate profitably, or an unprofitable CWB might petition for government funds beyond 2017.

[1]These areas include Manitoba, Saskatchewan, Alberta and the Peace River District of British Columbia. Alberta receives an exemption from the research portion of the check–off due to a preexisting exemption.

However the market will operate as a less regulated market regardless of the CWB's fate.

Canadian Grains Commission (CGC)

Historical Role of the CGC

The CWB and the CGC both play an important part in the Canadian barley sector. Similar to the CWB, the CGC was established by law in the early 20th century. The *Canada Grain Act (1985)* broadly stipulates that the CGCs purpose is to maintain the quality of Canadian grain and grain handling services. This means the CGC can do the following (Johnson, 1999):

- "establish grain grades and standards"
- "implement a system of grading and inspection for Canadian grain"
- "establish and apply standards and procedures regulating the handling, transportation and storage of grain, and also regulating facilities used in such operations"
- "conduct investigations and hold hearings when required"
- "undertake, sponsor and promote research in grain and grain products"
- "and advise the minister responsible for the Commission on matters relating to grain and grain products"

In short, the CGC must assure quality and regulate the grain handling industry.

The CGC accomplishes quality assurance by weighing and inspecting grain before export and by participating in grain quality research through their Grain Research

Laboratory. The standards by which grains are graded are determined by the Grain Standards Committee, whose members represent different areas of the Canadian grains sector. Although there are three major grades of malting barley, special select, select, and standard select, these grades do not play a large role in determining prices. Rather, buyers are generally interested in variety and maximum protein. Also, while export standards are maintained for barley shipments to most countries, shipments to the U.S. are only cleaned at the request of the buyer.

Variety Registration

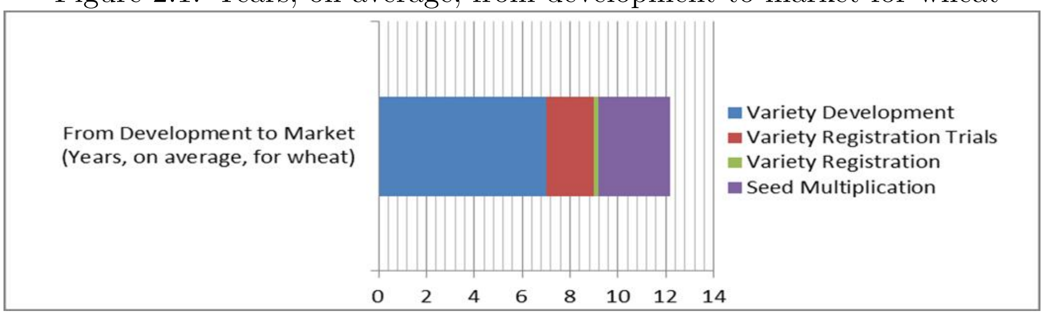
The CGC has played an important role in Canadian grain markets because only registered varieties of grain are qualified to be sold in Canada. New varieties are judged on whether they are as good as, or better than, the existing varieties in terms of end–use, disease resistance, etc. They are then considered by the Prairie Registration and Recommending Committee for Grain. If allowed, there is a two year interim period during which merit of the variety is confirmed. Then if the variety is successful in the interim period then it is awarded full registration. This process can mean that varieties developed by U.S. brewing firms are grown in the U.S. sooner than in Canada (Johnson, 1999).

According to the 2009 amendments to the *Seeds Regulations (2006)* act, barley is a Part I crop and subject to the most stringent level of regulatory requirements (*Regulations Amending the Seeds Regulations (Part III and Schedule III)*, 2009).[2] Part I crops require a recommending committee, an assessment of merit, and registration trials. In order to be a candidate for evaluation, a cultivar must be grown in at least six trials for the purpose of providing data regarding characteristics such

[2]Previously, all crops were subject to the same requirements. The amendment relaxed the requirements for a few crops, not including wheat or barley.

as yields and quality. A committee then evaluates a candidate for registration and makes a recommendation to the Canadian Food Inspection Agency. Recommending committees are comprised of members of the crop–specific industry. This includes individuals involved in every stage of the process, from production and development to marketing and regulation. For barley, the CGC uses the committee's evaluation to establish a list of varieties eligible for delivery into each market class (Commission, 2012).

Figure 2.1: Years, on average, from development to market for wheat



Current Status of the CGC

The CGC serves the same purpose but, due to the change in the CWB's status, the CGC's responsibilities now include managing rail cars. Internal changes include changes in fees and changes to the variety registration process.

Whereas rail cars used to be allocated by the CWB, changes to the *Canada Grain Act (1985)* reassigned the responsibility to ensure rail car availability to the CGC (Sec. 87) (*Canada Grain Act*, 2012). Applying for a producer car requires C$20 and a small amount of paperwork submitted two weeks before the requested week of availability (*Applying*, 2012). Similarly, changes in CGC user fees are anticipated. Most user fees for CGC services have not changed for the past 20 years. Until recently user–fees accounted for approximately 50% of CGC funding with the other 50% coming from the federal government. In the 2011–2012 marketing year, the CGC's total funding was C$82,733,000 and fee revenues accounted for C$38,292,000. In recent years, CGC costs have risen, so proposals to modernize CGC fees are currently being examined. The authority to charge and change user fees is derived from the *Canada Grain Act* (Sec. 116.1.r). The regulatory process currently underway is very involved:

- "complete a consultation process"
- "complete an impact assessment of the user fee "
- "identify the cost to deliver a service"
- "identify the cost to deliver the service"
- "identify what costs the user fee will address"
- "establish service standards and performance measurements"
- "establish an independent advisory panel to address complaints, if complaints arise"
- "report annually to Parliament" (*User fees - Consultation document*, 2012)

The CGC will set fees which will balance revenues and expenses over a 5–year period. It can be expected that fees will rise in order to meet its rising cost obligations (*User fees - Consultation document*, 2012).

The CGC recognizes that variety registration restricts timely access to new crop varieties. Despite this awareness, the current registration process for barley varieties does not address this issue (Commission, 2012). However, the classification system has changed in 2012 to reflect the different end uses of barely, namely that there is more human consumption of barley products outside of beer. The classification changes include adding a food class, removing the hulless class, and including hulless and covered grades for food, malting, and general purpose barley. In short, the new system classifies barley into food, malting or general purpose (*Barley classification to reflect different end uses*, 2012). The rationale of requiring variety registration continues to include health and safety concerns, but also ensuring the quality of Canadian grains. The CWB has historically used quality to differentiate Canadian grains in the world market; theoretically this lead to monopoly power in world grain markets. Since the CWB is no longer the sole marketer of Canadian grains, it is possible that recommending committees may relax the standards of merit required for recommendation of new varieties.

Canadian Rail Policy

History of Canadian Rail Policy

Railways in Canada have a long history of being regulated. Canadian rail lines were built in the 19th century using public funds and have had regulations regarding railway market power since the beginning. Low farm prices in the 1980s led to political support for rail subsidies in order to keep grain transportation costs low. The *Western Grain Transportation Act (1983)* provided subsidies from the federal government for transporting grain for export (M. Fulton et al., 1998). However, the *Western Grain Transportation Act (1983)* ended in 1995 and was subsequently replaced by the *Canadian Transportation Act (1996)* which did not include subsidies, but instead imposed maximum allowable revenue limits that rail companies could charge for grain transport.

Current State of Canadian Rail Policy

Revenue caps on rail transport are still in place under the *Canadian Transportation Act (1996)* (Sec.150–151), and the cap has not changed since 2000 (*Canada Transportation Act*, 2012). Although railways are allowed to set their own rates, the maximum amount of grain revenue allowable to the Canadian National Railroad and the Canadian Pacific Railroad is based on the following formula:

$$[A/B + ((C - D)0.022)]EF$$

where:

- A is the company's revenues for the movement of grain in the base year;
- B is the number of tonnes of grain involved in the company's movement of grain in the base year;
- C is the number of miles of the company's average length of haul for the movement of grain in that crop year as determined by the Agency;
- D is the number of miles of the company's average length of haul for the movement of grain in the base year;
- E is the number of tonnes of grain involved in the company's movement of grain in the crop year as determined by the Transportation Agency; and
- F is the volume–related composite price index as determined by the Transportation Agency (*Backgrounder: Western Grain Revenue Cap Program*, 2012)

Over the past 11 years, Canadian National Railway exceeded the revenue cap four times and Canadian Pacific Railway exceeded the revenue cap five times. However, both railways have been within 10% (above and below) of the cap for the past 11 years (*Western Grain Revenue Cap Statistics*, 2011), which indicates that the revenue cap is effective. As the cap is still in place, it will likely continue to be effective.

Surrounding Framework: Trade Policies

Institutional framework affecting North American barley markets, other than Canadian agencies, are trade agreements between the United States and Canada. Recently, trade agreements relating the North American malt barley markets have followed the general trend in Canadian grain markets of moving towards less regulation. Historically Canada and the United States have had disputes concerning the CWB, though state trading enterprises (STEs) are allowed by international trade agreements. This list outlines relevant trade agreements and export programs.

Canadian/United States Free Trade Agreement (CUSTA)

CUSTA was signed in 1988 and then actualized in 1989. In the context of malt barley markets, the significance of the agreement is that all nontariff measures were converted to tariffs, and all tariffs were to be phased out over a period of 10 years (Buschena et al., 1998).

Export Enhancement Program (EEP)

The 1985 Farm Bill established the Export Enhancement Program with the purpose of maintaining U.S. export market share. The Export Enhancement Program was carried out by providing subsidies to grain companies for shipments sold to certain destinations. Some of these destinations are former Soviet Union countries, Poland, and Saudi Arabia. These countries potentially received lower prices on feed barley due to the subsidies (Schmitz et al., 1998). Though, the last significant year of the Export Enhancement Program was 1995 (Hanrahan, 2008).

General Agreement on Trade and Tariffs (GATT)

The Uruguay Round of the GATT reached its final round in 1994 with the *Treaty of Marrakech (1994)*. This agreement stipulated that major barley exporting countries reduce their expenditures on subsidies by 36% and the subsidized quantity by 21% from their average levels in 1986–1988. At the same time, importing countries were expected to reduce their tariffs and trade restrictions by 15% for developed countries and 25%–33% for developing countries (Mao et al., 1996).

North American Free Trade Agreement (NAFTA)

NAFTA, authorized in 1993 and in effective in 1994, is an agreement between the three North American countries with the general goal of eliminating trade barriers. With regard to barley, NAFTA dictated that U.S. import tariffs on both barley and malt were eliminated by 1997. It also called for the elimination of Canadian tariffs on malt barley in 1996 and malt in 1998 (Buschena et al., 1998).

Following the adoption of both GATT and NAFTA there have not been any major trade disputes regarding grain trade between Canada and the United States. Though the U.S. General Accountability Office (GAO) has conducted several investigations concerning the CWB, none have resulted in action against the CWB. Table 2.2 outlines all notable trade disputes between the two countries for the past twenty years.

Table 2.2: Major Trade Disputes (*Chronological list of disputes cases*, 2012) (GAO, 1998)

1994	ITC	Investigation: Do Canadian wheat products harm U.S. farm programs? Result: Yes. Cap on Canadian exports to the United States for 1994–1995
1996	U.S. GAO	Investigation: Do STEs distort trade? Result: USDA officials did not have evidence that the CWB violated trade agreements
1998	U.S. GAO	Investigation into wheat trade issues
1998 (Consultation only)	GATT	Canada filed a complaint regarding restrictions imposed on trucks carrying cattle, swine, and grain originating in Canada.
Consultation 2002, report 2004	GATT	The United States filed a complaint against Canada saying that the CWB violated several sections of GATT. Result: certain sections of the *Canada Grain Act (1985)* and *Canada Transportation Act (1996)* were inconsistent with GATT and subsequent changes which were implemented in 2005.
2003	ITC	Investigation: do Canadian sales of hard red spring wheat violate anti–dumping and countervailing duty rules? Result: Yes, 11.4% punitive duty
2004 (Consultation only)	GATT	Canada filed a complaint against the United States concerning U.S. trade policies about hard red spring wheat imported from Canada. Canada contested the U.S. investigation and determination that hard red spring imports would harm U.S. industry and the subsequent duties applied to Canadian hard red spring wheat.
2005	NAFTA	CWB challenged the hard red spring case with Chapter 19. Result: the NAFTA panel upheld that hard red spring imports to the United States do not cause material injury to U.S. industry
2007	ITC	Canada challenged the United States to refund the duties collected during the hard red spring case Result: the court ruled in favor of the Canadian position.

Past U.S. contentions about the CWB include the following: it was a STE with a monopoly on Canadian grain sales and was subsidized both directly and indirectly. Although the role of the the CWB as an STE did not by itself violate international agreements, the United States attempted to pursue the CWB through domestic trade legislation which outlaws "dumping, actionable subsidies and surges in imports" (GAO, 1998). The United States was ultimately unsuccessful in these attempts but continued to push for action against STEs. In the new regulatory state in Canada the United States is unlikely to have the same objections, especially considering that many American companies are involved in Canadian grain markets.

Summary

After more than half a century of a government enforced monopsony and monopoly under the CWB, there is a less regulated market for Canadian grains. Grain pools and check–off funds are both voluntary for farmers. The CWB receives limited government support until 2017, when it will either continue as a corporation or shut down. The CGC will be adopting the CWB's former role managing rail car reservations in addition to maintaining varietal control. Grain transportation policy has not changed in recent years and the cap on rail revenues from grain transportation remains in place. Regarding trade policies, there are no tariffs on Canada–U.S. malt barley trade and it can be expected that U.S. regulators find the removal of the CWB amenable.

The next section discusses the potential economic reasons for establishing a single–desk for Canadian grains, and expands on the implications of these institutional changes by investigating the literature. Most importantly the literature gives insights into how changes in market structure, varietal control, and grain handling services influence the Canadian barley market and bilateral Canada–U.S. trade. In later chapters we model malt barley contracting in Canada accounting for the new institutional structure and the new possibility that U.S. brewers may now contract directly with Canadian farmers. Using our model we determine the probability conditions will be favorable for U.S. brewers to source malt barley from Canadian farmers. We also investigate how continuing Canadian grain regulations may influence malt barley contracting decisions.

LITERATURE

This chapter reviews previous studies on the past and future roles of the CWB and the related literature of on state trading enterprises. First, STEs are classified and their effects on international trade and welfare are discussed. Second we evaluate the potential benefits of the CWB; competitive marketing services, price discrimination, and higher export market share. Third, we investigate issues regarding firms.

State Trading Enterprises (STEs)

Organization and Classification

In order to understand their roles in domestic and world grain markets STEs are compared using methods based on either performance or trade distortion. McCalla & Schmitz (1979) and L. Martin (1980) base their comparisons of STEs on performance but note systematic problems with these methods. McCalla & Schmitz (1979) compare U.S. and Canadian grain marketing systems basing performance on producer prices and export market shares. But they find no clear "best" system because STEs directly influence consumers, producers, grain handlers, and policymakers and indirectly influence related industries. L. Martin (1980) first conceptualizes performance by specifying the expectations of market participants as a set of objectives, and suggests quantifiable measures for these objectives such as producer prices relative to costs, trends in supplies, and output relative to industry capacity. He then defines a set of performance indicators for each of the various objectives, examples of indicators are prices, the stability of prices, productivity, etc. Finally, these measures are used when comparing two STEs. However, this method is subject to issues relating to data availability, identification, and a lack of norms among the measures. Despite their problems, these types of comparisons may be helpful in that they may be able to give policy makers information on areas of poor STE performance.

When comparing how grain marketing systems relate to each other, the classification system based on a STE's ability to distort market share, suggested by Ackerman & Dixit (1999), is more intuitive. They categorize STEs into four types which are summarized in Table 3.1, the first not having much ability to distort the market and subsequent types escalating in severity of market distortion.

Type I: The STE does not control the domestic market or international trade. That is the STE competes with private firms.

Type II: The STE controls the domestic market but does not control external trade. Domestic market controls include price regulation, supply control, and domestic marketing. But domestic consumers and producers are allowed to take advantage of the international market.

Type III: This type controls the export market but competes with private firms in the domestic market.

Type IV: This STE controls both the export market and the domestic market.

Table 3.1: Classifying STEs based on their control of domestic markets and trade (Ackerman & Dixit, 1999)

Type	Trade Controls	Domestic market controls	Potential for trade distortion
Type I	No	No	Negligible
Type II	No	Yes	Low
Type III	Yes	No	Moderate
Type IV	Yes	Yes	High

The distortions caused by type I and II STEs are relatively low, and trade distortion becomes progressively increased. This scheme can be extended beyond a strict interpretation of STEs and, for example, the Commodity Credit Corporation in the

United States is between a Type I and a Type II STE. The former Australian Wheat Board (AWB) and the New Zealand Dairy Board (NZDB) are Type III STEs, while the CWB is a Type IV STE. However, the problem inherent with this particular method of comparison is that marketing systems do not operate independently of each other. McCalla & Schmitz (1979) point out that the CWB regularly uses the private grain transportation and handling system in the United States in order to carry out grain deliveries. Additionally, the CWB has historically made sales directly to grain firms in the United States. Still, classifying STEs can give insights into the purpose and effectiveness of a marketing system and its potential for trade distortion.

Imports/Exports

In general, as demonstrated by the classification scheme by Ackerman & Dixit (1999), we can consider two types of STEs: those that import goods and those that export goods. These types of STEs are fundamentally different because they have different goals. The purpose of an importing STE is to improve the terms of trade for its country where whereas the goal of an exporting STE is to increase market share in the world market. McCorriston & MacLaren (2007) provide a framework for which to think about the differences between importing and exporting STEs: importing STEs that limit market access are isomorphic to either tariffs or subsidies when compared to a private industry, and, depending on whether the exporting STE is concerned with profit maximization or producer interests, an exporting STE may effectively implement an export tax or an export subsidy. Both types of STEs reduce consumer welfare and both are important in world wheat and barley markets because exports often come from and go to countries with STEs (McCorriston & MacLaren, 2006).

One approach that Young & Abbott (1998) use to compare importing STEs to private markets is to examine the behavior of importing STEs and the behavior of private firms. Assuming that the goal of an importing STE could be to increase consumer surplus or to protect domestic consumers, Young & Abbott (1998) find that an importing STE methodically isolates a domestic market from the world market. Applying these conditions to a net import demand model shows importing STEs could be less responsive to changing market conditions. But results are mixed because importing STEs vary in their level of protection and responsiveness in world markets.

Barley exporting countries, e.g. Argentina, Australia, Russia, and Canada, are few compared to the many importing STEs in developing countries. Thus why grain exporting countries often use export subsidies is unclear. Brander & Spencer (1984) attempt to explain agricultural export subsidies by applying a Cournot duopoly model. In their simplified model, in which there are two exporting countries who sell to a third importing country, one exporter subsidizes sales and the other does not. They find that the terms of trade move will move against the subsidizing country. But price will still exceed the marginal resource cost of exports and the resulting expansion of exports can actually raise domestic welfare. Moreover, exporting countries have cooperative incentives to collude and not to use export subsidies, but they also have incentives to cheat on these agreements. Using simulations, Alston et al. (1993) also show that export subsidies are inefficient. However, it may be the case that, on the margin, governments are more concerned with revenue than with consumer welfare. In terms of the least–cost producer price support policy, an export subsidy may be better than an output subsidy because it uses less government revenue.

Welfare/Rents

Stemming from the potential of trade distortion several studies focus the transfer of rents that occurs when an exporting STE is present. This phenomenon is known as the rent–shifting hypothesis (Hamilton & Stiegert, 2002). The majority of papers in this area of the literature indicate that rent shifting does occur and the CWB transfers surplus from consumers to producers and from foreign to domestic firms.

However, before investigating the transfer of rents by the CWB, it must first be established in the literature that exporting STEs distort trade. McCorriston & MacLaren (2007) address this issue explicitly by modeling a single–desk STE in a developed country, for example the CWB in Canada, in a mixed oligopoly open economy environment. Using assumptions, such as some product differentiation, the findings suggest that STEs do significantly distort trade in the world market. Additionally, they show rent shifting results which implicitly substantiate trade distortion claims.

Several authors (for example, Veeman (1987)) argue that monopolistic marketing boards in Canada have generated substantial transfers from consumers to producers. Alston & Gray (2000) confirm these claims with results from a simulation model. In particular, the CWB increases producer surplus because they receive a price that is greater than the competitive price. They find that, although the policies would usually be optimized by equating marginal revenues among the markets, marginal revenue is less than marginal cost due to price pooling and output subsidies. An empirical test by Hamilton & Stiegert (2002) also confirms the rent–shifting hypothesis and tests whether exporting STEs employed an optimal pricing structure to shift rents to producers. In particular, their analysis of the world market for durum wheat shows that the CWB employed the optimal pricing structure to shift rents from foreign to domestic firms. They determined the key aspect of the CWB's ability to shift rents was the precommitment mechanism, the ability to secure contracts, and the delayed producer payment system, price pooling.

Alston & Gray (2000) also find that both STEs and export subsidies yield similar rent–shifting results, this brings into question their relative transfer efficiencies. When they compute these transfer efficiencies they find that, relative to an STE, the efficiency of export subsidies is ambiguous. Schmitz (2002) empirically investigates the transfer efficiencies of STEs using a two–region partial equilibrium model and data from Turkish cotton markets. He finds that although there is significant income redistribution, transfer inefficiency is very low. Yet an issue the not addressed in this area of literature are the costs of administration for either a STE, such as the CWB, or export subsidies, such as the Export Enhancement Program. Similarly, the costs of ensuring compliance with the export policies are omitted.

Canadian Wheat Board (CWB)

Marketing Services

The main services that the CWB directly provided were marketing services that included contracting, quality assurance, and reducing market instability. One aspect of the literature investigates whether the CWB provided an efficient amount of these services. Using a Niskanen model of bureaucratic decision making, Carter et al. (1998) finds that the CWB supplied more marketing services than is allocatively efficient and may have extracted consumer surplus that Canadian farmers would have otherwise enjoyed if they purchased marketing services in a competitive market. Furthermore, L. J. Martin & Warley (1978), conducting an empirical investigation of five commodities which include pork, tobacco, chicken broilers, turkeys, and eggs, conclude that marketing boards do not provide market stability. The consensus is that the uncertain stabilization benefits of marketing boards are not offset by the declining of competitive efficiency. Consequently when STEs do provide effectively provide marketing services, farmers are not beneficiaries.

Price Discrimination/Higher Prices

The CWB may have been able to charge higher prices for its grains because, especially in the case of wheat, Canadian wheat is thought to be of higher quality than U.S. wheat. Brooks & Schmitz (1999) empirically tested whether the CWB could price discriminate by testing if prices between market pairs were statistically different and found evidence of price discrimination. Alston & Gray (2000) compare the U.S. and Canadian marketing systems and find that both policies result in foreign and domestic consumers paying higher prices in countries where demand is relatively inelastic. Other studies also indicate that the CWB may have been in a situation where price discrimination was possible and may have occurred.

Some of the unique attributes of commodity prices in imperfectly competitive markets rely on product differentiation among exporting countries. Soregaroli & Sckokai (2011) found that there was concave behavior of consumer prices with respect to increasing levels of concentration in the export market. What they believed might happen in agricultural markets is that competitive producers benefit from an exporting STE because consumers pay higher prices. When empirically examining the CWB's ability to price discriminate in a differentiated–product wheat industry by class and quality, Lavoie (2005) finds that the CWB can indeed discriminate across export markets in high protein wheat, but this depends on the differentiation between Canadian and U.S. wheat. So the CWB does charge different prices to different countries for wheat of the same class and protein content. In fact, product differentiation could be the source of some degree of the CWB's market power.

Market Share/Market Power

As a Type IV STE, the CWB has domestically advertised that an advantage of the CWB is that producers are collectively able to exercise market power, and thus capture a greater export market share. The literature investigates whether the CWB can capture a greater world market share, and if the CWB actually exercises market power in world grain markets.

Whether or not grain STEs actually have market power is a subject for debate. Schmitz & Gray (2000) find that the CWB, by maximizing its return to the price pool, was able to capture an annual average of $72 million in additional revenue, revenue beyond the amount that would have been generated by purely competitive multiple sellers of Canadian barley during the years 1985–1994. Sexton & Lavoie (2001) point to New Empirical Industrial Organization Studies showing evidence of market power among marketing firms purchasing commodities at the farm level, in a similar oligopolistic setting. But Carter & Smith (2001) point out that if STEs are employing strategic trade policies and have market power, then STEs could plausibly cause food security problems in developing countries. Both the CWB and AWB have claimed that they can price discriminate against some developing countries. Though the CWB and AWB have claimed domestically that they price discriminate against Brazil and China, this has not been shown empirically. One possibility is that STEs have market power that they do not fully exercise.

Other authors discuss strategic trade policy with regard to market share using the assumption that grains are homogeneous products. Alaouze et al. (1978) look at accumulating stocks of grain as a method of exerting market power for the potential purpose of preserving market shares. Using a duopoly model to represent the United States and Canada, they find that if major exporters are concerned with market share, they will accumulate stocks and eventually, if one country does not meet its minimum market share that country will then flood the market with its available stocks and lower prices will prevail. In the long, run this could cause prices to be more variable and potentially higher than before. Thursby (1988) also examines strategic trade policy when homogeneous products are competitively produced but marketing is imperfectly competitive, and applies this to U.S. grain exports with a Cournot duopoly model. Her results show when a marketing board and a private export industry is composed of one or more firms and compete as Cournot rivals, the government of the country with the private industry would subsidize exports only when marketing is done by a monopolist.

Another strategy to gain market power might be for grain exporting nations to collude. Paarlberg & Abbott (1987) analyze the potential benefits of this for Australia, Canada, and the United States, using an imperfect competition model. In this model, importers and exporters exercise market power through individually determining domestic and trade policies based on domestic lobbying. They find that collusion would increase welfare for the policymakers in all three countries, but Australia and Canada would benefit more than the United States. Their analysis incorporates an interest group component and takes into account rents at different stages of production. Paarlberg & Abbott (1987) also develop a framework that could provide a means of examining trade–offs between extraction of rents from international markets and the domestic consequences of policies used to exercise international market power.

Firms

Disease

A fungal disease called fusarium head blight has plagued many U.S. producers since 1993. It is also known as scab. A toxic byproduct of fusarium head blight is deoxynivalenol (DON), thus there are significant price discounts for diseased barley. Barley acreage in the Dakotas and Minnesota fell by over 50% in the first six years of the outbreak (Johnson & Nganje, 2000). Nganje et al. (2004) estimate that fusarium head blight is such a problem for wheat and barley that the combined loss for both crops, directly and indirectly, was $7.7 billion for the period 1993 through 2001. They estimate that 123.8 million bushels of feed and malt barley were lost during this period.

There are a number of reasons why malt companies are not willing to pay as much for barley from areas where fusarium head blight is a concern. They include increased testing and inventory costs. Malt companies store grain in segregated bins based on variety and protein and, due to fusarium head blight, it is now necessary to separate grain based on DON levels as well. So, in addition to the increase in storage bin configurations, malt companies have had to hire more staff and equipment. Furthermore the malt byproduct is not worth as much as the byproduct of non–infected barley (Johnson & Nganje, 2000). For American malt companies, shrinking available acres and fusarium head blight means increasing uncertainty regarding malt barley availability and quality. This in turn, causes a greater reliance on Canadian supply. Johnson et al. (2000) uses a discrete stochastic programming model to study how U.S. malt firms might reduce dependence on Canadian imports due to fusarium head blight. They find that the CWB could have a pricing advantage, but do not examine what might happen without the CWB.

Transportation

Grain is transported in Canada by either rail or trucking. Under the *Western Grain Transportation Act (1985)* Canadian rail transport was subsidized until 1995. Under the Act, Canadian grain was competitive in offshore markets but, after the subsidies were eliminated, grain exports to the United States increased. This was because the cost of shipping to the United States became cheaper relative to shipping to offshore markets (Johnson & Wilson, 1995).

Although rail subsidies were eliminated in 1995, they were replaced by revenue caps in 1996. Vercammen (1999) models the hypothetical situation if Canada's two major railways compete for grain transportation business in a deregulated environment. This is done by choosing the freight rate at several hundred delivery points and using iterative numerical techniques to approximate the Nash equilibrium. Vercammen (1999) estimates the cost markup from eliminating the rate caps range, depending on assumptions about trucking costs, from 4% to 25%. The results of Fulton, Baylis, Brooks, and Gray (1998) support this conclusion. If rail revenue caps are eliminated freight rates will increase.

Trucking is also a major part of grain transportation. Some grain companies offer farmers trucking premiums, ranging from C$2–C$5, in order to increase their grain volume. Furthermore, Park et al. (1999) estimate that 85% of grain delivery points are within 50 miles of a competing railway. Thus, larger grain companies can potentially truck grain between the two competing railways. But most importantly, trucks offer additional access to U.S. markets via transporting grain to U.S. railways and U.S. grain companies. Given the importance of rail and trucking, rates for grain transportation are considered an important factor in bilateral barley trade.

Quality

Restrictions on variety, thought to be for the purpose of ensuring quality, may have prevented adoption of yield increasing technology. Several studies have shown that varietal control is costly for farmers. Ulrich et al. (1987) use a two–sector model and production possibility framework to show the results of a demand shift toward soft wheats and the slow licensing response of Canadian regulators. Constantine et al. (1994) uses a similar method to analyze the One–Variety Cotton Law in California. Both analyses conclude that farmer welfare would increase with the removal of varietal restrictions.

Summary

Although some areas the literature may seem fairly complete, several questions concerning the transition to a less regulated market for Canadian grains have not been addressed. One obvious reason is that the termination of the CWB's single–desk authority has just occurred. The other is a lack of relevant and similar natural experiments. The AWB and NZDB, were not Type IV STEs so there is no data available to use for comparison for the CWB's transition to a less regulated market. Moreover, influential regulation with regard to varietal control and transportation still exist and terminating the CWB's single–desk powers have ambiguous implications for bilateral U.S.–Canadian grain trade. This paper is the first to look at incentives for farmers and brewers to contract for malt barley. By modeling the incentives for malt barley contracting we are able to examine how the new institutional structure in Canada will affect opportunities for Canadian farmers and U.S. brewers.

THEORETICAL MODEL

Removing the CWB's single–desk powers created a single market for North American malt barley. Canadian farmers and U.S. malsters may now directly contract with each other, and these changes bring about at least three questions. Will Canadian farmers contract with U.S. maltsters? Will U.S. maltsters contract with Canadian farmers? And, at what price?

A Model of Canadian Farmers' Decisions to Contract with U.S. Maltsters

Consider a representative Canadian farmer with a single acre of land. Before planting, the farmer must first make a decision about which crop to plant. A risk neutral Canadian farmer grows malt barley if the opportunity cost of contracting and growing malt barley is greater than or equal to the opportunity cost of growing another crop (e.g. wheat). The farmer maximizes expected profits, π, and will grow malt barley if the expected profits from growing barley are larger than the expected profits from growing wheat, $\pi_b \geq \pi_w$.

Discrete Case[1]

In the discrete case, we assume that the farmer either contracts to grow malt barley or sells another crop, wheat, on the cash market. Let y_b and y_w represent barley and wheat yields, P_m the contract price of malt barley, P_f and P_w the expected cash prices of feed barley and wheat, b the cost of growing barley, c the cost of contracting, w the cost of growing wheat, and λ $(0 \leq \lambda \leq 1)$ represent the probability of making malt. Cost functions are increasing and include both variable and fixed costs.

The expected profits of malt barley and wheat are π_b and π_w.

$$\pi_b = y_b[\lambda P_m + (1-\lambda)(P_f)] - [b(y_b) + c(y_b)] \tag{4.1}$$

$$\pi_w = y_w(P_w) - [w(y_w)] \tag{4.2}$$

The probability of a barley crop making malt, λ, affects the farmer's decision to contract for malt barley because malt barley contracts are specific about the qualities required to make malt. If the barley meets these quality specifications, then the farmer's revenue is y_bP_m. If her malt barley does not meet malt quality specifications, the barley can still be sold for animal feed. So, she receives the feed barley price on the cash market and her revenue is y_bP_f. Typically $P_m > P_f$.

Since similar equipment is used for planting and harvesting wheat and barley, we assume the costs of growing and contracting barley are the same as the costs of growing wheat. That is $b(y_b) + c(y_b) = w(y_w)$. Thus, the farmer will grow malt barley if

$$\lambda P_m + (1-\lambda)(P_f) \geq \tfrac{y_w(P_w)}{y_b} \tag{4.3}$$

<u>Risk Aversion</u>

So far we have assumed the representative farmer is risk neutral, now let us assume the farmer is risk averse. Because her malt barley crop may not meet malt quality specifications the farmer faces two possible wealth outcomes from growing barley, in other words she faces a gamble of $\{\lambda[P_my_b - b(y_b) - c(y_b)], (1-\lambda)[(P_f) - b(y_b) - c(y_b)]\}$. If she is risk averse, the utility of the expected profits, $U(E(\pi))$, is greater than the utility of profits, $U(\pi)$.

$$U(E(\pi_b)) > U(\pi_b) \tag{4.4}$$

The farmer will choose to grow barley over wheat based on the utility of expected profits of barley versus the utility of the expected profits of wheat.

$$U(E(\pi_b)) > U(E(\pi_w)) \tag{4.5}$$

Assuming constant relative risk aversion, so demand for risk is linear in profit, and using the formula developed by Friedman and Savage. $U(E(\pi)) = \frac{E\pi^{(1-\theta)}-1}{1-\theta}$. Here $\theta \neq 1$ and θ represents a farmer's attitude towards risk. The measure of relative risk aversion is $r_R = \frac{-u''(\pi)}{u'(\pi)}\pi = \frac{-\theta\pi^{(\theta-1)}}{\pi^{\theta}}\pi = -\theta$. In this case the farmer will grow malt barley if

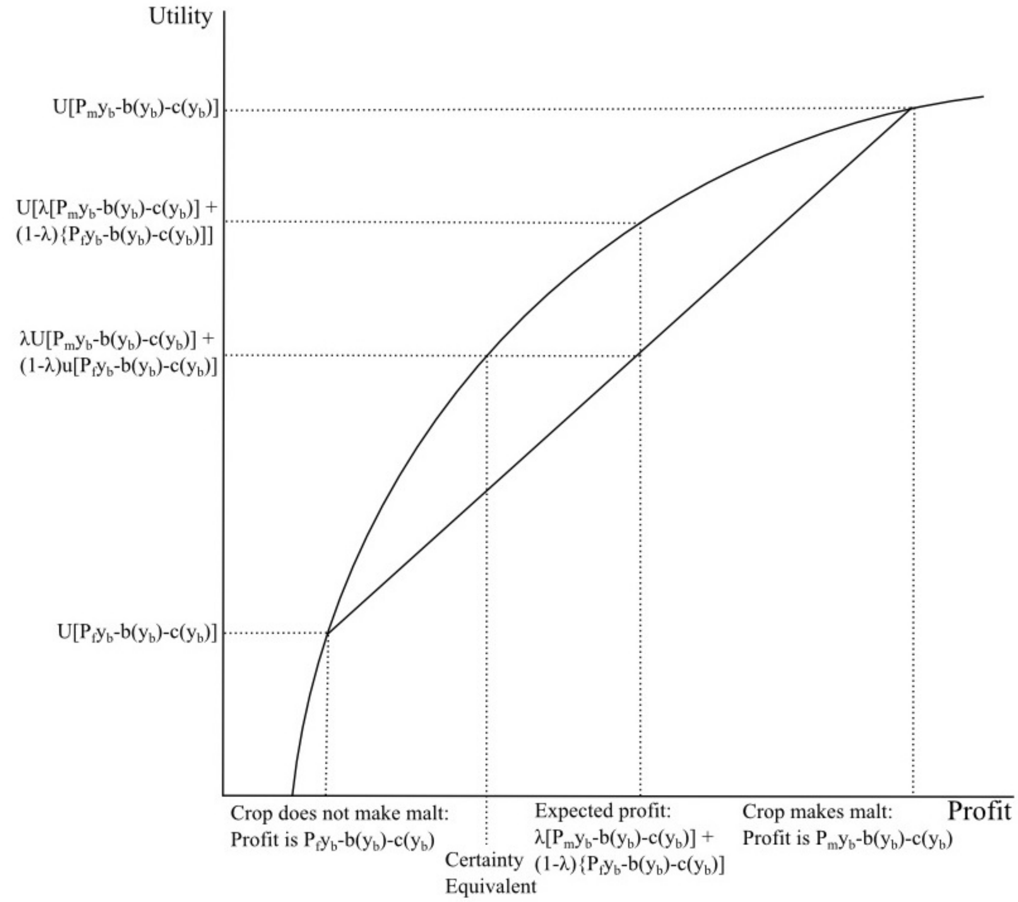
$$\begin{aligned} &U(E(\pi_b)) = \frac{\left(\lambda[P_m y_b - b(y_b) - c(y_b)] + (1-\lambda)[(P_f) - b(y_b) - c(y_b)]\right)^{(1-\theta)} - 1}{1-\theta} \\ &> \frac{(y_w(P_w) - w(y_w))^{(1-\theta)} - 1}{1-\theta} = U(E(\pi_w)). \end{aligned} \tag{4.6}$$

Suppose instead the farmer's utility function represents decreasing absolute risk aversion, say $U(E(\pi)) = ln(E(\pi)) + 1$. Here the measure of absolute risk aversion is $r_A = \frac{-u''(\pi)}{u'(\pi)} == \frac{\frac{-1}{\pi^2}}{\frac{1}{\pi}} = \frac{1}{\pi}$. The individual is less averse to taking small risks at higher levels of profits. Similarly to the case of constant relative risk aversion, the farmer will choose to malt grow barley if

$$\begin{aligned} &U(E(\pi_b)) = ln\left(\lambda[P_m y_b - b(y_b) - c(y_b)] + (1-\lambda)[(P_f) - b(y_b) - c(y_b)]\right) + 1 \\ &> ln\left(y_w(P_w) - w(y_w)\right) + 1 = U(E(\pi_w)). \end{aligned} \tag{4.7}$$

The farmer faces two outcomes when growing malt barley, either the malt barley is selected for malting or it is not. These two outcomes correspond to two levels of utility. As shown in Figure 4.1, utility is higher when the barley makes malt and she receives the malt premium price. However, when deciding whether to contract to grow malt barley, she considers the expected utility of taking the risk of producing malt barley. In this model, the risk the farmer considers is the risk that the crop might not make

Figure 4.1: Concave Preferences



malt. The farmer would be indifferent between planting malt barley and taking no risk while receiving a guaranteed return equal to the certainty equivalent (determined by the utility function and parameters of the profit function). The farmer might be willing to forgo some amount of expected profits, $E(\pi_b) - CertaintyEquivalent_{malt}$, in order to avoid receiving a low feed price for her malt barley crop. This means that she may choose to grow wheat over malt barley only if $CertaintyEquivalent_{malt} > E(\pi_w)$.

There are several drawbacks to the expected utility analysis. Using the logic above, the farmer may limit her risk by growing wheat but she still faces uncertainty. At the time of planting the variables in both the wheat and malt barley profit functions are stochastic. Additionally, using this model we analyze production decisions separately from input decisions. Although the model presented here is relatively simplistic, the purpose is to describe farmers' reactions to malt barley selection rates. Specifically, the framework can be applied to farmers with non–irrigated land as these farmers generally face lower, and more variable, malt barley selection rates.

A Model of U.S. Maltsters' Decisions to Contract with Canadian Farmers

U.S. malt firms will source barley from Canada under certain conditions. A representative maltster wants to minimize input costs, the cost of acquiring malt subject to malt output requirements. First, given a malt ouput requirement of Y, the maltster decides how many acres, n, shall be contracted.

$$Y = \lambda \sum_{i=1}^{n} y_{b,i} = n y_b \lambda \tag{4.8}$$

$$n = \frac{Y}{y_b \lambda} \tag{4.9}$$

So the maltster decides to contract for n acres based on expected yields and the expected selection rate. For simplicity, assume each farmer grows one acre. Then the maltster contracts with n farmers.

Second, the maltster wants to minimize the costs of acquiring some amount of barley from each farmer. Let z be the contracting costs the firm incurs. Then the firm's cost of $y_b\lambda$ barley from one farmer is

$$P_m y_b + z(y_b) \tag{4.10}$$

Assuming both the U.S. and Canada have the same yields and selection rates, a risk neutral maltster will contract with Canadian farmers if it is less expensive. For a maltster to source from Canada the following condition must be met

$$P_m^{U.S} y_b + z^{U.S}(y_b) \geq P_m^{Can} y_b + z^{Can}(y_b) \tag{4.11}$$

If expected yields and expected selection rates are different in the U.S. and Canada, the maltster will source barley in Canada if the expected costs of contracting for all their malt in the U.S. is higher than the expected costs of contracting for all their malt in Canada.

$$P_m^{U.S} y_b^{U.S.} \lambda^{U.S.} n^{U.S.} + z^{U.S}(y_b^{U.S} n^{U.S.}) \geq P_m^{Can} y_b^{Can} \lambda^{Can} n^{Can} + z^{Can}(y_b^{Can} n^{Can}) \tag{4.12}$$

where $y_b^{U.S.}$ and y_b^{Can} denotes U.S. versus Canadian barley yields, $\lambda^{U.S.}$ and λ^{Can} denotes U.S. versus Canadian selection rates, and $n^{U.S.}$ and n^{Can} denotes the number of farmers the firm must contract with in the U.S. versus Canada.

The maltsters will decide to source Canadian barley if the Canadian price and costs of contracting in Canada are less than the expected U.S. costs. Contracting costs can be thought of as the costs of doing business in Canada. For a U.S. maltster sourcing malt barley in Canada, this could include transportation costs to U.S. facilities and costs due to variety registration requirements in Canada.

Even if inequality 4.12 does not hold, circumstances exist where U.S. maltsters might still purchase Canadian barley. One may be that the firm needs *at least* Y bushels of malt and $Y > \lambda^{U.S.} \sum_{i=1}^{n} y_{b,i}^{U.S.}$ because there are less than n barley farmers (recall in this case farmers = acres) in the United States. Or perhaps maltsters are risk averse. In these scenarios it is possible that a malster will purchase barley from both the United States and Canada. In this case they will equate the marginal costs of contracting for barley from each country.

$$\frac{P_m^{U.S.} y_b^{U.S.} + z^{U.S.}(y_b^{U.S.})}{y_b^{U.S.}} = \frac{P_m^{Can} y_b^{Can} + z^{Can}(y_b^{Can})}{y_b^{Can}} \tag{4.13}$$

Conditions for a Feasible Contract

Canadian farmers and U.S. maltsters may contract with each other for the marginal acre of malt barley if the minimum malt price a Canadian farmer is willing to accept is less than or equal to the maximum price a U.S. maltster is willing to pay.

$$P_{min}^{Canfarmer} \leq P_m^{Can} \leq P_{max}^{U.S.brewer} \tag{4.14}$$

The lowest price a risk neutral Canadian farmer will accept is

$$P_m^{Can} \geq \frac{1}{\lambda}\left[\frac{y_w P_w}{y_b} - (1-\lambda)P_f\right] \tag{4.15}$$

Assuming yields are the same in Canada and the United States, the price a maltster is willing to pay is

$$P_m^{Can} \leq P_m^{U.S.} + \frac{1}{y_b}[z^{U.S}(y_b) - z^{Can}(y_b)] \tag{4.16}$$

Thus contracting will occur when

$$\frac{1}{\lambda}\left[\frac{y_w P_w}{y_b} - (1-\lambda)P_f\right] \leq P_m^{Can} \leq P_m^{U.S.} + \frac{1}{y_b}[z^{U.S}(y_b) - z^{Can}(y_b)] \tag{4.17}$$

Table 4.1: Equation 4.18 Derivatives

Variable	Change
P_w	$\frac{y_w}{\lambda y_b} \leq \frac{\partial P_m^{Can}}{\partial EP_w} \leq 0$
P_f	$\frac{-1+\lambda}{\lambda} \leq \frac{\partial P_m^{Can}}{\partial EP_f} \leq 0$
$P_m^{U.S.}$	$0 \leq \frac{\partial P_m^{Can}}{\partial P_m^{U.S.}} \leq \frac{y_b^{U.S.}}{y_b^{Can}}$
y_w	$\frac{P_w}{\lambda y_b^{Can}} \leq \frac{\partial P_m^{Can}}{\partial y_w} \leq 0$
$y_b^{U.S.}$	$0 \leq \frac{\partial P_m^{Can}}{\partial y_b^{U.S.}} \leq \frac{P_m^{U.S.}}{y_b^{Can}} + \frac{1}{y_b^{Can}} \left[\frac{dz^{U.S.}}{dy_b^{U.S.}} \right]$
y_b^{Can}	$\frac{-P_w y_w}{\lambda (y_b^{Can})^2} \leq \frac{\partial P_m^{Can}}{\partial y_b^{Can}} \leq \frac{-P_m^{U.S} y_b^{U.S.}}{(y_b^{Can})^2} - \frac{z^{U.S}(y_b^{U.S.}) - z^{Can}(y_b^{Can})}{(y_b^{Can})^2} - \frac{1}{y_b^{Can}} \left[\frac{dz^{Can}}{dy_b^{Can}} \right]$
λ	$-\frac{\frac{P_w y_w}{y_b^{Can}} - P_f(1-\lambda)}{\lambda^2} + \frac{P_f}{\lambda} \leq \frac{\partial P_m^{Can}}{\partial \lambda} \leq 0$

If yields are different in each region, then contracting occurs when

$$\frac{1}{\lambda}\left[\frac{y_w P_w}{y_b^{Can}} - (1-\lambda)P_f\right] \leq P_m^{Can} \leq P_m^{U.S.}\frac{y_b^{U.S.}}{y_b^{Can}} + \frac{1}{y_b^{Can}}[z^{U.S}(y_b^{U.S.}) - z^{Can}(y_b^{Can})] \quad (4.18)$$

Therefore, the Canadian price of malt barley depends on the selection rate, wheat and U.S. prices, yields, and the costs of contracting.

Price Movement

Given equation 4.18, Canadian malt barley prices change in response to changes in exogenous factors (see Table 4.1). For example, if expected Canadian wheat prices or wheat yields increase, then the minimum price Canadian farmers are willing to accept to grow malt barley also increases. Similarly, if the price U.S. malsters must pay for U.S. malt increases, then the price maltsters are willing to pay for Canadian barley increases. However, U.S. maltsters' response to changes in barley yields depend on their cost functions. And changes to the CWB's single–desk status may indirectly affect Canadian wheat and barley yields. But how Canadian farmers and U.S. maltsters react to simultaneous increases in yields, transaction costs, and selection rates is ambiguous based on the theoretical model alone. In later chapters, we determine how changes in these variables influence the probability U.S. maltsters will contract for Canadian malt barley, that is the probability that equation 4.18 will be true, by calibrating the model using historical data. By simulating each variable and then evaluating the model we are able to quantify how changes in yields and contracting costs change the probability of favorable contracting conditions.

DATA AND EMPIRICAL MODELING STRATEGY

The termination of the CWB's monopoly and monopsony powers is too recent to provide an opportunity to directly test hypothesis of the economic impacts of a less regulated market for Canadian malt barley. However, under reasonable assumptions, a carefully calibrated quantitative simulation model of markets under the new policy structure can offer important insights. We use historical price, yield, and transportation cost data to establish appropriate distributional assumptions for these factors and use these underlying assumptions to simulate market and production conditions to determine settings which satisfy the contracting conditions shown in equation 4.18.

Data

Historical yield and price data were collected for the three Canadian Prairie Provinces, Alberta, Saskatchewan, and Manitoba, and three U.S. states, Idaho, Montana, and North Dakota. These regions were chosen because they produce the majority of barley in Canada and the United States. In 2012, for example, the Prairie Provinces accounted for 90% of total Canadian barley production and the selected states accounted for 70% of total U.S. barley production (figure 5.1).

Wheat yield data are collected because wheat and barley grow in similar environments and use similar planting and harvesting machinery, thus they are substitutes in farm production. We collect data for spring wheat yields as opposed to other classes of wheat because spring wheat is a direct substitute in production with barley as both are planted in the spring. Additionally, spring wheat production is higher than either durum or winter wheat production in the Prairie Provinces. In Saskatchewan, which produces more wheat than any other province, spring wheat production accounted for

63% of total wheat production in 2012. Proportionally, production of spring wheat compared to durum and winter wheats in Alberta and Manitoba were even higher at 88% and 75%. Spring wheat yield data for Canadian provinces were available for the period 1973–2012 from the Canada Grains Council (CGC). Canadian barley yield data were also available from the CGC for the period 1964–2012. The barley yield data represent the average for both malt feed barley production and cannot be differentiated by class. All Canadian yield data were converted from kilograms per hectare to bushels per acre using the following weight to bushel equivalent ratios reported by the Canada Grains Council: 36.744 bushels of wheat per metric ton and 45.092 bushels of barley per metric ton. In the United States, annual total barley yields (bushels per acre) were obtained from the USDA's National Agricultural Statistics Service (NASS) for Idaho, Montana, and North Dakota over the period 1974–2012.

Changes in production technology and methods have caused average yields and the variability of yields to increase over time. For example, Figure 5.2 shows upward trending barley yields in Manitoba, with barley and spring wheat yields in other provinces and states exhibiting similar trends. This implies that the means and variances of our yield data change over time which could be problematic for simulation. Without detrending yields, we would not have comparable 1964–2012 yields that we can combine over time and from which we could obtain distributional specifications with which to generate observations for 2012 yields. Therefore, the yield data were detrended so the base case would reflect a typical grower in North American barley growing regions for the 2012 crop year. The yields were normalized, first estimating trend predicted yields, y_t, and then retrieving the error, e_t (see Goodwin & Mahul (2004)). Assuming deviations from y_t are proportional to the level of yields in order to account for possible increasing heteroskedasticity across time, we calculated the normalized yields as:

$$(normalized\ yield)_t = y_{2012} + \frac{e_t}{y_t} \tag{5.1}$$

Price data for Canadian spring wheat, feed barley, and U.S. malt barley, were also obtained from the Canada Grains Council and USDA–NASS. The CWB paid farmers from pooled accounts with the result that farmers in all regions received the same prices in each marketing year.[1] Therefore wheat and feed prices are assumed to be the total payments to producers from pooled accounts. Information on spring wheat prices were available for the "1 CWRS," "2 CWRS," and "3 CWRS" pools from 1965 to 2010. Price pools are designated by "grade" and "class," where grade is based on differing levels of quality which is determined by protein content and the physical condition of grain, such as frost damaged or sprouted kernels. Data on payments to feed barley producers were collected from the "1 CW Feed Barley" pool for the years 1965 to 2003. After 2004 the "1 CW Feed Barley" pool was split into "1 CW Feed Barley A" and "1 CW Feed Barley B." We collected payments to producers from these pools from 2004 to 2010 and calculated an average price across these pools. All Canadian prices were converted to U.S. dollars using the noon spot rate average exchange rate obtained from the Bank of Canada. Monthly U.S. malt barley cash prices were available from April 1968 to September 2012 for North Dakota, April 1990 to September 2012 for Idaho, and April 1991 to September 2012 for Montana. All prices, were converted to the 2012 base year using consumer price indices provided by the U.S. Department of Labor's Bureau of Labor Statistics.

[1]Farmers were actually paid different prices based on the elevator where the farmer delivered the grain, but the same price pool was used as the basis for the point of delivery price. Unfortunately, point of delivery prices were unavailable.

To calculate the total cost of shipping malt barley from each selected region we collected data on rail costs of grain transport and estimated the rail distance from each region to two major U.S. breweries: MillerCoors located in Golden, CO and Anheuser–Busch located in St. Louis, MO. Cost data of Canadian rail grain transport were available from the Canada Grains Council in terms of dollars per metric ton for transport from the mid prairie point, Wilkie SK, to the St. Lawrence Ports or the Pacific Seaboard for the marketing years 1975 to 2012. These costs were transformed to a (Canadian) dollars per metric ton per mile basis, averaged across the east and west routes, and converted to 2012 U.S. dollars using the methodology described above. Rail grain transportation costs in the United States were obtained from the USDA Agricultural Marketing Service (AMS), weekly rates are in dollars per metric ton for different routes for the period June 2012 to February 2013.

Distances from the three Canadian province production regions and three U.S. state production regions to the two major U.S. breweries were calculated using an origin location in each province or state and assuming that the final destinations were the Coors (39.755543, -105.221100) and Busch (38.627003, -90.199404) breweries. The origin location in each state or province was assumed to be the average latitude and longitude of the grain elevators in the state or province, using elevator location data obtained from the CGC and the BNSF and Union Pacific rail companies. Rail mileage information was not directly available and was therefore collected by comparing rail mileage to road distances, which are readily available. Using a rail distance calculator from Union Pacific's website, we compared road distances to rail distances for 260 pairs of rail yards. We determined that rail mileages were on average 1.11 times longer than road mileages. Therefore rail distances between barley production regions and the two breweries were estimated by first finding the road distance between the starting and ending locations using Google Maps and then multiplying the road distance by a factor of 1.11. Through this process we were able to approximate distances for shipping grain by rail and, using the estimated costs of per mile of shipping grain by rail, we are able to approximate the costs of shipping malt barley.

Estimation of Yield and Price Distributional Properties

To establish distributions for simulating yield variables, we fit historical yield data and tested the goodness of fit for a beta and a normal distribution. The use of a beta distribution allows for the possibility that crop yields are skewed and may not be appropriately characterized by normality (Nelson & Preckel, 1989). We test this assumption for historical yields in each production location using Kolmogorov–Smirnov, Cramer–von Mises, Anderson–Darling, and Chi–Square tests to ensure our conclusions are not biased by a single test. If we failed to reject the assumption that yields follow a beta distribution at the 5% significance level we characterized the yield distribution to be beta with the estimated α and β parameters. We also examine whether yields follow a normal distribution, as suggested by Anibal (1989). If distributional tests suggested that neither distribution was appropriate, we assumed the beta distribution as indicated in the literature. We rejected both the beta distribution and normality once. Results from the distributional tests are presented in Table 5.1 and the selected distributions and their parameterizations are presented in Table 5.2.

For each of the price variables an analogous process was used, but in this case prices were assumed to be characterized by either a lognormal or normal distribution. Lognormal distributions were considered because agricultural prices have been shown to be positively skewed (Mitra & Boussard, 2008). If the lognormality assumption was rejected at the 5% significance level, then we tested the fit of the normal distribution as suggested by Smid (2004). If goodness of fit tests suggested neither distribution was appropriate we used a lognormal. Both lognormality and normality were only rejected once. These results are in Tables 5.3 and 5.4.

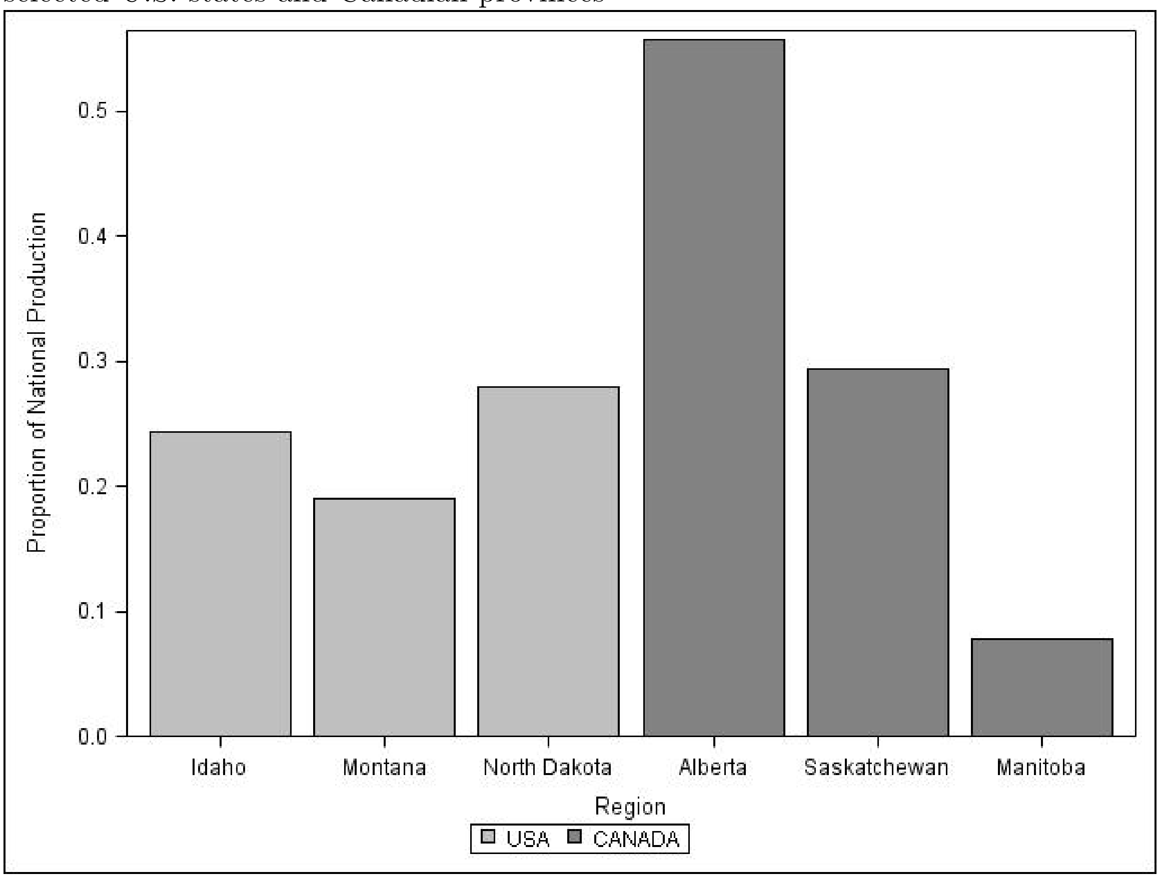
Within each region, growing conditions may be similar for wheat and barley because of access to similar resources and similar soil quality. This could mean that wheat and barley yields might be correlated within regions. Also systemic conditions, like drought, could affect both a region and its neighbors. If we simulated each yield variable independently, we could, for example, generate yields that reflect drought conditions for barley and wet conditions for wheat within a growing region. Similarly, it would be possible to generate data in which Saskatchewan experiences a drought while Alberta has a wet year. To avoid such unrepresentative outcomes, we ran correlation tests and found that wheat and barley yields were correlated both within and between regions. For example, wheat and barley yields are correlated within Saskatchewan and these yields are also correlated with yields in the neighboring provinces and states (Alberta, Manitoba, North Dakota, and Montana).

Using the information on distributions and correlations among crops and regions, the data were simulated using a normal copula. We first found the dependence structure given by the Spearman rank correlation using the historical data, simulated data based on the marginal distributions we found earlier, and then imposed the dependence structure on the simulated yields in each region. In this way we were able to connect the estimated multivariate yield distribution to the marginal distributions of each yield variable and simultaneously simulate Canadian wheat and barley yields and U.S. barley yields for each region. Using this method, generated wheat and barley observations reflect the fact that systemic events and conditions exist.

We also considered whether wheat, feed and malt barley prices may be correlated as there is evidence that this may be the case (Goodwin & Schroeder, 1991). Intuitively this makes sense because, if prices were significantly low in one region and high in a neighboring region, farmers might transport their grain to the location with the higher price. Arbitrage could also occur between grains if, for example, feed barley prices are relatively high the companies that produce feed might substitute wheat or corn into their product. Thus, we tested for correlations between Canadian feed and wheat prices and U.S. malt barley prices. However, Table 5.5 shows the sample size issues that we encountered when testing for correlation between Idaho and Montana malt barley prices and prices in North Dakota, Alberta, Saskatchewan, and Manitoba. Tests for correlations between barley prices in other regions and general barley prices, which until the years 1990 and 1991 did not include malt barley prices, indicated that there was statistically significant correlation between Idaho barley prices, Montana barley prices and prices in other regions. To avoid overestimation of price correlation for these regions, we assumed the correlation between North Dakota malt prices and Canadian malt prices are equal to the correlation between U.S. and Canadian prices. These data were also simulated using a normal copula by generating price observations from the marginal distributions and their parameters and imposing the amended correlation structure,

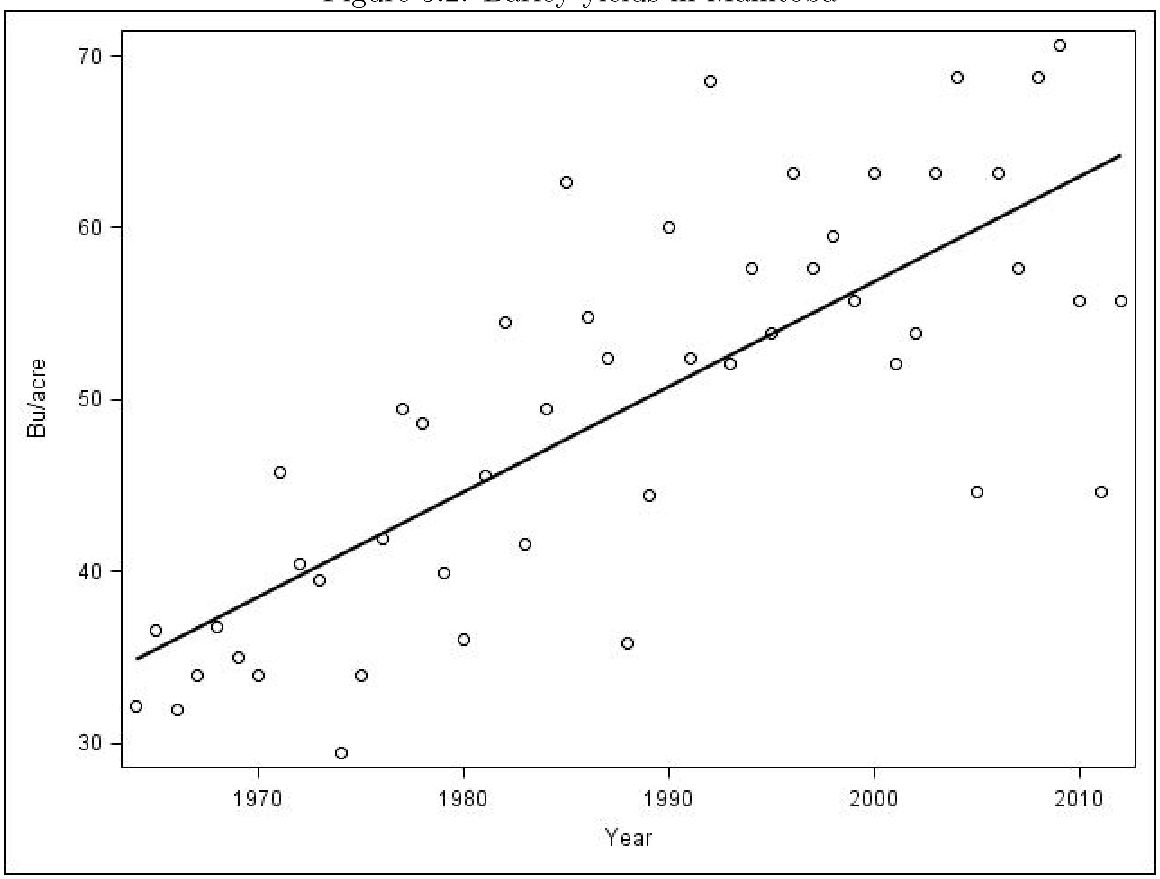
An additional concern is that barley yields and prices might be jointly distributed. However, correlation tests show that yields and prices are not significantly correlated. It is more likely that malt and feed barley prices are correlated with corn prices (Chambers, 2004), so the correlation among yields and barley prices is likely to be weak. Accordingly we assume yields and prices are independently distributed. Consequently, each Monte Carlo iteration was indexed so when merging price and yield data, and when comparing Canadian provinces to U.S. states, cross–variable independence was preserved.

Figure 5.1: Regional 2012 barley production as proportion of national production for selected U.S. states and Canadian provinces



Source: USDA–NASS and the Canada Grains Council.

Figure 5.2: Barley yields in Manitoba



Source: Canada Grains Council.

Table 5.1: Estimated yield distributions and goodness of fit p–values

	Test for Normal Distribution				Test for Beta Distribution				
	K–S	**C–vM**	**A–D**	**C–S**	**K–S**	**C–vM**	**A–D**	**C–S**	**Chosen Distribution**
U.S.									
Idaho barley yields	0.092	0.211	0.239	0.003	0.086	0.002	0.001	0.001	Normal
Montana barley yields	0.079	0.010	0.005	0.024	0.003	0.001	0.001	0.006	Beta
North Dakota barley yields	0.150	0.241	0.167	0.171	0.025	0.015	0.008	0.001	Normal
Canada									
Alberta spring wheat yields	0.150	0.250	0.187	0.097	0.500	0.500	0.500	0.529	Beta
Manitoba spring wheat yields	0.150	0.250	0.250	0.307	0.015	0.002	0.001	0.016	Normal
Saskatchewan spring wheat yields	0.150	0.250	0.154	0.001	0.250	0.250	0.178	0.030	Beta
Alberta barley yields	0.150	0.250	0.250	0.193	0.129	0.144	0.075	0.141	Beta
Manitoba barley yields	0.150	0.250	0.250	0.067	0.118	0.104	0.126	0.099	Beta
Saskatchewan barley yields	0.012	0.040	0.043	0.083	0.107	0.250	0.250	0.503	Beta

Notes: p–values correspond the the following distributional tests. K–S represents the Kolmogorov–Smirnov test, C–vM represents the Cramer–von Mises test, A–D is the Anderson–Darling test, and C–S is the Chi–Square test.

Table 5.2: Selected yield distributions and distributional specifications

	Mean	**Std. Dev.**	**Alpha**	**Beta**	**Chosen Distribution**
U.S.					
Idaho barley yields	93.137	13.106			Normal
Montana barley yields			2.428	1.710	Beta
North Dakota barley yields	64.807	14.560			Normal
Canada					
Alberta spring wheat yields			2.244	1.059	Beta
Manitoba spring wheat yields	42.778	6.226			Normal
Saskatchewan spring wheat yields			2.131	0.935	Beta
Alberta barley yields			2.867	1.809	Beta
Manitoba barley yields			1.753	1.456	Beta
Saskatchewan barley yields			2.075	1.508	Beta

Table 5.3: Estimated price distributions and goodness of fit p–values

	Test for Normal Distribution				Test for Beta Distribution				
	K–S	**C–vM**	**A–D**	**C–S**	**K–S**	**C–vM**	**A–D**	**C–S**	**Chosen Distribution**
U.S.									
Idaho malt barley prices	0.010	0.005	0.005	0.001	0.150	0.113	0.049	0.084	Lognormal
Montana malt barley prices	0.010	0.005	0.005	0.001	0.150	0.449	0.260	0.001	Lognormal
North Dakota malt barley prices	0.010	0.005	0.005	0.001	0.010	0.005	0.005	0.001	Lognormal
Cost to ship grain by rail	0.010	0.005	0.005	0.001	0.010	0.005	0.005	0.001	Lognormal
Canada									
1 CWRS	0.010	0.005	0.005	0.001	0.089	0.049	0.068	0.372	Lognormal
2 CWRS	0.012	0.005	0.005	0.001	0.022	0.033	0.032	0.053	Lognormal
3 CWRS	0.012	0.005	0.005	0.001	0.150	0.060	0.087	0.643	Lognormal
1 CW feed barley	0.029	0.006	0.005	0.003	0.150	0.136	0.141	0.840	Lognormal
Average cost to ship grain by rail	0.127	0.049	0.041	0.182	0.150	0.500	0.500	0.258	Lognormal

Notes: p–values correspond the the following distributional tests. K–S represents the Kolmogorov–Smirnov test, C–vM represents the Cramer–von Mises test, A–D is the Anderson–Darling test, and C–S is the Chi–Square test. "1 CWRS," "2 CWRS," "3 CWRS," and "1 CW feed barley" refers to Canadian wheat and barley pools which are denoted by "grade" and "class."

Table 5.4: Selected price distributions and distributional specifications

	Mean	**Std. Dev.**	**Chosen Distribution**
U.S.			
Idaho malt barley prices	4.583	0.900	Lognormal
Montana malt barley prices	4.458	0.854	Lognormal
North Dakota malt barley prices	5.336	2.493	Lognormal
Cost to ship grain by rail	0.053	0.023	Lognormal
Canada			
1 CWRS	8.937	4.397	Lognormal
2 CWRS	8.655	4.276	Lognormal
3 CWRS	8.228	4.157	Lognormal
1 CW feed barley	5.169	2.562	Lognormal
Average cost to ship grain by rail	0.073	0.013	Lognormal

Notes: "1 CWRS," "2 CWRS," "3 CWRS," and "1 CW feed barley" refers to Canadian wheat and barley pools which are denoted by "grade" and "class."

Table 5.5: Illustrating sample size issues when determining price correlation structure

	Canada 1CW feed	Canada 1CWRS	Canada 2CWRS	Canada 3CWRS	ND malt	MT malt	ID malt
Canada	1.000	**0.966**	**0.968**	**0.965**	**0.813**	-0.176	-0.173
1CW feed	[46]	[46]	[46]	[46]	[46]	[20]	[21]
Canada	**0.966**	1.000	**0.999**	**0.998**	**0.844**	0.107	0.069
1CWRS	[46]	[46]	[46]	[46]	[46]	[20]	[21]
Canada	**0.968**	**0.999**	1.000	**0.998**	**0.836**	0.105	0.056
2CWRS	[46]	[46]	[46]	[46]	[46]	[20]	[21]
Canada	**0.965**	**0.998**	**0.998**	1.000	**0.832**	0.110	0.047
3CWRS	[46]	[46]	[46]	[46]	[46]	[20]	[21]
ND malt	**0.813**	**0.844**	**0.836**	**0.832**	1.000	**0.879**	**0.774**
	[46]	[46]	[46]	[46]	[46]	[23]	[24]
MT malt	-0.176	0.107	0.105	0.110	**0.879**	1.000	**0.906**
	[20]	[20]	[20]	[20]	[23]	[23]	[23]
ID malt	-0.173	0.069	0.056	0.047	**0.774**	**0.906**	1.000
	[21]	[21]	[21]	[21]	[24]	[23]	[24]

Notes: Bold indicates significance at $\alpha = 10\%$ and values in brackets represent observation counts. "1CWRS," "2CWRS," "3CWRS," and "1CW feed" refers to Canadian wheat and barley pools which are denoted by "grade" and "class."

RESULTS

Now that the CWB's monopsony and monopoly powers have been terminated, we attempt to determine if direct contracting between U.S. malsters and Canadian farmers will occur using data generated by Monte Carlo simulation. First we analyze contracting conditions while considering current agricultural regulations in Canada. Then we consider the possibility of further deregulation in agricultural markets by removing revenue caps on rail grain transports. Finally we examine the consequences of less strict varietal regulation on spring wheat.

We conducted 5,000 Monte Carlo simulations of price, yield, and transportation cost values for each region and evaluated simulated free market farm prices and simulated free market firm prices to determine the probability that conditions are favorable to free market contracting in Alberta, Saskatchewan and Manitoba relative to Idaho, Montana and North Dakota when farmers and brewers are considering contracting for malt barley. The empirical model follows from the theoretical model developed in chapter 4, as represented by equation 4.18, which is restated as follows:

$$\begin{aligned} &\tfrac{1}{\lambda}\left[\tfrac{\hat{y}_w \hat{P}_w}{\hat{y}_b^{Can}} - (1-\lambda)\hat{P}_f\right] \leq P_m^{Can} \\ &\leq \hat{P}_m^{U.S.} \tfrac{\hat{y}_b^{U.S.}}{\hat{y}_b^{Can}} + \tfrac{1}{\hat{y}_b^{Can}}[(\hat{t}_a^{U.S.}\hat{d}_a^{U.S.})\hat{y}_b^{U.S.} - (\hat{t}_a^{Can}\hat{d}_a^{Can} + \hat{t}_b^{U.S.}\hat{d}_b^{U.S.})\hat{y}_b^{Can}] \end{aligned} \tag{6.1}$$

Where all simulated variables are denoted by a "hat."

We simplify contracting costs for a firm by assuming that marginal costs consist of only grain transportation to a maltster's facility. Therefore, $(\hat{t}_a^{U.S.}\hat{d}_a^{U.S.})$ represents the total simulated per bushel costs of transporting grain from a U.S. region to a company's brewing facilities, where $\hat{t}_a^{U.S.}$ is the estimated U.S. rail cost per mile per bushel and $\hat{d}_a^{U.S.}$ is the expected rail distance. Similarly, $(\hat{t}_a^{Can}\hat{d}_a^{Can} + \hat{t}_b^{U.S.}\hat{d}_b^{U.S.})$ represents the total expected cost of shipping grain from a Prairie Province to a U.S. malt facility. There are two cost components because rail tariffs for grain are different in Canada and the United States. Here $(\hat{t}_a^{Can}\hat{d}_a^{Can})$ is the total simulated cost per bushel to ship grain from the growing location to the U.S.–Canadian border and $(\hat{t}_b^{U.S.}\hat{d}_b^{U.S.})$ is the total simulated cost per bushel to ship grain from the U.S.–Canadian border to U.S. brewing facilities. With respect to the right hand side of the model, the farm decision, we continue to assume farmers are risk neutral. Also, Canadian spring wheat prices were previously linked to a set of different price pools. Hence we assume a farmer has an equal probability of falling into each potential spring wheat pool. Therefore $\hat{P}_w$ represents the expected price of spring wheat, averaged across all pools.

The simulated data were restricted to include only observations where the farm price of malting barley is greater than the price of feed barley. The decision to contract is based on farmer and firm expectations and if a farmer expected feed barley prices to be higher than malt barley prices, she would not be likely to contract for malt barley. This scenario did occur in the simulated data, because some prices were generated from the upper tails of the assumed feed price distributions. This event could happen in practice because contracting decisions are made before planting while feed prices are stochastic. However, in the historical data, Canadian feed prices were always lower than Canadian malting barley prices, and these situations are unlikely to occur under normal marketing conditions.

The model is used to compare the farm price and firm price across farmers' expectations of the malt barley selection rate. Selection rates, λ, are assumed to vary from 51%–99%, and to be between 51%–65% for dryland and between 80%–95% for irrigated production (Gustafson et al., 2006). Selection rates for dryland production are lower because malt grown on these acres is more susceptible to weather events and has higher variability with regard to the qualities maltsters seek. Irrigated acres have higher selection rates because they are less exposed to these types of events and are more consistent in terms of malt quality barley. Selection rates between 65%–80% could occur due to a farmer experiencing very good conditions for dryland production or very poor conditions for irrigated production.

If the simulated farm price for a given selection rate is less than the simulated firm price, we consider conditions to be favorable for contracting in Canada versus the United States. Observations where conditions were favorable to contracting in Canada were assigned a 1 and observations where conditions are not favorable were assigned a 0. By summing the number of times conditions were favorable and dividing by the total number of observations (5,000) for each selection rate, we can estimate the probability that conditions will be favorable for malt barley contracting in a Prairie Province versus Idaho, Montana, and North Dakota. However, an indication that conditions will be favorable to contracting does not necessarily imply contracting will occur, but we expect contracting to occur if both parties have perfect information.

Figure 6.1 shows how these probabilities vary across selection rates. In general, as the selection rate increases, conditions are more likely to be favorable to malt barley contracting. Ceteris paribus, as the farmer's expectation of the selection rate increases, she is willing to accept a lower price because the price risk associated with the crop not meeting malt quality standards decreases. For the selection rates 51%–99%, the probability of favorable conditions in Manitoba ranged from 23%–35% if the maltster was located in Colorado and from 32%–45% for malt shipped to Missouri. Saskatchewan had the highest probabilities of favorable conditions ranging from 36%–51% and 41%–55% for grain shipped to Colorado and Missouri. The final destination of the malt makes a difference in the likelihood of contracting for these two provinces. In Manitoba, the probability of favorable conditions increases by an average of 9.9 percentage points if the final destination for malt is Missouri. In Saskatchewan, the difference is less, but the likelihood of contracting still increases by an average of 3.7 percentage points if the maltster's facilities are in Missouri. St. Louis, MO is further away from the U.S. growing areas while Golden, CO is closer. This indicates conditions are considered to be favorable more often for a brewer in Missouri than a brewer in Colorado because brewers face different relative costs to ship grain from the Prairie Provinces rather than the United States.

In Alberta, there is no clear difference in the likelihood of contracting based on final destination. The likelihood of favorable conditions in Alberta ranged from 16%–26% for maltsters located in Colorado and 16%–25% in Missouri. Table 6.1 shows that shipping distances from Alberta are larger than from Manitoba or Saskatchewan, regardless of whether a firm is located in Colorado or Missouri. The lower probabilities and the similarities between probabilities despite malt destination could imply that the shipping distance for grain from Alberta crosses a threshold beyond which shipping costs are less important to U.S. brewers' decisions and contracts will only occur if conditions in Alberta are especially favorable (for example, if the price farmers were willing to accept in Alberta was low compared to Idaho, Montana, and North Dakota). While U.S. brewers may only sometimes consider Alberta for malt barley production, brewers located even further away may consider Alberta a primary source of malt barley. For example, brewers outside of North America may choose to source barley from Alberta because Alberta is closer to the Pacific Seaboard and Vancouver ports than Manitoba or Saskatchewan. In fact, the Canada Chinese Business Council has reported that Chinese brewer Tsingtao has been a buyer of large quantities of Canadian barley. According the Canadian Malting Barley Technical Center, after Canada and the United States, the leading markets for Canadian malting barley are in China and South America.

When conditions are favorable to contracting in Canada, the farm price of barley will be less than the maltster's price. The farm price (the left hand side of the empirical model, equation 6.1) can be interpreted as a lower bound for the price a farmer is willing to accept. If the malt price is below that price the farmer has a higher expected revenue from growing spring wheat. The firm's price (the right hand side of the empirical model in equation 6.1) can be interpreted as the upper bound beyond which, for the marginal acre, maltsters will have more favorable conditions in the United States. The actual contract price for malt barley will be between the farm price and firm price.

Table 6.2 presents summary statistics for farm prices and firm prices when contracting between the parties could occur. The highest mean farm prices and firm prices were in Saskatchewan, followed by Manitoba. The difference in prices between these two provinces were driven by higher barley yields in Manitoba. The benefits of higher barley yields were outweighed by higher shipping costs compared to U.S. growing regions. This lowered the price maltsters would be willing to pay for the marginal acre of malt barley from Manitoba. Figure 6.2 shows the mean farm price by region when contracting could occur. Prices in Alberta are the lowest, indicating that maltsters are only willing to contract in Alberta if farmers are willing to accept a lower price. Low malt barley prices would have to offset the extra shipping costs a brewer would pay to buy grain in Alberta instead of the United States.

Canadian Transportation Act Deregulation

Results from the base case simulation indicate that the costs of shipping malt barley influence the probability of favorable conditions for contracting. If this were not the case we would expect the probability of favorable market conditions to be similar for both the Colorado and Missouri brewery locations. We investigate the effects of further deregulation in Canadian grain markets associated with the removal of revenue caps on Canadian rail transport of grain imposed by the *Canadian Transportation Act (1996)*. Using the estimates of Vercammen (1999), we increased the cost of Canadian grain transport (that is, the cost of shipping grain from Canadian elevators to the U.S.–Canadian border) by 4% and re–evaluated the empirical model. We find that increasing rail rates only has a small effect on the probability of contracting for malt barley in Canada. Figure 6.3 shows that increasing Canadian rail costs results in these regions becoming less favorable for malt barley contracting. On average the probabilities of favorable conditions dropped by less than 1% due to rail rate increases.

These results imply that removing revenue caps on grain transport may not cause major changes in Canadian malt barley markets. Prairie farmers' contracting opportunities with U.S. brewers may not be adversely affected if further deregulation was considered. Most of the cost associated with shipping malt barley is the long distance from the U.S.–Canadian border to where the brewer is located. In order for contracting opportunities to change due to transportation costs, there would have to be a more considerable increase in Canadian rail costs or an increase in U.S. rail costs which would change brewers' relative costs of U.S. malt barley.

Revenue caps on grain transport seem to provide little benefit to the malt barley industry and rail companies, such as the Canadian National Railway and Canadian Pacific Railway, may actually benefit from cap removals. Canadian railways could potentially collect more revenue from malt barley if they were allowed to raise transportation prices. However, the effect of grain transportation deregulation for other grain markets is unclear. When Canadian rail transport of grain became ceased to be subsidized in 1995, and thus increased the costs of grain transport, this led to an increase in exports to the United States instead of offshore markets and an increase in grain production for domestic consumption (Doan et al., 2003). It is possible that another increase in Canadian rail rates could have a similar effect for grains like wheat or canola. This could increase Canadian agricultural exports to the United States and also Canadian production of high value crops.

Canadian Grain Commission Disengagement

Although removing revenue caps on rail transport does not greatly influence the likelihood of favorable conditions, the effect of removing varietal restrictions could be more substantial because of how increasing wheat yields changes Canadian farmers' willingess to accept lower prices for malting barley. We account for the possibility that the Canadian Grain Commission could have less strict varietal restrictions on spring wheat. Similar conditions for Canadian barley yields were not imposed because barley yields in each region, with the exception of Idaho, were not statistically different from each other. The difference between yields in Idaho and yields in other regions is likely because Idaho has a comparatively large proportion of irrigated acres. Also, because brewers contract for specific varieties, farmers planting malt barley would not necessarily choose to grow the highest yielding variety. Thus we only relax the conditions on spring wheat which results in a potential increase in spring wheat yields (Ulrich et al., 1987). We imposed the distributional characteristics of the average spring wheat yields of Idaho, Montana and North Dakota on each of the three Prairie Provinces and re–simulate the yield data in the empirical model.

The resulting probabilities of favorable contracting conditions are shown in Figure 6.4. The probability of favorable conditions in Alberta decreased by an average of 0.5 percentage points. However in Saskatchewan the probability of favorable contracting conditions decreased by an average of 15.6 and 15.1 percentage points for malt firms located in Colorado and Missouri. In Manitoba, contracting probabilities also decreased by an average of 5.3 and 5.7 percentage points. The increases in farm prices, driven by the increases in spring wheat yields, reduce the likelihood that conditions will be favorable to contracting. However, when we do expect contracts to occur, the mean farm prices without varietal control are not statistically different than mean farm prices when strict varietal restrictions are enforced. Figure 6.5 shows the mean farm prices when contracting conditions are favorable and varietal restrictions are removed.

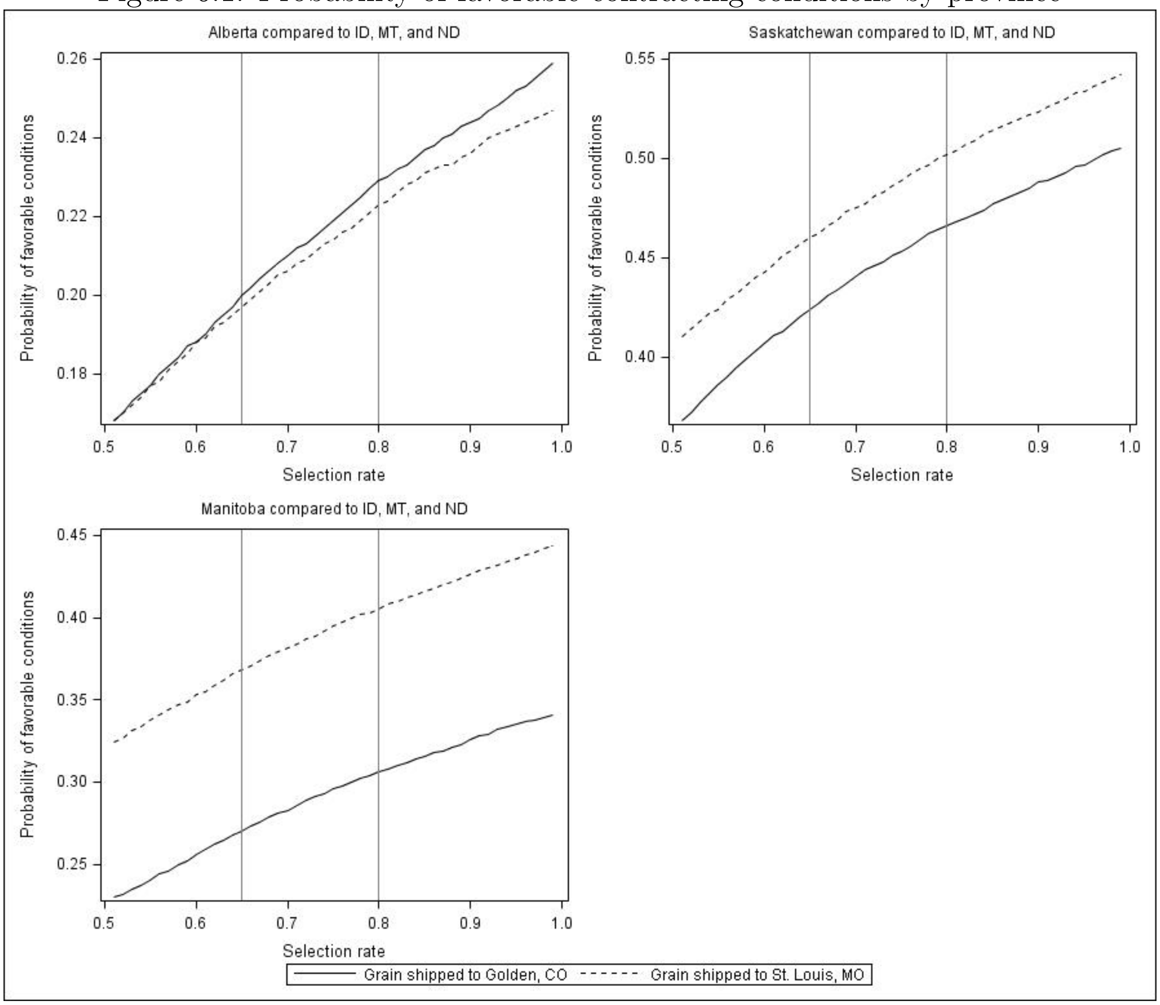
Prairie farmers may benefit from less strict varietal control of wheat. Allowing farmers to plant higher yielding spring wheat varieties only negatively influences the probability of favorable malt barley contracting conditions because Canadian farmers have more opportunities to increase farm revenue. The prices that maltsters would be willing to pay do not change. Thus, increasing wheat yields do not negatively influence the price of malt barley when contracts occur. This means that under strict varietal regulations a farmer may have chosen to increase farm revenue by contracting with a U.S. maltster because spring wheat yields were low. After varietal liberalization, she may choose not to contract for malt barley because increased spring wheat yields mean spring wheat revenues are even higher than malt barley revenues.

Fewer restrictions on spring wheat varieties do mean that U.S. brewers would be less likely to find Canadian farmers willing to accept a malt barley price that would compete with U.S. farmers. It is possible that removing varietal restrictions on spring wheat may be beneficial to both Prairie farmers and farmers in Idaho, Montana and North Dakota. Prairie farmers may earn higher farm revenues from growing spring wheat and U.S. farmers may have more opportunities to increase their farm revenues through malt barley contracting. Farmers in both countries could be in better positions when negotiating with U.S. maltsters if varietal restrictions were less strict. In short, increased competition for potential malt barley acres could benefit North American farmers.

Summary of Findings

We find that farmers may face new opportunities in the new institutional environment and the probability of these opportunities increase as the selection rate increases. In Manitoba and Saskatchewan, the likelihood of favorable conditions for contracting range from 23%–45% and 36%–55%. For these provinces relative grain shipping distance from Canada to the United States is statistically significant but removing rail grain revenue caps have a small effect on contracting opportunities. Deregulating varietal control of spring wheat decreases the probability contracting will occur, but increases Canadian farmer opportunities for higher revenue. Alberta has a lower probability of favorable contracting conditions and these probabilities have small responses to non–market to market transitions because Alberta is relatively far compared to U.S. growing regions. Historical and non–market policies in Canada may have limited malt barley contracting opportunities, and further deregulation by removing rail grain revenue caps and varietal restrictions may benefit malt barley market participants.

Figure 6.1: Probability of favorable contracting conditions by province



Note: A vertical line at $\lambda = 0.65$ denotes the expected upper bound for dryland selection rates. A line at $\lambda = 0.80$ denotes the expected lower bound for irrigated selection rates.

Table 6.1: Malt barley shipping distance by province of origin

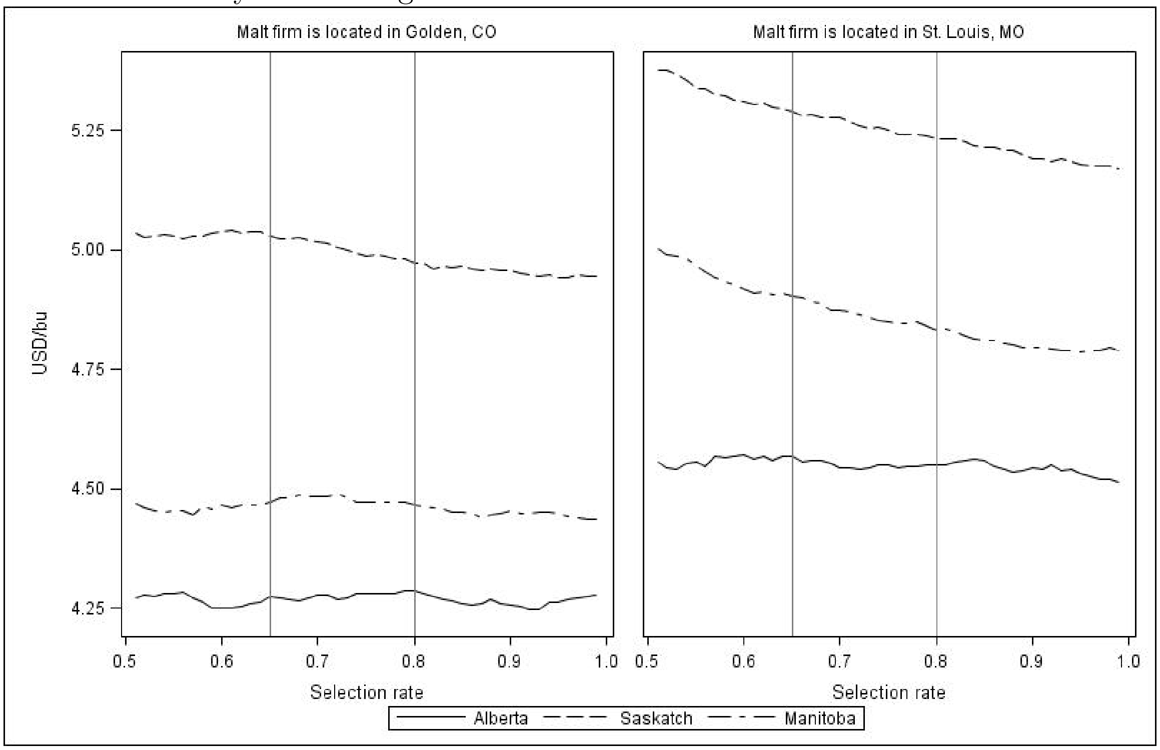
	Canadian Rail Distance	Canadian Cost	U.S. Rail Distance	U.S. Cost	Total Rail Distance	Total Costs
To Golden, CO						
Alberta	359.557	0.073	1010.112	0.056	1369.670	103.410
Saskatchewan	247.152	0.073	897.753	0.056	1144.905	82.512
Manitoba	180.826	0.073	1138.202	0.056	1319.028	87.416
To St. Louis, MO						
Alberta	359.557	0.073	1864.045	0.056	2223.602	151.391
Saskatchewan	247.152	0.073	1294.382	0.056	1541.534	104.798
Manitoba	180.826	0.073	1068.539	0.056	1249.375	83.502

Note: Estimated rail distances are in miles and costs are mean estimated rail costs in USD/bushel/mile.

Table 6.2: Mean farm price (USD/bu) when malt barley contracting conditions are favorable

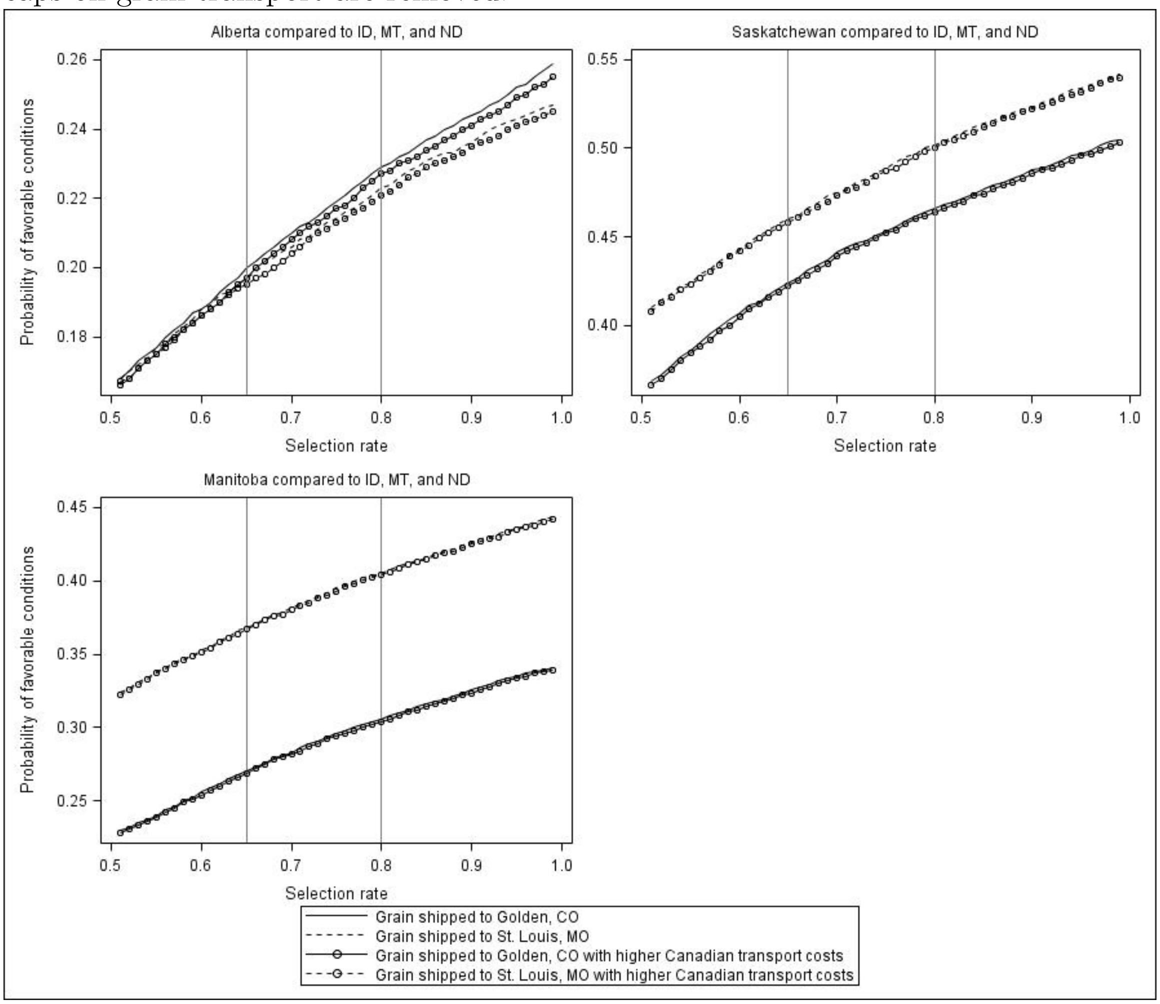
	Selection rate	From Alberta				From Saskatchewan				From Manitoba			
		To Golden, CO		To St. Louis, MO		To Golden, CO		To St. Louis, MO		To Golden, CO		To St. Louis, MO	
		Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.
						Farm Price							
Dryland production	51%	4.273	1.886	4.557	1.995	5.034	2.486	5.377	2.789	4.469	2.077	5.002	2.551
	52%	4.279	1.904	4.545	1.995	5.027	2.477	5.376	2.793	4.462	2.072	4.991	2.542
	53%	4.276	1.899	4.542	1.994	5.030	2.481	5.366	2.782	4.456	2.072	4.987	2.539
	54%	4.281	1.901	4.554	2.018	5.033	2.487	5.355	2.767	4.453	2.070	4.981	2.529
	55%	4.280	1.896	4.557	2.026	5.030	2.492	5.338	2.753	4.454	2.073	4.965	2.511
	56%	4.285	1.901	4.546	2.023	5.023	2.487	5.338	2.766	4.454	2.074	4.955	2.497
	57%	4.273	1.894	4.569	2.064	5.030	2.499	5.326	2.763	4.447	2.067	4.942	2.487
	58%	4.263	1.887	4.566	2.063	5.029	2.498	5.322	2.756	4.465	2.095	4.934	2.481
	59%	4.252	1.881	4.567	2.066	5.036	2.511	5.314	2.748	4.458	2.087	4.927	2.477
	60%	4.252	1.885	4.570	2.064	5.039	2.519	5.309	2.746	4.466	2.101	4.917	2.470
	61%	4.251	1.881	4.562	2.057	5.040	2.527	5.303	2.741	4.462	2.096	4.908	2.469
	62%	4.255	1.879	4.569	2.062	5.035	2.528	5.308	2.758	4.468	2.103	4.913	2.473
	63%	4.260	1.885	4.560	2.057	5.037	2.531	5.299	2.753	4.467	2.104	4.907	2.473
	64%	4.262	1.896	4.568	2.065	5.038	2.533	5.294	2.751	4.468	2.107	4.910	2.480
	65%	4.275	1.913	4.569	2.064	5.028	2.520	5.289	2.753	4.474	2.113	4.904	2.474
Irrigated production	80%	4.286	1.950	4.551	2.093	4.972	2.534	5.233	2.752	4.467	2.136	4.832	2.451
	81%	4.282	1.944	4.550	2.094	4.971	2.537	5.231	2.750	4.465	2.137	4.834	2.458
	82%	4.276	1.943	4.556	2.104	4.961	2.531	5.231	2.753	4.462	2.134	4.828	2.452
	83%	4.268	1.936	4.559	2.105	4.966	2.537	5.226	2.749	4.458	2.135	4.819	2.445
	84%	4.265	1.935	4.562	2.110	4.964	2.545	5.218	2.743	4.452	2.132	4.814	2.443
	85%	4.260	1.936	4.559	2.113	4.965	2.545	5.213	2.743	4.451	2.130	4.812	2.449
	86%	4.258	1.934	4.548	2.104	4.961	2.546	5.214	2.749	4.450	2.130	4.811	2.451
	87%	4.260	1.933	4.541	2.098	4.958	2.545	5.207	2.744	4.441	2.123	4.806	2.448
	88%	4.268	1.942	4.535	2.092	4.959	2.556	5.207	2.750	4.447	2.134	4.802	2.443
	89%	4.259	1.937	4.538	2.104	4.956	2.558	5.200	2.744	4.450	2.146	4.795	2.437
	90%	4.258	1.935	4.543	2.111	4.957	2.556	5.190	2.736	4.454	2.149	4.796	2.437
	91%	4.253	1.931	4.542	2.109	4.951	2.554	5.189	2.737	4.450	2.147	4.797	2.441
	92%	4.249	1.930	4.549	2.118	4.947	2.550	5.184	2.733	4.450	2.149	4.794	2.439
	93%	4.249	1.935	4.539	2.110	4.944	2.551	5.189	2.742	4.452	2.156	4.790	2.437
	94%	4.263	1.955	4.540	2.113	4.947	2.559	5.183	2.741	4.452	2.156	4.791	2.438
	95%	4.264	1.960	4.532	2.108	4.943	2.553	5.177	2.741	4.448	2.152	4.787	2.441
						Firm Price							
		5.035	2.611	4.888	2.913	7.021	2.837	7.638	3.690	5.676	2.837	6.715	3.260

Figure 6.2: Mean farm prices representing lower bounds for contract prices under which malt barley contracting in Canada is favorable



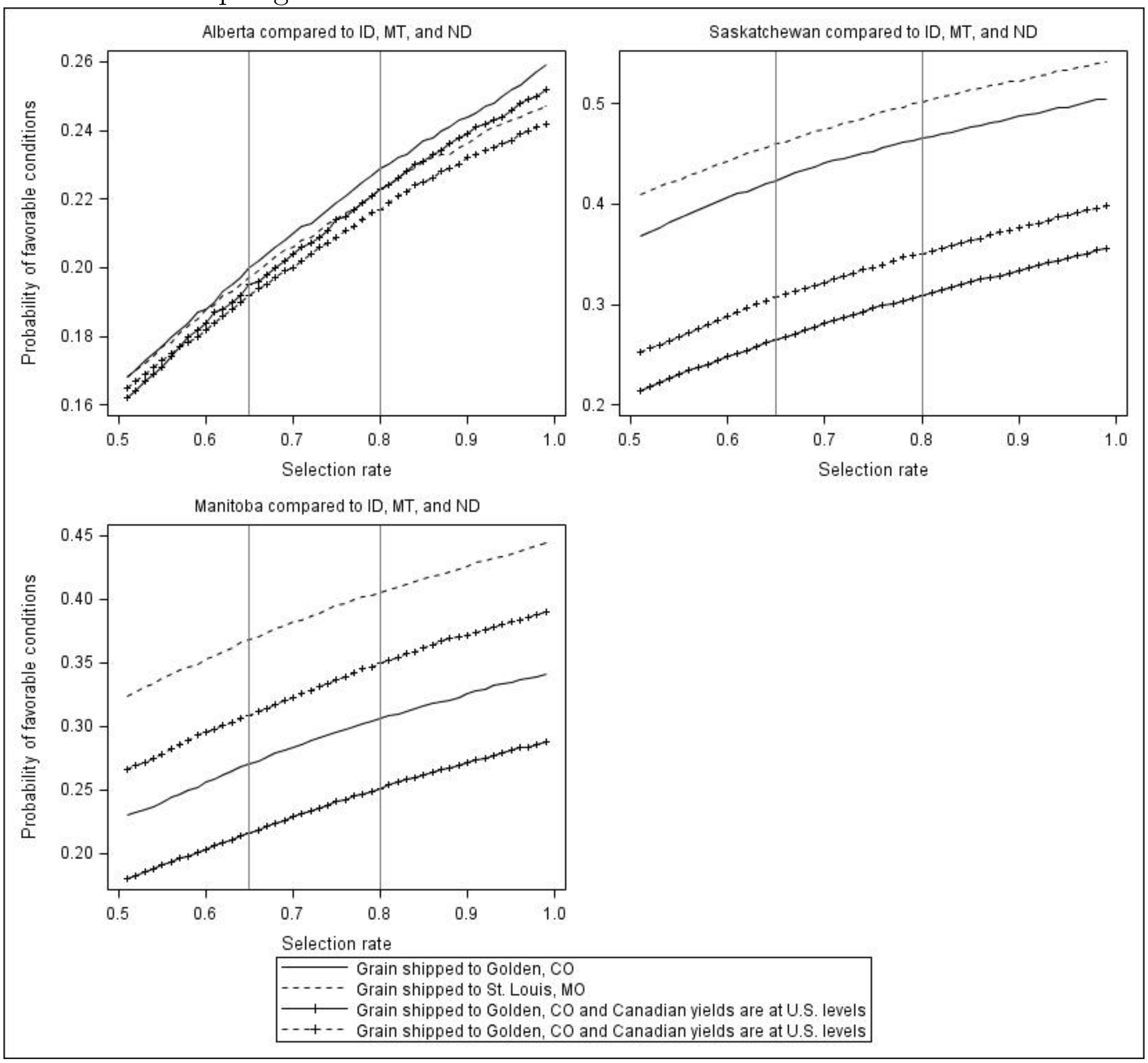
Note: A vertical line at $\lambda = 0.65$ denotes the expected upper bound for dryland selection rates. A line at $\lambda = 0.80$ denotes the expected lower bound for irrigated selection rates.

Figure 6.3: Probability of favorable contracting conditions by province when revenue caps on grain transport are removed.



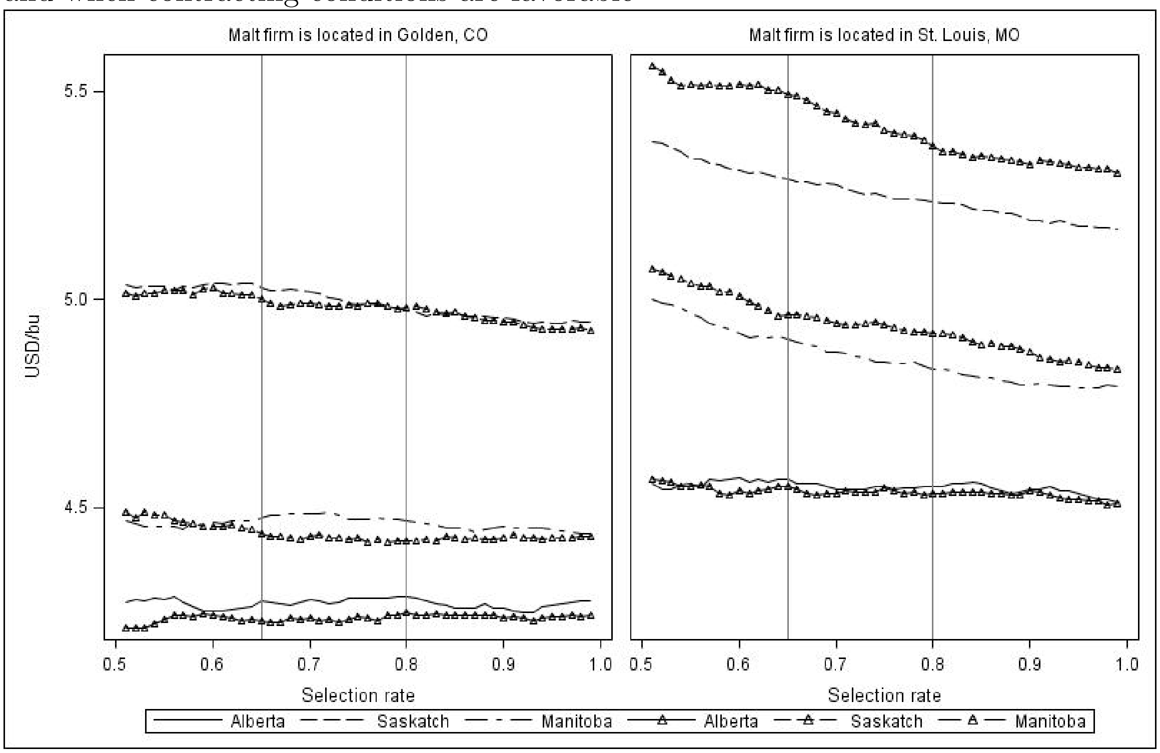
Note: A vertical line at $\lambda = 0.65$ denotes the expected upper bound for dryland selection rates. A line at $\lambda = 0.80$ denotes the expected lower bound for irrigated selection rates.

Figure 6.4: Probability of favorable contracting conditions by province when varietal restrictions on spring wheat are removed



Note: A vertical line at $\lambda = 0.65$ denotes the expected upper bound for dryland selection rates. A line at $\lambda = 0.80$ denotes the expected lower bound for irrigated selection rates.

Figure 6.5: Mean farm prices after varietal restrictions on spring wheat are removed and when contracting conditions are favorable



Note: Line with markers indicate mean farm prices after varietal restrictions on spring wheat have been removed. However, the mean prices after varietal restrictions have been removed are not statistically different from the mean farm prices in the base case. A vertical line at $\lambda = 0.65$ denotes the expected upper bound for dryland selection rates. A line at $\lambda = 0.80$ denotes the expected lower bound for irrigated selection rates.

CONCLUSION

The termination of the CWB's monopsony and monopoly powers raises a number of questions about the economic ramifications for North American grain markets. Previously, U.S. beer brewers and maltsters could not contract directly with Canadian farmers to grow malt barley, but the new Canadian institutional structure could affect contracting opportunities. To better understand these impacts, we developed a theoretical contract decision model that seeks ascertain if conditions will be favorable to contracting. Because the CWB was disbanded in August 2012, market data were unavailable to directly test this question and we, therefore, used Monte Carlo simulations to analyze the market impacts on Canadian and U.S. malt barley markets. We also considered further deregulation in Canadian grain markets by analyzing the effects of removing revenue caps on rail grain transport and reducing restrictions on varietal control of wheat by the Canadian Grain Commission (CGC). Within a simplistic less regulated market environment, we find that it may be advantageous for both Canadian farmers and U.S. brewers to contract for malt barley depending on their expectations of agricultural and market conditions. We expect, therefore, that contracting opportunities that were not previously available due to the CWB marketing restrictions may now be realized. Moreover, further transportation and crop variety deregulations may be beneficial to participants in North American malt barley markets.

We find that revenue caps on rail grain transport do not significantly affect contracting opportunities for Canadian malt barley farmers. In the context of malt barley markets, revenue caps seem to unnecessarily restrict opportunities for revenues in the grain handling industry. It was the CWB that initially obtained revenue caps on rail shipments of grain and there has been political discussion about changing Canadian rail policies so they are similar to U.S. rail policies (M. E. Fulton, 2006). Removing these caps from the *Canadian Transportation Act (1996)* (Sec. 151) would allow rail companies to increase revenue and would decrease the Canadian Transportation Agency's administrative costs associated with monitoring compliance with this policy. This could benefit rail companies and reduce the burden on taxpayers.

Additionally, the control exercised over varieties of wheat grown in Canada may harm the economic welfare of Canadian farmers. Under the CWB, there may have been justification for these restrictions, such as the ability sell a differentiated product on the world wheat market and potentially price discriminate in export markets (Lavoie, 2005). However, in the new institutional environment, the CWB might not be as strong an advocate for these types of restrictions. The variety approval process of the CGC creates a bias against technology adoption that could result in foregone revenue opportunities for Canadian farmers (Ulrich et al., 1987). Reducing varietal restrictions may not change the prices farmers receive for malt barley, but Canadian farmers could have higher spring wheat yields that result in higher farm revenues. A less regulated market outcome could be accomplished by modifying the standards for varieties to be approved, such as narrowing the broad scope of investigation in the varietal approval process. For example, the CGC could review new varieties solely on the basis of whether they meet food safety standards alone, rather than whether the variety jointly meets food safety, disease resistance, and end–use quality standards.

Compared to a less regulated market, Canadian non–market agricultural policies may not have been beneficial to North American malt barley market participants. Specifically, it seems that terminating the CWB's singe desk powers may facilitate economic activity that could not previously take place in Canadian malt barley markets. Other non–market policies also may have restricted opportunities for malt barley market participants. CWB deregulation and further deregulation of Canadian grain markets may benefit Canadian farmers, U.S. farmers, U.S. brewers, Canadian rail companies, and Canadian taxpayers.

Notwithstanding the insights provided by this study, there are avenues for future work. A more rigorous modeling of contracting costs could include more information about relative transaction costs. For example, search costs or knowledge problems on the part of the farmer and the maltster can offer additional information. Also, our model assumes transportation costs are the only marginal contracting costs for a U.S. brewer. While transportation costs account for a substantial portion of total transactions costs, other factors may change relative marginal contracting costs, such as differing selection rates and storage costs in each province and state. Furthermore, it is possible that despite ideal contracting conditions, a contract would not exist because both the farmer and maltster are unaware of the opportunity, and understanding reasons for such events is critical.

REFERENCES CITED

About us: Investor relations. (2012). Retrieved from http://www.cwb.ca/public/en/about/investor/

Ackerman, K. Z., & Dixit, P. M. (1999). An introduction to state trading in agriculture [Agricultural Economics Reports]. (33909).

Agricultural, food & beverages. (n.d.). Retrieved from http://www.ccbc.com/research-reports/sector-research/agricultural-food-beverages/

Alaouze, C. M., Watson, A. S., & Sturgess, N. H. (1978). Oligopoly pricing in the world wheat market. *American Journal of Agricultural Economics*, *60*(2), 173-185.

Alston, J. M., Carter, C. A., & Smith, V. H. (1993). Rationalizing agricultural export subsidies. *American Journal of Agricultural Economics*, *75*(4), 1000-1009.

Alston, J. M., & Gray, R. S. (2000, July). State trading versus export subsidies: The case of canadian wheat. *Journal of Agricultural and Resource Economics*, *25*(01), 51–67.

Anibal, M. E. (1989). *Estimation of crop yield variation and its use in farm financial planning* (Graduate Research Masters Degree Plan B Papers No. 11038). Michigan State University, Department of Agricultural, Food, and Resource Economics. Retrieved from http://ideas.repec.org/p/ags/midagr/11038.html

Applying. (2012, August). Retrieved from http://www.grainscanada.gc.ca/services-services/cars-wagons/apc-dwp-eng.htm

Backgrounder: Western grain revenue cap program. (2012, April). Retrieved from http://www.otc-cta.gc.ca/eng/publication/backgrounder-western-grain-revenue-cap-program

Barley classification to reflect different end uses. (2012). Retrieved from http://www.grainscanada.gc.ca/media-medias/bites-bref/bceu-couf-eng.htm

Brander, J. A., & Spencer, B. J. (1984, September). *Export subsidies and international market share rivalry* (NBER Working Papers No. 1464). National Bureau of Economic Research, Inc. Retrieved from http://ideas.repec.org/p/nbr/nberwo/1464.html

Brooks, H., & Schmitz, T. G. (1999). Price discrimination in the international grain trade: the case of canadian wheat board feed barley exports. *Agribusiness*, *15*(3), 313–322.

Buschena, D. E., Gray, R. S., & Severson, E. (1998). *Changing structures in the barley production and malting industries of the united states and canada* (Trade Research Center Policy Issues Papers No. 29168). Montana State University, Department of Agricultural Economics and Economics. Retrieved from http://ideas.repec.org/p/ags/motpip/29168.html

Canada grain act. (2012, August). Retrieved from http://laws-lois.justice.gc.ca/eng/acts/G-10/page-1.html

Canada transportation act. (2012, October). Retrieved from http://laws-lois.justice.gc.ca/eng/acts/C-10.4/20111215/P1TT3xt3.html

Canadian barley malting and brewing technical guide, 4 ed. (2011). Retrieved from http://www.cmbtc.com/CMBTC_Site/Technical_Guide_files/Barley%20Guide%202011-2.pdf

Canadian wheat board (interim operations) act. (2012, August). Retrieved from http://laws-lois.justice.gc.ca/eng/acts/C-24.2/FullText.html

Carter, C. A., Loyns, R. M. A., & Berwald, D. (1998). Domestic costs of statutory marketing authorities: The case of the canadian wheat board. *American Journal of Agricultural Economics*, *80*(2), 313-324.

Carter, C. A., & Smith, V. H. (2001). The potential impacts of state trading enterprises on world markets: The exporting country case. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, *49*(4), 429–439. doi: 10.1111/j.1744-7976.2001.tb00317.x

Chambers, W. (2004). *Forecasting feed grain prices in a changing environment.* US Department of Agriculture.

Chronological list of disputes cases. (2012). Retrieved from http://www.wto.org/english/tratop_e/dispu_e/dispu_status_e.htm

Commission, C. G. (2012). *Crop variety registration in canada: Issues.*

Constantine, J., Alston, J., & Smith, V. (1994). Economic impacts of the california one-variety cotton law. *Journal of Political Economy*, 951–974.

Doan, D., Paddock, B., & Dyer, J. (2003). Grain transportation policy and transformation in western canadian agriculture. In *Proceedings of international agricultural policy reform and adjustment project (iaprap) workshop, wye college, england, october* (Vol. 23).

Faq: Payments and check-offs. (2012, August). Retrieved from http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1311891454058&lang=eng

Fulton, M., Baylis, K., Brooks, H., & Gray, R. (1998). The impact of deregulation on the export basis in the canadian grain handling and transportation system. *Report presented to Saskatchewan Agriculture and Food. Regina, Saskatchewan.*

Fulton, M. E. (2006). *The canadian wheat board in an open market: The impact of removing the single-desk selling powers* (Miscellaneous Publications No. 31787). University of Saskatchewan, Knowledge Impact in Society (KIS) Project.

GAO. (1998). *U.s. agricultural trade: Canadian wheat issues* (Tech. Rep.). United States General Accounting Office.

Goodwin, B. K., & Mahul, O. (2004). *Risk modeling concepts relating to the design and rating of agricultural insurance contracts* (Vol. 3392). World Bank Publications.

Goodwin, B. K., & Schroeder, T. C. (1991). Price dynamics in international wheat markets. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, *39*(2), 237–254. doi: 10.1111/j.1744-7976.1991.tb03570.x

Goodwin, B. K., & Schroeder, T. C. (1994). Human capital, producer education programs, and the adoption of forward-pricing methods. *American Journal of Agricultural Economics*, *76*(4), 936–947. doi: 10.2307/1243753

Gustafson, C. R., Wilson, W. W., & Dahl, B. L. (2006). *Production risk and crop insurance in malting barley: A stochastic dominance analysis* (2006 Annual meeting, July 23-26, Long Beach, CA No. 21095). American Agricultural Economics Association (New Name 2008: Agricultural and Applied Economics Association).

Hamilton, S. F., & Stiegert, K. W. (2002). An empirical test of the rent-shifting hypothesis: the case of state trading enterprises. *Journal of International Economics*, *58*(1), 135-157. doi: 10.1016/S0022-1996(01)00159-3

Hanrahan, C. E. (2008). Agricultural export provisions of the 2008 farm bill.

Johnson, D. D. (1999). *Grain quality in the canadian barley sector: A review of regulations, industry practices, and policy issues* (Agricultural Economics Reports No. 23408). North Dakota State University, Department of Agribusiness and Applied Economics.

Johnson, D. D., DeVuyst, E. A., & Nganje, W. E. (2000). *Supply-side risks and malting barley procurement and storage* (2000 Annual Meeting, June 29-July 1, 2000, Vancouver, British Columbia No. 36367). Western Agricultural Economics Association.

Johnson, D. D., & Nganje, W. E. (2000). *Impacts of don in the malting barley supply chain: Aggregate costs and firm-level risks* (Agricultural Economics Miscellaneous Reports No. 23103). North Dakota State University, Department of Agribusiness and Applied Economics.

Johnson, D. D., & Wilson, W. W. (1995). Canadian rail subsidies and continental barley flows: A spatial analysis. *Logistics and Transportation Review*, *31*(1).

Lavoie, N. (2005). Price discrimination in the context of vertical differentiation: An application to canadian wheat exports. *American Journal of Agricultural Economics*, *87*(4), 835-854.

Magnan, A. (2011). Bread in the economy of qualities: The creative reconstitution of the canada-uk commodity chain for wheat. *Rural Sociology*, *76*(2), 197–228. doi: 10.1111/j.1549-0831.2010.00038.x

Mao, W., Koo, W. W., & Krause, M. A. (1996). *World feed barley trade under alternative trade policy scenarios* (Agricultural Economics Reports No. 23272). North Dakota State University, Department of Agribusiness and Applied Economics.

Martin, L. (1980). Comparing international market performance: Conceptual and measurement issues. *American Journal of Agricultural Economics*, *62*(5), 889-894.

Martin, L. J., & Warley, T. K. (1978). The role of marketing boards in stabilizing commodity markets. *American Journal of Agricultural Economics*, *60*(5), 878-884.

McCalla, A. F., & Schmitz, A. (1979). Grain marketing systems: The case of the united states versus canada. *American Journal of Agricultural Economics*, *61*(2), 199-212.

McCorriston, S., & MacLaren, D. (2006). *The economic effects of state trading enterprises: Market access and market failure* (2006 Annual Meeting, August 12-18, 2006, Queensland, Australia No. 25326). International Association of Agricultural Economists.

McCorriston, S., & MacLaren, D. (2007). Deregulation as (welfare reducing) trade reform: The case of the australian wheat board. *American Journal of Agricultural Economics*, *89*(3), 637-650.

Mitra, S., & Boussard, J.-M. (2008). *Storage and the volatility of agricultural prices: A model of endogenous fluctuations* (Fordham Economics Discussion Paper Series No. dp2008-11). Fordham University, Department of Economics.

Nelson, C. H., & Preckel, P. V. (1989). The conditional beta distribution as a stochastic production function. *American Journal of Agricultural Economics*, *71*(2), 370–378.

Nganje, W. E., Kaitibie, S., Wilson, W. W., Leistritz, F. L., & Bangsund, D. A. (2004). *Economic impacts of fusarium head blight in wheat and barley: 1993-2001* (Agribusiness & Applied Economics Report No. 23627). North Dakota State University, Department of Agribusiness and Applied Economics.

Paarlberg, P. L., & Abbott, P. C. (1987). Collusive behavior by exporting countries in world wheat trade. *North Central Journal of Agricultural Economics*, *9*(1), 13-27.

Park, J. J., Wilson, W. W., & Johnson, D. D. (1999). *Canadian transportation and grain handling: Issues affecting the north american barley sector* (Agricultural Economics Reports No. 23158). North Dakota State University, Department of Agribusiness and Applied Economics.

Qualman, D. (2004, May). Saskatchewan's farm income crisis. *Saskatchewan Notes*, *3*(7).

Questions farmers are asking. (2012, Jul/Aug). *Grain Matters*.

Regulations amending the seeds regulations (part iii and schedule iii). (2009, July). Retrieved from `http://www.gazette.gc.ca/rp-pr/p2/2009/2009-07-08/html/sor-dors186-eng.html`

Regulations respecting research, market development and technical assistance (wheat and barley). (2012, July). Retrieved from `http://canadagazette.gc.ca/rp-pr/p2/2012/2012-08-15/html/sor-dors152-eng.html`

Schmitz, T. G. (2002, April). Measuring inefficiency in the presence of an export tax, an import tariff, and a state trading enterprise. *Journal of Agricultural and Applied Economics*, *34*(01), 81–94.

Schmitz, T. G., & Gray, R. (2000). State trading enterprises and revenue gains from market power: The case of barley marketing and the canadian wheat board. *Journal of Agricultural and Resource Economics*, *25*(2), 596-615.

Schmitz, T. G., Koo, W. W., & Wahl, T. I. (1998). *The impact of the export enhancement program on international feed barley markets* (1998 Annual meeting, August 2-5, Salt Lake City, UT No. 21018). American Agricultural Economics Association (New Name 2008: Agricultural and Applied Economics Association).

Sexton, R. J., & Lavoie, N. (2001). Chapter 15 food processing and distribution: An industrial organization approach. In B. L. Gardner & G. C. Rausser (Eds.), *Marketing, distribution and consumers* (Vols. 1, Part B, p. 863 - 932). Elsevier. doi: 10.1016/S1574-0072(01)10023-X

Smid, M. (2004, November). *Normal approximation of the disrtibution of the equilibrium price in markets with random demand and supply* (GE, Growth, Math methods No. 0411001). EconWPA.

Soregaroli, C., & Sckokai, P. (2011, September). *Modelling agricultural commodity markets under imperfect competition* (2011 International Congress, August 30-September 2, 2011, Zurich, Switzerland No. 116012). European Association of Agricultural Economists.

Thursby, M. (1988, May). Strategic models, market structure, and state trading: An application to agriculture. In *Trade policy issues and empirical analysis* (p. 79-108). National Bureau of Economic Research, Inc.

Ulrich, A., Furtan, W. H., & Schmitz, A. (1987, February). The cost of a licensing system regulation: An example from canadian prairie agriculture. *Journal of Political Economy*, *95*(1), 160-78.

User fees - consultation document. (2012, February). Retrieved from `http://www.grainscanada.gc.ca/consultations/2010/fees-frais/ufcd-dcfu-05-eng.htm#archived`

Veeman, M. M. (1987). Marketing boards: The canadian experience. *American Journal of Agricultural Economics*, *69*(5), 992-1000.

Vercammen, J. (1999). Impact on western grain rail rates from an elimination of the legislated rate cap. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, *47*(3), 251–264. doi: 10.1111/j.1744-7976.1999.tb00224.x

Western grain revenue cap statistics. (2011, December). Retrieved from `http://www.otc-cta.gc.ca/eng/publication/western-grain-revenue-cap-statistics`

Young, L. M., & Abbott, P. C. (1998). *Wheat-importing state trading enterprises: Impacts on the world wheat market* (1998 Annual meeting, August 2-5, Salt Lake City, UT No. 20825). American Agricultural Economics Association (New Name 2008: Agricultural and Applied Economics Association).

APPENDICES

APPENDIX A

CONTINUOUS CASE OF THE FARMER'S DECISION TO CONTRACT

In the continuous case, the representative farmer can choose to contract to grow only a portion of their crop, α, as malt barley and grow the remaining portion as feed barley. Alternatively, she may choose to contract to grow a proportion of a wheat crop, β, selling the remaining proportion of wheat on the cash market. Here the P_w is the contract price of wheat. Note $0 \leq \alpha, \beta \leq 1$.

$$\pi_b = \alpha y_b[\lambda P_m + (1-\lambda)(P_f)] + y_b(1-\alpha)P_f - [b(y_b) + c(\alpha y_b)] \tag{A.1}$$

$$\pi_w = y_w(1-\beta)P_w + \beta y_w P_w - [w(y_w) + c(\beta y_w)] \tag{A.2}$$

Since the farmer makes malt with probability λ, the farmer faces two possible outcomes from growing barley with a portion contracted as malt. The contracted barley does not make malt, the farmer's revenue is $P_f y_b$, or the portion of her crop for which she contracted does make malt and her revenue is $P_f y_b(1-\alpha) + P_m y_b \alpha$. Her revenue is higher if she makes malt because $P_m > EP_f$.

Again assuming the costs of growing and contracting for barley and wheat are the same and the farmer is risk neutral, then the farmer grows barley if and only if

$$(1-\alpha)P_f + \alpha[\lambda P_m + (1-\lambda)(P_f)] \geq \frac{y_w[(1-\beta)P_w + \beta P_w]}{y_b} \tag{A.3}$$

If the farmer would choose to contract for all the barley crop, that is if $\alpha = 1$, and if the farmer would not contract to grow wheat (that is $\beta = 0$) then the result the same as the discrete case.

In this model, individual farmers choose which crop to grow based on expected profits. However, the model does not preclude differences in choices among farmers. Different choices among farmers may be observed due to differences in wheat and barley yields caused by dissimilarities in experience and soil quality. These differences might also explain why a risk neutral farmer might contract for a portion of their total land as opposed to the entirety.

APPENDIX B

NORMAL COPULA METHODOLOGY

When simulating the yield and price variables, specifying the distributions of each variable and simulating independently required strong assumptions since we have several related random variables of interest. For example, we simulated wheat and barley yield variables within the same regions and these same variables for neighboring regions. Thus, when simulating we wanted to specify the marginal distributions and the joint distribution between the variables. Using a copula function provided a mechanism to accomplish this, the function is $C[F_1(f_1|\bullet), ..., F_k(f_k|\bullet), \nu]$ where $F_i(f_i|\bullet)$ denotes a variable of interest and its marginal distribution, "$\bullet$" is its distributional specifications, and ν denotes dependence parameters. The simulation process was as follows:

1. Raw yield and price data were collected, largely from the Canada Grains Council and the United States Department of Agriculture. Reasons specific data were collected and why they were collected are described in more detail in the Data section of the Data and Empirical Modeling Strategy chapter.

2. Yield data were detrended and prices were deflated to reflect yields and prices for the 2012 base year. These process are also described in the Data section of the Data and Empirical Modeling Strategy chapter.

3. For each variable, the distribution and distributional specifications were determined.

    (a) We fit yield variables, say $y_1, ..., y_m$, and tested goodness of fit for beta and normal distributions. After determining the appropriate distributions, we obtained a set of alpha and beta parameters from the beta distributed variables and mean and variances from the normally distributed variables.

(b) Similarly, we fit price variables, say $z_1, ..., z_n$, and tested goodness of fit for lognormal and normal distributions and obtained the means and variances of these distributions.

From this process and the original data we obtained characterizations of the marginal distributions for the yield variables, $Y_1(y_1|\bullet), ..., Y_m(y_m|\bullet)$, and characterizations of the marginal distributions for the price variables, $Z_1(z_1|\bullet), ..., Z_m(z_m|\bullet)$. "$\bullet$" denotes distributional parameters for each distribution. For the normally and lognormally distributed variables, "$\bullet$" denotes the mean and standard deviation. For the beta distributed variables, "$\bullet$" defines the alpha, beta, and non–standard distribution parameters.

4. We determined the correlation structure between the yield variables, Σ, and the correlation structure between the price variables, Θ. Σ and Θ are the correlation matrices determined from the historical data using the Spearman rank correlation.

5. The first step in the actual simulation process was to perform Cholesky decompositions of the correction matrices $\Sigma = HH^T$ and $\Theta = JJ^T$ where H and J are lower triangular matrices with nonnegative diagonal entries. If $\check{L} \sim N(0, I)$, then $H\check{L} \sim N(0, \Sigma)$ and $J\check{L} \sim N(0, \Theta)$. Next we generate a multivariate normal vectors $\vec{S} \sim N(0, \Sigma)$ for the yield variables and $\vec{T} \sim N(0, \Theta)$ for the price variables.

6. For the next simulation step these vectors were then transformed from $\vec{S}$ into $\vec{Y} = (Y_1(s_1|\bullet), ..., Y_m(s_m|\bullet))^T$ and $\vec{T}$ into $\vec{Z} = (Z_1(t_1| \bullet 1), ..., Z_n(t_n|\bullet))^T$.

7. Steps five and six were repeated 5,000 times for both the yield and price variables in order to obtain a data set with 5,000 simulated observations.