Agricultural Economics Report No. 357 **September 1996**

An Economic Analysis of International Feed and Malting Barley Markets: An Econometric Spatial Oligopolistic Approach

Troy G. Schmitz
Won W. Koo

Department of Agricultural Economics
Agricultural Experiment Station
North Dakota State University
Fargo, ND 58105-5636

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Abstract

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Key Words: Malting, Feed, Farm Subsidy, Trade Policy, Export Market, Welfare

Table of Contents

Table of Contents (Continued)

Table of Contents (Continued)

List of Tables

List of Tables (Continued)

List of Figures

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Highlights

The four leading exporters of feed and malting barley are the European Union (EU-15), Canada, Australia, and the United States. These countries account for more than 95 percent of world trade in feed and malting barley. The EU-15 is the largest feed barley exporter, but Australia and Canada are the major malting barley exporters. The EU-15 and Australia grow 2-row malting barley varieties almost exclusively. The United States grows more 6-row malting barley than 2-row malting barley while Canada grows more 2-row varieties than 6-row. World 6-row malting barley production is concentrated in the upper Midwestern region of the United States and the central prairie region of Canada. U.S. brewers use mostly 6-row malting varieties for brewing purposes while almost all other countries use 2-row malting varieties.

The United States is both an exporter and importer of feed and malting barley. In recent years, it has become a net importer of 6-row malting barley and a substantial importer of feed barley. Over 95 percent of all U.S. barley imports originate from Canada. The EU-15 became a net exporter of barley in the early 1980s. Increased competition in international barley markets has heightened trade tensions among the four major exporters. Differences in agricultural policies among these countries contribute to multiple complexities regarding the economic analysis of international barley markets.

Canadian and Australian policies influence markets through the single-desk seller status granted to marketing boards for the sale of malting barley and the export of feed barley. The Canadian Western Grain Transportation Act (WGTA) functions as a subsidy to Canadian producers for overseas barley exports. A number of ad-hoc Canadian farm programs have also influenced barley markets. The U.S. Export Enhancement Program (EEP) has had a major impact on the structure of international barley markets. The Acreage Reduction Program and Conservation Reserve Program provide direct subsidies to U.S. producers, but they also act to restrict supplies and curtail exports. Variable import levies under the Common Agricultural Policy of the EU-15 insulate its producers from import competition while export restitutions essentially provide export subsidies for EU-15 grain traders.

This report contains an in-depth economic analysis of the implications of these agricultural policies on production, consumption, and trade of feed and malting barley. The analysis includes the economic welfare impacts of changes in various farm subsidy programs on producers, taxpayers, and consumers in the four major barley exporting countries. A “hybrid” spatial price equilibrium model is developed under which the market structure imposed by agricultural policy regimes (in place from 1991 to 1993) is used for purposes of comparison. The actions of competitive U.S. grain traders under EEP cause feed barley exports to be segmented into two distinct markets. The Canadian Wheat Board (CWB) and Australian marketing boards act as oligopolists in export markets under arbitrage conditions induced by U.S. and EU-15 grain traders.

Six possible agricultural policy regimes are examined. These are compared and contrasted with the actual policy regime that existed from 1991 to 1993. Following are some of the major results:

- *The Elimination of EEP would decrease the average U.S. domestic price, reduce Canadian exports of feed barley to the United States, and increase the price of feed barley in both EEP and non-EEP markets. This would also increase the average price received by Canadian and Australian feed barley producers. However, it would significantly increase the level of carry-over stocks in the United States. The analysis suggests that EEP has the effect of raising U.S. domestic prices and significantly reducing U.S. barley stocks at the expense of Canadian, Australian, and EU-15 farmers. These benefits also come at a cost to U.S. taxpayers who are essentially subsidizing feed barley importers in EEP markets.*

- *If the CWB did not face the threat of retaliatory policy action by the United States caused by expanding barley imports, it could reallocate a portion of its feed barley exports away from EEP markets and into the U.S. market so as to maximize the total revenue accruing to Canadian feed barley producers. However, such an aggressive strategy would increase the average price received by Canadian farmers for feed barley by only 4 cents per bushel, but would cost the U.S. government $67 million in additional aggregate export subsidy payments. In practice, if Canadian feed barley exports to the United States came anywhere near this level, the U.S. would alter its policies significantly. One likely outcome would be the imposition of import restrictions similar to those placed on durum wheat in 1994/95.*

- *Removing the Canadian WGTA subsidy would increase the level of feed barley exports from Canada to the United States by 288,000 tonnes. This result is contrary to what many U.S. producer groups might expect.*

- *The elimination of short-term U.S. set-asides, assuming all other policies remain the same, would dramatically increase the U.S. domestic supply of feed and malting barley and increase U.S. barley stocks. U.S. producers would lose $14 million in barley revenue. U.S. taxpayers would pay an additional $45 million in export subsidies, but would save $135 million in deficiency payments. U.S. feed barley exports to EEP markets would increase, displacing substantial quantities of Canadian and Australian feed barley exports from EEP markets. Canadian malting barley exports to the United States would decrease. Domestic prices in the United States, Canada, and Australia would drop by roughly $5 per tonne causing total Canadian and Australian farm revenue to fall.*

- *The results of a partial world policy liberalization can be used as a guide for analyzing the potential economic impacts of a "Freedom to Farm" type 1996 Farm Act under average 1991 to 1993 market conditions. The analysis shows that even if U.S. barley farmers do not receive any lump-sum payments under the new Farm Bill, their aggregate revenue from feed and malting barley would still increase by $15 million while U.S. treasury costs to support the barley program would be reduced by $227 million. This outcome does not include the potential decoupled lump-sum payments that U.S. farmers may receive under the new farm program nor does it take into account the fact that at the time of this writing, average barley* *prices have increased significantly over their average 1991 to 1993 levels. Either of these additional conditions would push the net increase in farm revenue accruing to U.S. barley producers beyond the estimated $15 million.*

AN ECONOMIC ANALYSIS OF INTERNATIONAL FEED AND MALTING BARLEY MARKETS: AN ECONOMETRIC SPATIAL OLIGOPOLISTIC APPROACH

INTRODUCTION

Troy G. Schmitz and Won W. Koo*

The international grain trade has attracted much controversy in recent years. Most of this controversy has centered around the wheat and barley industries. In North America, increasing exports of wheat and barley from Canada to the United States have raised concerns over the two countries' respective marketing and support systems for grains and the effect of those systems on the Canadian and U.S. markets and on competition between the two countries in third country markets.[1] A Canada-United States Joint Commission on Grains was established in September 1994 to study this issue. Most U.S. producers feel that the Canadian Wheat Board (CWB) has recently utilized its position as single-desk exporter of wheat and barley to capture monopolistic economic rents by dumping grain into the U.S. market. They contend that increased CWB sales to the United States have lowered U.S. domestic prices, decreasing farmers' revenues. In addition, they feel that Canadian agricultural policies such as the Western Grains Transportation Act (WGTA) give Canadian farmers a distinct advantage in U.S. markets as well as third country markets. On the other hand, the Canadian Wheat Board takes the position that U.S. farm policies such as the Acreage Reduction Program (ARP), the Conservation Reserve Program (CRP), and the Export Enhancement Program (EEP) have caused a shortage of U.S. domestic grain supplies, which has raised U.S. domestic prices making it a more attractive market for Canadian suppliers, and that EEP gives the United States a distinct advantage in third country markets [CWB Policy Group, 1992].

There are factions within Canada that believe Canadian farmers do not benefit from the monopolistic selling powers vested in the CWB. In fact, some have argued that Canadian farmers would be better off under a competitive marketing system for wheat and barley than under the current Canadian Wheat Board structure. With respect to barley, in 1992, the Minister of State for Grains and Oilseeds in Canada commissioned a study [Carter, 1993] to perform an economic analysis of the existing barley marketing system within Canada. A concurrent study was performed by Schmitz et al., 1993. Carter concluded that "there is no economic evidence that the CWB has significant market power in the world barley market or in the United States." Schmitz et al. concluded that "such a move [to a continental barley market] would reduce market revenue from barley produced in Western Canada" implying that Canadian farmers do benefit from the monopolistic pricing power of the Canadian Wheat Board. Other papers contained in the agricultural economics literature were written in response to these two studies. As a result, a major liberalization of the Canadian barley marketing system was implemented in August, 1993. However, after over a month of private contracting between Canadian producers and U.S. buyers, the Canadian courts reversed the decision in September of that same year. To say that these

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*Schmitz is visiting assistant professor, University of Florida, Gainesville and Koo is professor at North Dakota State University, Fargo.

[1] Canada - United States Joint Commission on Grains preliminary report, June 1995.

issues have not yet been entirely resolved would be an understatement.

Most previous literature on international barley markets focused only on issues between Canada and the United States. For example, Johnson and Wilson (1994) developed a spatial price equilibrium model to analyze the allocation of barley between U.S. states and Canadian provinces. However, Canada and the United States are only two of the four major competitors in the international barley market. The main reason cited for establishing the Export Enhancement Program in the United States under the 1985 Farm Bill was to maintain export market share in the face of rapidly expanding grain exports from the European Union [Haley, et al., 1992]. The European Union is by far the largest exporter of barley in the world. The 15 countries of the European Union (EU-15) typically export more than twice the barley volume of Canada, which is typically the second largest barley exporter. Australia competes with Canada as one of the two largest exporters of malting barley in the world. Hence, analysis of international barley markets is incomplete without the inclusion of EU-15 and Australia alongside Canada and the United States. Haley et al. include Australia and EU-10 in their analysis of EEP, but their analysis is based on 1986 and 1987, which were the first two years of EEP and the years with the largest government EEP payments. In addition, the Haley study does not include an analysis of malting barley since it focuses on EEP which was used to subsidize only feed exports until 1993.

The objective of this study is to evaluate changes in production, consumption, and trade of feed and malting barley under alternative domestic and agricultural trade policy regimes. The analysis includes the economic welfare impacts of changes in various farm subsidy programs on the United States, Canada, Australia, and EU-15 which are the four major barley exporting countries in the world. The paper is organized as follows. Section 2 provides an overview of agricultural policies in the United States, Canada, Australia, and EU-15 that affect the structure of both domestic and international barley markets. A discussion of some of the issues within each country as they affect domestic and export markets as well as the structure of both feed and malting barley marketing systems are given. Section 3 provides a more complete picture of barley markets in the four main countries through the use of detailed data obtained or approximated from numerous sources. In each country, barley is divided into feed barley and malting barley. Where applicable (i.e., the United States and Canada), malting barley is further subdivided into 2-row and 6-row varieties. In most cases, regional data within each country are also explored. Supply, demand, and price issues for the different types of barley are discussed. Barley exports for each country from 1983 to 1993 are divided into feed and malting barley by destination and then aggregated to give a view of the volume and type of barley exported by the four countries to various importing countries. Finally, malting barley selection rates are approximated and a discussion of the importance of these values is included.

In Section 4, econometric estimates of domestic feed and malting barley supply and demand parameters for the United States, Canada, Australia, and EU-15 are established. In Section 5, the econometric estimates of Section 4 are combined with various import and export market clearing conditions as well as restrictions implied by the structure of barley markets and certain agricultural policies to develop an econometric simulation model of international barley markets. The model is implemented in two separated stages. The first stage determines domestic supply and demand conditions for both feed barley and malting barley for each of the four exporting countries. The second stage determines import market conditions, links export prices with import prices, and establishes equilibrium consumption levels, stock levels, and trade flows under a "hybrid" spatial price equilibrium model. The solution concepts follows along the lines if T.G. Schmitz (1995). In particular, it is assumed that U.S. and EU-15 exporters behave competitively while Canadian and Australian exporters behave oligopolistically. In equilibrium, the model establishes a different consumer price for feed and malting barley in each of the four exporting countries, a different realized price received by farmers for feed and malting barley, an equilibrium import price for feed barley in export markets that receive subsidies under the U.S. Export Enhancement Program (e.g., Saudi Arabia), and an equilibrium import price for feed barley in export markets that do not receive subsidies under EEP (e.g., Japan).

In Section 6, the econometric simulation model derived in Sections 4 and 5 is used to establish a base scenario that reflects average market conditions during the 1991 to 1993 period. Once the base scenario is established, further simulation results are generated that are used to estimate the economic effects of the following changes in agricultural polices with respect to feed and malting barley markets in the United States, Canada, EU-15, and Australia:

- The average U.S. EEP subsidy is reduced to 0.
- Canadian feed barley export levels to the United States are unconstrained.
- The WGTA subsidy is eliminated and U.S. feed imports are unconstrained.[2]
- Short-term U.S. set-aside requirements are eliminated.
- North American trade policies are liberalized with respect to barley markets.
- World trade policies are partially liberalized (possible 1996 Farm Act outcome).

Section 7 provides a summary and highlights of the policy implications.

AGRICULTURAL POLICIES

UNITED STATES

A number of domestic agricultural policies in the United States affect the barley industry. The United States institutes "Farm Bill" legislation once every five years. Feed grains were included under the 1990 Farm Bill. Farm Bill provisions that play a major role with respect to the barley industry are target prices, Acreage Reduction Programs (ARP), the Conservation Reserve Program (CRP), the Malting Barley Assessment provision, and the Export Enhancement Program (EEP).

Target Prices

Target prices for barley were established under the Agriculture and Consumer Protection Act of 1973. Barley producers receive deficiency payments whenever the target price exceeds the

[2]The WGTA is scheduled to be phased out over the 1995/96 and 1996/97 crop year. Canadian farmers will cease to receive WGTA subsidies after 1997.

U.S. average market price during a specific period. "In simplest terms, the deficiency payment to a producer equals the deficiency payment rate for the commodity (target price minus the higher of the loan rate or average market price) multiplied by the farm's program production of the commodity (payment acres times program yield per acre)" [Lin et al., 1995]. The only year in which the loan rate for barley was higher than the average feed barley market price was 1985, and even in that year, the difference between the loan rate and average feed barley market price was only $4.60 per metric ton (tonne). Hence, the deficiency payment rate is typically the target price minus the average market price for all barley. The barley target price was set at $119.42 per tonne in 1981 and remained constant until 1987. The target price dropped to $115.28 and $112.07 per tonne in 1988 and 1989, respectively. The target price was then set at $108.39 per metric tonne in 1990 and remained at that level through 1995. In order to be considered for deficiency payments in a given year, the planted area must first be enrolled in the program. One condition of enrollment is that some area be idled under the Acreage Reduction Program.

Acreage Reduction Program

Acreage Reduction Programs have been implemented in order to limit Federal budget outlays and to prevent excessive stock buildups. The 1981 Farm Bill established crop specific acreage bases. The Acreage Reduction Program for barley limits the planting of barley to a specific percentage of its acreage base as a condition for a producer to receive deficiency payments. The minimum ARP requirement for barley was set at 10 percent following the 1981 Farm Bill and remained constant until 1987. For 1987 and 1988, the minimum set-aside was 20 percent, which was reduced to 10 percent for 1989 and 1990. In 1991, it was reduced to 8 percent and then to 5 percent in 1992.

Since 1992, there has been no minimum set-aside requirement for barley. However, the Farm Bill was modified in 1990 so that an additional 15 percent of the base acreage does not qualify for any deficiency payments. This area is referred to as "flex acres" and does not need to be set-aside. The flex acres can be used to plant any crop without loss of barley base, but no deficiency payment is received on that crop. An optional provision was added under the 1990 Farm Bill for an extra 10 percent of "optional flex acres" which cannot receive deficiency payments, but can be used for other crops without loss of base. The 1990 version of ARP has become known as a "triple-base" program for obvious reasons.

Conservation Reserve, 50/92 and 0/85-92 Programs

The Conservation Reserve Program was established under the 1985 Farm Bill. Under CRP, producers bid to enroll environmentally sensitive land in the program for 10 years. Producers must idle 100 percent of the land enrolled in CRP, forgoing deficiency payments in favor of annual rental payments. The land is taken out of its allotted acreage base for the duration of its enrollment. In 1994, the total enrollment of land from the barley acreage base into long-term CRP contracts was 1.13 million hectares.

In addition to long-term CRP contracts, the 1985 Farm Bill included a provision to allow producers to receive 92 percent of their expected deficiency payments while planting as little as 50 percent of permitted acreage (base less ARP acres). The non-seeded area had to be put into conservation uses. This provision became known as 50/92. This provision was later changed to 0/92 and is known as 0/85-92. The current 0/85-92 provision allows a producer to devote all the permitted acreage to conservation uses while receiving 85 to 92 percent of projected deficiency payments. The total barley base area set-aside under these short-term CRP programs (50/92, 0/92, and 0/85-92) in 1994 was 1.09 million hectares.

Malting Barley Assessment

Under the 1990 Farm Bill, a provision for an assessment on malting barley was added. This provision stipulates that an assessment of no more than 5 percent of the value of malting barley produced on the farm can be levied against producers of malting barley. This provision was added because feed barley prices are used exclusively for calculating deficiency payments. This results in a higher program cost than differentiating between feed and malting barley because farmers who sell malting barley receive a premium over feed barley which is not reflected in the calculation of the deficiency payments. Only malting barley receiving deficiency payments produced on payment acres is subject to the assessment. The volume of malting barley was assessed at 5 percent of the state average malting barley price received by producers during the first five months of the marketing year prior to 1993. In 1993, the assessment was reduced to 2.5 percent and then 0 percent.

Under 1990 farm legislation, the target price for barley cannot be less than 85.8 percent of the target price for corn on a per bushel basis. However, barley's feed energy value relative to corn is only 77 percent (measured in bushels) which implies that the target price may already take the malting barley premium into consideration. In addition, if the malting barley assessment were to remain above 0, malting barley producers might switch barley plantings away from malting varieties into feed varieties due to the additional paperwork requirements and extra assessment. This would increase the supply of U.S. feed barley at the expense of malting barley production, causing the United States to be less competitive than Canadian producers in the malting barley market [Lin et al., 1995].

Export Enhancement Program

The Export Enhancement Program, established under the 1985 Farm Bill, provides subsidies to U.S grain companies on certain grain shipments sold to targeted countries. Algeria, Bulgaria, Cyprus, Egypt, the former Soviet Union, Iraq, Israel, Jordan, Morocco, Poland, Romania, Saudi Arabia, and Tunisia have all benefited from lower prices due to EEP subsidies for feed barley. China (1994) and Slovenia (1993) have benefited from EEP subsidies for malting barley, but as of 1994/95, they each received only one EEP shipment of malting barley. Since 1985 (with the exception of 1988 and 1989), virtually all feed barley export sales have received substantial EEP bonuses. In 1988, only 35 percent of sales received EEP bonuses, while roughly 55 percent of sales in 1989 received bonuses. The weighted average of EEP bonuses per shipment from 1986 to 1994 (excluding 1988 and 1989) was $39.33 per tonne. However, perhaps due to the 1988 drought, the average EEP bonuses in 1988 and 1989 were only $6.49 and $12.11 per tonne, respectively.

While it is apparent that the Export Enhancement Program has had some positive effect on

U.S. barley exports, it is not clear that the benefits of the program outweigh the associated costs [Haley et al., 1992]. The Export Enhancement Program increases U.S. exports by lowering the import price for targeted countries. There are two costs associated with this program. The U.S. treasury must pay an amount equal to the EEP bonus multiplied by the quantity shipped. This is the explicit cost. However, there are also implicit costs involved with the program. The Export Enhancement Program reduces the supply available to domestic consumers, which causes domestic prices to rise. The U.S. market then becomes attractive for Canadian suppliers, who increase exports to the United States. Since the early 1990s, the United States has exported large quantities of feed barley, but has also imported significant amounts from Canada.

CANADA

Canadian Wheat Board

The Canadian Wheat Board (CWB) was established as a Crown Agency by the Canadian Wheat Board Act of 1935. The CWB is a single-desk state trading agency responsible for the marketing of all wheat and barley sold for human domestic consumption and for export. The CWB may also market wheat and barley used for feed purposes in the domestic market, but is not the sole marketing agency for feed. The three major responsibilities of the Canadian Wheat Board are to market wheat and barley grown in the prairie region to the best advantage of grain producers, to provide price stability to producers through an annual "pooling" or price-averaging system, and to ensure that each producer obtains a fair share of the available grain market [McGarry and Schmitz, 1992]. The CWB has jurisdiction over Alberta, Saskatchewan, Manitoba, and a small section of British Columbia. These regions are often referred to as the “designated area.” The designated area typically produces 95 percent of the entire Canadian wheat and barley crop. Roughly half of the barley produced in Western Canada is fed to livestock and sold either directly to feedlots or fed on farms and does not enter the country elevator system. Hence, the CWB markets approximately half of all barley produced in Canada.

The Canadian Wheat Board achieves price equalization for producers through a price pooling system. Since 1975, the CWB has separated barley into two pool accounts: feed and designated barley. Designated barley is high quality malting barley that is sold for use in the production of barley based alcohol such as beer. At the beginning of each crop year, the government establishes initial producer prices for grain sold to the CWB. These prices are announced in advance, normally in April (but not always), and are different for each grade. The CWB issues a series of marketing quota books on the basis of seeded area. The quota system is used to ensure orderly marketing and its objective is to ensure that each producer receives a "fair share" of available markets. If a producer has an unfilled quota book, he can deliver the grain to the CWB at which time he receives an initial payment which is usually well below the final pooled price. The initial payment is the same no matter what time of the year the grain is sold, does not depend on geographical location within the designated area, and does not depend on deductions for freight, etc. Once the CWB has marketed all the grain in a particular pool, freight and handling charges are deducted, the revenue is pooled, and a final payment is distributed to each individual producer based on the relative producer share of grain in that particular pool. Occasionally, interim payments may be made at different dates throughout the crop year.

The Canadian grain marketing system is affected, not only by the operation of the Canadian Wheat Board, but also by a number of other institutions as well as somewhat ad-hoc grain policies. The following gives a brief description of the more important programs, some of which are no longer in place.

Western Grain Transportation Act

The Western Grain Transportation Act (WGTA) was enacted in 1983. Under this Act, the Canadian government provided rail companies with an annual payment of up to $658 million Canadian dollars (C$658) with adjustment for inflation to cover the transportation of eligible grain shipments to select shipping terminals at western and eastern ports. This payment is sometimes referred to as the "Crow Gap" and is an estimate of the shortfall in revenues experienced by the Canadian railway companies as a result of price ceiling regulations on grain freight rates dictated by the Canadian government. Under the Canadian-U.S. Free Trade Agreement (CUSTA), exports to the western United States through Vancouver do not qualify for subsidized rail rates, but exports to the eastern United States through Thunder Bay do qualify. The Canadian Wheat Board has maintained equality in pooled Thunder Bay/Vancouver prices even though relative prices between Vancouver and the lower St. Lawrence have changed over time. Through the WGTA subsidy, the producer at a particular location pays the lower of the rate to Vancouver or Thunder Bay which depends upon distance to port. Under the WGTA, the Canadian government pays a share of the cost that is a constant proportion of the full rate. The government typically subsidizes over one-half of the shipping costs for barley in a given year.

The WGTA subsidy was eliminated in July, 1995. The effects of the elimination of this subsidy have been estimated [Agriculture Canada, 1994]. Because the Canadian Wheat Board provides the same total payment regardless of location, producers at the geographical midpoint between Vancouver and Thunder Bay (i.e., Reford, Saskatchewan) have the lowest net value of grain shipped to either port. It has been postulated that the elimination of the WGTA subsidy will lower grain prices by a relatively larger amount in those regions that are near the geographical center of Canada. However, one side effect of this deregulation could be that the premium that already exists between Canadian and U.S. domestic barley prices could widen due to the lower price received by Canadian producers for grain shipped by rail. This would increase the incentives to market western Canadian grain by truckload to some U.S. locations (e.g., Saskatchewan to North Dakota).

Western Grain Stabilization Act

The Western Grain Stabilization Act (WGSA) was a voluntary program that allowed farmers to contribute a percentage of their gross sales to a stabilization fund. The Canadian government then matched approximately one-half of the producer contribution. The program was designed to pay out when net cash receipts fell below 90 percent of the 5-year average. The highest WGSA payout was C$1.4 billion for the 1986/87 crop year. This program was terminated in the early 1990s due to the huge burden on the Canadian treasury.

Special Canadian Grains Program

The Special Canadian Grains Program (SCGP) was an ad-hoc program that was implemented in 1986 and 1987 in the face of low grain prices worldwide. The SCGP was enacted to offset the loss incurred by Canadian producers resulting from the subsidy war between the United States and European Union. The SCGP transferred C$1 billion and C$1.1 billion from the Canadian government to grain producers in 1986 and 1987, respectively. This program was used during only the two years following the implementation of the U.S. Export Enhancement Program.

Crop Insurance and Gross Revenue Insurance

Crop insurance was essentially a voluntary production guarantee program where premiums were paid by producers and matched by the federal government. Administrative costs were paid by the provincial governments. This program was integrated into the Gross Revenue Insurance Program (GRIP) in 1991. GRIP is a voluntary program. Farmers must pay an insurance premium to enter GRIP. It provides a minimum gross income per hectare which is derived by multiplying the minimum average yield for a given area by the 15-year moving average price. If the farmer receives total revenue that is below the GRIP amount, he receives the difference, regardless of whether the actual yield or actual prices are below the average. Subject to a cap limitation, the farmer can set aside up to 2 percent in an individual account to be matched by the federal and provincial governments. The program triggers payments when a farm's gross margin falls below a 5-year average or the net income falls below C$10,000.

Australia

Australia produces barley in 5 states: South Australia, Victoria, Western Australia, New South Wales, and Queensland. A small amount of barley is also grown in Tasmania. Australia covers a huge area, but most grain is produced near the region spanning the southwest to southeast coasts. Sheep and wheat are the major competitors for land with barley. It is common practice in Australia to rotate land use between wheat, 2-row barley, and sheep grazing. The pasture phase of the rotation is typically extended in years when expected grain prices are low relative to expected wool prices. Crop production fluctuates more widely in Australia due to price and climate variability than in the other major barley exporting countries. Barley marketing is controlled by a marketing board system as in Canada. However, in Australia there are a few smaller barley marketing boards that differ from state to state.

The political philosophy in Australia has been that farmers should have control over how their product is marketed. Producers have been adamant that where institutions have been set up for this purpose under state or federal legislation, they should operate without ministerial interference. In addition, there have been times that this mechanism has allowed the implementation of domestic price controls in the form of price discrimination in that domestic prices have been higher than export prices. One justification for this two-price policy is that domestic prices can be manipulated counter cyclically to export prices, making the "equalized" or weighted average producer price more stable than the export price [McGarry and Schmitz, 1992].

Australian Marketing Boards

There are over fifty grain marketing boards in Australia. However, the Australian Barley Board has jurisdiction over both South Australia and Victoria which typically seed over one-half of all barley in Australia. The other three marketing boards handling barley are the Grain Pool of Western Australia, the New South Wales Grain Board, and Queensland Co-operative Bulk Handling Limited. Under the Australian Constitution, powers to set prices and control production belong to each state, but the Commonwealth has exclusive powers with respect to excise duties and customs duties. The Commonwealth can legislate on export and interstate trade, but the Constitution provides for free trade among states. As a result of the Constitutional division of powers, federal-level marketing boards such as the Australian Barley Board are mainly involved in export marketing activities. State-level boards and corporations can set prices and control production levels within their own borders; however it is possible for a producer to circumvent the jurisdiction of the state boards by selling produce across state borders.

The Australian board system is similar in many respects to the operations of the Canadian Wheat Board, except that Australia has more than one board. Farmers receive an initial payment upon delivery. This payment is the same regardless of the season in which barley is sold and is typically different for each state board. Each board pools all barley received and issues a final payment based on the revenue received from sales less handling fees. Hence, producers can obtain a guaranteed minimum price for the barley that is delivered. As is the case in Canada, Australian Boards market all the barley used for malting purposes, but market only the residual feed.

EUROPEAN UNION (EU-15)

The European Union is the largest producer and exporter of feed barley in the world. The composition of the European Union has changed over time. During the late 1970s and early 1980s up until 1986, the European Union was comprised of only ten countries (EU-10): Belgium, Luxembourg, Denmark, France, West Germany, Greece, Ireland, Italy, Netherlands, and United Kingdom. In 1986, Spain and Portugal were added to create the EU-12. In 1990, East Germany was merged with West Germany to form a reunified Germany. In 1995, Austria, Finland, and Sweden were added to form the EU-15. Therefore, any discussion of agricultural policy issues in the European Union would not be complete without including all of the countries in the EU-15.

All member countries of the European Union fall under the jurisdiction of the Common Agricultural Policy (CAP). The two policy instruments that have a major effect on both domestic and international barley markets are variable import levies and export restitution payments.

Variable Import Levies

Under the Common Agricultural Policy, any grain that is imported by European Union member countries is subject to a variable import levy. A threshold price is set for each commodity. Imports are not allowed to be sold on the domestic market for less than the threshold price. Because the threshold price is usually higher than the domestic price, domestic consumers will purchase barley from domestic producers before they will purchase imports. This rules out price competition in the domestic market. CAP reform, which began in 1992, has dropped the threshold price but it is still prohibitive in most cases.

The new General Agreement on Tariffs and Trade (GATT) signed in 1994 as a result of the Uruguay round of trade negotiations has prompted a change in the old variable import levy system. Under GATT all non-tariff barriers are to be converted to tariffs. This has resulted in a two-tiered tariff system, described in Schmitz, DeGorter, and Schmitz (1996). However, the Special Safeguard Provisions (SSPS) under GATT allow the EU-15 to use either a quantity trigger or a price trigger (but not both) in combination with a two-tiered tariff system. When the European Union offered its tariff schedule it included an indication of the trigger prices it intends to use under the SSPS. Depending upon the relationship between future world prices and trigger price levels, the new system may look like a cross between a fixed tariff system in the spirit of GATT or the old variable levy system. As a by-product of the EU commitment, it is likely to charge a form of variable duty bridging the gap between the world price and a maximum duty-paid price [Josling and Tangermann, 1995]. In any event, it is most likely that at least in the near future, imports of barley from outside member EU-15 countries will continue to remain negligible.

Export Restitution Payments

The Common Agricultural Policy contains a provision for a system of export subsidies known as export restitution payments. This provision was in place long before the initialization of the Export Enhancement Program by the United States. If a sale of barley in the export market qualifies for export restitution, the government pays the difference between the (higher) domestic price and the (lower) price received for the export sale. To offset the high level of EEP bonuses under the U.S. Export Enhancement Program during the 1986/87 crop year, EU export refunds on feed barley reached as high as $139.75 European Currency Units (E$139.75) per metric tonne. By the 1988/1989 crop year, the maximum refund available had dropped to as little as E$59.95 per tonne due to smaller EEP bonuses during that period. Export restitution payments play a major role in international barley markets as they act as an export subsidy for feed barley shipments to countries outside the European Union.

INTERNATIONAL BARLEY MARKETS

PLANTED BARLEY AREA

United States

Farmers in the United States grow both 2-row and 6-row varieties of barley. The American Malting Barley Association (AMBA) establishes a list of varieties that are recommended for malting purposes. The list is different for each state and varies annually. A truckload of barley is considered of malting quality if the variety is approved by the AMBA, meets the grading standards established by the Federal Grain Inspection Services (FGIS), and meets several additional non-grade quality factors. These non-grade factors are specified by the individual malster in individual contracts. If a shipment is not of malting quality, then it is sold as feed barley. There is no market distinction between 2-row and 6-row feed barley.

The United States can be segmented into three distinct barley growing regions. The Midwest region contains North Dakota, Minnesota, and South Dakota. These three states comprise roughly one-half of the entire U.S. barley area. Figure 3.1 shows the area planted tomalting and feed varieties in the Midwestern United States from 1970 to 1994.[3] Total barley area reached its peak in 1986 when 2.3 million hectares were planted. It steadily declined to 1.4 million hectares in 1994. North Dakota has by far the largest barley area planted in the country. In 1994, North Dakota planted 971,000 hectares of barley while Minnesota and South Dakota seeded 263,000 and 160,000 hectares, respectively. The Midwest does not seed any noticeable area to 2-row malting varieties. Most of its barley area is planted to 6-row malting varieties while a small quantity of feed varieties are also planted. In 1980, 88 percent of Midwest barley plantings were 6-row malting varieties. This number declined to 71 percent in 1994. Minnesota seeds the highest percentage of 6-row malting varieties followed by North Dakota and then South Dakota. For example, in 1985, 95 percent of the barley area planted in Minnesota was 6-row malting, followed by 83 percent in North Dakota and 60 percent in South Dakota.[4]

3.1

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3 Data for 1970 to 1985 were calculated from the barley variety surveys conducted by the USDA. The data give total area planted and percentages for each barley variety in each state by name. The acceptable 2-row and 6-row malting varieties listed by the AMBA in Know Your Malting Barley Varieties for each state and year were used to aggregate the data. Only those varieties that were accepted in a particular state in a given year were considered malting varieties. Any variety that did not fit this criteria was considered feed.

4 Data for 1986 to 1994 were collected by the North Dakota Barley Council. These values are reported in aggregate form for the Midwest and western regions in the United States Barley Statistics published by the North Dakota Barley Council in April, 1995. Hence, data for individual states for these years are not readily available.

The western region contains Montana, Idaho, Washington, Oregon, Colorado, and Wyoming. These six states comprise over 40 percent of all barley planted in the United States. Figure 3.2 shows feed, 2-row malting, and 6-row malting barley area planted in the western United States from 1970 and 1994. Total barley area reached its peak of 2.2 million hectares in 1985 and steadily declined to 1.1 million hectares in 1994. Montana has the largest area planted to barley in the West. In 1994, Montana planted 526,000 hectares followed by 300,000 hectares in Idaho. The West plants feed, 2-row malting, and 6-row malting varieties. In 1980, 65 percent of the total barley area in the West was planted to feed varieties, followed by 33 percent planted to 2-row malting varieties and only 2 percent to 6-row malting. The fraction of total barley planted to feed and 6-row malting varieties has increased over the last 15 years while the fraction of 2-row malting varieties has declined. In 1994, 71 percent of the total area was planted to feed while only 24 percent of Western barley area was planted to 2-row malting varieties. The area planted to 6-row malting varieties has increased to 5 percent of total area planted in the West. Montana grows most of the 2-row malting barley produced in the United States. In 1985, 45 percent of all barley planted in Montana was 2-row malting varieties, and none was 6-row malting.[5] In absolute terms, the area planted to 2-row malting varieties in the western United States has decreased while the area planted to 6-row malting varieties has increased.

The third region includes California and the rest of the United States. This region accounts for roughly 10 percent of the total barley area in the United States (350,000 hectares in 1994). Virtually all barley planted in this region are feed varieties.[6]

Figure 3.3 shows the area planted to feed, 6-row malting, and 2-row malting barley varieties in the United States from 1970 to 1994.[7] The area planted to all types of barley decreased from 1970 to 1974, increased until 1977, and then dropped sharply until 1980. In 1980, the area planted to all barley in the United States was roughly 3.4 million hectares. It increased to its highest historic level of 5.3 million hectares in 1985. Since 1986, barley area has dropped significantly. In 1994, total barley area had fallen to 2.9 million hectares--the lowest level in recent years. During the 5-year period from 1990 to 1994, the area planted to feed barley dropped sharply while the area planted to malting varieties did not fall as dramatically. Feed barley planted area reached a historic low of 1.6 million hectares in 1994, but the area planted to 2-row malting varieties was 259,000 hectares in 1994, which is higher than 1987, 1988, 1989 and 1992 levels. The area planted to 6-row malting varieties in 1994 was 1.1 million hectares which is higher than the 1979 level and similar to the level of 6-row malting varieties planted in the early 1970s. Aside from various agricultural policies and several market factors,

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[5] In recent years, farmers in Montana near the North Dakota border have seeded a small area to 6-row malting varieties.

[6] Survey data are available only for California, and no data exist after 1985. A small amount (roughly 3 percent) of the area in California was planted to 2-row malting varieties before 1982, and roughly 2 percent was planted to 6-row malting varieties before 1973. The data reported for 1982 to 1985 show that 100 percent of the barley grown in California was planted to feed varieties.

[7] Data on total barley area planted in the United States are taken from the USDA Crop Reporting Board and Crop Production Reports, various issues. The area planted to 6-row and 2-row malting varieties are taken from Figures 3.1 and 3.2. The residual, which includes Colorado and Wyoming from 1970 to 1973 and California from 1986 to 1994, is assumed to be 100 percent feed.

3.2

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the higher rate of decrease in feed acreage may be due to the reduction in yield differentials between feed and malting varieties.

Canada

Farmers in Canada grow both 2-row and 6-row varieties of barley. The Canadian Grain Commission, through a committee comprised of industry, government, and academics, determines a list of registered varieties for each barley type. If a variety is not on this list, it is assigned the lowest grade in its class. The main difference between Canada and the United States is that for a variety to be registered for 2-row and 6-row malting purposes in Canada, it must be visually distinguishable from feed varieties unless it is grown under special contracting programs. Canadian 2-row malting varieties have long-haired rachillae to visually distinguish them from 2-row feed varieties. Canadian 6-row malting varieties have had a blue aleurone to distinguish them from white aleurone feed varieties. Over the last two decades, Canadian malsters have trended toward 2-row varieties for domestic malting use. This, combined with the fact that the United States uses 6- row white varieties, has caused a shift away from 6-row blue aleurone varieties in favor of 6-row white varieties. Since 1991, plantings of 6-row white varieties have increased from near 0, to roughly 500,000 acres. These 6-row white varieties are typically grown under contract for the U.S. market.

Almost all of the barley in Canada is grown in Alberta, Saskatchewan, and Manitoba. Before 1993, these three provinces planted nearly 95 percent of the total Canadian area. In 1993 and 1994, this number decreased to under 90 percent. Figure 3.4 shows the area planted in Canada to feed barley varieties by region from 1974 to 1994.[8] The total feed area planted in Canada decreased from 1974 to 1979. It increased to its peak level of 1,850,000 hectares in 1986, then dropped to 1,230,000 hectares in 1992. Feed barley area rose to 1,415,000 hectares in 1994 due to the large increase in feed barley planted outside the designated area. Alberta is the largest grower of feed barley. In 1994, that province planted 879,000 hectares to feed varieties, or 49 percent of its total barley area. Manitoba planted 134,000 hectares to feed varieties in 1994, or 35 percent of its total barley area. Saskatchewan planted 180,000 hectares to feed barley in 1994, or 16 percent of the total barley area planted in that province. Saskatchewan plants most of its barley area to malting varieties.

Figure 3.5 shows the area planted to 6-row malting varieties by province from 1974 to 1994. The total area planted to 6-row malting varieties in Canada dropped from roughly 2.5 million hectares in 1974 to only 811,000 hectares in 1994. This same trend is evident in all three provinces. In 1994, Alberta planted 311,000 hectares to 6-row malting varieties which comprised 18 percent of its total barley area that year. Manitoba planted 151,000 hectares to 6-row malting, which was 29 percent of its total barley area. Saskatchewan planted 223,000

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[8] The data for Alberta, Saskatchewan, and Manitoba are from the malting barley variety surveys conducted by the Brewing and Malting Barley Research Institute, reported in the Barley Briefs. The data for the rest of Canada is calculated as the residual from the total barley area planted as reported in the Canadian Grains Industry Statistical Handbooks. It is assumed that the rest of Canada grows feed only.

3.4

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hectares which was only 19 percent of its total barley area. Typically, Saskatchewan plants most of its barley area to 2-row malting varieties while Alberta plants most of its area to feed barley.

Figure 3.6 shows the area planted to 2-row malting varieties by province from 1974 to 1994. Alberta planted 753,000 hectares to 2-row malting varieties in 1994 which was 41 percent of total barley plantings. Manitoba does not grow much 2-row malting barley. In 1994, it planted only 98,000 hectares to 2-row malting varieties which accounted for only 25% of its total barley area. Saskatchewan planted 724,000 hectares to 2-row malting varieties in 1994 which represented 63% of its total barley area.

Figure 3.7 shows the total Canadian barley area planted to each type of barley from 1970 to 1994. Plantings of feed and 2-row malting barley have trended upward over time while plantings of 6-row malting barley has decreased dramatically. Canadian feed barley area increased from 671,000 hectares in 1970 to 1,414,000 hectares in 1994. The area planted to 2-row malting varieties increased from 733,000 hectares in 1970 to 1,866,000 hectares in 1994. The area planted to 6-row malting varieties decreased from 2,600,000 hectares in 1970 to only 811,000 hectares in 1994. In 1994, 35 percent of the total Canadian barley area was seeded to feed varieties, 45 percent was seeded to 2-row malting varieties, and 20 percent was seeded to 6-row malting varieties.

Australia

Australian barley producers currently plant 2-row varieties almost exclusively. The Australian Bureau of Statistics reports that in 1987, only 107,000 hectares of 6-row barley was planted in Australia. In that same year, 2.2 million hectares of 2-row barley were planted. After 1987, separate statistics for 2-row and 6-row barley were no longer reported as the percentage of 6-row barley in Australia declined even further. The quantity of 6-row barley planted in Australia is typically less than one percent in a given year. Hence, Australian malting barley varieties are not distinguished throughout the remainder of this report.

Australia can be segmented into five different growing regions. Figure 3.8 shows the area planted to barley varieties in Australia.[9] South Australia historically seeds the largest barley area. In 1993, that state seeded 1.1 million hectares to barley varieties, roughly 33 percent of the entire Australian barley crop. Western Australia has historically seeded the second largest area to barley, but New South Wales has surpassed Western Australia in some years. In 1993, Western Australia seeded 794,000 hectares of barley which represented 23 percent of the Australian crop. New South Wales seeded 600,000 in that same year, roughly 18 percent of the entire barley crop in that year. Victoria is historically been behind New South Wales, with the exception of 1993 in which that state planted 649,000 hectares of barley (18 percent) while Queensland planted 233,000 hectares (6 percent). The Australian Barley Board has jurisdiction

[9] Data for Australian barley area by state are from 1970 to 1979 are from the Australian Barley Board Annual Reports, and data for 1980 to 1993 are from the ABARE Commodity Statistical Bulletins. Tasmania is not included because under 40,000 hectares are planted to barley each year.

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over both South Australia and Victoria and controlled roughly 52 percent of the Australian barley area in 1993.

The total barley area planted in Australia increased from 1.8 million hectares in 1974 to a record high of 3.5 million hectares in 1984. It dropped significantly in 1986 due to the low pooled price in 1985. It reached another peak in 1993 at 3.4 million hectares. In 1994, the projected area was 2.5 million hectares, nearly one million hectares less than 1993 due to low pooled returns in 1993. Unfortunately, consistent data are not available for the percentage of barley planted to malting varieties in each Australian growing region. The Australian Barley Board reports these figures for South Australia and Victoria. In Victoria, an average of 88 percent of barley planted were malting varieties for the 1989 to 1993 period. The annual variability of this number is small. On the other hand, South Australia had an average of only 35 percent seeded to malting varieties over the same period. There is a large difference between these two regions alone. Hence, it is not possible to obtain consistent estimates of the percentage of barley area planted to different varieties in Australia using available data.

European Union (15)

Farmers in the European Union can grow barley in either the spring or in winter. Varieties differ depending upon the season. Winter barley is usually used in rotation with other crops and is typically grown for use as feed. The southern regions of the EU-15 (i.e., Italy, Greece, and Portugal) do not grow significant quantities of spring barley while the northern regions (i.e., Sweden and Finland) do not grow significant quantities of winter barley. The majority of area planted to winter barley in the EU-15 is 2-row feed varieties although some regions (notably France) grow significant quantities of 6-row winter varieties as well. Spring barley can be of feed or malting quality. Because Europeans use 2-row varieties for malting almost exclusively, nearly all spring malting varieties are 2-row. As is the case in the other exporting countries, the market for feed barley rarely distinguishes between 2-row and 6-row varieties. In addition, the market for 6-row malting barley in the EU-15 is almost non-existent.

Table 3.1 shows the estimated area planted to spring barley for each country in the EU-15.[10] In 1994, Spain had the largest area (2.2 million hectares) followed by Greece (780,000 hectares). Denmark, France, the United Kingdom, and Finland each had roughly 475,000 hectares of spring barley in 1994. There has been a consistent downward trend in the area planted to spring barley since 1980 with the exception of Germany and Spain. The larger area in Germany after 1989 can be attributed to the unification of East and West Germany. Spanish spring barley area was on a upward trend from 1981 to 1992, but dropped off in 1993 and 1994.

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[10] Most data for the area planted to spring barley come from the Gerson and Gauger Statistical Digests for the August to July crop year with the following additional assumptions. Disaggregate data for Finland and Sweden are not available so it is assumed that these two countries don't grow any winter barley. Due to data limitations on winter vs. spring area in some years, the following values were interpolated: It is assumed that Austria has the same winter/spring area ratio as they did in 1993, East Germany has the same winter/spring area ratio before 1990 as they did in 1990, and Spain and UK have the same winter/spring ratio from 1980 to 1983 as they did during the three year average period from 1984 to 1986.

tbl 3.1

In 1980, the total area planted to spring barley in EU-15 was 8.9 million tonnes. By 1994, this level had dropped to 5.7 million tonnes. This trend in total spring barley area is similar to that in Canada for malting barley (Figure 3.7), but opposite that of Australia (Figure 3.8).

Table 3.2 shows the estimated area planted to winter barley for each country in the EU-15 from 1980 to 1994.[11] In 1994, Spain and Germany had the largest area (1.4 and 1.3 million hectares respectively) followed by France and the United Kingdom. Unlike the spring barley case, the area planted to winter barley in the EU-15 did not start to decline until 1985 and it has decreased at a slower rate than spring barley area. In 1980, winter barley area was 7.1 million hectares. The area increased to 7.9 million hectares in 1985 and has steadily declined since then. In 1994, total winter barley area was down to 5.3 million hectares. Total EU-15 barley area is divided equally between spring and winter barley in a typical year. The total barley area in EU-15 has dropped from 16 million hectares in 1980 to 11 million hectares in 1994.

BARLEY SUPPLY

Different regions of the world have different barley supply and demand requirements. Brewers in the United States use mostly 6-row white aleurone varieties of barley in the malting process. Most other countries use 2-row malting barley for beer with the exception of some Latin American countries and a small number of Canadian breweries. The United States produces a large quantity of 6-row barley, but only a small quantity of 2-row barley. Canada produces a larger share of 2-row barley than the United States, but it produces a large quantity of both types. It exports 6-row malting barley to the United States. The rest of the world requires 2-row malting barley for malting purposes and is supplied through domestic production and imports from Canada and the United States, as well as Australia and EU-15.

Malting Selection Rates

Not all barley planted to malting varieties is sold for use in the malting process. Some of it is sold for feed use. The quantity of barley produced in a certain country that is accepted for malting purposes does not vary significantly from year to year. However, the percentage of barley that is accepted for malting fluctuates significantly from year to year due to variability in yield.

There are two ways to measure the percentage of barley used in the malting process. The first may be referred to as the "planted" malting selection rate and is defined as the percentage of production from fields planted to malting varieties that is actually accepted for use in the malting process. This measure can only be used when the percentage breakdown between the area planted to feed and malting barley varieties, as well as the percentage of total barley production used for malting purposes, is known. The planted selection rate is empirically difficult to estimate because one must know which fields are seeded to malting varieties and which are seeded to feed varieties. In addition, separate observations on the yield difference between malting and feed varieties are required.

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[11] Table 3.2 has the same source as Table 3.1.

3.2

Another measurement of the malting selection rate which does not require prior knowledge of area planted may be referred to as the "produced" malting selection rate. The produced selection rate equals the percentage of total barley production that is used in the malting process. This measure does not require the use of separate yield or area data. Note that the planted selection rate must be at least as large as the produced selection rate and that these two measures are equivalent only if all of the area planted to barley is seeded to malting varieties exclusively.

The most difficult part of calculating the selection rate is acquiring observations on the total quantity of barley actually purchased for malting by malsters. For most exporting regions (excluding Canada), the quantity of malting barley demanded/produced must be estimated indirectly. In this report, the yearly quantity of barley used for malting in the United States, Australia, and EU-15 (both produced and consumed) is estimated as malting barley exports[12] subtracted from the sum of domestic malting consumption[13] (including that portion which may be re-exported in malt or liquid form) and malting barley imports.[14] The quantity of barley purchased for malting in Canada is obtained directly from the CWB Annual Reports. Since 1975, The Canadian Wheat Board has kept separate pool accounts: one for feed barley and the other for "designated" malting barley. The produced malting selection rate in all four exporting countries is calculated as the malting quantity purchased divided by total barley production. The method used to calculate selection rates for each individual country as well as the resulting production levels for the four major barley exporting regions are described below. These results are critical for the economic analyses of Sections 4 and 5.

United States

Figure 3.9 shows the produced malting selection rates facing the United States, Canada, Australia, and EU-15 from 1980 to 1994. The produced malting selection rate in the United States averages 33 percent in normal years. This excludes 1980, 1988, and 1989 which were years of abnormally low production and 1984 to 1986 which were years of abnormally high production. In 1988, which was the year of lowest production in recent memory, the produced malting selection rate increased to 54 percent. In 1986, which was the year of largest historic production, this number dropped to 26 percent. Hence, in years when yield and production is high, the selection rate is lower because malsters tend to tighten their non-grade standards due to the abundance of good quality barley. When production is abnormally low, they tend to loosen their standards which result in higher selection rates. In addition, especially in 1988, some high quality feed barley held in reserve from the previous year may have been used for malting purposes.

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[12] The procedure for estimating malting barley exports and imports is described in Section 3.4.

[13] The procedure for estimating domestic malting barley consumption is described in Section 3.3.

[14] This assumes that there is no change in malting barley stocks from year to year. Considering that malting barley is not stored for long periods of time, malting barley stocks are assumed negligible. Any adjustment in yearly ending stocks are incorporated into feed barley demand estimates (Section 3.3).

fig 3.9

Data are also available for the area distribution of feed vs. malting barley for the United States (Figure 3.3). From these data, planted malting selection rates facing U.S. barley producers can also be calculated. Average planted malting selection rates of 67 percent are witnessed for normal years (the results are not shown). Following the 1988 drought, the planted malting selection rate rose above 100 percent. This indicates that either some malting quality stocks were held over from 1987 or that high quality feed stocks from 1987 were used to supplement the 1988 malting barley crop.

Table 3.3 shows feed, malting, and aggregate barley production levels for the four major barley exporters from 1970 to 1994.[15] From 1970 to 1973, barley production remained near 9 million metric tonnes. In 1974, the combination of smaller barley area and low yields forced production down to 6.5 million metric tonnes. Production increased until 1979. In 1980, lower yields caused production to drop to 7.9 million metric tonnes. From 1981 to 1986, production increased to its historically high level of 13.3 million metric tonnes in 1986. In 1988, the drought caused very low yields, and production dropped to a minimal level of 6.3 million metric tonnes. From 1989 to 1993 production leveled off, averaging roughly 9 million metric tonnes per year. In 1994, production was 8.2 million metric tonnes. While current production levels are similar to those of the early 1970s, Figure 3.3 indicates that the area planted is much lower. This is due to the increased yield realized by barley growers (2.8 tonnes per hectare in 1994 vs. roughly 2.2 tonnes per hectare in the early 1970s). However, there was no noticeable increasing yield trend over the 5-year period from 1990 to 1994.

Canada

In Canada, the Canadian Wheat Board purchases all of the barley used for malting purposes in any given year. Since 1975, this value has been recorded in the designated barley pool account by the Canadian Wheat Board.[16] Hence, unlike the U.S. case, the produced malting selection rate in a given year can be calculated directly as the CWB designated barley purchases divided by the total Canadian barley supply. These values are shown alongside their corresponding U.S. values in Figure 3.9 for 1975 to 1993. The average Canadian produced malting selection rate from 1975 to 1987 was 8 percent. However, the 6-year average of produced selection rates after 1987 increased to 11 percent. Since 1987, Canadian selection rates have trended upward but with high variance. In 1993, the Canadian produced malting selection rate reached 13.3 percent.

For comparison, the United States produced malting selection rate averaged 33 percent in normal years and was 35 percent in 1993. Canadian malting selection rates have historically been lower than those in the United States, but the gap has narrowed slightly in recent years. While selection rates in the United States tend to vary inversely with U.S. production levels, Canadian selection rates do not show a similar relationship with respect to Canadian production

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[15] Aggregate U.S. production data is from USDA ERS-NASS (April, 1995) Feed Grains: Background for Farm Legislation (AER-714).

[16] Data for Canadian barley supply are taken from the Canadian Grains Industry Statistical Handbook. Designated barley purchases are found in CWB Annual Reports.

tbl 3.3

levels. This suggests that Canadian malting quality standards are not as variable as those in the United States.

As in the United States, Canadian planted malting selection rates can be calculated from produced selection rates (using the data shown in Figure 3.7) by dividing by the percentage of barley area planted to malting varieties.[17] The planted malting selection rate in Canada (not shown) averaged 11 percent from 1975 to 1987 with little variance. In 1988, the planted selection rate jumped to almost 16 percent. After 1987, it trended upward, but with a high variance. In 1993, the Canadian planted malting selection rate reached 20 percent. For comparison, the United States has an average planting malting selection rate of 67 percent during normal years. The difference in the planted malting selection rates between Canada and the United States is higher than the difference in produced malting selection rates. Some of this discrepancy is due to the fact that Canada seeds a higher percentage of barley to malting varieties than the United States (Figure 3.7 vs. Figure 3.3). However, some of this discrepancy may be attributed to tighter quality standards by Canadian domestic malsters compared to their U.S. counterparts.

Table 3.3 shows total Canadian barley production from 1975 to 1993. There is a small increasing trend since 1975, but Canadian production levels follow a somewhat cyclical pattern of production levels that peak typically once every 4 years. The total level of barley production in 1975 was 9,510,000 tonnes. The production level in 1994 was 11,690,000 tonnes. Production levels peaked in 1977, 1982, 1986, and 1990. Yields increased from roughly 2.2 tonnes per hectare to 2.5 tonnes per hectare in 1989. Total barley yields from 1990 to 1994 leveled off at around 2.85 tonnes per hectare. These numbers are similar to those in the United States. As is the case in the United States, there was no appreciable trend in Canadian barley yields from 1990 to 1994.

Australia

In Australia, four barley boards purchase all of the barley used in the malting process from producers. Unfortunately, consistent time series data on area planted to feed and malting varieties as well as the quantity of malting barley received by each Australian barley board are only available for the Australian Barley Board which has jurisdiction over only South Australia and Victoria. Hence, the total quantity of malting barley received by all Australian marketing boards is estimated indirectly as total Australian malting barley exports plus the total quantity of Australian malting barley used in the production of malt for both domestic and export purposes. This value is then divided by total barley production estimates to obtain the produced malting selection rates.

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[17] This approximation assumes that yield differences between malting and feed varieties are negligible. Some would argue [Schmitz et al., 1993 and Brooks, 1993] that Canadian yield differentials may be as little as 5 percent. Carter (1993) argues that at times it may be as high as 25 percent. Informal consultation with the American Malting Barley Association and North Dakota State University Extension Service indicate that yield differentials are probably currently just over 5 percent. Data on the percentage of barley area planted to malting varieties come from various Barley Briefs.

Australian planted malting selection rates are shown in Figure 3.9 for 1978 to 1992. Australian selection rates are roughly in line with the those of the United States in normal years. For example, in 1992, the Australian produced malting selection rate was 30 percent. Australian malting selection rates are inversely correlated with production levels. This result is similar in the United States. High malting selection rates, combined with low domestic consumption levels, are the cause of the relatively high levels of malting barley exports from Australia.[18]

While planted malting selection rates cannot be calculated for Australia as a whole, these numbers are provided by the Australian Barley Board for South Australia and Victoria (not shown). Because South Australia typically plants around 35 percent of its total barley area to malting varieties, its planted malting selection rate averages 18 percent. On the other hand, Victoria plants nearly 90 percent malting varieties which is almost all selected for malting purposes. Such a large difference in selection rates between these two states makes it extremely difficult to ascertain the true nature of planted malting selection rates for all of Australia.

Table 3.3 shows that Australian barley production divided into feed and malting categories. Malting barley production is approximated as the sum of domestic barley use for malting purposes, exports of barley malt (in barley equivalent form), and exports of malting barley.[19] Because malting barley is typically held for only a short period of time, it is assumed that there are no malting barley stocks held over from previous years. Feed production is calculated as the residual using the Australian Bureau of Agricultural and Resource Economics (ABARE) estimates of total Australian production.

Table 3.3 indicates that malting barley production has trended upward since 1985. In 1985, Australia produced 920,000 tonnes of malting barley compared to 1.6 million tonnes in 1992. This trend is similar to that of Canada. The level of feed barley production has been somewhat cyclical. It took a huge jump from 1.3 million tonnes in 1982 to 3.7 million tonnes in 1983, and increased again to 4.6 million tonnes in 1984. After 1984, it declined to 2 million tonnes in 1988, but rose to 3.8 million tonnes in 1992. Total Australian barley production reached its peak in 1984 and again in 1993, corresponding to the large planted area in those years. Total Australian barley production in 1992 was 5.4 million tonnes, and 1993 production (not shown in Table 3.3) was estimated at 7 million tonnes.

EU-15

Produced malting selection rates aggregated over all 15 countries in the European Union from 1980 to 1993 are shown in Figure 3.9. Malting barley use is calculated by taking the aggregate malt production of all fifteen countries, multiplying by a 1:1.25 malt to malting barley ratio and adding net malting barley exports (see Section 3.4). The produced malting selection rate

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[18] See Section 3.4 for a complete description of Australian barley export markets.

[19] Data on domestic barley used for malting purposes and barley malt exports are aggregated from ABARE Commodity Statistical Bulletins data on "receivals" and disposals by Australian barley boards. ABARE uses a malt to malting barley ratio of 1:1.25 until 1991 and 1:1.20 after 1991. Total malting barley exports for 1978 to 1982 are taken directly from ABARE. Malting barley exports from 1983 to 1993 are aggregated from estimates compiled by the author and are described in Section 3.4.

is approximated by dividing malting barley use by total winter and spring barley production. A cursory glance at Figure 3.9 shows that EU-15 selection rates steadily increased from 1984 to 1993. In 1984, the EU-15 produced malting selection rate was only 10 percent. In 1993, the rate was 17 percent. This is due to the relatively large reduction in area planted to feed barley in the winter and the relatively larger proportion of malting barley planted in the spring over the 1984 to 1993 period.

As the EU-15 covers a wide area with a variety of climates, dramatic variability in aggregate malting selection rates is not evident due to lower variability in aggregate yields. EU-15 produced malting selection rates are typically 4 percent above corresponding Canadian rates. Because the EU-15 has a larger consumption base than the other major exporting countries, its malting barley exports to non-member countries are much smaller than Canadian and Australian malting barley exports. However, its share of feed barley exports to non-member countries is larger than any other exporter.[20]

The yield difference between spring and winter barley is quite large in the EU-15 when compared to other major barley exporting countries. Further, yields vary dramatically across EU-15 member countries. Yield differences in the larger northern countries (i.e., Germany, France, and the United Kingdom) are typically one tonne per hectare in favor of winter crops. In the southern countries however, spring yields are typically slightly higher than winter yields. Table 3.3 shows total barley production for each EU-15 country from 1980 to 1994.[21] Regional data are not shown, but the following gives a flavor of the regional distributional aspects of EU-15 barley production.

Germany (East and West) has the highest level of barley production in the European Union. In 1994, 11 million tonnes of barley were produced in Germany. France produced 7.8 million tonnes of barley in 1994. Although Spain has the largest area planted to spring and winter barley, its yield is usually at least 3 hectares per tonne lower than the other major producers. For example, in 1994 the average yield for both spring and winter barley in Germany was 5.27 compared to only 2.13 in Spain. In 1994, total barley production in Spain was only 7.7 million tonnes. Because winter barley yield for most of the EU-15 countries is typically higher than spring barley, EU-15 produces more winter barley than spring Barley. In 1994, total Winter barley production was 23.4 million tonnes while spring production was only 20.4 million tonnes for a total level of production for all barley of 43.8 million tonnes. Although yields have increased slightly due to better input technology, barley production has declined since 1984 when a record 64.5 million tonnes of barley were produced in EU-15.

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[20] See Section 3.4.

[21] Malting barley production is calculated using Gauger and Gerson Digests data on EU-15 malt production, aggregated and converted into malting barley using a malt to malting barley ratio of 1:1.25. As malt imports from outside EU-15 are almost negligible, this process approximates actual malting barley production levels.

BARLEY DEMAND

Barley producers receive a price that depends on the quality of the truckload that is sold. Various grading systems determine the general quality of a certain shipment. Non-grade factors are also major determinant of quality. These factors vary annually and by individual buyer. Some of these factors include plumpness, protein, germination, and varietal purity.[22] If a shipment is considered to be of malting quality, the farmer receives a price premium over the feed barley price. Barley growers in the United States and Canada receive a different price for feed, 2-row malting, and 6-row malting barley while producers in Australia and EU-15 receive a premium on 2-row malting barley over feed.

United States

U.S. barley producers receive a different price for barley used as feed and barley used for malting. The premium for 2-row malting barley is different from 6-row malting barley. Figure 3.10 shows estimated cash prices received by farmers for feed, 6-row malting, and 2-row malting barley from 1979 to 1994.[23] The U.S. cash price for 6-row malting barley is approximated as the U.S. cash feed price plus the premium between the North Dakota malting and feed cash prices. Similarly, the cash price for U.S. 2-row malting barley is approximated as the U.S. average cash feed price plus the premium between the Montana malting and feed cash prices.[24]

In most years, the premium for 2-row malting barley was higher than for 6-row malting barley. However, in 1980 and 1988, the premium for 6-row malting was higher than the 2-row malting barley premium. Production was also at its lowest level during those two years. Cash prices for all types of barley were lowest in 1986 and 1987 due to abnormally high production levels in 1984, 1985, and 1986. The premium for 2-row malting barley has increased over the last 15 years. The premium for 2-row malting barley in the early 1980s was around $20 per tonne. It has increased to approximately $40 per tonne in the 1990s. On the other hand, the premium for 6-row malting barley has remained between $10 and $20 per tonne over the last 15 years. The increase in the premium for 2-row malting barley may be attributed to the world market place. While the demand for 6-row malting barley has remained in just a few countries,

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[22] In some years there is also concern over certain types of diseases. For example, potential buyers of U.S. grain were concerned with the high levels of vomitoxin (a toxic substance of mold origin) caused by excess moisture that appeared in the 1993 and 1994 crops. Price discounts emerged, especially in spring wheat markets (see Johnson, Wilson, and Diersen, 1995).

[23] The U.S. feed price is calculated as the yearly July to June average of monthly average U.S. cash prices reported by the USDA in the Agricultural Prices Summary. The USDA did not divide its price series into feed and malting categories before 1979 nor do they report a separate cash price for 6-row and 2-row malting barley.

[24] North Dakota is the major producer of 6-row malting barley and does not plant significant quantities of 2-row malting varieties. Montana plants the majority of 2-row malting barley in the United States and virtually no 6-row malting varieties. Hence, this procedure should give reasonable estimates. Monthly cash price data were acquired from the North Dakota Agricultural Statistics Service and by facsimile from the USDA Agricultural Statistics Service.

fig 3/10

the world market for 2-row malting barley has expanded. Thus, exporting countries can command higher premiums for 2-row malting barley.

Table 3.4 shows estimated consumption levels for feed and malting barley as well as the feed stock adjustments from 1980 to 1994 in the four major barley exporting regions.[25] U.S. malting barley consumption has grown steadily from 3 million tonnes in 1970 to 3.6 million tonnes in 1994.[26] This reflects the increase in U.S. beer demand due to population growth. In 1970, U.S. domestic feed barley consumption was around 9.3 million tonnes. This number fell during the 1970s. Consumption levels rose sharply from 1981 to 1985 and decreased from 1986 to 1988. Feed consumption has trended upward since 1989. U.S. feed consumption was 8.7 million tonnes in 1994. Comparisons between Table 3.4 and Figure 3.10 shows that feed consumption is negatively correlated with barley prices, but that malting barley consumption is not. The level of malting barley consumption increases over time as population and beer consumption increase.

Canada

Canadian barley producers receive different payments from the Canadian Wheat Board depending upon the type and quality of the barley delivered. Figure 3.11 shows the pooled cash prices received by Canadian barley producers from 1972 to 1993. The data are presented in Canadian dollars per metric tonne.[27] Average feed barley prices reached a peak in 1980 at 146.55 Canadian per tonne. In 1987, feed prices bottomed out at $74.08 per tonne. In 1993, the pooled feed price was roughly $100 per tonne. There has been a large historic fluctuation in malting price premiums. For example, the premium between feed and 6-row malting barley in 1972 was only $4.82 per tonne. That was due to short supplies of good quality barley in that year. However, in 1986, the price premium was $104.40 per tonne due to a surplus of good quality barley that year. In 1993, the price premium between feed and 6-row malting barley was $43.96 per tonne.

Figure 3.11 also shows the pooled prices received for 2-row and 6-row malting barley. Until 1982, the 2-row and 6-row malting prices were nearly identical. Starting in 1982, the price premium began to increase. For example, the price premium between 2-row and 6-row malting barley reached $16.90 per tonne in 1993. The increase in the price of 2-row vs. 6-row malting barley has been due to increased world demand for 2-row malting barley relative to 6-row varieties.

t 3.4

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[25] Ending stocks for the United States, Canada, and EU-15 are taken from USDA PS&D View. Australia is assumed to have no yearly stock adjustment as its ending stocks are low and ending stock data are somewhat inaccurate. The feed stock adjustment for year t equals barley ending stocks in year t-1 minus ending stocks in year t. It is assumed all carry-overs are used for feed use.

[26] U.S. consumption data are from Feed Grains: Background for 1995 Farm Legislation. Malting barley consumption is approximated as food and industrial use while the residual is assumed to be used as feed.

[27] Prices shown equal the total pooled payment per metric tonne for the highest grade in each category in a given year. Starting in 1985, the barley prices are CWB #1 Feed Barley, 2-row Special Select, and 6-row Special Select. The data are taken directly from the Canadian Wheat Board Annual Report (various issues).

3.11

Table 3.4 shows Canadian consumption levels for feed and malting barley from 1980 to 1994.[28] Malting barley consumption steadily declined from 1980 to 1985, but since 1986, consumption levels have widely fluctuated, reaching a low of 564,000 metric tonnes in 1987 and a high of 871,000 tonnes in 1993. Canadian feed barley consumption rose between 1980 and 1983, but then dropped in 1984. It increased to an all-time high of 8.3 million tonnes in 1987 due to the record barley crop in 1986. After 1987, feed consumption steadily dropped to roughly 7.1 million tonnes in 1992. In 1993, feed consumption rebounded to 8.2 million tonnes.

Australia

Australian barley producers receive different payments depending upon which grain marketing board handles barley in that farmer's particular state. The total pooled barley payment received by Australian farmers varies by region as well as by variety and quality. Consistent price time series data for each individual barley board are unavailable. However, data are available for South Australia and Victoria from the Australian Barley Board and from the Grain Pool of Western Australia. As the Australian Barley Board typically controls over 50 percent of the Australian barley production and South Australia is the major barley supplier, the final pooled price received by Australian farmers in South Australia can be used to approximate the price received by Australian farmers. These barley prices are shown in Figure 3.12 for 1970 to 1993 and are measured in Australian dollars per metric tonne.[29]

Figure 3.12 shows that Australian barley prices trended upward from 1971 to 1983 when farmers received $140 Australian per tonne for 2-row feed barley and $160 Australian per tonne for 2-row malting barley. The premium between feed and malting barley was $20 per tonne. In 1985, the feed price had dropped to $111 per tonne while the malting price dropped to $121 per tonne which represents a $10 per tonne malting premium. After 1985, the premium between malting and feed barley took a large jump. In 1986, although prices were relatively low, the price premium increased to $30 per tonne. A similar phenomenon occurred in Canada at the same time (Figure 3.11) although Canadian premiums were higher than those in Australia and the United States. This increase in premiums may have resulted from the Export Enhancement Program in the United States which dumped a huge quantity of feed quality barley on the international market during 1986--the first year of the program. These relatively large premiums continued through 1992. In 1993, the pooled barley price received by Southern Australian farmers dropped to only $93 per tonne for feed and $121 per tonne for malting barley. This is why the area planted to barley in 1994 dropped by almost 1 million hectares from 1993 levels (see Figure 3.8).

fi 3.12

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[28] Domestic malting barley consumption is calculated by subtracting malting barley exports in Canadian Grain Exports from the "Designated Barley acquired" entry in the CWB pool account statement of operations for designated barley contained in the CWB Annual Reports. Feed (and seed) consumption is approximated as the total barley disposition in Canadian Grains Industry Statistical Handbook less the sum of the aforementioned domestic malting barley consumption and total Canadian barley exports.

[29] Price data are taken directly from the Australian Barley Board Annual Report (various issues). Prices are shown for the highest barley grade in each category. The ABB reports a separate price for 6-row feed barley but the amount is quite small. Note that the grading system can vary from year to year.

Table 3.4 shows feed and malting barley consumption in Australia from 1980 to 1992.[30] Malting barley consumption levels rose steadily from 402,000 metric tonnes in 1984 to 780,000 tonnes in 1992 due to increased population and increased export opportunities for barley malt and barley malt based alcohol. Domestic feed consumption levels in Australia have been erratic as they depend on the relative costs of alternative feed grains. Domestic barley feed consumption peaked in 1987 and again in 1992 due to higher relative costs for other feed substitutes such as feed wheat and corn.

EU-15

Figure 3.13 shows the yearly average of monthly prices from July to June received by farmers in Germany, France, and the United Kingdom for feed and malting barley.[31] Prices are reported in European Currency Units (Ecu = E$). Data on these three countries are shown because they produce a large portion of barley in EU-15 and are all original members of the European Union. As Figure 3.13 shows, barley cash prices reached their peak across the board in 1983 and have been on a downward trend ever since. There are significant differences in the price levels of both types of barley between different countries within the EU-15. Malting prices in Germany are higher than those in UK, while malting prices in France are significantly lower. In fact, French malting barley prices are typically lower than U.K. and German feed prices. French feed prices are also significantly lower than those in Germany and UK. Prices for both types of barley in all three countries trended together until 1985. In 1986, as EU feed prices dropped, German and French malting barley prices actually increased. This is partly due to the U.S. export enhancement program which dumped a large quantity of lower quality barley on the world market in 1986.

Malting premiums reached a peak in 1987. In that year, the average malting barley prices received by farmers in Germany, the United Kingdom, and France were E$219, E$177, E$166 per tonne, respectively. The corresponding feed prices were E$170, E$153, and E$128 per tonne. 1987 malting premiums were E$49 per tonne in Germany, E$24 per tonne in the United Kingdom, and E$38 per tonne in France. By 1993, malting barley prices had dropped to E$157 per tonne, E$154 per tonne, and E$136 per tonne in Germany, the United Kingdom, and France, respectively. Corresponding feed prices had dropped to E$129, E$140, and E$118 respectively. U.K. feed prices surpassed German feed prices in 1990. By 1993, the malting premium had dropped to E$28 per tonne in Germany, E$14 per tonne in the United Kingdom, and only E$18 per tonne in France. The downward trend in EU-15 barley prices and malting premiums is the major reason that area and production levels in EU-15 have declined since 1987.

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[30] Consumption of malting barley is defined as the total quantity used by Australian malsters to produce malt for both domestic and foreign use and is from ABARE data on "receivals." Feed consumption is calculated as total barley receivals minus malting consumption minus feed exports (see Section 3.4). Hence, stock levels are not explicitly taken under consideration.

[31] Data on monthly prices received by farmers for malting and feed barley are aggregated from Agricultural Prices, a monthly Eurostat publication from Luxembourg, using the July to June unweighted average of monthly prices from various issues.

fig 3.13

Table 3.4 shows EU-15 feed and malting barley consumption from 1980 to 1993.[32] Malting barley consumption, which includes all barley used in the malting process by EU-15 malsters for resale in both domestic and export markets, dropped to 6.7 million tonnes in 1985. After 1985, EU-15 malting barley consumption trended steadily upward until it reached its highest level of 8.1 million tonnes in 1991. Total malting barley consumption was 7.8 million tonnes in 1993. Looking back at Figure 3.13, malting barley consumption in EU-15 is not highly negatively correlated with prices as would be expected. Instead, malting barley demand is derived from the demand for beer.

EU-15 feed consumption jumped from only 44.2 million tonnes in 1983 to a historic high of 50.6 million tonnes in 1984. This was in large part due to the increase in feed barley prices from 1980 to 1983 and the subsequent price decrease in 1984 and 1985. Feed barley consumption in EU-15 went on a major downward trend after 1984. By 1992, feed barley consumption had reached a low of 31.3 million tonnes, but rebounded slightly to 34.7 million tonnes in 1993. This rebound was due to a major drop in the price of feed barley price from 1992 to 1993.

BARLEY EXPORTS

The Export Enhancement Program, established under the 1985 Farm Bill, provides subsidies to U.S grain companies on certain grain shipments sold to targeted countries. As of 1994, Algeria, Bulgaria, Cyprus, Egypt, the former Soviet Union, Iraq, Israel, Jordan, Morocco, Poland, Romania, Saudi Arabia, and Tunisia have all benefited from lower prices due to EEP subsidies for feed barley. These 13 countries will henceforth be referred to as EEP markets while all other importing countries will be referred to as non-EEP markets. While Slovenia and China benefited from EEP subsidies for malting barley on one shipment each of 37,500 tonnes and 150,000 tonnes in 1993 and 1994, respectively. These countries are referred to as non-EEP markets. This study covers the EEP period up to 1993. Hence, the effects of EEP on malting barley for the purposes of this study are assumed to be negligible.

[32] Malting barley consumption is calculated as total malting barley production (see Table 3.3) plus malting barley imports minus malting barley exports (see Section 3.4). This approximation assumes that all stocks held at the end of the year are only of feed quality. Note that any significant quantity of malt imported by EU-15 member countries is imported from another country from within the Union. Feed consumption equals total consumption minus malting barley consumption. Total consumption is approximated as total production plus non EU-15 net imports plus a stock adjustment. The stock adjustment is calculated as the difference between this year's ending stock and last year's ending stock as reported in the USDA PS&D View and is shown in Table 3.4.

MALTING BARLEY EXPORTS

Table 3.5 shows malting barley exports from the United States,[33] Canada,[34] Australia,[35] and EU-15,[36] to rest-of-the-world (ROW) non-major barley exporting destinations from 1983 to 1993. The Table also shows Canadian malting barley exports to the United States and EU-15 imports from outside the member countries.

Disaggregated data on 2-row and 6-row malting barley exports from Canada and the United States are not available. Hence, the relative quantities of malting barley exports can only be indirectly ascertained by examining the varietal requirements by brewers in both countries. For example, Anheuser-Busch (the second largest brewer in North America) uses 70 percent 6-row white varieties and 30 percent 2-row white. In the past, Miller brewing company utilized 100 percent 6-row white varieties but recently announced that they would switch to 20 percent 2-row white varieties. Coors, the sixth largest brewing company in North America, uses 100

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[33] Data on U.S. exports of all barley are taken from United States Barley Statistics reported by the North Dakota Barley Council. Export data for feed and malting barley are not available; however, data for malting barley exports are available for Canada, Australia, and Germany. The weighted ratio of malting/barley exports for these countries were used to approximate U.S. malting barley exports in the following fashion: All barley sold to China, South America, and Central America are assumed to be of malting quality. Barley sold to the current European Union (EU-15) and Turkey before 1985 is assumed to be feed. All exports to EU-15 after 1984 are assumed to be of malting quality and 18 percent of the barley sold to Turkey after 1984 is assumed to be malting barley. In addition, 3 percent of exports to Japan and 27 percent of U.S. exports to Taiwan are assumed to be malting barley. Finally, data available on each individual barley shipment under the Export Enhancement Program, acquired from the USDA Foreign Agricultural Service, were aggregated by year and the North Dakota Barley Council data were altered so that in years that the reported EEP shipments are greater than total barley exports to a given country, the data are replaced with the reported EEP quantity. The EEP data subdivide exports into malting and feed barley and only two shipments of malting barley were made under EEP. These were 37,500 tonnes to Slovenia in 1993 and 150,000 tonnes to China in 1994.

[34] Canadian export data are divided into feed and malting barley exports by country of destination in the Canadian Grain Commission's Canadian Grain Exports publications.

[35] The disaggregated export data are from the Gerson and Gauger Statistical Digests. The Gerson data do not separate feed and malting barley in 1983 to 1986. Hence, feed barley exports for those years are estimated as the Gauger data, minus the explicit malting barley export data given in the ABARE Commodity Statistical Bulletins. The following additional assumptions and changes were made due to the lack of disaggregated data for some data points and the obvious inaccuracies present in either the Gerson or ABARE data when cross-checked with each other and the International Wheat Council World Grain Statistics: Turkey is assumed to import only malting barley in 1985; in 1984, feed exports were set at 1.72 million tonnes for Saudi Arabia, 392,000 tonnes for the former Soviet Union, 481,000 tonnes for Japan, 182,300 tonnes for Singapore, and 0 tonnes for Sri Lanka.

[36] Yearly export data from each EU-15 country to each importing country were grouped and aggregated from Gerson and Gauger Statistical Digests reported for January to December. Intra EU-15 trade includes all 15 countries for each year even though the number of countries in the European Union increased from 8 to 15 over the period in question. To disaggregate malting barley from feed barley, it was necessary to approximate the percentage of malting barley imports on an individual country basis by taking the weighted percentage for similar shipments from Canada, Australia, and Germany as these are the only data that disaggregate barley exports into feed and malting. The following malting/total barley weights were used. Using the German data on trade within the EU-15, it was found that the roughly 25 percent of barley exported from Germany was malting barley and this number is applied to any Intra EU-15 exports. EU-15 exports to Switzerland are assumed to be 2 percent malting barley, 18 percent for Turkey, 3.5 percent for the Former Soviet Union, 75 percent for former Czech-Slovakia, and 100 percent for all Asian, African, and South American countries. Exports to the United States and Canada are also assumed to be of malting quality. In practice, EU-15 exports to the United States and Canada were made only in a few instances. The volume of these shipments were almost negligible.

tbl 3.5

percent 2-row varieties. The other U.S. brewers have historically used 100 percent 6-row varieties. Labatt's brewery uses 50 percent 6-row blue and 50 percent 2-row white varieties. The other Canadian brewers use 100 percent 2-row white varieties.[37] The recent rise in the use of 2-row white varieties relative to 6-row varieties in North America has increased the area planted to 2-row varieties in Canada which has increased the export of 2-rowed white malting barley from Canada into the United States. It seems likely that the United States exports almost exclusively 6-row varieties (mostly to Latin American countries) and that almost all of U.S. malting barley imports from Canada are 6-row white varieties.

As Table 3.5 shows, the United States has been a net importer of malting barley since 1986--the first year of the Export Enhancement Program (EEP). Virtually all malting barley imported into the United States originates in Canada. U.S. malting barley imports have increased over recent years. In 1993, they reached a historically high level of 546,000 metric tonnes. The United States and EU-15 play only a minor role in international malting barley markets.

The two major players in international malting barley markets are Australia and Canada. China, Taiwan, Japan, and Brazil are the major markets for Australian malting barley exports. The United States, China, and Colombia are the major markets for Canadian malting barley exports. Canadian malting barley exports reached a historically high level of 860,000 tonnes in 1993.

Australian malting barley exports have steadily increased and have reached a historic high of roughly 1 million tonnes in 1993. A large portion of this increase can be attributed to the large increase in malting barley exports to China. For example, China imported an average of over 500,000 tonnes of malting barley from Australia over the 5-year period ending in 1993. The yearly average malting barley exports to China for the previous five years was under 100,000 tonnes.

Historically, Australia exported large quantities of malting barley to countries in the EU-15. For example, in 1983 it exported 334,000 tonnes of malting barley to the EU-15, most of which was imported by the former East Germany. Australia continued to export malting barley to the EU-15 until 1990 as shown in Table 3.5. Since 1990, no country from outside the current European Union has exported significant quantities of either type of barley to the EU-15. Because the EU-15 has a larger consumption base than the other major exporting countries, its malting barley exports to non-member countries are relatively small. The EU-15 became a net exporter of malting barley in 1988. In 1993, the EU-15 exported only 142,000 metric tonnes of malting barley to non-member countries.

Feed Barley Exports

Table 3.6 shows feed barley exports to EEP destinations by source country and Canadian feed barley exports to the United States from 1983 to 1993. Table 3.7 shows feed barley exports to non-EEP destinations by source, as well as U.S., Canadian, and Australian feed barley exports

[37] Johnson, D. and W. Wilson (1994).

tbl 3.6

to EU-15.[38] Saudi Arabia is the largest feed barley importer in the world followed by the Former Soviet Union and Japan. These three countries account for nearly one-half of all feed barley imports in the world in a given year.

Tables 3.6 and 3.7 show estimated U.S. feed barley exports.[39] Before 1984, the United States exported significant quantities of feed barley to the European Union. After 1984, exports to the EU-15 dropped to 0. Before 1985, feed exports to countries that have not received EEP bonuses were higher than after 1985. For example, feed exports to countries that have not received EEP bonuses were 821,000 tonnes in 1984. In 1986, this number was only 98,000 tonnes.

The total volume of barley exports from the United States was the lowest in 1985 and highest in 1986. During the first year of EEP in 1986, U.S. barley exports rose to the record level of 3.1 million tonnes due to high stock levels caused by high production levels from 1984 to 1986 and anticipation of the program. After 1985, virtually all U.S. feed barley exports were to countries that have received EEP bonuses. For example, in 1986, more than 3 million tonnes of feed barley were exported to EEP destinations while only 100,000 tonnes were exported to non-EEP destinations. EEP sales and total feed exports were low in 1988 and 1989 due to low EEP bonuses during those same years. In 1993, feed exports to EEP destinations were 1.2 million tonnes while feed exports to non-EEP destinations were only 79,000 tonnes.

Tables 3.6 and 3.7 show Canadian feed barley to EEP markets and the United States, and feed exports to non-EEP markets, respectively. Total Canadian feed barley exports reached their peak in 1986 when 6.5 million metric tonnes of barley were exported. In 1993, Canadian barley exports totaled 3.8 million tonnes. The U.S. Export Enhancement Program came into effect in 1986, but seemed to have had little initial effect on the quantity exported to targeted countries. In 1985, Canadian barley exports to U.S. EEP destinations were 1.75 million tonnes. In 1986, this quantity increased to 4,667,000 tonnes which was roughly 75 percent of total feed barley exports. The quantity sold by Canada to EEP destinations remained high until 1991. In 1991, it decreased to 1.2 million tonnes--less than 50 percent of total feed exports. In 1993, only 594,000 tonnes were exported EEP destinations. This was less than 25 percent of total Canadian feed barley exports in that year.

Tables 3.6 and 3.7 show Australian feed barley exports from 1983 to 1993 to EEP and non-EEP destinations, respectively. Feed exports to those countries receiving EEP bonuses dropped dramatically once the program was implemented in 1986. For example, in 1985 feed exports to EEP destinations from Australia were 2.3 million tonnes. This number was reduced to 755,000 tonnes in 1986. After 1986, feed exports to EEP destinations did not rise above that number until 1993, when Australia exported 1.6 million tonnes to Saudi Arabia as a result of the abnormally large area planted to barley in that year (Figure 3.8). 1994 exports are projected to be low due to lower area and yields. Table 3.6 seems to suggest that the Export Enhancement

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[38] See Section 3.4.1 for a discussion of the techniques used for approximating feed and malting barley exports by region.

[39] Feed exports for the United States are calculated by taking the North Dakota Barley Council data for total exports, and subtracting estimated malting barley exports. This data is replaced by data on EEP shipments for countries in years where reported EEP shipments are higher (see Section 3.4.1).

3.7

Program in the United States had more of an immediate effect on Australia than on Canada in terms of relative export market shares.

Tables 3.6 and 3.7 show EU-15 feed barley exports to EEP and non-EEP destinations, respectively as well as its feed barley imports by source country from 1983 to 1993. Intra-EU trade makes up a large portion of EU-15 exports. Only the non Intra-EU trade levels are shown in Tables 3.6 and 3.7. Table 3.6 shows that the largest portion of EU-15 barley exports is comprised of feed barley imported by countries that receive EEP bonuses from the United States. EU-15 is the largest feed barley exporter in the world. The reason that is most often cited as justification for the U.S. Export Enhancement Program is to counter the effects of restitution payments and import levies by the European Union in order to maintain export market share in the face of rapidly expanding EU-15 grain exports.

Table 3.6 shows the increase in feed barley exports to those countries targeted by EEP from 1983 to 1985. Feed exports to EEP destinations increased from 2.1 million tonnes in 1983 to 6.8 million tonnes in 1985. EU-15 feed exports more than tripled in only three years. Most of this export expansion occurred in Saudi Arabia and the former Soviet Union. For example, feed exports to Saudi Arabia jumped from 846,000 tonnes in 1983 to 3.1 million tonnes in 1984. In addition, feed exports to the former Soviet Union increased from 793,000 tonnes in 1984 to 2.6 million tonnes in 1985.

When the Export Enhancement Program was initiated in 1986, it had success against EU-15 feed exports for the first two years as feed exports to EEP destinations dropped to 5 million tonnes in 1987. Once the EEP bonus dropped in 1988 and 1989, EU-15 exports increased again. In 1990, higher EEP bonuses pushed EU-15 exports down, but even in the face of large bonuses, feed exports to EEP destinations continued to increase after 1990 until total barley exports outside the EU-15 reached the record level of 9.8 million tonnes in 1992. By 1993, the European Union had exhausted their barley stocks due to CAP policy reform and the future outlook for even lower grain prices. Total barley exports outside the EU-15 dropped to 5.9 million tonnes in 1993.

ESTIMATION OF DOMESTIC SUPPLY AND DEMAND

DOMESTIC BARLEY SUPPLY

United States

Farmers in the United States can plant feed barley, 2-row malting barley, and 6-row malting barley varieties. The largest barley growing states are in the upper Midwest where corn is not a significant alternative crop. There are some specialty crops available such as sunflowers and more recently canola, but the largest competing crop is spring wheat and durum wheat. Hence, the area planted to barley at time t should theoretically be a function of the expected barley price and the expected wheat price. However, the U.S. farm program under the 1990 Farm Bill distorts this potential relationship. Barley growers who participate in the U.S. farm program must adhere to historically based constraints on the land base allowed for barley production. Potential barley growers can decide to either participate in the barley farm program (in which case they must satisfy certain set-aside requirements under the Acreage Set Aside Program), to not participate in the program and plant whatever crop they wish (in which case they are not eligible for deficiency payments), to leave the land fallow, or to place marginal land in the Conservation Reserve Program (in which case they receive a government subsidy in the form of a specified rental rate). If the farmer chooses to participate in the U.S. farm program, the participating barley producer receives revenue equal to the domestic price multiplied by the quantity sold and receives additional revenue in the form of a deficiency payment which equals the quantity of barley sold multiplied by the difference between the target price and the domestic price. Since the late 1970s, 1980, 1988, and 1989 have been the only years in which farmers have not received deficiency payments for barley. Hence, due to relatively high target prices (which have remained constant at $108.39 per tonne of barley since 1990), farmers' planting decisions do not necessarily depend on the expected domestic barley price. Their decisions may be affected by various policy variables associated with the U.S. farm program in addition to expected prices. These variables must be considered when constructing an econometric model of barley supply.

Table 4.1 shows the estimated coefficients of the behavioral equations associated with the U.S. barley industry. Each row represents a dependent variable that is affected by selected explanatory variables in each column. Planted area is depicted in units of thousands of hectares, prices are in U.S. dollars per tonne, consumption and stock levels are in thousands of tonnes, yield is in tonnes per hectare, and the selection rate is in percentage units. Each non-empty entry in the table represents the estimated coefficient associated with the ordinary least squares regression of the dependent variable with respect to the independent explanatory variable. All equations are linear with respect to the explanatory variables. The last two columns give the number of observations used in the analysis (beginning in 1980), the R^2, and standard error. The R^2 value gives an indication of the percentage of variation in the dependent variable that is explained by the combination of explanatory variables. Each parameter has an associated t-value which is given in parentheses underneath the parameter. A high absolute t-value implies that the independent variable has a high statistical significance of affecting the dependent variable. Typically, an absolute t-value of over 1.8 implies that one can be at least 95 percent confident that variations in the explanatory variable contribute to variations in the dependent variable.

The first three rows of Table 4.1 give the coefficients of the equations that estimate the area planted to feed, 2-row, and 6-row malting barley varieties in the United States. The area planted to feed barley varieties varies inversely with total barley set-asides and the expected wheat price. Total barley set-asides equal the program barley area that is set aside under the Acreage Reduction Program (roughly 1 million tonnes in 1993) plus the program barley area registered under the Conservation Reserve Program (1.1 million tonnes in 1993). The expected farm wheat price at time t equals the yearly average of the July to June monthly weighted average of feed barley prices received by U.S. farmers at country elevators for all wheat at time t-1 as reported by the National Agricultural Statistics Service (NASS). Hence, when the expected wheat price rises, the area planted to feed barley varieties decreases. Barley feed area also varies positively with logarithmic time. That is, over time (starting in 1980 ceteris paribus), the area planted to feed barley expands, but at a decreasing rate. The expected feed barley price

tbl 4.1

is not included in the feed area equation because when it was included, it resulted in a negligible and insignificant effect. This may be partially due to the distorting effects of the U.S. farm program and/or multicollinearity between expected barley prices and expected wheat prices. Similar relationships hold for 6-row malting barley as shown in the third row of Table 4.1. Again, neither the expected feed price nor the expected 6-row barley price was significant so they were excluded from the analysis.

The second row of Table 4.1 gives the coefficients associated with 2-row malting barley area. In this case, the expected 2-row malting barley price is significant, and expected wheat prices are insignificant and excluded. The expected 2-row malting barley price at time t is calculated as the yearly average of the July to June monthly weighted average feed barley prices received by U.S. farmers at country elevators for all barley at time t-1 plus the difference between the yearly average malting barley price received at Montana elevators by Montana farmers at time T-1 and the yearly average feed barley price received at Montana elevators by Montana farmers at time T-1 as reported by NASS. Hence, as the expected 2-row malting barley price increases, the area planted to 2-row varieties increases. The area planted to 2-row malting varieties has expanded over time as some U.S. brewers have shifted toward barley malt composed of 2-row varieties.

Some of the 6-row and 2-row malting barley that is planted is not actually used in the malting process. If the quality of a certain malting barley crop is too low, it must be sold as feed barley. To calculate the actual supply of feed and malting barley, the yield must be known, and the selection rate must be calculated. The selection rate is computed as the percentage of production from the area planted to malting varieties that is actually used in the malting process. Unfortunately, accurate records of the actual yields for each variety of barley planted in a given year are not kept so the average aggregate yield must be used to calculate supply. Row 4 of Table 4.1 shows that the malting barley selection rate in the United States is highly dependent on the average barley yield. The negative relationship between selection rates and yields suggests that U.S. brewers may relax their grading standards in years of tight supply and restrict their standards when supply is abundant. In addition, high aggregate yields can be associated with abundant precipitation which generates crops with higher protein levels. High protein levels are good for feed uses, but not for malting purposes.

Following similar logic, it may be that malting premiums (the difference between the price received for malting and feed barley) are higher in years when supply is tight when compared to years of abundant supplies. Two-row malting barley premiums are approximated by taking the difference between the monthly weighted average malting barley and feed barley prices received by Montana farmers at the elevator. Montana is used because 2-row varieties comprise over 95 percent of the area planted to malting barley in that state. Similarly, 6-row malting barley premiums are approximated by taking the difference between the monthly weighted average malting barley and feed barley prices received by farmers at North Dakota elevators. North Dakota is used because 6-row varieties comprise over 95 percent of the area planted to malting barley in that state. Rows 6 and 7 in Table 4.1 show the results of 2-row and 6-row malting premiums regressed against average yield and time. While the yield coefficient of the 2-row malting barley premium is negative, it is not significant. Instead, empirical evidence suggests that the 2-row malting barley premium has been increasing over time (as indicated by the high t-value of 4.5), regardless of yield. A similar analysis of 6-row malting barley premiums shows that while

6-row malting barley premiums have slowly trended upward, ceteris paribus, yield variability explains most of the premium variation as indicated by the extremely high t-value of -6.5 on the yield coefficient and the corresponding R^2 of 78 percent. The values for the exogenous variables along the top of Table 4.1 and the coefficients in Table 4.1 can be used to construct an economic model to simulate U.S. barley supply response.

Canada

Barley farmers in Canada grow feed barley, 2-row malting barley, or 6-row malting barley varieties. Most brewers in Canada use 2-row malting varieties while most U.S. brewers use 6-row white malting varieties. Most of the 6-row malting barley that is planted today is contracted with U.S. malsters for sale to U.S. brewers such as Anheuser-Busch. The Canadian Wheat Board (CWB) is the single-desk buyer and seller of Canadian 2-row and 6-row malting barley and is the single-desk exporter of Canadian feed barley. Although western Canadian farmers can grow oats and specialty crops such as canola, wheat is the largest alternative crop for Canadian barley producers. Hence, one would expect the area planted to barley in Canada to depend on expected wheat prices as well as expected barley prices. Table 4.2 shows the estimated coefficients of the behavioral equations associated with the Canadian barley industry. Table 4.2 is similar to Table 4.1 in most respects. The expected price at time t is approximated using total payments by the Canadian Wheat Board over the August to July crop year for the highest grade of grain in each category at time t-1. Since 1986, these grades have been categorized as: #1 feed barley, special select 2-row malting barley, special select 6-row malting barley, and #1 Canadian western spring wheat. The units in Table 4.2 are the same as those for Table 4.1, except that all prices are given in Canadian dollars per metric tonne.

Rows 1 and 2 of Table 4.2 show that the area planted to feed and 2-row malting barley depends on expected feed and 2-row malting prices, but the coefficients are not significant at the 95 percent confidence level. However, the t-values of 1.4 and 1.6, respectively, indicate that expected barley prices play some role in determining feed and 2-row malting barley areas. The expected wheat price plays a significant role in determining feed barley area. In the 2-row malting barley case, there has been a slightly decreasing logarithmic time trend in area planted. The EEP dummy variable (which equals one during the EEP years and 0 before that) represents a structural shift in 2-row area planted. After 1986, the first year of the Export Enhancement Program, Canadian 2-row malting barley area jumped to nearly 2 million hectares and stayed near that level until 1991. Since 1991, the area planted to 2-row malting varieties in Canada declined steadily. As shown in Table 4.2, 6-row malting barley area increases significantly with an increase in the expected 6-row malting barley price and decreases significantly with logarithmic time. The explanatory variables associated with Canadian feed barley area (R^2 of 24 percent) are not as significant as the explanatory variables associated with the 2-row malting (R^2 of 76 percent) and 6-row malting (R^2 of 93 percent) barley area. Two reasons that the expected CWB feed barley price may not be highly significant in explaining feed barley planting decisions are that an increasing portion of Canadian feed barley originates in non-designated CWB areas and barley producers within the designated area have the option of selling feed barley to other Canadian grain companies as well as to other farmers.

tbl 4.2

Average barley yields in the United States have a significant impact on U.S. selection rates and also affect 6-row malting barley premiums. Does there exist a similar pattern in Canada? The evidence presented in Rows 4, 5, and 6 of Table 4.2 show the coefficients associated with the selection rate, 2-row malting premium, and 6-row malting premium. Row 4 shows that the Canadian selection rate has trended upward over time, but the t-value of -0.1 on the yield coefficient indicates that Canadian selection rates do not significantly depend on average yield levels. What about Canadian malting barley premiums? Rows 5 and 6 indicate that there is some relationship between malting premiums and yield levels, but this relationship is not significant at the 95 percent confidence level as indicated by the low t-values of -1.0 on the yield coefficients for both 2-row and 6-row malting barley. Moreover, the evidence suggests that there is no significant time trend for Canadian malting premiums.

Australia

Australian barley producers plant feed barley varieties and 2-row malting barley varieties. Over 95 percent of all Australian barley is planted to 2-row varieties. There is no significant quantity of 6-row malting barley planted in Australia. In Australia, farmers not only have the option of growing wheat, they also graze a significant number of sheep to produce wool as an alternative to growing barley. Hence, one would expect the Australian barley area to depend on the expected barley price, expected wheat price, and expected wool price. Table 4.3 shows the estimated coefficients of the behavioral equations associated with the Australian barley industry. Table 4.3 is similar to Tables 4.1 and 4.2. The expected feed barley price at time t is approximated as the total payments received by farmers in South Australia from the Australian Barley Board (ABB) during the November to October crop year at time t-1. The ABB typically controls over 50 percent of all barley production in Australia, and South Australia is its largest producer (prices received by Victorian farmers are similar to those received by South Australian farmers). Consistent data are not available for some of the other Australian states. All prices in Table 4.3 are given in Australian dollars per metric tonne.

Row 1 of Table 4.3 shows the relationship between the area planted to all barley varieties in Australia and the expected feed price, the expected wool price, and the logarithmic time parameter. All of the coefficients are highly significant. When the expected feed barley price rises, the total barley area in Australia expands. When the expected wool price rises, some barley area is taken out of production and used for sheep grazing. There has been an increasing time trend in the area planted to barley in Australia. Unfortunately, consistent disaggregate data on 2-row malting and feed barley area are not available for all Australian states. Expected Australian Wheat Board wheat prices were originally included in the analysis of Australian barley area, but the results were not significant.

Row 2 of Table 4.3 shows the relationship between the Australian selection rate and the average barley yield. Because disaggregate barley area data are not available, the selection rate for Australia is approximated as the percentage of total barley production that is used in the malting process. It is assumed that all malting barley in Australia is 2-row. Table 4.3 indicates that as the average yield increases, the Australian selection rate decreases. The relationship is not significant at the 95 percent confidence level, but it is significant at a slightly lower confidence level. In addition, Australian selection rates have trended upward over time as

tbl 4.3

indicated by the 2.1 t-value associated with the time parameter in Row 2. Row 3 of Table 4.3 indicates that the 2-row malting premium in Australia does not depend significantly on the average barley yield, but has trended upward over logarithmic time. Again, because almost all malting barley produced in Australia is 2-row, there is no analysis of 6-row malting premiums provided in Table 4.3.

European Union 15

Farmers within the EU-15 can grow barley during both the winter and spring seasons. Those countries farthest south (e.g., Greece and Portugal) plant barley in the winter while those furthest north (e.g., Sweden and Finland) plant barley in the spring. The countries in the middle (e.g., France, Germany, and the United Kingdom) grow significant quantities of both spring and winter barley. Typically, winter barley has a higher yield than spring barley, but most winter barley is used for feed while spring barley of high enough quality is used in the malting process. The European Union plants almost 100 percent 2-row varieties for malting purposes.

Table 4.4 shows the estimated coefficients of the behavioral equations associated with the EU-15 barley industry. Prices are given in European Currency Units (ECU) per metric tonne. Consistent monthly price series are not available for all countries within the EU-15, but monthly prices received by farmers for feed barley and for malting barley are available for France, Germany, and the United Kingdom--the three major grain producing countries. The expected EU-15 barley price at time t is approximated as the July to June average of monthly prices received by farmers (as reported by Eurostat) in France, Germany, and the United Kingdom at time t-1, weighted by each country's share of total barley production at time t-1. The analysis of the European Union depicted in Table 4.4 starts in the year 1983 as opposed to 1980 (as was the case for the United States, Canada, and Australia) because of the inherent structural shift associated with the fact that the EU-15 went from a net importer of barley before 1983 to a major net barley exporter.

Row 1 of Table 4.4 shows that the expected feed barley price has a significant impact on the winter barley area seeded in the EU-15 as shown by the t-value of 5.2 on the expected feed price coefficient and the R-square of 73 percent. Row 2 of Table 4 shows a similar relationship with respect to malting barley. The t-value associated with the expected malting barley price coefficient is 2.8, and the R^2 for the spring barley equation is 44 percent. Hence, when the expected feed barley price increases, winter barley area in the EU-15 expands; and when the expected malting barley price increases, spring barley area expands.

Row 3 of Table 4.4 gives the results of the regression of the selection rate with respect to the spring barley yield and time. Disaggregate data on winter and spring barley yield for each country in the EU-15 were available. The selection rate in the EU-15 is approximated as the percentage of spring barley production that is actually used in the malting process. The high t-value of -5.9 associated with the spring barley yield coefficient indicates that in years of abundant supply, the selection rate decreases while in years of restricted supply, the selection rate increases. In addition, the high t-value of 8.4 associated with the time parameter indicates that the EU-15 selection rate has steadily increased over time. Part of the reason for the high statistical significance associated with the yield and time parameters in the EU-15 is that because the EU-15 covers such a wide and diverse area, there is less variability in aggregate yields. The

tbl 4.4

steady increase in EU-15 yields may have increased feed production at a faster rate than malting barley production. In addition, high quality malting barley may be grown in a few specific regions whose crop composition and land base have not changed significantly over time. Hence, while the absolute level of production of malting barley may change only a little, the relative level of malting barley production with respect to feed barley production can vary significantly.

Row 4 of Table 4.4 shows the results of the regression of the average EU-15 malting premium with respect to spring yield. The average malting premium is computed as the July to June yearly average of the difference between monthly malting barley prices and feed barley prices received by farmers in France, Germany, and the United Kingdom, weighted by their respective production shares. The t-value of -1.5 associated with the spring yield coefficient for 2-row malting barley premiums is not significant at the 95 percent confidence level but is significant at a slightly lower level. Looking back at Tables 4.1 to 4.3, barley yield has a slight effect on 2-row malting premiums in Canada and the EU-15, but time is not a factor. On the other hand, barley yield does not affect 2-row malting premiums in Australia or the United States, but 2-row premiums in these two countries are increasing over time.

DOMESTIC BARLEY DEMAND

The demand for barley can be separated into the demand for feed barley, 2-row malting barley, and 6-row malting barley. Once a truckload of barley has been determined to be of malting quality, it becomes a separate commodity for marketing purposes. Feed and malting barley are not substitutes in demand. Malting barley is used for processing malt that is further processed to create alcoholic beverages (mainly beer). However, feed barley is used as feed and has many demand substitutes. In the United States, corn, soybeans, oats, and feed wheat are all demand substitutes for feed barley. In Canada, feed wheat and oats are the main feed barley demand substitutes while feed wheat is the major feed substitute in Australia. Consumers in the European Union have a wide range of feed substitutes, the composition of which varies by region. Because of the high degree of substitutability among various feed grains, the prices of the major feed demand substitutes must be considered when constructing an econometric model of barley demand.

Tables 4.1 to 4.4 contain the relationship between domestic feed and malting barley consumption and domestic prices in each of the four major exporting regions. Disaggregate data on 2-row and 6-row malting barley consumption in the United States and Canada are not available, but estimates of aggregate malting barley consumption can be approximated. The third and second to last rows in Tables 4.1 to 4.4 show the coefficients associated with feed and malting barley consumption. Table 4.1 indicates that U.S. feed barley consumption depends on the price of feed barley (approximated as the July to June yearly average of monthly price quotes for Duluth #2 barley) and the price of feed corn (approximated as the July to June yearly average of monthly price quotes for Chicago #2 corn) with associated t-values of -4.1 and 2.7, respectively. Hence, when the price of barley increases, ceteris paribus, the consumption of U.S. feed barley decreases and when the price of corn increases, ceteris paribus, the consumption of U.S. feed barley increases.

Table 4.2 shows a similar result for Canada except that feed wheat is used as the feed substitute. The feed barley price is approximated as the August to July yearly average of the monthly average price quotes for Winnipeg #1 barley. The feed wheat price is approximated as the August to July yearly average of the monthly average price quotes for Winnipeg #3 feed wheat. The t-value of -2.6 associated with the feed barley coefficient and the t-value of 2.4 associated with the feed wheat coefficient confirm that when the feed barley price declines and the feed wheat price rises, the consumption of feed barley in Canada increases. Table 4.2 also shows a significant increasing time trend in Canadian feed barley consumption.

Table 4.3 shows a similar result for Australia except that corn is used as a proxy for feed wheat because a consistent time series on Sydney feed wheat prices is not available. The Australian domestic feed barley price and corn price are approximated as the yearly average cash price paid for domestic 2-row English bulk barley and domestic maize at Sydney, Australia (ABARE). The t-values of -2.4 and 3.5 associated with the coefficients on the domestic feed barley and corn price indicate results similar to those for the United States and Canada.

Table 4.4 shows the results of the coefficients on EU-15 domestic feed barley consumption. Because data on EU-15 consumer prices are not available, producer prices are used as a proxy for the consumer prices. The t-value of -3.4 on the feed barley price shows the expected result that when the price of feed barley in EU-15 rises, the consumption of domestic barley falls. However, the highly significant t-value of -6.6 on the time coefficient in Table 4.4 indicates that consumption of feed barley in EU-15 has steadily declined since 1983. This time trend is not apparent in Australia and the United States. On the other hand, Canadian consumption of feed barley has trended upward over time. Part of the reason for the declining time trend in EU-15 feed consumption is that there exists a wide variety of substitute crops which different countries within the EU-15 can use instead of barley for feed purposes. In the analysis of feed barley consumption in the United States, Canada, and Australia (Tables 4.1 to 4.3), substitute crops are used as explanatory variables. EU-15 wheat price series, similar to those used for EU-15 feed barley, are also available. However, these prices are highly correlated with feed barley prices and are excluded from the analysis.

The results of malting barley demand estimates are shown in Tables 4.1 through 4.4. In the malting barley case, the effect of the absolute domestic malting barley price on domestic malting barley consumption is not statistically significant in any of the four major exporting countries. Malting barley is only a small component of the ingredients used in the production of beer. Malting barley demand is derived from beer production which is highly correlated with population growth. As time increases, the consumption of beer—and hence, the consumption of malting barley—increases with world population growth. As indicated in Tables 4.1 to 4.4, malting barley consumption has increased over time with statistical significance in all four major exporting regions. The domestic consumption of malting barley is determined indirectly through the selection rate which is different in each country and can vary with the relative quantity and/or quality of the domestic barley crop in a given year (see Section 4.1).[40] The domestic price of malting barley is determined indirectly and is based on the feed barley price plus a malting

[40] One should also keep in mind that domestic malting barley is used to produce beer for both consumption at home and consumption abroad. An increase in the demand for beer abroad increases the domestic consumption of malting barley used to produce both beer and barley malt for export.

premium that varies by type and by country. This malting premium can vary with the relative quality of the domestic barley crop in a given year. For example, the domestic U.S. premium between 6-row malting barley and feed barley varies with the quality of the U.S. barley crop in a given year. As shown in Table 4.1, the average U.S. barley yield (which is used as a proxy for crop quality) has a statistically significant affect on the U.S. premium for 6-row malting barley. In years when U.S. barley yields are low, the U.S. 6-row malting premium is higher than in years when U.S. barley yields are high.

DOMESTIC BARLEY STOCKS

In most exporting countries, significant quantities of barley stocks are carried over from one year to the next. Because feed grains can be stored for relatively long periods of time, farmers tend to hold more stocks when prices are relatively low than when prices are high. In the case of barley, virtually the entire volume of carry-over stocks is feed quality barley. Malting barley carry-overs are typically negligible. An econometric estimation of feed barley supply and demand would not be complete without adjusting stock levels as feed barley prices change. The last row in Tables 4.1, 4.2, and 4.4 shows the estimated relationship between stock levels and domestic prices for the United States, Canada, and EU-15, respectively. An analysis of Australian stock levels is not included because consistent estimates are not available. However, inferences from several sources suggest that Australian barley stocks are much lower than those in the other major exporting countries. For these reasons, annual differences in Australian carry-over stocks are assumed to be negligible.

The t-values of -3.7, -3.5, and -2.9 in the last rows of Tables 4.1, 4.2, and 4.4 associated with the coefficient estimates for the United States, Canada, and EU-15 indicate that the domestic feed price is a statistically significant determinant of the level of feed barley carry-over stocks in those countries. In all three exporting regions, an increase in the domestic price of feed barley causes markets to become more attractive to producers, which causes a decrease in feed barley stocks. The R^2 associated with all three exporting regions is over 50 percent, indicating that variations in the domestic feed barley price explain over 50 percent of the variation in carry-over stocks in those countries.

BARLEY SIMULATION MODEL

An econometric simulation model will be used to estimate the economic impacts of proposed policy changes on international barley markets. The model uses statistical relationships among the area planted to feed and malting varieties, feed and malting consumption levels, stock levels, selection rates, malting premiums, average yields and expected prices in the United States, Canada, Australia, and EU-15. These domestic relationships are combined with various import and export market clearing conditions and restrictions implied by the structure of barley markets and certain agricultural policies to simulate the workings of international barley markets.

MODEL OVERVIEW

An overview of the concepts driving the simulation model is provided in this section. Specifically, a hybrid spatial model is developed to simulate feed barley and malting barley trade flows. The feed barley sector is described first, followed by the malting barley sector. Figure 5.1 is provided so that the reader can more readily follow world barley trade flows. The rectangular boxes in the middle of Figure 5.1 represent the four major barley exporters. These indicate the countries of origin from which barley production and barley stocks are released. The four oval-shaped boxes at the top of Figure 5.1 represent the domestic markets corresponding to the four major barley exporters. Production of barley from each major exporting country flows to its corresponding domestic market. Feed barley stocks can either be released or withheld from the domestic market. The three oval-shaped boxes at the bottom of Figure 5.1 represent the international barley markets with excess barley demand. Excess supply originating from any of the four major exporters is shipped to the world malting barley market if it is of malting quality. If the excess barley is not of malting quality, it is shipped to either the "EEP destination" feed barley market or the "non-EEP destination" feed barley market. A dashed line in Figure 5.1 represents the flow of malting barley while a solid line represents the flow of feed barley. The arrowhead indicates the direction of trade flows.

It is easiest to start with the feed barley sector in the European Union 15 (EU-15). The Common Agricultural Policy (CAP) in the EU-15 utilizes two instruments of protection. The first is the variable import levy system which essentially establishes a prohibitive trade barrier to potential importers. Hence, it is assumed that no barley imports from outside EU-15 member countries enter the EU-15. The second instrument is the export restitution payment system. Export restitutions insulate EU-15 farmers from economic price discovery implied by supply and demand conditions through a process whereby the government chooses a producer price level and provides export restitution payments such that farmers within the EU-15 receive the same price regardless of whether they sell to the domestic market, non-EEP destinations, or EEP destinations. For this reason, feed barley prices facing EU-15 are assumed to be exogenous in this model. Because the domestic and foreign prices facing EU-15 producers are the same, an assumption with respect to the relative export allocation between EEP destination importers and non-EEP destination importers must be made. In this model, it is assumed that the EU-15 exports a certain quantity of feed barley to non-EEP destinations. This quantity is fixed with respect to price, but increases with time. The stock-adjusted difference between EU-15 feed production and the sum of domestic feed consumption and feed exports to non-EEP destinations is dumped into EEP destination markets. The EU-15 will attempt to export feed barley to the non-EEP destinations first due to a small price premium that non-EEP markets pay over EEP markets. Two justifications for fixed export levels to non-EEP destinations are provided. The first is that the EU-15 provides feed barley to certain non-EEP markets exclusively (e.g., Libya) whose import requirements have increased somewhat steadily over time, regardless of price. The second is that the volume of feed barley exports from the EU-15 into non-EEP destinations is much lower than the volume of exports into EEP destinations and that in practice, EU-15 exports to EEP markets have fluctuated dramatically while exports to non-EEP markets have not.

fig5.1

Consider the additional restrictions imposed on international feed barley markets by the interaction of U.S. grain traders in the marketplace. Since EEP became effective in 1986, high EEP bonuses have caused U.S. grain exporters to reallocate virtually all of their feed barley exports away from non-EEP markets in favor of EEP markets. This is because the introduction of EEP made it no longer as profitable for U.S. grain traders to sell feed barley into non-EEP markets. This essentially severed the price linkage that had existed before 1986 between the U.S. domestic price and the import price in non-EEP markets. However, the price linkage between the U.S. domestic price and the import price in EEP markets was strengthened. The United States can be viewed as a competitive price taker in international barley markets because it is comprised of multiple grain traders and few barriers to entry. Hence, the "law of one price" between domestic and EEP feed barley markets must hold (from the U.S. perspective). That is, in equilibrium, the feed barley price that U.S. grain traders receive from the domestic market must be equal to the price that U.S. grain traders receive for exporting feed barley to EEP destinations (which includes the EEP bonus). If this were not the case, a revenue maximizing U.S. grain trader would reallocate feed barley across the two markets until prices became equalized. This condition implies that in equilibrium, the average import price in EEP markets must equal the U.S. domestic price minus the average EEP bonus, plus the average cost of transportation to the Pacific Northwest port, plus the transportation cost from the U.S. port to the average EEP destination. It seems intuitive that the market conditions implied by the profit maximizing behavior of U.S. grain traders can be viewed as the "spatially competitive" portion of the simulation model.

Now consider the Canadian case. The Canadian Wheat Board is the single-desk exporter of both feed and malting barley which implies that it has some monopoly power in the international market place. The Canadian Wheat Board has four market outlets for feed barley. It has the option to sell feed barley into the domestic market, the EEP market, the non-EEP market, and the U.S. market. Hence, it can maximize total revenue with respect to all four markets through price discrimination. However, this maximization behavior is not unconstrained. The CWB is limited by several structural constraints imposed by agricultural policies of other exporting countries. Two of these constraints have already been discussed (the residual dumping of feed barley into EEP markets by the EU-15 due to export restitutions and the price link that must exist between the U.S. domestic market and the EEP market due to EEP). The CWB is also faced with U.S. supply and demand relationships which include stock adjustments and the reaction of the Australian marketing boards. In addition, the CWB does not have monopoly power in its domestic feed market. Further, the Western Grain Transportation Act (WGTA) has provided for a discount on railroad freight rates for barley transported to Vancouver for export. The level of this subsidy affects the relative allocation of Canadian barley exports between overseas destinations and U.S. markets. In this model, it is assumed that the CWB acts as a competitive price taker with respect to its domestic feed market and that a price link exists between the EEP feed market (which is used as a proxy for the equilibrium world price) and the Canadian domestic feed market. This price link is directly affected by the average EEP subsidy provided by the U.S. government because the EEP bonus affects the import price in EEP markets. The price link is also directly affected by the level of subsidy provided by the government under the WGTA. To summarize, the Canadian Wheat Board maximizes total revenue with respect to the four feed barley markets subject to a number of constraints imposed on feed barley markets. In addition, the CWB faces the reaction of the Australian marketing boards which function as its direct oligopolistic competitor in international export markets.

Here we consider the case of Australia which is the last of the four major feed barley exporters in the world. There are a handful of marketing boards in Australia which function as the single-desk exporter of Australian barley. The Australian Barley Board (ABB) is the largest barley marketing board in Australia. It controls over 50 percent of the entire Australian barley crop. This model assumes that Australian marketing boards can collectively behave as a price discriminating oligopolist in international markets and that the CWB behaves as its oligopolistic competitor. It is further assumed that Australian marketing boards act as a price taker in the domestic market, and that a price link exists between the EEP feed market (which is used as a proxy for the equilibrium world price) and the Australian domestic feed market. The major logistical difference between the Australian marketing boards and the Canadian Wheat Board is that Australia does not have access to the U.S. market. Hence, the Australian boards maximize total revenue with respect to the domestic feed market, the EEP market, and the non-EEP market subject to all of the market constraints imposed by the agricultural policies of the different exporting countries as discussed above. It is assumed that the CWB and Australian marketing boards take each other's export quantities as given when maximizing total revenue so that a Cournot equilibrium between Canada and Australia is established given the competitive nature of the United States, the ex-post static nature of the EU-15, and the market clearing condition that the total feed barley supply must equal the total feed barley demand in international markets. It seems intuitive to view the interaction between Canada and Australia in feed barley markets as the "spatially oligopolistic" portion of the simulation model.

The malting barley portion of the simulation model is partially based on the market equilibrium established under the feed barley portion of the model. Equilibrium malting barley consumption levels and 2-row and 6-row malting barley prices are determined indirectly using the selection rate, malting barley price premiums, and equilibrium feed barley prices established by the feed barley portion of the model. The selection rate is endogenous, is different in each country, and can vary with the relative quantity and/or quality of the domestic barley crop in a given year. Once the selection rate is determined in each exporting country, it is assumed that domestic malting barley demand for Canada, Australia, and the EU-15 is filled by the home country and the residual is exported into the world market. EEP has not been much of a factor in malting barley markets as only two malting barley shipments have received EEP bonuses over the ten years of its existence (Slovenia in 1993 and China in 1994). Hence, unlike the feed barley case, the export market for malting barley is not divided into two distinct markets. If U.S. domestic malting barley demand cannot be satisfied by producers in the United States, Canada exports the residual quantity to the United States to make up the difference.

In the malting barley portion of the simulation model, malting premiums are endogenous, vary by type and by country, and can vary with the relative quality of the domestic barley crop in a given year. It is assumed that the relative share of 2-row vs. 6-row malting barley sold by the United States and Canada for malting purposes is the same as their respective planting shares. The equilibrium price of malting barley in each country is obtained by adding the endogenously determined malting premium in each country to the equilibrium feed barley price in that country. There is no stock adjustment for malting barley, because it is assumed that differences in yearly carry-over stocks are due to feed barley adjustments only.

MATHEMATICAL SPATIAL FORMULATION

In Canada and the United States, separate behavioral equations are estimated for the area planted to feed barley varieties (A_F^{US} and A_F^{CN}); the area planted to 2-row malting varieties (A_2^{US} and A_2^{CN}); and the area planted to 6-row malting varieties (A_6^{US} and A_6^{CN}). The area planted to a particular type of barley in each country is estimated as a function of the expected (lagged) domestic price for that particular type of barley (which is exogenous), the expected (lagged) domestic price of alternative crops (which is exogenous), and time. In Australia, one behavioral equation is specified. The total area planted to barley in Australia (A_B^{AU}) is a function of the expected domestic feed barley price (which is exogenous), the expected domestic price of alternative crops (which is exogenous), and time. Two behavioral equations are specified for the barley area planted in the European Union (EU-15). The area planted to winter barley in the EU-15 (A_W^{EU}) is specified as a function of the expected domestic feed barley price while the area planted to spring barley in the EU-15 (A_S^{EU}) is specified as a function of the expected domestic malting barley price.

The selection rate in the United States, Canada, and EU-15 is defined as the percentage of the area planted to malting barley varieties that is sold for malting purposes and is represented by the parameter θ^I. For Australia, θ^{AU} is defined as the selection rate out of all barley varieties planted (both malting and feed) due to data constraints. Each country has a separate behavioral equation for θ^I which is estimated as a function of the average barley yield for that country and time. Yield is exogenously specified. For the United States, Canada, and Australia, the yield (Y_B^I) is averaged over the total barley crop which includes both feed and malting varieties. For EU-15, winter barley yield (Y_W^{EU}) is disaggregated from spring barley yield (Y_S^{EU}). In this case, the EU-15 selection rate (θ^{EU}) is specified as a function of the average spring barley yield and time since most malting barley comes from spring plantings.

The relationship that specifies the supply of feed and malting barley in each of the major exporting countries can be formulated using the behavioral equations. Specifically, the supply of malting barley in each of the four countries is computed as

$$S_M^{US} = \theta^{US} \bullet Y_B^{US} \bullet (A_2^{US} + A_6^{US})$$
$$S_M^{CN} = \theta^{CN} \bullet Y_B^{CN} \bullet (A_2^{CN} + A_6^{CN})$$
$$S_M^{AU} = \theta^{AU} \bullet Y_B^{AU} \bullet A_B^{AU}$$
$$S_M^{EU} = \theta^{EU} \bullet Y_S^{EU} \bullet A_S^{EU}$$

where S_M^I is the total supply of malting barley in exporting country I. The supply of feed barley in each of the four countries becomes

$$S_F^{US} = Y_B^{US} \bullet A_F^{US} + (1-\theta^{US}) \bullet Y_B^{US} \bullet (A_2^{US} + A_6^{US})$$
$$S_F^{CN} = Y_B^{CN} \bullet A_F^{CN} + (1-\theta^{CN}) \bullet Y_B^{CN} \bullet (A_2^{CN} + A_6^{CN})$$
$$S_F^{AU} = (1-\theta^{AU}) \bullet Y_B^{AU} \bullet A_B^{AU}$$
$$S_F^{EU} = Y_W^{EU} \bullet A_W^{EU} + (1-\theta^{EU}) \bullet Y_S^{EU} \bullet A_S^{EU}$$

where S_F^I is the total supply of feed barley in exporting country I. The two sets of above equations specify the supply from this year's crop, but stock level adjustments must be taken into account to obtain the entire supply relationship. In this model, all barley stocks are assumed to be of feed quality, and ending stock levels are specified as a function of the domestic feed barley price in each exporting country and time. Ending stock levels in each exporting country are represented by $EST^I(P_F^I)$ where P_F^I equals the domestic price of feed barley in exporting country I. There is no specified relationship for Australian stock adjustments since these are considered negligible. Beginning feed barley stocks in country I are defined as BST^I and are exogenously specified. Hence, the behavioral equations that determine the stock adjustment become

$$SA_F^{US}(P_F^{US}) = BST^{US} - EST^{US}(P_F^{US})$$
$$SA_F^{CN}(P_F^{CN}) = BST^{CN} - EST^{CN}(P_F^{CN})$$
$$SA_F^{AU}(P_F^{AU}) = 0$$
$$SA_F^{EU}(P_F^{EU}) = BST^{EU} - EST^{EU}(P_F^{EU})$$

where SA_F^I is positive if some feed barley is taken out of stocks and supplied to the domestic market, but is negative if more feed is placed into stock reserves.

Feed Barley Simulation

Consider the domestic demand for feed barley in exporting country I. Domestic feed barley demand is specified as a function of the domestic feed barley price, the price of feed substitutes in demand (which is exogenous), and time. $D_F^I(P_F^I)$ represents the domestic demand equation for feed barley in exporting country I. Domestic malting barley consumption is defined as malting barley that is used by the domestic country to produce malt which can, in turn, be consumed in any country. Domestic malting barley consumption in exporting country I (D_M^I) is a function of time only. That is, malting barley consumption does not directly depend on either the feed barley price or the malting barley price. All regression results with respect to all exporting countries indicate that prices do not affect domestic malting barley consumption levels.

The excess feed and malting barley supply relationships for each of the four major barley exporting countries can now be formulated. Specifically, for exporting country I:

$$ES_F^I(P_F^I) = (S_F^I + SA_F^I(P_F^I)) - D_F^I(P_F^I)$$
$$ES_M^I = (S_M^I - D_M^I)$$

where $ES_F^I(P_F^I)$ is the excess supply of feed barley in exporting country I which is a function of the domestic price of feed barley in that country, and ES_M^I is the excess supply of malting barley in exporting country I.[41]

Now we turn to the import demand for feed barley. Feed barley importers (in non-exporting countries) are grouped into two regions. The first region, “the EEP market”, is defined as those countries that have received subsidies under the Export Enhancement Program for feed barley imports originating from the United States. The second region, “the non-EEP market”, is defined as those countries that have never received EEP subsidies for feed barley originating in the United States. Excess feed barley demand in the EEP market, $ED_F^{EP}(P_F^{EP})$, is specified as a function of the price that importers in the EEP market must pay for feed barley imports from any exporting country and is also a function of the (exogenous) price of alternative feed commodities.

[41] For the United States, ES_M^{US} can be negative, in which case it represents excess malting demand.

Similarly, the excess feed barley demand in the non-EEP market, $ED_F^{NE}(P_F^{NE})$, is specified as a function of the price that importers in the non-EEP market must pay for feed barley imports from any exporting country and is also a function of the (exogenous) price of alternative feed commodities.

Several behavioral equations can now be formulated whose solution will determine the direction of world trade flows of feed barley from each of the four exporting countries and the allocation of excess feed barley among export markets. The quantity of EU-15 feed barley imported by the non-EEP market (QF_{EU}^{NE}) is specified as an increasing function of time. The residual (QF_{EU}^{EP}) represents the quantity of EU-15 feed barley that is dumped into the EEP market. In addition, because the export restitution payment system exists in EU-15, European feed barley producers are insulated from changes in world feed barley prices. Hence, this model assumes that the EU-15 domestic feed barley price is set exogenously by the EU-15 governing body.

Now consider the United States. The quantity of feed barley exports from the United States to the non-EEP market during periods when the EEP bonus is in place is almost negligible. Hence, QF_{US}^{EP} is set to an exogenously determined constant whose value is very small. In addition, because there are many grain traders in the United States, the "law of one price" from the U.S. perspective implies that in equilibrium the following relationship must hold (see Section 5.1):

(1) $P_F^{EP} = P_F^{US} - \delta + T_{US}^{EP}$

where δ is the average per unit EEP bonus offered by the United States and T_{US}^{EP} is the cost of transportation from the U.S. domestic market to the EEP market.

Consider the Canadian case. The Canadian Wheat Board is the single-desk exporter of Canadian feed barley. It has some monopoly power in world feed barley markets because it can control the allocation of large volumes of feed barley sales across markets. This implies that the actions of the CWB affect the relationship among relative feed barley prices in different potential markets. However, the CWB has little control over its domestic feed barley market. In this model, the CWB is assumed to be a price taker in its domestic feed barley market. The Canadian domestic feed barley price must be linked to world prices. Unfortunately, under these conditions, there is no single "world price" that can be used for this purpose because the EEP bonus drives a wedge between the feed barley prices in different markets. In this model, the Canadian domestic feed barley price is linked to world prices through the following relationship

(2) $P_F^{EP} - P_F^{CN} = \alpha^{CN} + \beta^{CN}\,\delta$

where α^{CN} and β^{CN} are parameters obtained through the ordinary least squares regression of the price difference ($P_F^{EP} - P_F^{CN}$) with respect to the EEP bonus δ. That is, the EEP bonus drives a wedge between the EEP market price and the Canadian domestic price. As the EEP bonus approaches $0.00 per tonne, the Canadian domestic feed barley price approaches the EEP market price minus the constant α^{CN}.

The Australian marketing boards function in a manner similar to the CWB. Australian marketing boards control Australian feed barley exports, but are assumed to be a price taker in the Australian domestic feed barley market. The Australian domestic feed barley price is linked to world prices through the following relationship

(3) $P_F^{EP} - P_F^{AU} = \alpha^{AU} + \beta^{AU}\,\delta$

where α^{AU} and β^{AU} are the Australian versions of their Canadian counterparts.

A mathematical maximization problem for the CWB and Australian marketing boards can be formulated. The objective of the CWB is to maximize the revenue accruing to Canadian feed barley producers. The CWB can sell feed barley into four different markets: the Canadian domestic market, the U.S. domestic market, the non-EEP market, and the EEP market. It will distribute its feed barley supply (S_F^{CN}) among these markets to solve the following problem:

Maximize total feed barley revenue for Canadian producers:

- $TR_F^{CN} = P_F^{CN}QF_{CN}^{CN} + (P_F^{US}-T_{CN}^{US})QF_{CN}^{US} + (P_F^{NE}-T_{CN}^{NE})QF_{CN}^{NE} + (P_F^{EP}-T_{CN}^{EP})QF_{CN}^{EP}$

  with respect to $\{QF_{CN}^{CN}, QF_{CN}^{US}, QF_{CN}^{NE}, QF_{CN}^{EP}\}$

subject to the structural constraints:

$$P_F^{EP} = P_F^{US} - \delta + T_{US}^{EP}$$
$$P_F^{EP} - P_F^{CN} = \alpha^{CN} + \beta^{CN}\,\delta$$
$$P_F^{EP} - P_F^{AU} = \alpha^{AU} + \beta^{AU}\,\delta$$

and subject to the market clearing excess supply conditions:

$$ES_F^{US}(P_F^{US}) + QF_{CN}^{US} = QF_{US}^{NE} + QF_{US}^{EP}$$
$$ES_F^{CN}(P_F^{CN}) = QF_{CN}^{US} + QF_{CN}^{NE} + QF_{CN}^{EP}$$
$$ES_F^{AU}(P_F^{AU}) = QF_{AU}^{NE} + QF_{AU}^{EP}$$
$$ES_F^{EU} = QF_{EU}^{NE} + QF_{EU}^{EP}$$

and subject to the market clearing excess demand conditions:

$$ED_F^{EP} = QF_{US}^{EP} + QF_{CN}^{EP} + QF_{AU}^{EP} + QF_{EU}^{EP}$$
$$ED_F^{NE} = QF_{US}^{NE} + QF_{CN}^{NE} + QF_{AU}^{NE} + QF_{EU}^{NE}$$

At the same time that the CWB is maximizing its producer revenues, the Australia marketing boards are doing the same thing. That is, the Australian boards can sell feed barley into three different markets: the Australian domestic market, the non-EEP market, and the EEP market. The Australian boards allocate feed barley supply (S_F^{AU}) across markets to solve the following problem:

Maximize total feed barley revenue for Australian producers:

- $TR_F^{AU} = P_F^{AU}QF_{AU}^{AU} + (P_F^{NE}-T_{AU}^{NE})QF_{AU}^{NE} + (P_F^{EP}-T_{AU}^{EP})QF_{AU}^{EP}$

  with respect to $\{QF_{AU}^{AU}, QF_{AU}^{NE}, QF_{AU}^{EP}\}$

subject to the structural constraints:

$$P_F^{EP} = P_F^{US} - \delta + T_{US}^{EP}$$

$$P_F^{EP} - P_F^{CN} = \alpha^{CN} + \beta^{CN}\,\delta$$
$$P_F^{EP} - P_F^{AU} = \alpha^{AU} + \beta^{AU}\,\delta$$

and subject to the market clearing excess supply conditions:

$$ES_F^{US}(P_F^{US}) + QF_{CN}^{US} = QF_{US}^{NE} + QF_{US}^{EP}$$
$$ES_F^{CN}(P_F^{CN}) = QF_{CN}^{US} + QF_{CN}^{NE} + QF_{CN}^{EP}$$
$$ES_F^{AU}(P_F^{AU}) = QF_{AU}^{NE} + QF_{AU}^{EP}$$
$$ES_F^{EU} = QF_{EU}^{NE} + QF_{EU}^{EP}$$

and subject to the market clearing excess demand conditions:

$$ED_F^{EP} = QF_{US}^{EP} + QF_{CN}^{EP} + QF_{AU}^{EP} + QF_{EU}^{EP}$$
$$ED_F^{NE} = QF_{US}^{NE} + QF_{CN}^{NE} + QF_{AU}^{NE} + QF_{EU}^{NE}$$

To solve the allocation problems of the CWB and Australian marketing boards simultaneously, it is assumed that these two countries interact with each other in a Cournot fashion under the segmented markets hypothesis. That is, they take each other's export quantities in each market as given when maximizing revenue. The solution to the feed barley simulation model involves a "hybrid spatial" solution concept. It is partly a competitive spatial price equilibrium model and partly an oligopolistic spatial model. The technique utilized to solve the feed barley portion of the simulation model is similar to that developed in T.G. Schmitz (1995).[42]

The process described above generates two feed barley prices under Nash equilibrium conditions. One equilibrium feed barley price is generated for the EEP market and one price is generated for the non-EEP market. Equilibrium domestic feed barley prices in each of the exporting countries are obtained from these two prices through equations **(1)** to **(3)**. The malting barley portion of the simulation model builds on the results established under the feed barley simulation.

Malting Barley Simulation

Consider the domestic price of malting barley in the four major barley exporting countries. Malting barley consumption does not depend directly on the price of malting barley. Instead, malting barley consumption is determined indirectly through the endogenously determined selection rate and production levels (see Section 5.2). In addition, an equilibrium malting barley price can not be obtained directly as is the case for feed barley. Domestic malting barley prices are endogenously determined by adding domestic price premiums between malting and feed barley to domestic feed barley prices generated in Section 5.2.1. The domestic price premium in exporting country I is specified as a function of the barley yield in country I and time (see Section 4). This premium is added to the domestic feed barley price to obtain the domestic malting barley price in each country. Through this relationship, the model determines the U.S. price of 2-row malting barley (P_2^{US}), the U.S. price of 6-row malting barley (P_6^{US}), the Canadian price of 2-row malting barley (P_2^{CN}), the Canadian price of 6-row malting barley (P_6^{CN}), the Australian price of

[42] See Schmitz, Troy G. (1995) for more details.

malting barley (P_M^{AU}), and the EU-15 malting barley price (P_M^{EU}).

The malting barley portion of the model assumes that there is only one importing region, "the rest of the world", so that once the excess supply of malting barley is determined in Australia and EU-15, the residual is imported by the rest of the world. If there is excess demand in the U.S. malting barley market, it is assumed that Canada allocates enough malting barley to satisfy the U.S. market first. The residual Canadian malting barley is exported to the rest of the world.

MODEL IMPLEMENTATION

To implement the above econometric simulation model, the supply and demand relationships established in Section 4 (shown in Tables 4.1 to 4.4) are combined with estimates of EU-15 feed barley exports to non-EEP destinations, import feed barley demand estimates for both EEP and non-EEP markets, price linkages between domestic and world prices, and price linkages between consumer prices and prices received by farmers. The econometric results of these estimates are shown in Table 5.1. Each relationship is examined in turn.

Export Market Relationships

The top section of Table 5.1 shows the results of the econometrically estimated exports to non-EEP markets by the EU-15 and the import demand functions with respect to the EEP and non-EEP destination markets. All of the export estimates in the first three rows of Table 5.1 cover 1983 through 1993, since disaggregate export data by destination and type are only available over that period. Consider the first row of Table 5.1 which shows the equation relating EU-15 exports to non-EEP destinations and logarithmic time. While the t-value of 1.6 on the time variable is not significant at the 95 percent confidence level, it is significant at a slightly lower confidence level. An alternative would have been to compute an average export level for non-EEP destinations, but the assumption of an increasing time trend seems more appropriate.

The second row of Table 5.1 shows the estimated demand equation for feed barley imports by EEP destinations. The import level in each year is approximated as the sum of all feed barley exports from the United States, Canada, Australia, and EU-15 that are imported by any country that ever received an EEP subsidy from the United States for feed barley. Data on actual prices for sales to EEP destinations are not available to the authors. The average import price in EEP feed barley markets is estimated as the yearly average of Pacific Northwest price quotes for exports of #2 feed barley from the United States, minus the yearly average of weighted monthly EEP bonuses for feed barley exports from the United States, plus the approximate cost of transportation from the Pacific Northwest port (PNW) to Saudi Arabia (which is the largest feed barley EEP destination and is roughly in the geographical center of

tbl 5.1

EEP markets). The transportation cost is $16.85 U.S. dollars per metric tonne which is calculated as the (1993 to 1994) average of transportation costs from PNW to Saudi Arabia in early January provided through personal communication with the Canadian Wheat Board. Row 2 of Table 4.5 shows a t-value of 2.0 on the import price coefficient of the import demand equation for EEP destinations with a corresponding R^2 of 31 percent.

The third row of Table 5.1 shows the estimated demand equation for feed barley imports by non-EEP destinations. The import level in each year is approximated as the sum of all feed barley exports from the United States, Canada, Australia, and EU-15 that are imported by all countries that have never received an EEP subsidy from the United States for feed barley. Data on actual prices for sales to non-EEP destinations are also not available to the authors. The average import price in non-EEP feed barley markets is estimated as the yearly average of PNW price quotes for exports of #2 feed barley from the United States plus the approximate cost of transportation from PNW to Japan (which is the largest non-EEP destination). The approximate transportation cost is $30.75 U.S. dollars per metric tonne which is calculated as the (1993 to 1994) average of transportation costs from PNW to Japan in early January provided through personal communication with the Canadian Wheat Board. Row 3 of Table 5.1 shows a t-value of 2.0 on the import price coefficient of the import demand equation for non-EEP destinations and also shows a t-value of 3.7 with respect to the corn export price which was calculated as the yearly average of monthly price quotes for #3 corn at the U.S. Gulf ports plus the $30.75 transportation cost to Japan. The R^2 of 68 percent on this equation indicates that the variation in feed barley import demand in non-EEP markets can be reasonably explained using export prices for feed barley and feed corn.

Price Linkages

The domestic U.S. price is directly linked to the PNW price, which is directly linked to the import price facing EEP markets because of the Export Enhancement Program (see Section 5.1). The difference between the PNW price for #2 feed barley and the U.S. domestic consumer price (#2 Duluth feed barley) is assumed fixed. In practice, this relationship holds with a high degree of accuracy. Specifically, the U.S. consumer price for #2 Duluth feed barley is set equal to the PNW price for #2 feed barley minus $19.51 per metric tonne. This difference is computed as the 1986 to 1994 yearly average difference between the two prices and can be viewed as the approximate transportation cost from domestic producers in the United States to the PNW.

Row 4 of Table 5.1 shows the price linkage between the Canadian domestic feed barley price and the “world import price.” The feed barley price facing Canadian consumers is approximated as the August to July yearly average of monthly Winnipeg #1 feed price quotes in U.S. $/tonne. The “world import price” is approximated as the feed barley import price in EEP destination markets (see Section 5.2.1). The dependent variable in Row 4 of Table 5.1 is the difference between the average import price in EEP markets and the Canadian consumer price. The high t-value of -7.1 and the R^2 of 81 percent indicate that the EEP subsidy level plays a major role in determining the linkage between the Canadian feed barley price facing consumers and the "world feed barley price." As the average EEP bonus increases, the price facing importers in EEP destinations decreases, which causes the difference between the import price and the Canadian domestic price to decrease.

Row 5 of Table 5.1 shows a similar relationship between the domestic feed barley price facing Australian consumers and the price facing importers in EEP markets. However, the t-value of -1.5 on the EEP coefficient and the corresponding R^2 of only 15 percent indicates that this relationship is not as strong as in the Canadian case.

Row 6 of Table 5.1 shows the relationship among the U.S. domestic consumer feed barley price, the price received by U.S. farmers for feed barley, and the weighted average EEP bonus. The independent variable is equal to the July to June yearly average of the monthly average of price quotes for Duluth #2 feed barley, minus the July to June yearly average of the monthly U.S. average feed barley price received by farmers at U.S. elevators. This difference is affected by the July to June yearly weighted average EEP subsidy as indicated by the t-value of 4.4 on the EEP coefficient and the R^2 of 59 percent. This relationship suggests that farmers do not receive the full benefit of the EEP subsidy provided by the government. Hence, U.S. grain traders may benefit in at least two ways from EEP subsidies. First, it allows them to increase their volume of sales by dropping the effective price in the export market, which in turn increases their total profits. Second, the evidence suggests that the full benefit of the EEP subsidy does not pass through to U.S. barley producers. U.S. grain traders retain a portion of the EEP subsidy which adds to their total revenue.

Feed Revenue and Transportation Costs

In the United States, the price received by farmers for feed barley is directly linked to the domestic consumer price, which is directly linked to the PNW price, which is directly linked to the import price in EEP markets. Hence, total revenue received by U.S. farmers for feed barley sales can be computed as the average price received by U.S. farmers (linked to the EEP market price through the relationships described in Section 5.2), multiplied by the quantity sold by U.S. farmers, plus total deficiency payments. The total deficiency payment is calculated as the difference between the target price and the domestic price multiplied by the volume of sales.

In Canada and Australia, the pooled prices received by producers for feed barley are not rigidly linked to the domestic price as they are in the United States because Canada and Australia sell into other markets besides the domestic market and the EEP market. The revenue from each of these markets depends on the quantity sold to each market, the different prices received in each market, and the difference in transportation costs to each market. Once the total revenue received for feed barley in all markets is calculated, the average pooled feed barley price received by farmers in Canada and Australia equals the total feed revenue from all markets, divided by the total quantity of feed barley sold to all markets.

In Australia, total revenue is determined by adding up the revenue from the domestic market, the EEP market, and the non-EEP market. The average transportation cost from Australian domestic markets to the EEP market is assumed to be $23.00 per metric tonne which is the approximate average transportation cost from Sydney to Saudi Arabia. The average transportation cost from Australia to non-EEP markets is assumed to be $30.75 per tonne which is the approximate average transportation cost form Sydney to Japan. Both of these transportation costs were computed as the average of costs in early January from 1992 to 1994 provided upon personal consultation with the Canadian Wheat Board.

The total revenue received by Canadian farmers is equal to the revenue from sales into the domestic market, the EEP market, the non-EEP market, and the U.S. market. The cost of transportation from Vancouver equals $16.35 per tonne for sales to EEP markets (Saudi Arabia), and $30.75 per tonne for non-EEP markets (Japan). The average transportation cost for Canadian producers to Vancouver equals $26.86 per tonne which equals the (1991 to 1993) average rail rate from Regina, Saskatchewan (located near the middle of the Canadian grain growing region) to Vancouver. However, producers pay only a portion of that cost due to the WGTA subsidy. The subsidy covered approximately 62 percent of the rail costs from Regina to Vancouver over the 1991 through 1993 period. Hence, only 38 percent of the rail freight to port is subtracted from the revenue calculation for sales to offshore EEP and non-EEP markets. Transportation costs from Regina to Vancouver are approximated as the average of costs provided upon personal consultation with the Canadian Wheat Board.

Transportation costs from Canada to the United States are difficult to approximate but must be used in revenue calculations for Canadian producers into U.S. markets. This model approximates these costs by using trucking cost information provided upon informal consultation with independent grain truckers in south-central Saskatchewan. Specifically, it is assumed that Canadian truckers charge $3.00 Canadian per mile for a "legal" truckload of barley that contains roughly 1,100 bushels with no back-hauling and that the average distance covered is 200 miles.[43] When that distance is multiplied by the mileage rate and converted into U.S. dollars, the average transportation cost from Canada to the United States becomes $17.92 per metric tonne.

In the EU-15, total revenue is calculated as the total sales of all feed barley multiplied by the producer price target level which is fixed because of export restitution payments. The implied level of restitution payments can be calculated given the EEP and non-EEP import prices as well as the transportation costs to those two markets. The cost of transportation from EU-15 to EEP markets is assumed to be equal to $13.83 per tonne which is calculated as the average cost from the French Rouen port to Saudi Arabia. Hence, the EU-15 has a $3 per tonne transportation advantage over the United States and Canada and a $9 per tonne advantage over Australia with respect to EEP markets. The cost of transportation from EU-15 to non-EEP markets is set at $28.50 which equals the approximate transportation cost from the EU-15 to Libya. Note that Libya is the main non-EEP destination for EU-15 feed barley. The EU-15 does not compete with the other countries in the Japanese market.

SIMULATION RESULTS

[43] For example, the distance from Regina, Saskatchewan, to Crosby, North Dakota, through the border crossing at Portal is roughly 200 miles.

This section provides results of the econometric simulation model described in Sections 4 and 5. First, a base case scenario is established. The base case provides a benchmark from which subsequent changes in policy variables can be measured. Once the base case is established, several scenarios which represent different policy alternatives are developed to determine the economic impacts of various policy options on international barley markets.

Base Scenario (1991 to 1993)

Table 6.1 shows the values assigned to the variables that are exogenous to the econometric simulation model in the base case. In the base case, most of the values are set at their 1991 to 1993 average levels with the exception of beginning stock levels. Beginning feed stock levels for the United States, Canada, and EU-15 are set equal to their respective 1988 to 1990 3-year average of ending stock levels. The beginning and ending stock levels in Australia are both set to 0 tonnes since Australian stock adjustments are assumed to be negligible.

Table 6.2 depicts the production, consumption, and trade of feed and malting barley resulting from the base simulation. The top portion of Table 6.2 shows the resulting area planted to each type of barley as well as the resulting selection rates. The second portion of Table 6.2 shows the production, consumption, imports, and exports of malting barley. Malting barley production is determined by the 2-row and 6-row area planted and the selection rate. Malting barley consumption is determined by the exogenous time parameter which is the first entry from Table 6.1 and equals 1992 for the base period. In Canada, Australia, and EU-15, malting barley exports equal the difference between production and consumption. In the United States, malting barley exports are set at their 1991 to 1993 average level of 44,000 metric tonnes. The U.S. malting barley import level is set at the difference between consumption plus exports and production. It is assumed that 100 percent of U.S. malting barley imports originate in Canada.

The next portion of Table 6.2 shows the results of the feed barley simulation. The stock adjustment is determined by the exogenous beginning stock level and the endogenous domestic price. Under the domestic feed price level resulting from the base assumptions, the United States carries over 619,000 metric tonnes of feed barley stocks while Canada takes 192,000 tonnes out of stocks and the EU-15 carries over 2.1 million tonnes. U.S. feed imports are determined by the model. Under the base case, a voluntary export restraint is placed on Canadian exports of feed barley to calibrate the model. Canadian exports of feed barley to the United States are constrained so that they do not exceed the 3-year average level of 509,000 tonnes. Total feed exports are calculated as feed production minus consumption plus imports.

Domestic feed consumption in each country is determined by the equilibrium domestic price generated by the model. The elasticity of feed barley demand with respect to the domestic feed barley price can be calculated for each exporting country given the consumption level generated by the base model and the coefficients estimated in Section 4. These parameters are: -1.43 for the United States, -0.53 for Canada, -0.86 for Australia, and -1.32 for the European Union. Hence, all things being equal, a 1 percent increase in the consumption level in the

tbl 6.1

tbl 6.2

United States or EU-15 implies a more 1 one percent decrease in those two country's domestic prices while a 1 percent increase in the consumption level in Canada and Australia implies a less than 1 percent decrease in those two countries' domestic prices. The main reason for these differences is that feed barley is the major feed grain in both Canada and Australia, hence their consumers (e.g. livestock producers) can not substitute away from feed barley as readily as United States and EU-15 consumers.

The fourth portion of Table 6.2 shows the relative feed barley exports that are allocated to the EEP and non-EEP destination markets. U.S. feed barley exports to non-EEP countries are set at the 1991 to 1993 3-year average of 61,000 metric tonnes. This quantity is virtually negligible. EU-15 feed exports to non-EEP countries are determined by the exogenous time parameter and its coefficient determined in Section 4 (Table 4.4). The residual is dumped into the EEP market. The model establishes an equilibrium level of feed barley exports from Canada and Australia to both EEP and non-EEP markets, an equilibrium level of feed exports from Canada into the United States, and an equilibrium level of feed exports from the United States into EEP markets. The equilibrium feed export levels under the base scenario are shown in the fourth portion of Table 6.2.

The fifth portion of Table 6.2 shows the resulting equilibrium prices under the base scenario. The first three rows show the equilibrium price faced by EEP and non-EEP importers as well as the average EU-15 export restitution level that is implied by the exogenous targeted producer price (third row, fourth column of Table 6.1). The import demand elasticities under the base assumptions can be computed given the equilibrium EEP and non-EEP market prices, their respective equilibrium quantities, and their associated coefficients from Table 5.1. Under the base assumptions, the demand elasticity for the excess demand equation in EEP markets is -0.46, and the demand elasticity for the excess import demand equation in non-EEP markets is -1.01. The average EU-15 restitution payment for barley under the base assumptions is $88.35 per tonne. The average per-unit restitution payment by the EU-15 is more than double the average U.S. per unit EEP subsidy of $39.52 per tonne, and more the five times as high as the average per unit subsidy under the Canadian WGTA of $16.65 per tonne.

The bottom portion of Table 6.2 gives the results of the economic welfare analysis with respect to producers, taxpayers, and consumers. The implied U.S. export subsidy equals the per-unit EEP bonus multiplied by the total feed exports to EEP destinations. The implied Canadian export subsidy equals the government portion of the shipping cost to port multiplied by the level of off-shore exports of both feed and malting barley. The implied EU-15 export subsidy equals the difference between the weighted average of exports to EEP and non-EEP destinations multiplied by the difference between the domestic price (established by the target producer price level) and the price received for feed barley shipped into the EEP and non-EEP destinations net of transportation costs.

U.S. producers receive two additional subsidies from the government. They receive additional payments on short-term set-asides, and CRP payments on the barley program area set-aside for conservation purposes. The aggregate CRP payment is calculated as the CRP set-aside level (1.13 million tonnes under base assumptions) multiplied by the average rental rate of $50 per acre (converted to metric tonnes). Total deficiency payments received by farmers under the U.S.

barley program are comprised of two parts. The first part equals the program participation rate (75 percent in the base model) times the total feed and malting barley production level determined by the model, multiplied by the difference between the target price and the domestic price. The second part equals 85 percent of the difference between the target price and the domestic price multiplied by the 0/85 set-aside area times yield.[44]

Total farm revenue for Canada, Australia, and the EU-15 is estimated as the sum of the feed and malting barley revenue from each market (net of transportation costs). Aggregate CRP and barley program deficiency payments are added to the market revenue in the United States. Export subsidies are not added because they are already taken into account when determining revenue from both the feed and malting barley markets. Absolute consumer and domestic welfare measures are given in the bottom two rows of Table 6.2. These measures are examined under the forthcoming alternative scenarios, as relative measures are more important than absolute measures for analysis purposes.

SCENARIO 1: AVERAGE EEP SUBSIDY EQUALS 0

Perhaps the most interesting policy variable to consider in international grain markets is the average per unit level of EEP subsidy received for feed barley by U.S. grain exporters. Since the inception of EEP in 1986, no other U.S. export crop has been covered by a higher percentage of exports under the Export Enhancement Program than feed barley. Scenario 1 examines the economic impacts of a decrease in the average EEP subsidy level on feed barley exports from $39.52 per tonne under the base case to $0 per tonne. The results of this analysis can be used to determine the situation that would have existed in international barley markets had the Export Enhancement Program not been in place. The following analysis assumes that all other exogenous variables remain the same as under the base scenario. Table 6.3 shows the economic impact on production, consumption, and trade for feed and malting barley that result from no EEP subsidy, all else remaining the same as under the base case. These impacts are measured as deviations from the base case (Table 6.2). Hence, a positive (negative) value indicates an increase (decrease) over the base case.

The third and fourth portions of Table 6.3 shows the impact of no EEP subsidy on feed exports. In the United States, no EEP subsidy would cause feed barley exports to drop to 0 tonnes and would increase carry-over stocks by 1 million tonnes. As a result, Canadian feed barley exports to the United States would drop to 182,000 metric tonnes because with the EEP subsidy gone, Canada has little incentive to export feed barley to the United States. In practice, the United States was a net importer of barley in 1993. In that year, the United States exported 1.2 million tonnes of feed barley, but imported roughly the same amount from Canada. This indicates that EEP increases export volumes at the expense of higher import levels. Canada and Australia reallocate exports to fulfill the feed barley import requirement in EEP markets. Under

[44] This method of deficiency payment calculation implicitly assumes that the mandatory area set-aside requirement for barley is 0 percent, so that all acreage set-asides fall under the 0/85 portion of the 1990 Farm Bill. In practice, the mandatory area set-aside requirement for barley was dropped to zero in 1993.

tbl 6.3

the simulation model, Australia takes a portion of its feed exports away from the non-EEP markets in favor of the EEP market once the EEP subsidy is eliminated. Canada reallocates some of the feed exports that had gone to the United States towards both the EEP and non-EEP markets. This reallocation of exports coupled with no EEP bonus causes the import price of feed barley in EEP markets to rise by $26.65 per tonne and the import price in non-EEP markets to rise by $9.95 per tonne (Table 6.3). The changes in equilibrium feed barley trade flows under the no EEP bonus scenario have a major impact on domestic prices and aggregate farm revenue.

The fifth portion of Table 6.3 shows the impacts of no EEP subsidy on equilibrium prices. Notice that the U.S. consumer price for feed barley drops by $12.88 per tonne when the average EEP subsidy is reduced from $39.52 per tonne to $0 per tonne. These values indicate that a $1 per tonne increase in the EEP subsidy causes U.S. consumer prices for feed barley to rise by 33 cents per tonne. Scenario 1 also shows the effects of no EEP bonus on prices received by farmers. The average farm price received by U.S. farmers for feed barley increases by $2.72 per tonne under Scenario 1, but the aggregate market revenue received by farmers for feed barley decreases by $74 million. This is due to the more than 1 million additional tonnes of feed barley that are held in stock reserves over the base model for which farmers are not receiving revenue.

The bottom portion of Table 6.3 shows the aggregate economic impacts on the four major barley exporting regions in terms of farm revenue, government treasury costs, and consumer surplus. Table 6.3 shows that while eliminating EEP saves the U.S. government $93 million in export subsidies, it increases deficiency payments on barley program area by $135 million, assuming all other things (including target prices) remain the same as under the base scenario. Aggregate farm malting revenue increases slightly by $8 million due to the slightly higher farm feed price. The aggregate net revenue accruing to U.S. barley farmers increases by $69 million because the increase in deficiency payments outweighs the loss in market revenue. However, total U.S. government payments of export subsidies and deficiency payments increase by $42 million. U.S. consumer feed surplus increases by $81 million under no EEP bonus due to the decrease in the domestic feed price. Net U.S. economic welfare, which equals total farm revenue minus deficiency payments plus consumer surplus, rises by $100 million under no EEP subsidy. This increase in U.S. domestic welfare under no EEP subsidies does not take into account the effects of the 1 million tonnes of additional carry-over feed barley stocks that do not get sold in the market place.

Scenario 1, under which the U.S. EEP subsidy is reduced to $0 per tonne, has favorable economic implications for Canada, Australia, and the European Union. The feed price received by Canadian and Australian farmers increases by $6.31 and $10.87 per tonne, respectively. This increases aggregate farm revenue for Canadian and Australian farmers by $75 million and $39 million, respectively. Total payments for barley deliveries under the Canadian WGTA subsidy program increase by $7 million due to the reallocation of exports away from U.S. markets towards overseas destinations. The EU-15 treasury reaps the majority of the benefits from no EEP subsidies because import prices in the rest of the world increase. Average aggregate restitution payments in the EU-15 are reduced by $173 million under no EEP subsidies which translates into a decrease of $23.64 per tonne in the average implied EU-15 restitution price level.

SCENARIO 2: UNCONSTRAINED U.S. IMPORTS

This scenario considers the economic impacts of unconstrained Canadian feed barley exports to the United States under the assumptions that the CWB maximizes producers revenue and that budgetary pressures in the United States do not cause the United States to modify existing agricultural policies in response. Table 6.4 shows the results of unconstrained U.S. imports when compared to the base scenario, all else being equal.

Under these assumptions, U.S. imports of feed barley from Canada would increase to 2.2 million metric tonnes. U.S. exports of feed barley to EEP destinations would increase to 4 million metric tonnes. Canadian feed barley exports to EEP markets would drop to 0 tonnes as all feed exports previously targeted for EEP markets, and a portion of feed barley exports previously targeted for non-EEP markets, would be reallocated to the U.S. market. Australia would reallocate some feed exports from EEP markets into non-EEP markets. Aggregate Canadian feed barley exports would actually decrease by 30,000 metric tonnes under such a strategy.

Extreme caution should be exercised when interpreting these results for policy purposes. Remember, this outcome would hold only if the United States did not modify its agricultural policies in response to the aggressive exporting strategy of the CWB. To understand the importance of a possible dynamic U.S. policy response to this scenario, consider the 1.7 million metric tonne increase in U.S. exports to EEP markets. Such high levels of U.S. exports could be maintained only if the average per-unit EEP subsidy remained at the base level of $39.52 per tonne. If the per-unit subsidy level decreased even slightly, the price received by U.S. grain traders in EEP markets would drop. This would cause the feed barley price facing U.S. domestic consumers to drop and would make the U.S. market less attractive to the CWB. In view of the possibility of this type of policy reaction, the optimal decision rule by the CWB would be to export less feed barley to the United States than generated in Scenario 2.

It seems highly likely that budgetary pressures in the U.S. Congress would force the United States to react to such an aggressive export strategy by the CWB because the total budgetary allocation under the feed barley portion of EEP would have to increase by $67 million to maintain the 4 million tonnes of feed barley exports to EEP markets generated by Scenario 2. That represents over a 70 percent increase in the U.S. budgetary outlay for feed barley under EEP. Such a high aggregate subsidy would cause U.S. grain traders to reallocate significant quantities of feed barley from the U.S. domestic market into EEP markets. Increased exports of Canadian feed barley would satisfy most of the additional demand requirements of U.S. consumers. In essence, the CWB would increase its U.S. feed barley exports at roughly the same rate that U.S. grain traders would increase exports into EEP markets. Because of this, it is likely that if U.S. imports of Canadian feed barley reached anywhere near the level generated by Scenario 2, the U.S. government would react in at least one of several different ways. It would most certainly decrease per-unit feed barley export subsidies substantially to maintain a ceiling t 6.4

on its total budgetary outlay for feed barley EEP subsidies. It may also impose an import quota and/or prohibitive tariff on Canadian feed barley exports.

The premise for this type of policy response has already been established. In 1994, concerns over high volumes of durum wheat imports from Canada caused various U.S. commodity groups, farmers, and the wheat commissions of certain Northern Plains states to put pressure on U.S. policy makers to limit Canadian grain imports. This triggered hearings by the U.S. International Trade Commission which eventually led to an agreement between the U.S. and Canadian governments. The agreement essentially placed a "voluntary" limit of 450,000 tonnes on Canadian durum wheat exports through a two-tiered tariff-rated quota schedule. The "voluntary" agreement was put into place on August 1, 1994, but was removed September 11, 1995.[45]

Perhaps to put these results in perspective, the aggressive feed barley export strategy by the CWB generated by Scenario 2 would increase the average feed barley price received by Canadian farmers by only $1.81 per metric tonne (4 cents per bushel). One might question the wisdom of obtaining a 4 cent per bushel increase in feed barley prices at the expense of heightening trade tensions with the United States. Moreover, the CWB has substantially increased feed barley exports into the United States since 1992. Referring to Table 6.2, Canadian feed barley exports to the United States are constrained at the 3-year average (1991-1993) of 509,000 tonnes in the base scenario. However, further examination of the period after 1992 reveals that the 3-year average (1993-1995) of Canadian feed barley exports to the United States is more than double the 1991-1993 average. Hence, the CWB has expanded feed barley exports to the United States in recent years. This behavior is consistent with the revenue maximizing position of the CWB generated by Scenario 2 of the model.

SCENARIO 3: NO WGTA SUBSIDY OR U.S. IMPORT CONSTRAINT

This scenario examines a case similar to Scenario 2 except that the Crow payment subsidy under the Western Grain Transportation Act is eliminated and U.S. imports are unconstrained. The same precautionary statements with reference to policy application and interpretation apply here at least as strongly as they did under Scenario 2. Table 6.5 shows the simulation results under these assumptions. It is perhaps more appropriate to compare the results under Scenario 3 with those under Scenario 2. The elimination of the WGTA (all other assumptions being equal to those under Scenario 2) increases unconstrained Canadian feed barley exports to the United States by 288,000 tonnes to 2.5 million tonnes which, in turn, increases U.S. exports to EEP markets by 213,000 tonnes and increases U.S. export subsidies by an additional $9 million over the level obtained in Scenario 2. Hence, under current U.S. per-unit EEP subsidy levels, current U.S. set-aside requirements, and unrestricted access to the U.S. market, the elimination of the WGTA subsidy would result in an increase of 288,000 tonnes in imports of U.S. feed barley from Canada. Hence, the elimination of the export subsidy implied by the Canadian WGTA would not further the interests of U.S. farmers even though many U.S.

[45] See Duncan and Koo (1995).

tbl 6.5

commodity groups argued for the elimination of the WGTA subsidy during GATT and NAFTA negotiations. In practice, this subsidy was terminated in 1995. Individual Canadian farmers will directly receive the last two payments of the WGTA subsidy for the 1995/96 and 1996/97 crops. The amount of the subsidy will be determined by total area, area average yields, and distance to market. The Western Grain Transportation Act will cease to exist in any form after the 1996/97 crop.

SCENARIO 4: SHORT-TERM U.S. SET-ASIDES ARE ELIMINATED

Scenario 4 analyzes the impact of the elimination of short term set-asides under acreage reduction programs in the United States. All short-term set-aside programs are eliminated so that the deficiency payments provided on the 955,000 hectares of enrolled program barley area under the base scenario are removed. The long-term Conservation Reserve Program is preserved and all other assumptions under the base scenario are maintained, including the WGTA subsidy and the voluntary restraint on Canadian feed barley exports to the United States. In this scenario, it is assumed that 100 percent of the land set-aside under the barley program goes back into barley production, but that the yield on that land is only 80 percent of the current yield, reflecting the fact that typically marginal land is set-aside under acreage reduction programs. In addition, it is assumed that the malting selection rate on the new land is only 33 percent as opposed to the 63 percent selection rate under the base scenario. These assumptions imply that the average aggregate yield under Scenario 4 equals 2.78 tonnes per hectare and that the malting selection rate out of the aggregate crop falls to 57 percent. The results of this model can be used as a guideline to determine the economic impact of a return of roughly one-half of the total short-term and long-term set-asides in the United States to barley production.

Table 6.6 shows the deviation of the results of the econometric simulation model from the base scenario. The 955,000 increase in total barley area causes malting barley production to increase by 275,000 tonnes, thereby reducing the requirements for malting barley imports from Canada to 184,000 tonnes. It also results in an increase in U.S. feed barley production of 1.9 million tonnes--404,000 tonnes of which is added to carry-over reserves. U.S. exports to EEP markets increase by 1.1 million tonnes, displacing Canadian feed barley exports by 675,000 tonnes and Australian feed barley exports by 207,000 tonnes. The increased feed production lowers domestic prices in each exporting country by $5.02 per tonne, and there are similar reductions in prices received by farmers in the United States, Canada, and Australia. The European Union is forced to increase the average restitution payment by $4.61 per metric tonne at an additional cost of $34 million. Aggregate Canadian farm revenue drops by $71 million, and Australian farm revenue drops by $20 million. The revenue realized by U.S. producers from the feed and malting barley markets increases by $120 million due to the huge increase in production caused by eliminating set-aside requirements. However, the $135 million deficiency payment previously received by U.S. barley producers is eliminated because there is no longer a set-aside program. Hence, aggregate farm revenue accruing to U.S. farmers actually decreases by $14 million. The net domestic welfare of the United States increases by $77 million over the base scenario due to cheaper consumer prices and lower aggregate government payments.

tbl 6.6

SCENARIO 5: NORTH AMERICAN TRADE LIBERALIZATION

Scenario 5 examines the economic implications of North American trade liberalization in barley over the base scenario. Specifically, it is assumed that the Canadian WGTA subsidy is eliminated, the U.S. EEP subsidy is reduced to $0 per tonne, and the U.S. feed import constraint is eliminated. Table 6.7 gives the results of the estimated economic effects resulting from the simulation model under these assumptions compared to those under the base scenario.

North American trade liberalization causes U.S. exports of feed barley to EEP markets to fall to 0 tonnes and U.S. feed barley carry-over stocks to increase by 1.1 million metric tonnes. In addition, Canadian exports of feed barley to the United States are reduced to only 241,000 metric tonnes. Both Canada and Australia reallocate feed exports from non-EEP markets to EEP markets due to the increase in the relative import prices between EEP and non-EEP markets caused by the removal of EEP. The price facing consumers for feed barley imports in EEP destinations increases by $26.27 per tonne while the price facing importers in non-EEP destinations increases by only $13.95 per tonne. Canadian feed exports increase by 65,000 tonnes while Australian feed exports increase by 173,000 tonnes. Aggregate U.S. export subsidy payments are reduced by their full amount of $93 million, but deficiency payments are increased in the face of lower U.S. domestic prices. Revenue received by U.S. farmers from the feed and malting barley markets decreases by $143 million but increased deficiency payments of $140 million offset most of this loss in revenue. The total aggregate revenue received by U.S farmers falls by only $3 million. U.S. consumers gain $83 million in the form of consumer feed surplus caused by lower prices. Total government payments for export subsidies, CRP, and area set-asides increase by $45 million. Net domestic economic welfare in the United States increases by $51 million under North American trade liberalization when compared to the base scenario.

The aggregate revenue accruing to Canadian farmers increases by $13 million due to increased world prices caused by the reduction of EEP payments. Canadian government payments for the WGTA subsidy are eliminated which saves the Canadian government $58 million. Consumer surplus is only reduced by $4 million as Canadian domestic prices are barely affected. Net domestic economic welfare in Canada increases by $66 million under North American trade liberalization when compared to the base scenario. Australian farmers receive an increase of $63 million in farm revenues due to higher world prices and higher domestic prices. Australian consumer feed surplus falls by $11 million while consumer malting barley surplus is decreased by the full amount of the increase in Australian malting barley revenues received by farmers. Hence, Australian net domestic welfare increases by $30 million under North American trade liberalization when compared to the base scenario.

SCENARIO 6: PARTIAL WORLD POLICY LIBERALIZATION

This final scenario is used to estimate the economic impacts resulting from partial world policy liberalization in the spirit of GATT as well as the likely outcome of the 1995 U.S. farm bill debate. At the time of this writing, barley market conditions are not the same as they were

tbl 6.7

in the base years of 1991 to 1993 as short supplies caused by low stock levels and low yields have nearly doubled barley prices. Hence, this scenario must be viewed from the perspective of pre-existing market conditions during the base period. Specifically, it is assumed that the average per-unit EEP subsidy for feed barley in the United States is cut in half from $39.52 per tonne to $19.76 per tonne and that the implied average per-unit restitution payment of $88.35 per tonne in the EU-15 is reduced by the same amount ($19.76 per tonne), resulting in a decrease of 16.26 European Currency Units per tonne to 123.71 European Currency Units per tonne for the feed barley target price received by EU-15 producers. It is assumed that the Canadian WGTA subsidy is eliminated as well. In "Feed Grains: Background for 1995 Farm Legislation" by Lin et al. (1995), the authors indicate that CRP contract holders intended to return 63 percent of their acres to crop production. Using this as a guideline, it is assumed that U.S. short-term set-aside requirements are eliminated so there are no deficiency payments and that 63 percent of the barley program area is returned to barley production. In addition, it is assumed that the barley program area under long-term CRP contracts is reduced by 63 percent and that the remaining area is returned to barley production. This results in an additional 601,000 hectares of short-term set-asides returned to production from U.S. barley program area and 714,000 additional hectares of long-term CRP area returned to production. Similar to Scenario 4, the yield on the new area returned to production is set at 80 percent of current yield resulting in an aggregate yield of 2.75 tonnes per hectare and the malting selection rate of the new area is set at 33 percent, resulting in an aggregate selection rate of 55 percent. Finally, the voluntary restraint placed on Canadian feed barley exports to the United States under the base scenario is increased to its 1993 level of 1.2 million tonnes.

Table 6.8 shows the economic impacts of the partial world policy liberalization on international feed barley markets, compared to the base scenario. Under the expanded area, U.S. malting production increases by 379,000 tonnes reducing Canadian exports of malting barley into the United States to 81,000 tonnes. U.S. feed production increases by 2.7 million tonnes, 642,000 tonnes of which are added to carryover stocks. U.S. exports to EEP markets increase by 2.1 million tonnes, but the $19.76 EEP bonus coupled with the relaxed feed export restraint causes Canada to increase its feed exports to the United States by 737,000 metric tonnes. Canadian feed barley exports to EEP and non-EEP destinations drop and total Canadian feed barley exports drop. Australian feed exports to EEP markets increase by 148,000 tonnes while its feed exports to non-EEP destinations decrease by 98,000 tonnes. The drop in EU-15 restitution payments causes EU-15 feed barley exports to EEP markets to fall by 2.2 million.

The price for feed barley facing consumers in EEP markets increases by $11.79 per tonne over the base scenario while the feed barley price facing consumers in non-EEP markets increases by $7.92 per tonne. This causes a decrease in U.S. and Canadian feed prices, but an increase in Australian feed prices. U.S. producers gain $176 million in feed market revenue and $61 million in malting market revenue. However, the $135 million deficiency payment is eliminated and aggregate long-term CRP payments are reduced by $88 million. Thus, the total revenue accruing to U.S. farmers under the partial world policy liberalization assumptions increase net U.S. farm revenue by $15 million. There is a substantial savings of $227 million in government payments, the aggregate EEP subsidy is reduced by $4 million, and U.S. consumer

tbl 6.8

surplus is increased by $50 million. Aggregate net welfare in the United States increases by $230 million under the partial liberalization compared to the base scenario.

Canadian aggregate farm revenue falls by $37 million under the partial liberalization assumption due to displaced exports, lower domestic prices, and no WGTA subsidies. However, the Canadian government saves $58 million in transportation subsidies, and Canadian consumers benefit by $9 million due to lower feed prices resulting in an increase in net Canadian domestic welfare of $33 million over the base scenario.

Australian barley farmers gain $17 million in feed market revenues and $9 million in malting markets. Australian consumers lose $3 million in surplus resulting in an increase of $14 million in net domestic welfare over the base scenario. Market revenue accruing to EU-15 farmers falls by $501 million in feed markets and $177 million in malting markets due to the lower domestic price implied by lower restitution payments. However, EU-15 export restitution payments are reduced by $358 million, and consumers gain $580 million from the decrease in domestic feed prices. Hence, net domestic welfare in EU-15 increases by $438 million under the partial liberalization scenario when compared to the base scenario. The scenario does not include the possibility that under a "Freedom to Farm" type 1996 farm bill outcome, U.S. producers would receive extra revenue in the form of lump-sum subsidies. If these subsidies, and the possibility of higher barley prices, are added to the extra farm revenue of $15 million that would already accrue to U.S. farmers under partial world policy liberalization, U.S. barley producers would fare well.

CONCLUSIONS

This paper developed and implemented a theoretical model to determine the economic impact of changes in agricultural policies with respect to feed and malting barley from the perspective of the United States, Canada, Australia, and the European Union. Some conclusions of the analysis are:

- Under 1991 to 1993 market conditions, a reduction of average per-unit EEP subsidies provided to feed barley producers in the United States from $39.52 per metric tonne to $0 per tonne would decrease the U.S. consumer feed price by $12.88 per tonne, increase the import price of feed barley in EEP destination markets by $26.65 per tonne, and increase the import price of feed barley in non-EEP destination markets by $9.95 per tonne. This would cause the average feed barley price received by Canadian and Australian farmers to rise by $6.31 and $10.87 per tonne, respectively. In addition, Canadian feed barley exports to the United States would be reduced to 182,000 metric tonnes and the level of implied EU-15 restitution payments would be reduced by an average of $23.64 per tonne. The results of this analysis suggest that the Export Enhancement Program has the effect of raising U.S. domestic prices at the expense of Canadian, Australian, and EU-15 farmers while subsidizing feed barley importers in EEP destination markets.

- If the Canadian Wheat Board did not face the threat of retaliatory policy action by the United States caused by expanding barley imports, the CWB could reallocate a portion of its feed barley exports away from EEP markets and into the U.S. market so as to maximize the total revenue accruing to Canadian feed barley producers. Total Canadian exports of feed barley into the United States would increase to 2.2 million tonnes while its exports to EEP markets would drop by 1.6 million tonnes. At the same time, the U.S. would increase subsidized exports of feed barley to EEP destinations at roughly the same rate as Canadian imports. The result would be an additional 1.7 million tonnes of subsidized U.S. feed barley exports to EEP destination markets. Such an aggressive strategy by the Canadian Wheat Board would increase the average price received by Canadian farmers for feed barley by only 4 cents per bushel, but would cost the U.S. government $67 million in additional aggregate export subsidy payments. In practice, if Canadian feed barley exports to the United States came anywhere near this level, the U.S. would decrease the level of per-unit EEP subsidies dramatically, impose an import quota on Canadian barley exports, or impose a prohibitive tariff. The premise for this type of U.S. policy response was set in 1994, when U.S. durum wheat imports were effectively restricted through the imposition of a two-tiered tariff-rated quota. In addition, one might question the wisdom of a strategy that increased the average price received by Canadian feed barley producers by only 4 cents per bushel, at the expense of heightened trade tensions with the United States.

- Removing the Canadian Western Grains Transportation Act would increase the level of feed barley exports from Canada to the United States by 288,000 tonnes. This result is contrary to what many U.S. producer groups might expect.

- The elimination of short-term U.S. set-asides would increase U.S. domestic supply of both feed and malting barley dramatically. This would reduce Canadian malting barley exports to the United States by 275,000 tonnes and increase U.S. feed barley exports to EEP markets by 1.1 million tonnes. The additional excess supply of U.S. feed barley in EEP markets would displace 675,000 tonnes of Canadian feed barley exports from EEP markets and 207,000 tonnes of Australian feed barley exports from EEP markets. In addition, domestic prices in the United States, Canada, and Australia would drop by $5.02 per tonne causing aggregate Canadian farm revenue from both feed and malting barley sales to decrease by $71 million and aggregate Australian farm revenue from barley sales to decrease by $20 million.

- North American trade liberalization would occur if both the Canadian WGTA subsidy and the U.S. Export Enhancement Program in feed barley were eliminated. These two policy changes would cause the U.S. consumer feed price to fall by $13.25 per tonne, but would increase the average import price in EEP markets by $26.27 per tonne. Higher relative prices facing Canada and Australia in EEP markets would cause the two countries to reallocate a portion of feed barley exports away from non-EEP markets into EEP markets. This would increase the average import price in non-EEP markets by $13.95 per tonne under average 1991 to 1993 market conditions. Canadian feed barley exports to the United States would decrease by 268,000 metric tonnes and U.S. feed barley exports to EEP markets would drop to 0. However, U.S. farmers would lose only $3 million in aggregate revenue due to increased deficiency payments. Total revenue accruing to Canadian barley farmers would rise by $13 million and aggregate Australian revenue would rise by $63 million due to the $6.35 per tonne increase in the Australian domestic feed price. If one includes domestic consumers and government payments in the analysis, then the net economic welfare with respect to barley in the United States, Canada, Australia, and EU-15 would increase by $51 million, $66 million, $30 million, and $176 million, respectively. However, caution should be exercised when interpreting these results for the United States as its domestic carry-over stocks of feed barley would increase by almost 1.1 million tonnes under North American trade liberalization.

- The results of a partial world policy liberalization were estimated. These results can be used as a guide for analyzing the potential economic impacts of a "Freedom to Farm" type 1996 Farm Act under average 1991 to 1993 market conditions. Under this scenario, it is assumed that the average U.S. EEP bonus is reduced by one-half to $19.76, the EU-15 target price for domestic producers is dropped by the same amount, U.S. deficiency payments are eliminated and 63 percent of barley program short-term and long-term CRP set-asides are returned to barley production. The results indicate that even if U.S. barley farmers do not receive any lump-sum payments under the new Farm Bill, their aggregate revenue from feed and malting barley would still increase by $15 million under partial world policy liberalization while U.S. treasury costs to support the barley program would be reduced by $227 million and consumer feed surplus would increase by $50 million. Hence, net domestic welfare in the United States would increase by $230 million under a partial world policy liberalization. This outcome does not include the potential decoupled lump-sum payments that U.S. farmers may receive under the new farm program nor does it take into account the fact that at the time of this writing, average barley prices have increased significantly over their average 1991 to 1993 levels. Either of these additional conditions would push the net increase in farm revenue accruing to U.S. barley producers beyond the $15 million calculated in this report.

REFERENCES

Agriculture Canada (October, 1994). Transportation Policy Impacts on Grain Prices within Western Canada. Prepared by: Adaptation and Grain Policy Directorate, Policy Branch, Agriculture Canada. Ottawa, Ontario.

American Malting Barley Association, Inc. (1970-1994). Know Your Barley Varieties. Various issues. Milwaukee, Wisconsin.

Australian Barley Board (1980-1994). The Australian Barley Board Annual Report. Australian Barley Board annual publication. Various issues.

Australian Bureau of Statistics (1971-1981). Crops Australia. ABARE catalogue #7302.0. Various issues. Canberra, Australia.

Australian Bureau of Statistics (1982-1986). Crops and Pastures Australia. ABARE catalogue #7321.0. Various issues. Canberra, Australia.

Australian Bureau of Agricultural and Resource Economics (1986-1994). Commodity Statistical Bulletin. ABARE publication. Various issues. Canberra, Australia.

Brewing and Malting Barley Research Institute (1970-1994). Barley Briefs. Various issues. Winnipeg, Manitoba.

Brooks, Harvey G. (1993). “First, Let's Assume We Have a Can Opener: An Analysis of the Economics of a Single North American Barley Market.” *Canadian Journal of Agricultural Economics*. Vol. 41, 271-281.

Canada Grains Council (1970-1994). Canadian Grains Industry Statistical Handbook. Various issues. Winnipeg, Manitoba.

Canada-United States Joint Commission on Grains (June, 1995). Preliminary Report. Winnipeg, Manitoba.

Canadian Grain Commission (1972-1994). Canadian Grain Exports. Canadian Grain Commission Publication. Various issues.

Canadian Wheat Board (1972-1994). The Canadian Wheat Board Annual Report. Canadian Wheat Board Annual Publication. Various issues.

Canadian Wheat Board Corporate Policy Group (December, 1992). Performance of a Single Desk Marketing Organization in the North American Barley Market. Canadian Wheat Board Report. Winnipeg, Manitoba.

Carter, C. (March, 1993). "An Economic Analysis of a Single North American Barley Market." Report submitted to the Associate Deputy Minister, Grains and Oilseeds Branch, Agricultural Canada. University of California, Davis.

Co-Operative Bulk Handling Limited (1982-1992). Co-Operative Bulk Handling Limited Annual Report. Various issues. Australia.

Duncan, M. and W. Koo (1995). "The United States/Canada Durum Wheat War." *CHOICES*. First Quarter, 1995. pp. 29-34. Ames, Iowa.

Eurostat. (1979-1994). Agricultural Prices. A quarterly publication from Luxembourg.

Gauger, H.M. (1991-1994). Gauger Statistical Digest. Various issues. H.M. Gauger, Belgium.

Gerson, (1984-1990). Gerson Statstical Digest. Gerson, Belgium. (publication continued by H.M. Gauger in 1991). Various issues.

Gibney, S. and H. Furtan (1983). "Welfare Effects of New Crop Variety Licensing Regulations: The Case of Canadian Malt Barley." *American Journal of Agricultural Economics.* 41(1993):243-255.

Grain Handling Authority of New South Wales (1980-1988). Grain Handling Authority of New South Wales. Various issues. Sydney, Australia.

Grain Pool of Western Australia (1984-1993). Grain Pool of Western Australia Annual Report. Various issues. Australia.

Haley, S., P. Riley, K. Ackerman, and M. Smith (1992). "Evaluating Export Subsidy Programs: The Case of U.S. Barley." *Journal of International Food and Agribusiness Marketing,* Vol. 4(1), 1-29.

International Wheat Council (1990-1994). World Grain Statistics. An International Wheat Council Yearly Publication. Various issues. London, England.

Johnson, D. and B. Varghese (1993). "Estimating Regional Demand for Feed Barley: A linear Programming Approach." North Dakota State University Agricultural Economics Report No. 303. Fargo, North Dakota.

Johnson, D. and W. Wilson (1993). North American Barley Trade and Competition. North

Dakota State University Agricultural Economics Report No. 314. Fargo, North Dakota.

Johnson, D., W. Wilson, and M. Dierson (August, 1995). Quality Uncertainty and Grain Merchandising Risk: Vomitoxin in Spring Wheat. North Dakota State University Agricultural Economics Report No. 333. Fargo, North Dakota.

Josling, Tim and Stephan Tangermann (1995). "Tariffication in the Uruguay Round Agreement on Agriculture: Its significance for Europe," in World Agriculture in a Post-GATT Environment: New Rules, New Strategies. Richard Gray, Tilman Becker, and Andrew Schmitz editors, University of Saskatchewan Press. Saskatoon, Saskatchewan.

Lin, William, Peter Riley, and Sam Evans (April, 1995). Feed Grains: Background for 1995 Farm Legislation. USDA Economic Research Service Report, AER-714, 341 Victory Drive, Herndon, Virginia.

Livestock Feed Bureau (March, 1995). Weekly Market Price Comparison of Export Values. Compiled Facsimile Request, Canadian Economic Research Livestock Feed Bureau, Policy Branch, Quebec, Canada.

Malting Barley Improvement Association (1970-1985). Barley Variety Survey. Compiled by the United States Department of Agriculture - Statistical Reporting Service. Various issues. Milwaukee, Wisconsin.

McGarry, Michael J. and A. Schmitz (1992). The World Grain Trade: Marketing, Institutions, and Policy. Westview Press. Boulder, Colorado.

New South Wales Grains Board (1993). New South Wales Grains Board Annual Report. Sydney, Australia.

North Dakota Barley Council (April, 1995). United States Barley Statistics. Prepared by the North Dakota Barley Council. Fargo, North Dakota.

Schmitz, A., R. Gray, and A. Ulrich. (April, 1993). "A Continental Barley Market: Where are the Gains?." Agricultural Economics Department, University of Saskatchewan. Saskatoon, Saskatchewan.

Schmitz, A., H. DeGorter, and T.G. Schmitz (1996). "Consequences of Tariffication" in Regulation and Protectionism under GATT: Case Studies in North American Agriculture. Edited by Andy Schmitz, Garth Coffin, and Ken Rosaasen. Westview Press. Boulder, Colorado.

Schmitz, T.G. (1995). "The Economic Effects of GATT on Supply Management in Canadian Agriculture: Spatial Models of the Canadian Broiler Industry." A dissertation completed for partial fulfillment of the requirements for the Ph.D. degree in Agricultural and Resource Economics at the University of California, Berkeley.

Statistics Canada (1972-1994). Grain Trade of Canada. Statistics Canada Catalogue No. 22-201 Annual. Various issues. Ottawa, Ontario.

USDA-NASS (1979-1994). Agricultural Prices Summary. Various issues. Washington, DC.

USDA-NASS-ED-ESB-CPS (September, 1995). Monthly Cash Barley Prices Received by Montana Farmers. Compiled Statistics, Washington, DC.

USDA-North Dakota Agricultural Statistics Service (September, 1995). Monthly Barley Prices Received by Farmers, North Dakota: Official Estimates. Compiled Statistics, Fargo, North Dakota.

USDA (October, 1995). PS&D View Agricultural Data Viewer, United States Department of Agriculture. Washington, DC.

Veeman, Michele (1993). "A Comment on the Continental Barley Market Debate." *Canadian Journal of Agricultural Economics.* Vol. 41, 283-287.

Wilson, William W. (May, 1983). "Barley Production and Marketing in the United States." North Dakota State University Agricultural Economics Miscellaneous Report No. 66. Fargo, North Dakota.

Wilson, William W. and D. Demcey Johnson (October, 1995). "North American Malting Barley Trade: Impacts of Differences in Quality and Marketing Costs." North Dakota State University Agricultural Economics Report No. 335. Fargo, North Dakota.