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NORTH AMERICAN BARLEY TRADE AND COMPETITION

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Highlights

Barley production in the United States is concentrated in the northern plains states, contiguous to the principle growing regions in Canada. Both regions are surplus producers and therefore potential competitors. Traditionally, barley trade between the U.S. and Canada was negligible. However, recent changes in the policy, institutional and competitive environment have led to increased trade and a rise in trade tensions.

From a policy perspective, the North American barley market presents some interesting contradictions. In the United States, barley supplies have been managed through acreage controls, while exports have been subsidized through the Export Enhancement Program. These policies are intended, in part, to support market prices and reduce the costs to taxpayers of deficiency payments. However, higher U.S. prices and lower prices in subsidized offshore markets have encouraged the influx of Canadian grain, particularly in the more open trading environment that has emerged under the Canadian-U.S. Free Trade Agreement.

Canada's agricultural policies and grain marketing institutions differ drastically from those of the United States. The Canadian Wheat Board (CWB) holds a monopoly on barley procurement for uses other than domestic feed. As a single-seller agency, the CWB can target markets through discriminatory pricing. Canada does not have explicit acreage controls. The government provides an important indirect subsidy to producers through Western Grain Transportation Act (WGTA): rail movements to Vancouver and Thunder Bay are subsidized by the government, reducing the cost of barley shipments to offshore markets and the eastern United States. Grain handling costs are high relative to those in the United States. This creates an incentive to circumvent the Canadian handling system through cross-border truck shipments to U.S. elevators.

Opportunities for North American barley trade have inspired much debate in Canada. Recent studies have reached sharply different conclusions about whether the CWB has been under-selling barley into the U.S. market. A major liberalization of barley marketing was implemented in August, 1993. The move toward a "Continental Barley Market" allowed Canadian producers or traders to sell directly to U.S. buyers, bypassing the CWB. This was reversed through a September court decision after substantial volumes of Canadian barley had been contracted for sale to U.S. buyers.

In addressing the effects of policy changes, numerous complexities have to be recognized. First, the North American barley market is comprised of many distinct regional markets. Prices are connected spatially through transport and handling costs, but also reflect impacts of trade policies (i.e., U.S. tariffs and export subsidies, and Canadian export permits). Second, quality factors are an important determinant of regional flows, especially where malting barley is concerned. Third, there is little published information on the demand for feed barley at state or province level. Feed demand ultimately depends on the size and composition of livestock herds and on the prices of substitute feedstuffs, which vary by region.

This results presented in this paper are based on a detailed, spatial equilibrium model of the North American barley market. Results of several policy simulations are reported. The base case corresponds to a freer trade regime in Canada, as advocated under the Continental Barley Market proposal. Other simulations show effects of U.S. import *restrictions; removal of Canadian rail subsidies; different EEP subsidy levels; supply conditions; and retention of CWB control over Canadian barley sales. Following are some of the major results:*

- *Canada has considerable potential for exporting barley to the United States. Under conditions of liberalized barley marketing in Canada--the Continental Barley Market proposal--Canadian exports to the U.S. could reach 3.5 million metric tons. In base-case simulations, Canada captures 43% of the U.S. feed barley market, and 24% of the U.S. malting barley market.*

- *Using authority under Section 22 of the Agricultural Adjustment Act, the United States could restrict barley imports through quotas or tariffs. If Canadian barley were excluded from the U.S. market, U.S. producer prices would be 8 cents/bu higher than in the base case. Canadian producer prices would be 20 cents/bu lower. A U.S. tariff of approximately $25 per metric ton ($.54/bu) would be required to completely curtail barley imports from Canada.*

- *Elimination of Canadian rail subsidies (i.e., for movements to Vancouver and Thunder Bay) would not benefit U.S. producers. To the contrary, simulations suggest that compensatory rail rates (with Canadian shippers paying the full cost of rail movements) would induce a larger flow of Canadian barley into the U.S. market.*

- *The U.S. Export Enhancement Program has an important impact on North American barley flows and producer welfare. As the EEP bonus is increased, U.S. domestic prices rise relative to offshore markets. This accentuates pressure for Canada to export barley to the United States. When Canada's access to the U.S. market is constrained through trade restrictions, high EEP bonus levels have a significant, negative impact on Canadian producer revenue.*

- *In recent years, U.S. barley acres have been reduced through the Conservation Reserve Program. Simulation results suggest that the return of CRP acres to barley production would lower producer prices in both the United States and Canada while reducing the volume of U.S. barley imports by 7 percent.*

- *In Canada, regulations on variety release have limited the production of 6-rowed, white aleurone malting barley, the type preferred by most U.S. brewers. Simulations indicate that if 25% of Canada's malting barley acreage were shifted into 6-rowed white varieties, Canada could capture up to 38 percent of the U.S. malting barley market.*

- *The role of the Canadian Wheat Board has major implications. Model simulations were used to evaluate the CWB's allocation of barley sales between North American and offshore markets. Because of demand relationships embedded in the model, results indicate that the CWB's optimal strategy is to expand sales to the United States beyond levels projected in the base case. This gives credence to the view that the CWB has been underselling barley into the U.S. market, possibly because of the political sensitivity of these trade flows.*

NORTH AMERICAN BARLEY TRADE AND COMPETITION

By Drs. D. Demcey Johnson and William W. Wilson*

Introduction

Barley is the third leading cereal crop grown in the world and the United States and the second most important crop (by volume) grown in the Canadian prairies. Barley production in the United States is concentrated in the northern plains states, contiguous to the principal growing regions in Canada. Both regions are surplus producers and, therefore, potential competitors. Traditionally, barley trade between these two countries has been negligible. However, recent changes in the policy; institutional and competitive environment have resulted in increased trade and a rise in trade tensions. Institutional and policy factors appear to hold potential for further, drastic changes in competitive relationships and spatial flows.

The study analyzes effects of selected trade and marketing policies on barley trade flows, prices and price differentials, and economic welfare. These include impacts of free trade in North American barley, potential trade restrictions, and the U.S. Export Enhancement Program (EEP). In addition, impacts of selected marketing policies are analyzed. There are important policy tradeoffs for the United States, such as whether the U.S. should pursue a policy of increasing exports via EEP or of protecting its domestic market. Canada confronts equally difficult issues, including whether to divest the Canadian Wheat Board (CWB) of its monopoly over U.S. sales.

In addressing these questions, numerous complexities have to be recognized. First, the North American barley market is comprised of many distinct regional markets. Prices are connected spatially through transport and handling costs, but also reflect trade policies, such as tariffs, import licenses, and export permits. Second, quality factors are an important determinant of regional flows, especially where malting barley and malt are concerned. Third, there is little published information on the demand for feed barley at state or province level is small. Feed demand ultimately depends on the size and composition of livestock herds and on the availability and prices of substitute feedstuffs; these vary drastically by region.

The centerpiece of our analysis is a spatial equilibrium model based on mathematical programming. The model combines regional and industry detail and provides a comprehensive basis for studying the impacts of trade and agricultural policies, transportation rates, and supply conditions. Through model simulations, we gauge the effects of critical parameters on trade flows, market shares, and producer prices.

Both traditional and nontraditional (e.g., prairie-border crossing) flows are allowed in the model. Supplies are taken as exogenous in each country. Barley quality characteristics vary across states and provinces. Beer demand and malt capacity are also taken as fixed, but quality requirements vary. Vertical integration in this sector (i.e., ownership by brewers of individual malt plants) is captured through a set of additional constraints on malt flows. Export demand is separated into subsidized and nonsubsidized

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markets. Feed demand functions are specified for each state and province; these are derived from least-cost feed ration models, which incorporate detailed information on regional livestock inventories and prices of substitutes.

The first five sections provide background to the analysis. Pressures for change, and results from previous studies, are outlined in the first section. The second section describes trends in North American barley production and trade. The third section provides detailed background on malting barley. The U.S. beer and malting industries are described in the fourth and fifth sections. The sixth section describes the analytical model. Results of simulations are described and presented in the seventh section. The report concludes with a summary and discussion of some of the policy issues confronting this industry.

1. Pressures Affecting North American Barley Trade

Both internal and external pressures have emerged for changes in the U.S. and Canadian barley marketing systems. These generally relate to trade and agricultural polices, market dynamics, marketing policies, and transportation and handling cost differentials.

Trade and Agricultural Policies

The United States and Canada have different agricultural policy mechanisms, and different regulations governing grain trade. These have important consequences for North American barley.

The Conservation Reserve Program (CRP) and other supply control mechanisms have affected barley production in the United States. Up to 20-25% of U.S. barley base acres have been idled under CRP, while the Acreage Reduction Program (ARP) set-aside has averaged 11% of base acreage over the past decade. EEP has played a major role in assisting barley exports, and more recently exports of malt and malting barley. This program has the effect of raising domestic prices, creating price spreads (net of transportation) that favor sales of Canadian barley into U.S. markets. These price spreads are apparent at interior shipping points.[1]

Another important element of U.S. trade and agricultural policy is Section 22 of the Agricultural Adjustment Act. This provides a mechanism whereby the Secretary of Agriculture can impose quotas on imports of a commodity if they adversely affect domestic farm program operations. Technically, either an *ad valorem* import duty of 50% or import quotas (not to exceed 50% of a representative movement) could be imposed, either through an emergency action or following study by the U.S. International Trade Commission (National Grain Trade Council, p. 1).

[1]This has accentuated pressure within Canada (i.e., from producers who are situated near the border) for dismantling of the Wheat Board's control over U.S. sales.

Canada's policy mechanisms and marketing system differ drastically. Unlike the United States, Canada does not restrict the production of individual grains through explicit government intervention. Acreage has not been idled through government policies since the LIFT (Lower Inventory for Tomorrow) program of 1971.

The Canadian Wheat Board (CWB) is the fulcrum of many of the marketing and export policies in the Canadian system. As a single-seller agency,[2] the CWB can target markets, execute longer-term marketing strategies, and discriminate among customers using price and other marketing policies. This general approach to marketing is facilitated by having a monopoly on procurement and by being able to control imports and exports. However, the CWB competes with non-Board sales of barley and on-farm feed use.

Another important feature of the Canadian system is that subsidies are paid directly to railroads for a portion of the shipping cost. While this has a long and controversial history within Canada, rail subsidies have recently become a focal point of trade disputes with the United States.[3] To some extent, U.S. pressure may have contributed to Canada's movement toward reforming the 'method of payment' of the Crow subsidy.

In June 1993, the Minister of Agriculture announced major reforms of Canada's marketing system. The proposed "Continental barley market" would have removed the CWB's monopoly over North American sales. Canada's export licensing scheme was to be eliminated, allowing Canadian producers unrestricted access to U.S. markets.[4] The reforms were implemented in August, but were soon reversed through court action. For now, the Canadian Wheat Board retains control over all barley exports.

The U.S./Canada Free Trade Agreement (CUSTA) has no unique features for barley or malt trade. Tariffs are to be reduced over a 10-year period. Rail subsidies are not allowed on barley shipments to the West Coast, but are allowed for easterly movements. The United States retains Section 22 authority. Canada will retain import licensing authority for barley and malt until Producer Subsidy Equivalents (PSE) became equal in the two countries.

The North American Free Trade Agreement (NAFTA) contains a few special features regarding barley. Specifically, quotas for exporting to Mexico are allocated to Canada and the United States; sales within these quota limits are tariff free.

Policies and marketing mechanisms differ substantially between the United States and Canada. Without possibilities for bilateral trade, this would pose no special difficulties. However, for different reasons, an open trading environment is seen as incompatible with existing institutions and policies on both sides of the border.

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[2] Technically, the CWB has a monopoly on the procurement of barley for uses other than domestic feed, including sales of Canadian barley outside of Canada.

[3] See Wilson for a discussion of these issues and implications in the case of wheat.

[4] The CWB has authority to issue export permits, which are required to legally ship barley to any other country, including the United States.

Market Dynamics

Barley markets have important underlying dynamics and spatial dimensions. Beer demand has grown slowly. In fact, U.S. beer consumption has fallen on a per capita basis, resulting in a growing surplus of malting capacity in the United States. However, the international market for malt has been growing.

The West Coast region is one of the largest feed deficit markets in North America. This market is traditionally served with midwest corn and barley, both of which incur relatively high freight costs. Allegations are made that this market could be competitively served from Canada, particularly Alberta, which is the primary barley production region in Canada.

Marketing Policies

Numerous marketing policies affect the barley sector. First, major differences exist in barley quality. U.S. and Canadian supplies are heterogeneous (and subject to much regional variation) in terms of varieties planted and crop quality. End-use requirements vary across brewers, which affects the demand for specific barley varieties and malt. Second, this industry is subject to a fairly high degree of vertical integration, as some brewers have acquired malt plants. Third, handling tariffs in the two countries reflect different competitive environments. Complicated rail and truck freight rate structures exist, resulting from competitive and structural attributes within each country.

Transportation and Handling Costs

There are numerous reasons for what we refer to as prairie-border-crossing trade. These include spatial price differentials and the system of delivery quotas in Canada. Restrictive delivery quotas and the demand for cash can induce prairie-border-crossing shipments by Canadian shippers or producers. Spatial price differentials are affected by a number of factors, including quality premiums, EEP subsidies, and transport and handling costs. Because of fundamental differences in marketing institutions and philosophies, Canadian initial payments (and therefore *street prices*) can differ drastically from U.S. spot prices.

One of the major differences in the marketing systems between these two countries concerns grain handling and transportation. There are important structural differences, as well as differences in regulatory environments, between the United States and Canada.

Most notable are the Western Grain Transportation Act (WGTA) rail rates and the related subsidy mechanism. This results in a pricing regime whereby the shipper pays a portion of the total rail shipment cost, referred to as the *Shipper's Portion*. The balance, the *Government's Cost*, is paid directly to the railroads as a subsidy. These levels and proportions are adjusted on an annual basis.[5]

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[5]In addition, a cap applies to the Canadian Government's share of total shipping costs.

These rates apply to all rail movements of barley and malt from the Prairies to Vancouver (for offshore export) and Thunder Bay. Under terms of the CUSTA, exports to the western United States do not qualify for subsidized rail rates; however, the rates do apply for shipments through Thunder Bay to the eastern United States. A proposal has been made to change these rates, beginning in the 1994/95 crop year. At issue is the method of payment (MOP) for the Crow subsidy. Over a 4-year period, the subsidy (formerly paid to railroads) would be converted into direct producer payments. How this change will be administered has not been determined. However, most important for this study is that railroads will be allowed to raise the shipper portion of the rates charged on WGTA movements, resulting in lower producer prices in the Prairies.

Notable differences also exist in the handling systems in the two countries.[6] In Canada, the Canadian Grain Commission establishes handling regulations for licensed elevators and maximum tariffs for each function (e.g., storage, country handling, cleaning, fobbing). In contrast, a multitude of competitive forces in the United States determine rail rates and handling costs. Generally, these have resulted in lower handling costs.

Comparisons are made in Figures 1.1 and 1.2, using selected shipping origins and destinations used in this study. Data sources for these are described on pp. 45-49. For Canadian origins, the Government's share of shipping costs is equal to the Crow subsidy. If the Government were to convert this subsidy into direct producer payments, the costs borne by Canadian shippers would increase. Thus, comparisons of Canadian costs, with and without the Government share, indicate how changes in the method-of-payment will affect the costs of shipping Canadian barley. Handling costs are also shown for both country and export elevators. For domestic movements within North America, export elevation costs do not apply.

The comparisons in Figure 1.1 illustrate the total handling and shipping costs to two common destinations. Excluding the government portion, the cost of shipping from Winnipeg to Thunder Bay is slightly less than the cost of shipping from Larimore, ND to Duluth. However, the effect of the implicit rail subsidy of 19¢/b is partially offset by the handling cost differential. A similar comparison is made for westbound shipments, from Shelby, Montana, and Lethbridge, Alberta to Pacific ports excluding the government portion, Canadian shipping costs are less, but the impact of the subsidy (30¢/b) is offset to some extent by the higher handling costs (33¢/b including export elevation, versus 16¢/b in the United States).

Figure 1.2 compares shipping costs to selected U.S. destinations. For shipments to Wisconsin malt plants, the value of Canadian rail subsidies is sizable. However, this advantage is dissipated by higher Canadian handling costs and the U.S. rail share of the total movement. On the right-hand side of the figure, two movements are shown from Lethbridge to the California feed market. The comparison indicates that a prairie-border-crossing movement by truck costs less than a direct rail movement.

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[6]See Agriculture Canada (Regulatory Review) for a discussion of these issues.

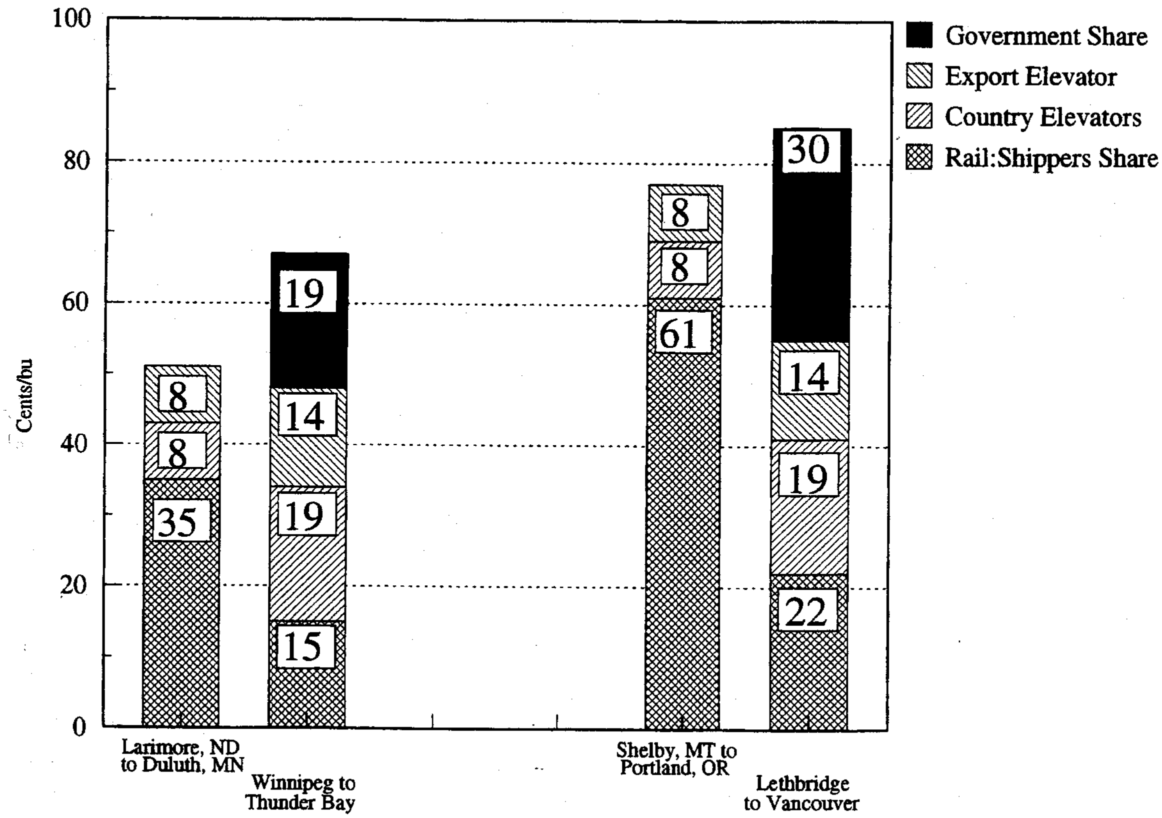

Figure 1.1. Grain Handling and Transport Cost Comparison for Third Country Export (U.S. Cents/Bu)

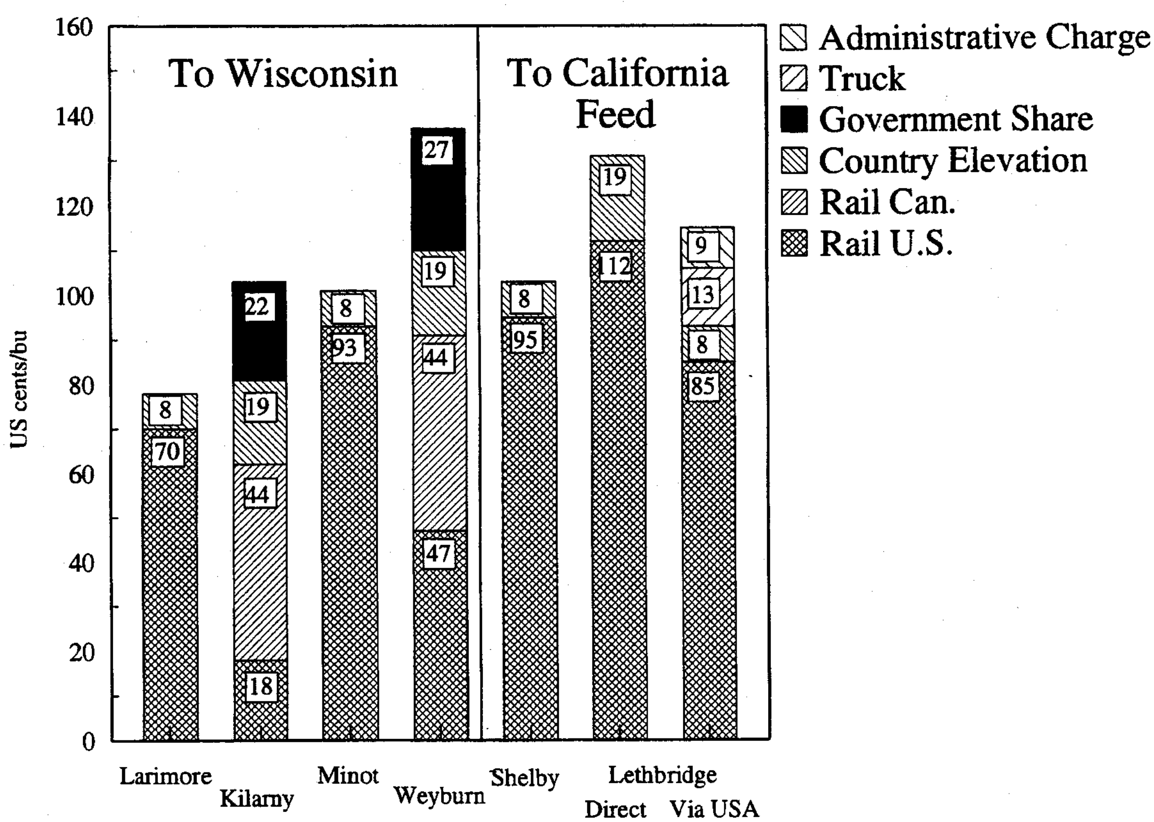

Figure 1.2. Grain Handling and Transport Cost Comparisons to U.S. Destination

Previous Studies[7]

Opportunities for North American barley trade have inspired much debate in Canada. Recent studies have reached sharply different conclusions about whether the CWB has been under-selling barley into the U.S. market, and whether the Board should retain its monopoly over Canadian exports. These studies are briefly summarized to provide background and impetus to our analysis.[8]

Alberta Agriculture. This study was one of the first published on the topic and presented a proposal to liberalize barley trade in North America. Following are some of the major points:

1) The prairie farmer cost/price squeeze provides impetus to seek new markets and a different market regime.

2) Canadian marketing costs have been rising, whereas those in the United States have been declining since the early 1980s.

3) The Canadian feed grain market is less spatially efficient than that in the United States.

4) The CWB total payment for barley at Red Deer, Alberta, has averaged C$27/mt less than the Great Falls price.

5) Alberta has capacity to sell 1-1.4 mmt of barley into the Northwestern region of the United States (Magnusson and Lerohl).

Agriculture Canada. In its regulatory review, Agriculture Canada found that the single-desk selling of barley was a priority issue requiring attention. Ultimately, they reaffirmed that the CWB should remain as the sole exporter of barley to third countries. However, for North American trade, they recommended that an intensive analysis be undertaken. This eventuated in the Carter report.

Canadian Wheat Board. In its December 1992 report, the CWB presented a number of arguments in defense of the existing marketing system:

1) As a single-desk seller, the CWB continuously reviews all markets to identify those with the greatest payoff. Whenever sales into the United States offer the best net return, sales are made.

2) Increased sales to the United States would ultimately lower export earnings in some third countries (e.g., Japan) because prices to those countries are

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[7]Another study by Haley et al. analyzed impacts of the EEP program using SWOPSIM, a static, non-spatial trade model.

[8]Veeman provides a useful review of the controversy surrounding the Continental Barley Market.

based on U.S. prices. Conversely, by restricting sales to the United States, total pooled export earnings are supported.

3) In general, net returns from sales to Japan have been the greatest of all markets, followed by Saudi Arabia, and then distantly by sales to U.S. destinations (p. 23).

4) A continental barley marketing system would have the following impacts: (a) an increase in exports to the United States and reduction in the U.S. barley price; (b) reduction in returns from offshore markets; (c) a loss in malting barley premiums; (d) possible U.S. retaliation; and (e) transhipment of Canadian barley through the U.S. marketing system.

Carter Report. An extensive and detailed analysis of the North American barley market was conducted for the Agriculture Canada Grains and Oilseeds Branch. This was in response to the earlier *Regulatory Review* recommendation.

The principal question was "whether barley farmers benefit from monopoly selling powers vested in the CWB." This debate during the past few years has centered around five principal points: (a) the overall impact of a single continental market for barley producers; (b) domestic pricing efficiency; (c) why such a large proportion of Prairie barley area is planted to malting varieties, given the market size and premium; (d) the market potential of U.S. western states for Canadian feed barley; and (e) impacts of the U.S. EEP program on barley flows and income.

A multifaceted study was initiated to address these questions. Following are some of the principal findings (Carter, p. 2):

1) The CWB does not exert market power in either the United States or the world market.

2) Sharp inefficiencies within the Canadian marketing system could be corrected through greater exposure to U.S. competitive pressures.

3) Significant opportunities exist for expanded sales of barley from Canada to the United States. If more liberalized trading were allowed, an additional 500,000 mt of feed barley and 400,000 mt of malting barley could be sold into the United States Producer revenues from barley could increase by up to 17% if a continental market were adopted.

Because of this study, the Minister of Agriculture recommended liberalizing barley trading for North America, beginning with the 1993/94 marketing year. This included eliminating import licenses for sales of malt and barley into Canada.

University of Saskatchewan. Schmitz, Gray and Ulrich conducted a concurrent study on the subject. They used a world barley trade model with four markets, and various simplifying assumptions about intermarket price spreads.[9] Results from that study indicated that a Continental barley market would increase the equilibrium trade flow from 620,000 mt to 740,000 mt, with only a slight reduction in producer welfare. Thus, opening the border would not have a significant impact on revenue from the feed market; however, the major negative impact would be on malt trade and on malting barley premiums of Canadian producers.

2. North American Barley: Production, Use, and Trade

Barley Supply

Barley production is concentrated in the midwest and western states and in the western Canadian provinces. Barley is generally grown in regions that are not suited for row crops, mainly competing with wheat for acreage. U.S. barley acres vary from year to year; however, 10 states (California, Colorado, Idaho, Minnesota, Montana, North Dakota, Oregon, South Dakota, Washington, and Wyoming) have accounted for about 90% of planted acres since 1980. Harvested acres are shown in Figure 2.1 for the 10 largest barley-producing states.

The area planted to barley has declined significantly since the early 1980s. This decrease largely reflects impacts of CRP, (Figure 2.2) which has removed about 2.75 million barley acres from production throughout the United States. About 23% of the area planted in 1986 has been set aside under the CRP program; however, the percentage reduction varies geographically. This land may be returned to production beginning in 1996, staggered in annual increments corresponding with the 10-year anniversary of entries into the program. Thus, the sharp reduction in U.S. barley area that has occurred under CRP may be reversed in future years.

Apart from CRP, other factors have led to reduced barley acreage in individual producing states. Competing crops for barley vary substantially. In western states, high-valued competing crops include potatoes, alfalfa, edible beans, sugar beets, and some irrigated vegetables. Feed barley, which has a significantly higher yield in these western states, also competes for acreage with malting barley.

In contrast, competing crops in the midwest are largely hard red spring wheat, durum wheat, and sunflower. Increasingly, other row crops are penetrating the southern producing areas in North Dakota and displacing barley production. Feed barley varieties in this region do not have substantially greater yields and, thus, do not represent an important cropping alternative for producers.

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[9]Demand elasticities (evaluated at mean trade levels) for the U.S. and Canadian domestic markets were -1.30 and -.70, respectively, while the demand elasticity for offshore (EEP) markets was -1.20. The U.S.-Canada price spread was specified as a linear function of the bilateral trade volume. This was based on a freight rate comparison for two U.S. destinations (Yakima vs. Central Valley in California), but did not reflect detailed analysis of regional demand schedules.

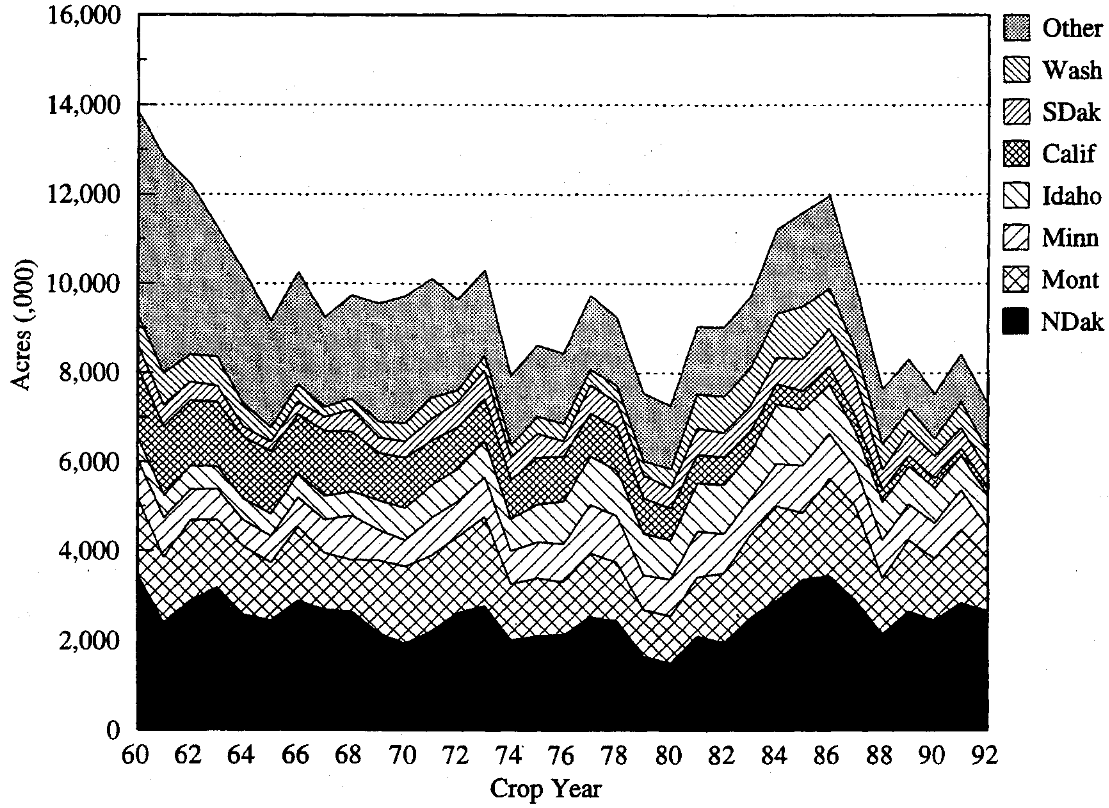


Figure 2.1. U.S. Harvested Barley Acres

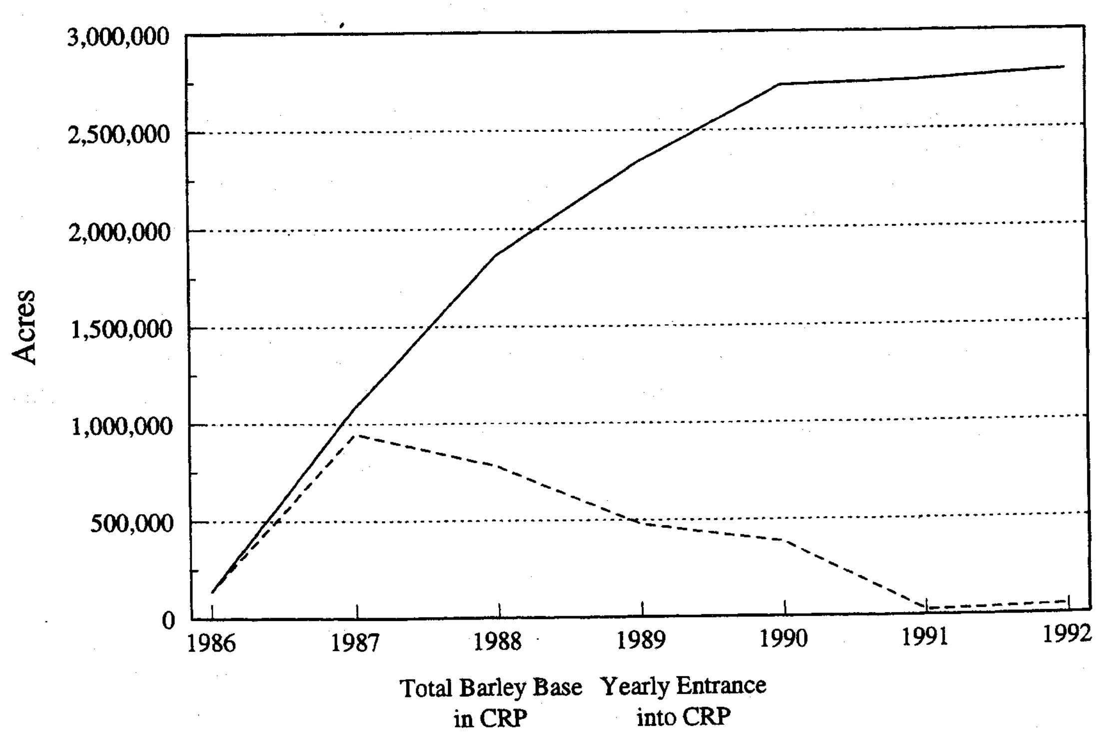


Figure 2.2. Total Barley Base and Yearly Entrance in CRP

Acreage in California and Oregon has declined since the 1960s. Since 1984, acreage has declined in Colorado, Idaho, Washington, Minnesota, Montana, and South Dakota. In North Dakota, acreage decreased by 20% between 1983 and 1992.

Barley production in Canada is concentrated primarily in Alberta and Saskatchewan (Figure 2.3). Through most of the 1980s, area planted to barley was in the 11 to 12 million acre range; however, area planted fell sharply in 1992. Competing crops in Canada include spring wheat, durum wheat, and canola.

Yields have increased slightly since 1960 in the United States and Canada (Figure 2.4). Comparisons across states and provinces are shown in Figure 2.5. The western states of Colorado, Idaho, Oregon, and Wyoming are irrigated and, consequently, have the greatest yields. Average midwest yields (except for Minnesota) are lower than in western states, but are generally comparable. In Canada, average yields are lowest in Saskatchewan.

Barley varieties are either 6-rowed or 2-rowed. They are further divided into malting or feed varieties (the distinction is described in the next section). In recent years, 6-rowed malting and 2-rowed feed varieties have accounted for the largest and second largest shares, respectively, of barley varieties grown in the United States (Figure 2.6). The proportion of feed varieties grown has increased slightly since 1989. Varieties grown in Canada are predominantly 2-rowed and 6-rowed malting. Figure 2.7 shows the geographical distribution of 1991 production by type in the United States. Malting barley production dominates in the midwest, but is less dominant in western states. Carter (p. 9) showed that between 1985 and 1992, the area planted to malting varieties in Western Canada ranged between 62 and 69%, similar to U.S. levels (Figure 2.6).

Components of U.S. barley supply are shown in Figure 2.8. First, imports (exclusively from Canada) are shown. Second, supply has declined noticeably during the latter 1980s. Third, government stocks were depleted in the early 1990s. And fourth, the volume of private stocks is abnormally large relative to other grains, and relative to other countries. Privately-owned stocks of 100 million bushels represent about 2/3 of annual requirements for the malting industry, which suggests that brewers carry large stocks in anticipation of crop/quality shortages.

Comparable data for Canada are also shown. Total supplies are typically near 15 million mt. Canadian production exceeds U.S. production, but stocks are about equal; thus, relative stockholding is greater in the United States.

Barley Use

Barley is used primarily in the malt and livestock feed industries in both domestic and export markets. The North American malting industry is discussed in the next section after feed and export demand. A comparison of the composition of barley demand is shown in Figure 2.9, using averages for two periods.

Barley use for beer (and, therefore, malting) is greater in the United States than in Canada. Feed use is of greater relative importance in Canada, since barley is the primary feed grain in western Canada. Canada also exports a greater amount of barley than the United States.

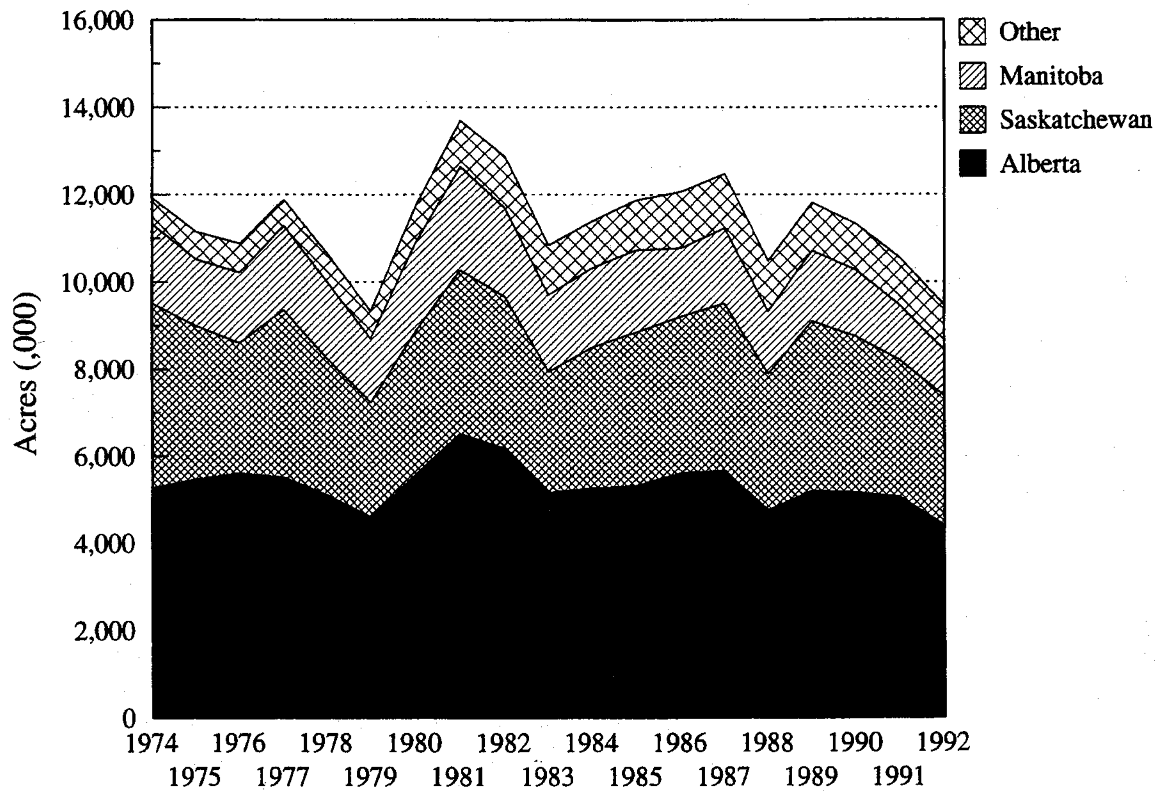
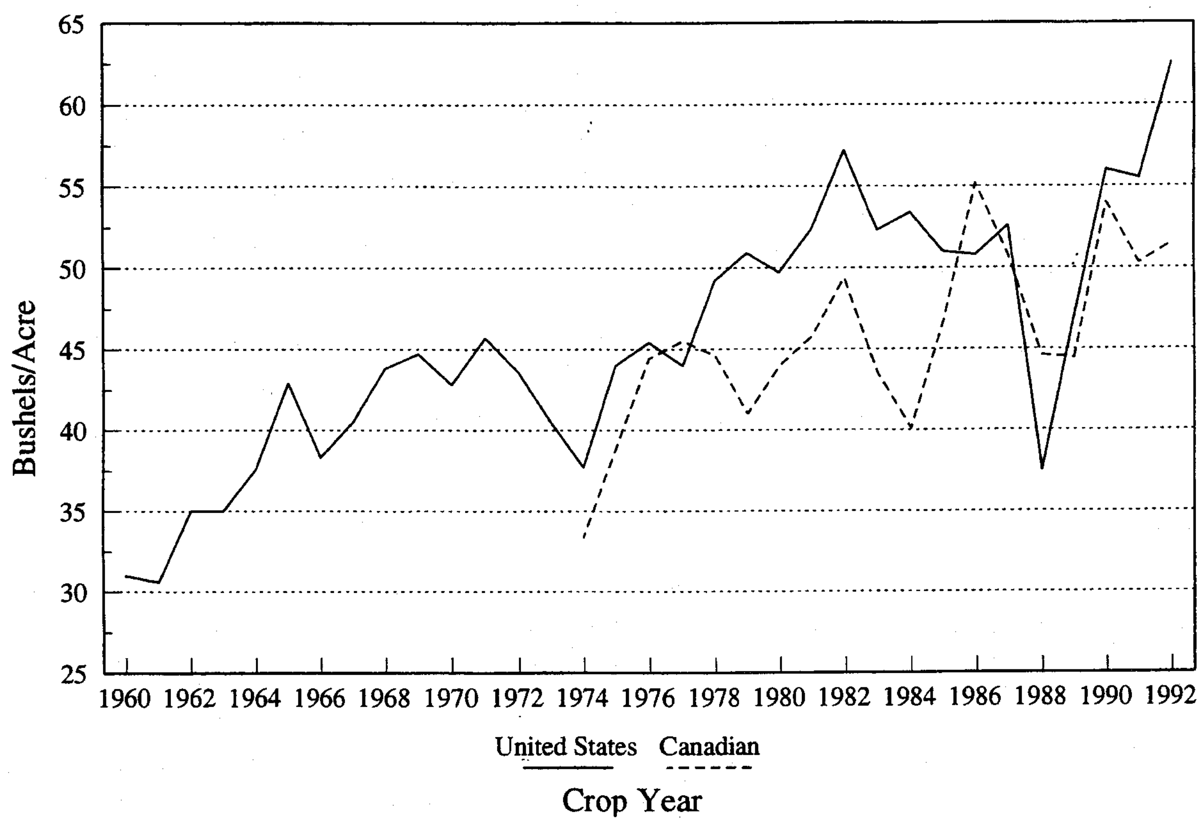
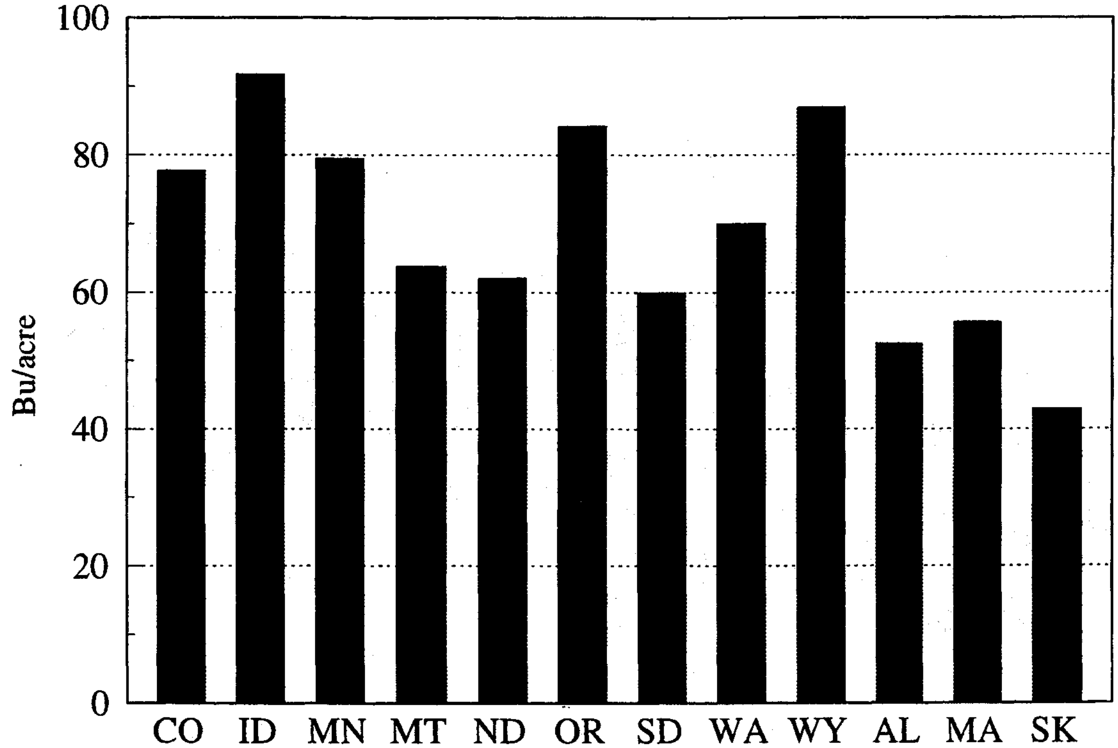


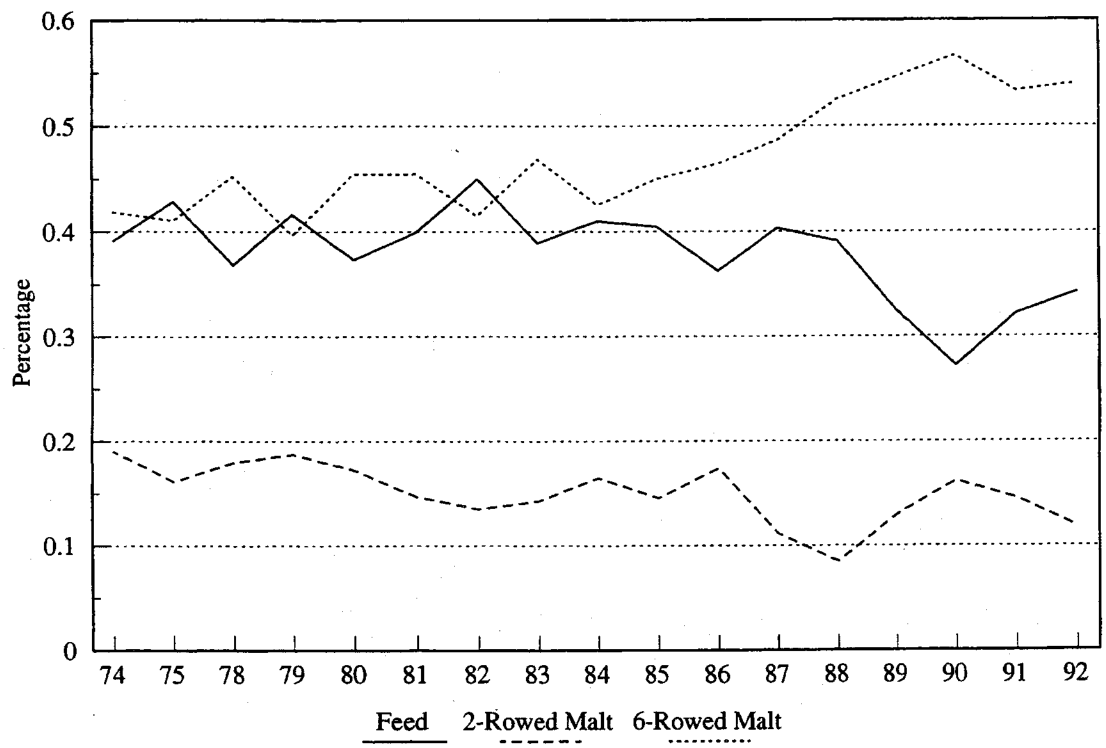
Figure 2.3. Canadian Barley Area



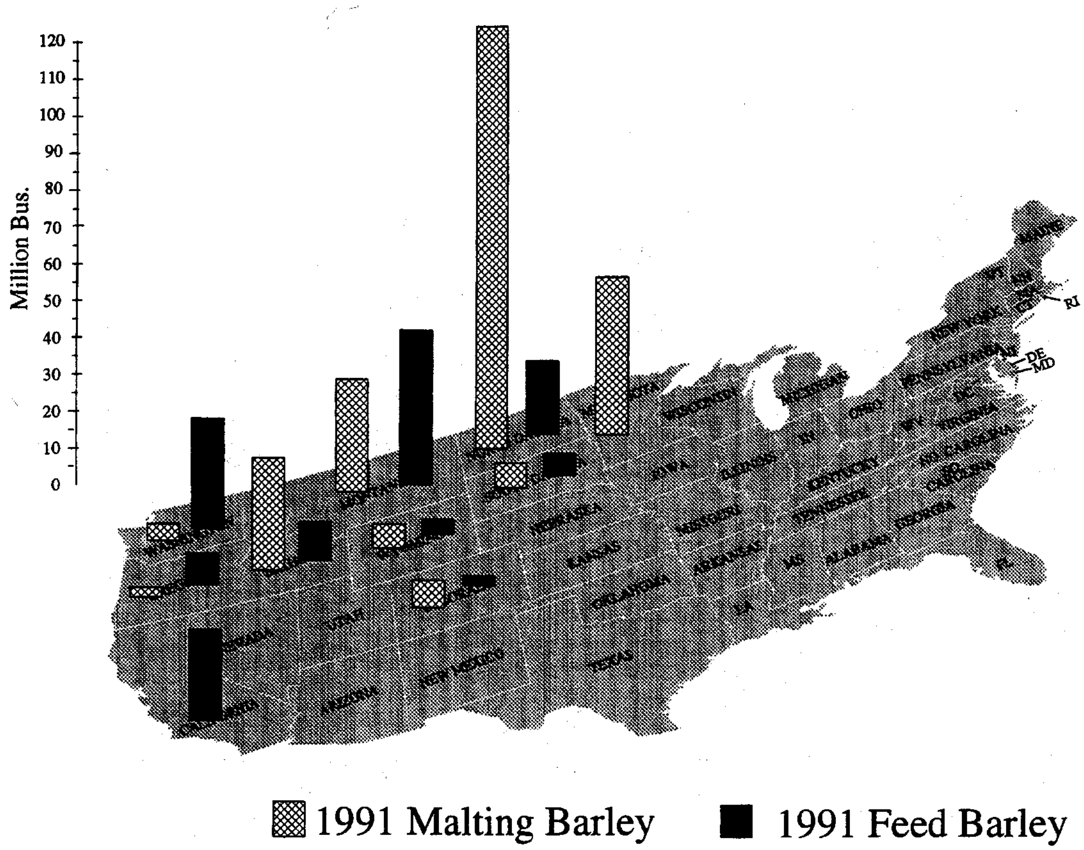
2.4. North American Average Barley Yield



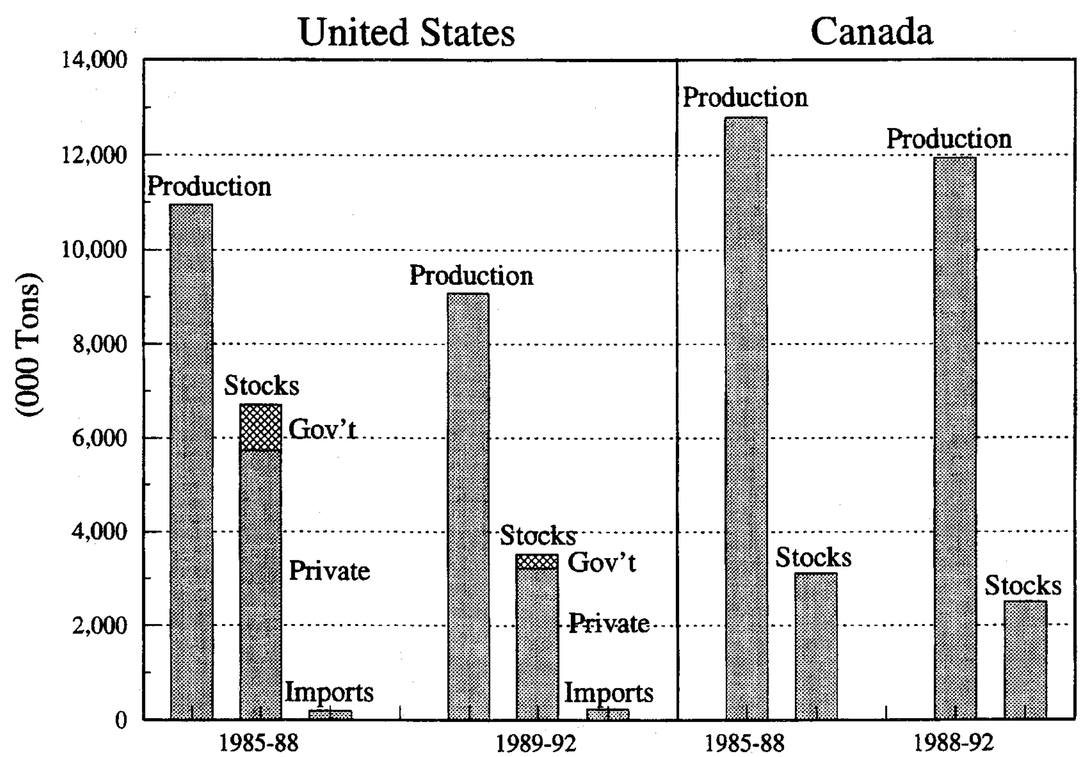
2.5. Comparison of U.S. and Canada Yields for State/Province, 4-year Average (1989-1992)



2.6. Acres of Barley Planted, By Type



2.7. Malting and Feed Barley Production: By State



2.8. Components of Barley Supply, U.S. and Canada (Averages for 1985-88 and 1989-92)

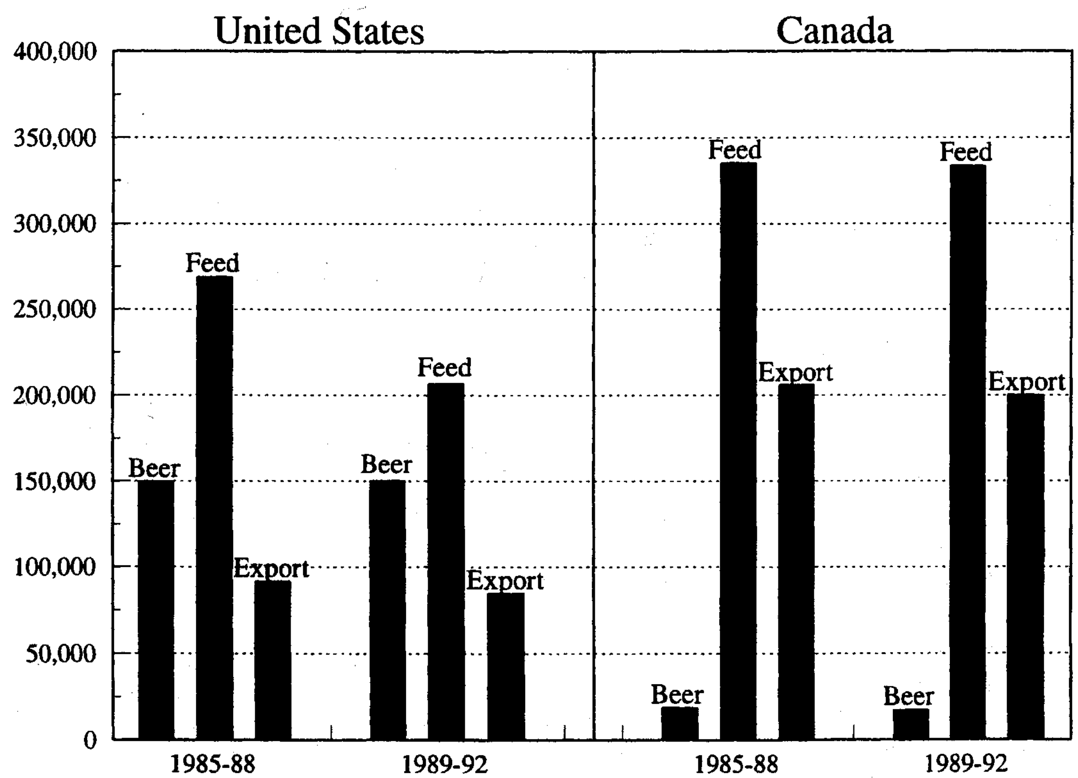


Figure 2.9 Components of Barley Demand, U.S. and Canada (Average 1985-88 and 1989-92).

2.9. Components of Barley Demand, U.S. and Canada (Average 1985-88 and 1989-92)

Feed Demand

Barley is a good source of energy and nutrients for many animal groups.[10] In the United States, feed accounts for the greatest use of barley, followed closely by beer and alcohol use. Barley used as feed is reported as a residual in USDA estimates. Variability of feed use is greater than variability of other domestic uses.

Johnson and Varghese developed a model to analyze regional demand for feed barley. Their analysis was based on a linear programming approach to least-cost feed formulation. Nutritional requirements for 5 livestock classes (beef, dairy, swine, poultry, and sheep) and 37 individual animal diets were incorporated into the model. By varying the barley price while holding other ingredient prices fixed, barley demand schedules were derived for each livestock category. These were weighted together, using published livestock inventory data, to yield regional demand schedules.

Barley feeding varies substantially across regions due to the size and composition of livestock herds and the price of barley relative to alternative feed ingredients. Barley

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[10]"Competition among feed ingredients depends primarily on relative price and relative energy value. The percentage of metabolizable energy in barley is slightly less than corn and sorghum averaged across all livestock classes. Barley is equivalent to corn in terms of feeding value when fed to ruminants like dairy and beef cattle and sheep. Barley's high fiber content makes it less palatable and digestible to young swine and poultry" (Ash and Hoffman, p. 4).

is a principal feed ingredient in western Canada due to its availability and the high freight costs for competing feed ingredients. In the United States, regions east of the barley-producing regions are largely surplus corn-producing states; barley is generally not competitive in those regions. Barley feeding is more competitive in the western United States where the costs of alternative feed grains (primarily corn) are high.

Barley Exports

Barley exports from the United States have been erratic since 1960 (Figure 2.10), though increases occurred during the late 1980s. EC-12 was the largest purchaser of barley from the United States in the 1960s; however, its purchases have virtually ceased. Saudi Arabia started to buy barley in the late 1970s and accounted for most of the barley exported from the United States during the 1980s.

A comparison of U.S. and Canadian exports to primary destinations for the 1991/92 marketing year is shown in Figure 2.11. Canada dominates in each of the markets except for Saudi Arabia. Figure 2.12 shows barley quantities under the EEP program since 1986. These have ranged from a high of nearly 3.5 mmt to a low of less than 1.0 mmt in 1989. Saudi Arabia has been the major recipient of EEP for barley. Average bonuses over this period were $32/mt, but ranged from $18/mt in 1989 to $41/mt in 1991 (Figure 2.13).

Exports of barley are primarily for non-malting purposes. Malting barley has ranged from 0.16% to 8.55% of total barley exported from the United States (Figure 2.14). Since 1988, Israel, Japan, and Mexico have accounted for most of these malting barley exports. Exports of malting barley from Canada are greater and have increased since 1989 (Figure 2.15). A major component of that increase has been exports of malting barley to the United States and China.

3. Malting Barley Production

Barley is classed into feed or malting varieties. In the United States, malting varieties are those that the American Malting Barley Association, Inc. (AMBA) has recommended for malting in specific states. Producers plant malting varieties in hopes of meeting malting quality standards (e.g., for plumpness and protein). If barley is of an approved variety, but fails to meet malting standards, it is sold as feed barley.[11]

[11]The Federal Grain Inspection Services (FGIS) is the agency that establishes standards and factor limits for barley. These grade standards follow the conventional "least factor approach" as is used in many countries and for other grains. To be classed as a malting barley, the variety must be recommended by AMBA. In addition, there are numerous non-grade determining factors which have an important impact on quality. Values of nongrade factors are specified in contracts, and premiums or discounts may apply; thus, they are important for handlers in making binning/blending decisions. Of particular importance for malting barley are plumpness, protein, germination, and varietal purity. See Wilson, Scherping, Cobia, and Johnson for a detailed discussion of this system.

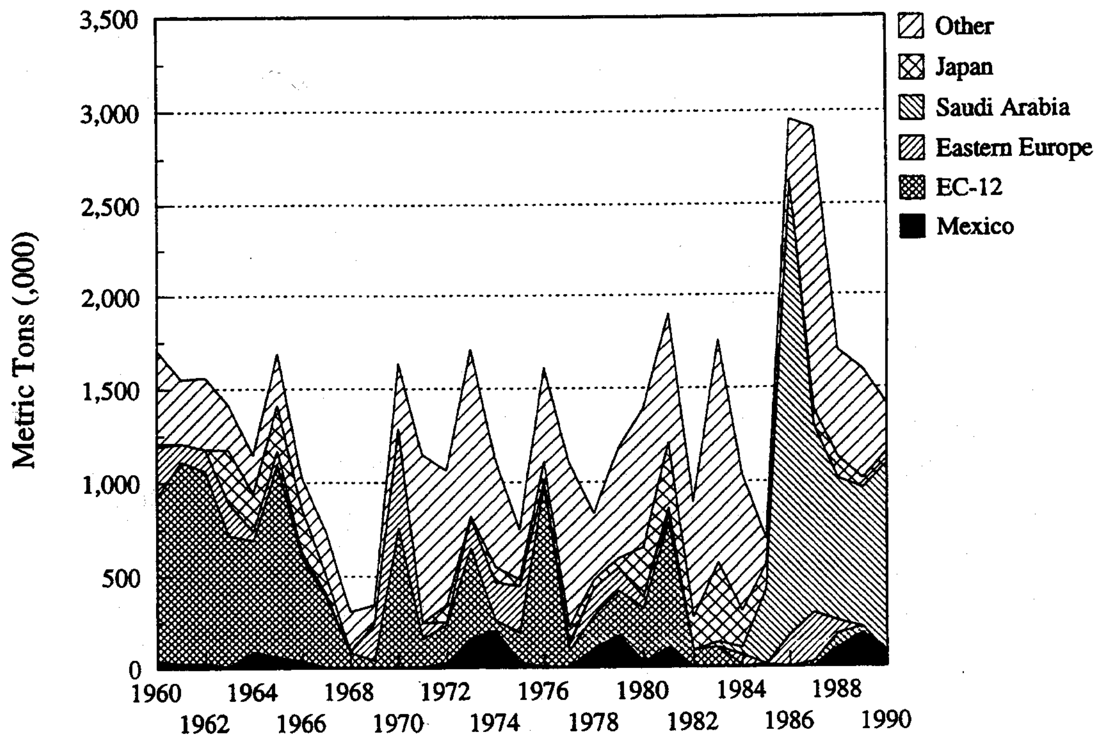
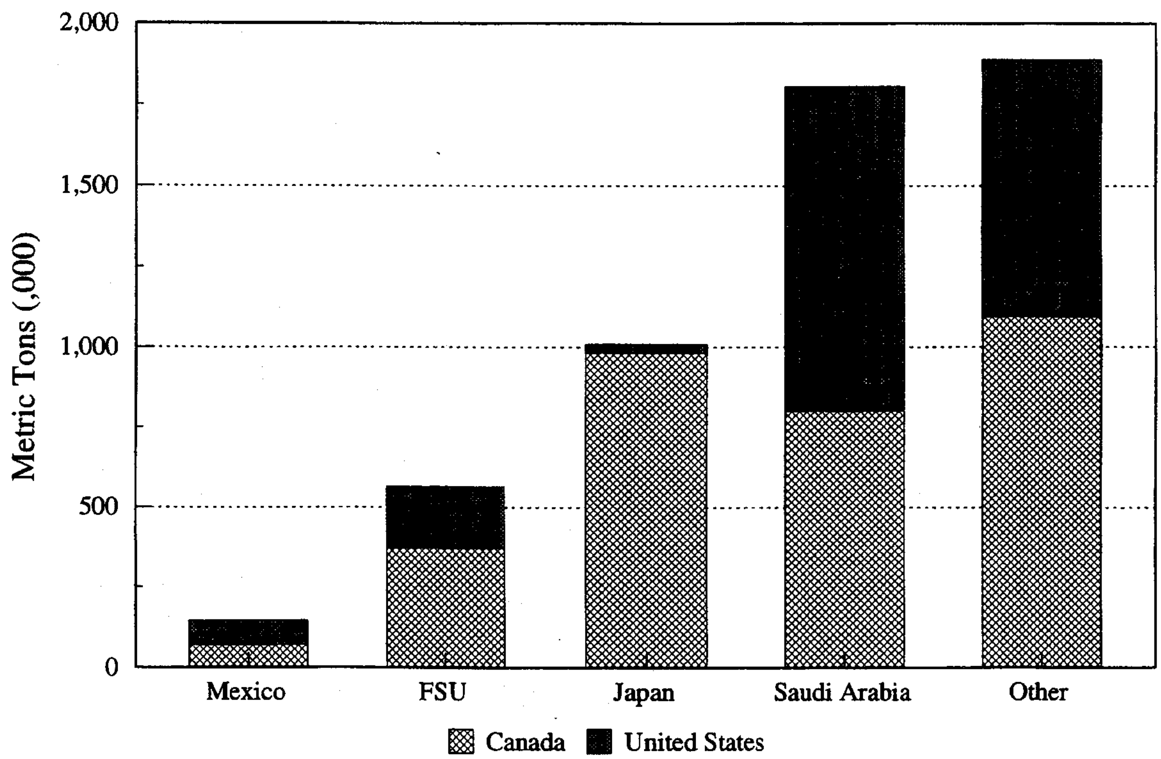
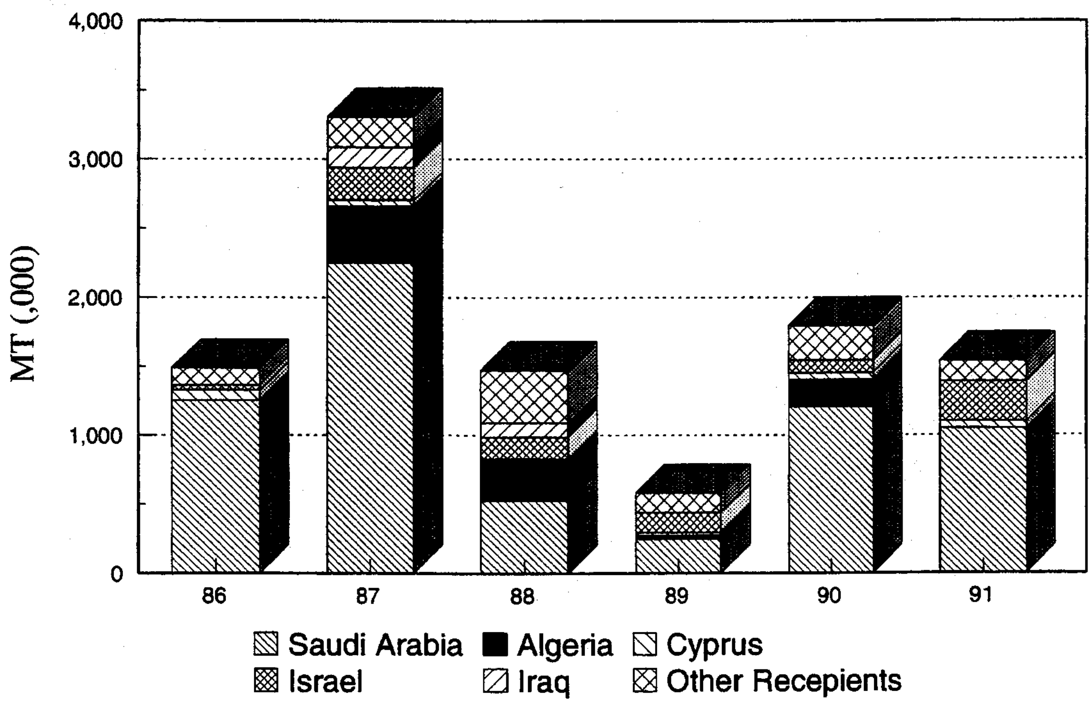


Figure 2.10. U.S. Barley Exports.
Source: USDA PS&D View.

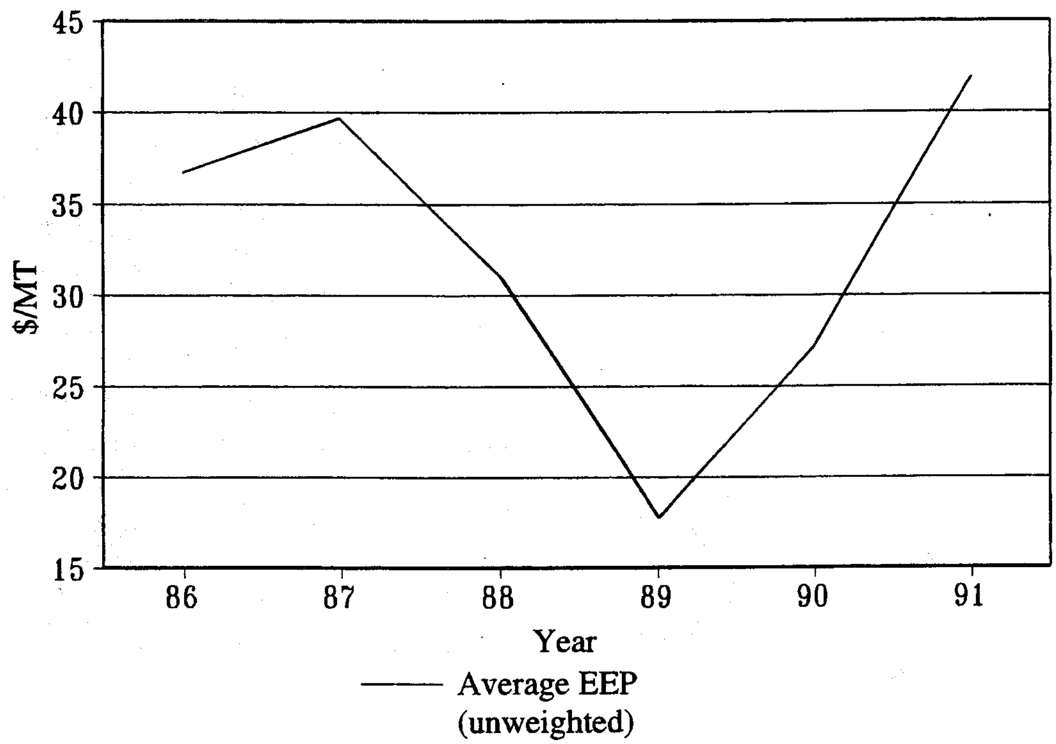
2.10. U.S. Barley Exports



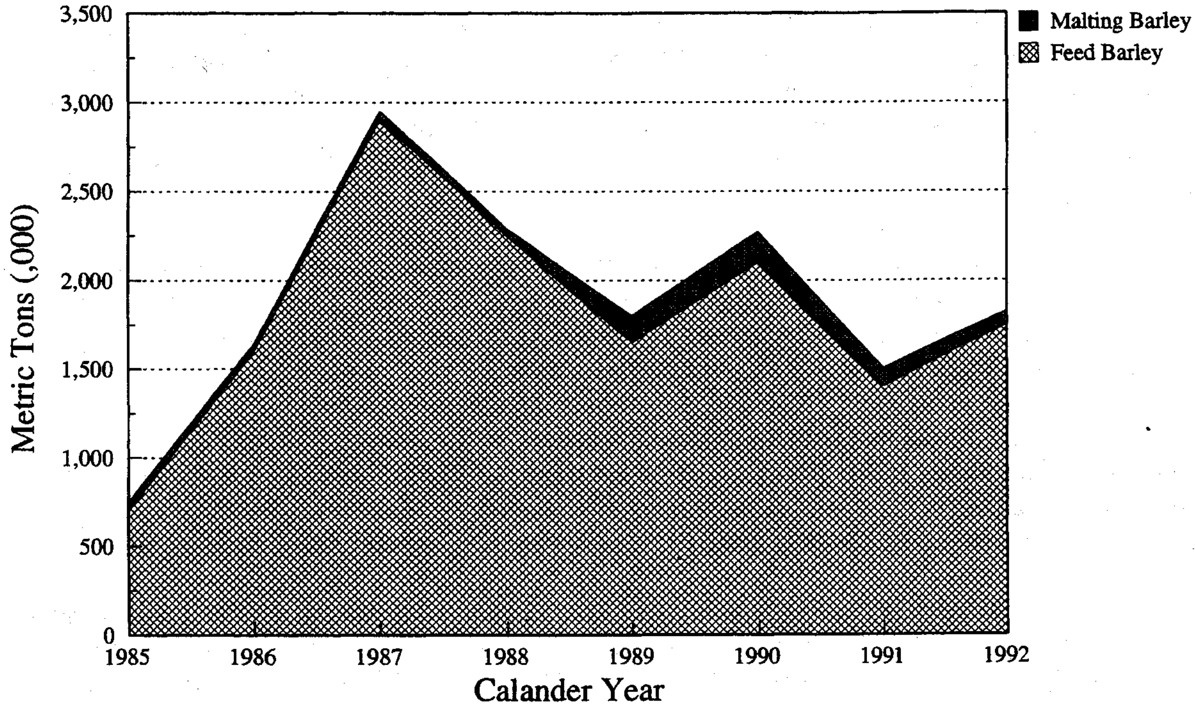
2.11. U.S. and Canadian Exports for 1991/92 Marketing Year



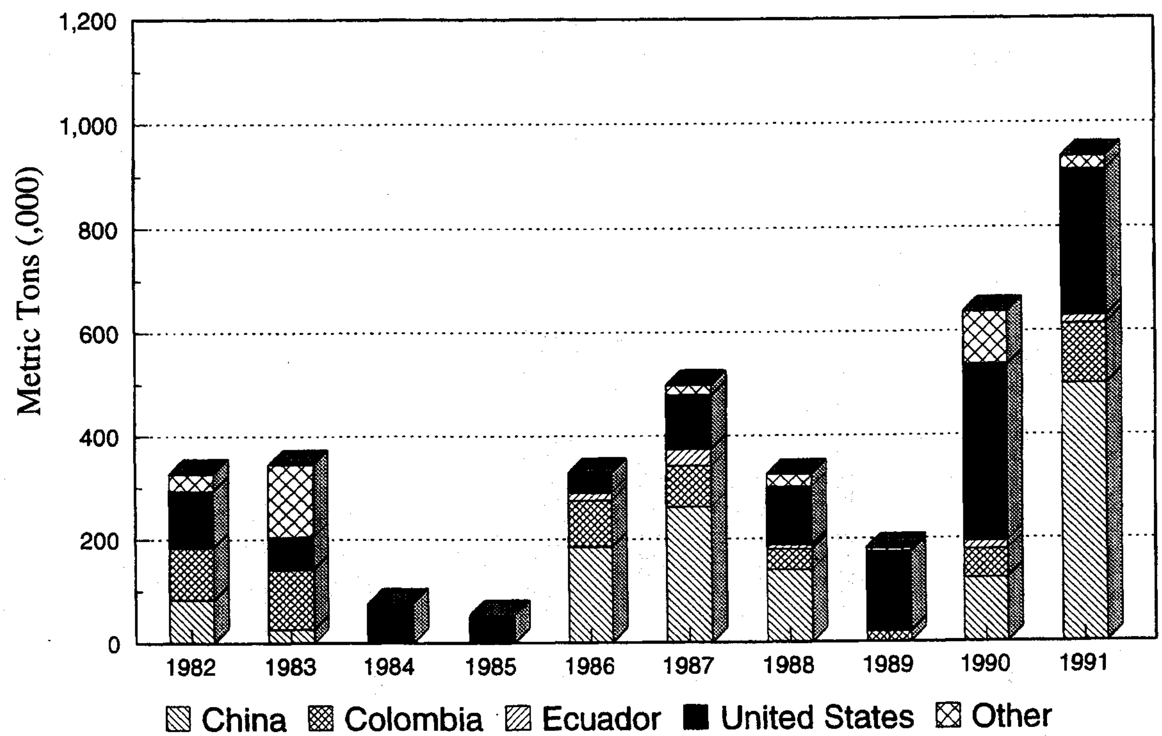
2.12. Barley Quantity Sold Under EEP



2.13. Annual Average U.S. EEP Bonus



2.14. U.S. Exports of Feed and Malting Barley



2.15. Canadian Malting Barley Exports

Breeding programs, agronomic practices, soil characteristics, and climatic conditions determine varietal types of barley grown in each state. Production estimates by type of barley were derived at the state level and are shown in Figure 3.1 for 9 major producing states. Individual barley varieties were classified as feed or malting, 2-rowed or 6-rowed. The fraction of acreage planted to these individual barley varieties was multiplied by production in that state.

Minnesota, North Dakota, and South Dakota grow primarily 6-rowed malting varieties. Since 1976, acres planted to 6-rowed feed varieties have been decreasing, while acres planted to 2-rowed feed varieties have been increasing in the Dakotas. Minnesota grows 6-rowed malting varieties almost exclusively.

Both feed and malting varieties are grown in Colorado and Idaho in significant amounts. The share of barley planted to 2-rowed malting varieties in Colorado has increased relative to feed varieties. In Idaho, the share of 6-rowed malting varieties has grown due to increased contracting with maltsters during the late 1980s.

Montana and Wyoming mainly produce 2-rowed varieties. Most of the acres in Montana are planted to 2-rowed feed varieties, while 2-rowed malting varieties dominate in Wyoming. The coastal states of California, Oregon, and Washington produce mainly 6-rowed feed varieties. Planted acres in California and Oregon have been decreasing since 1962.

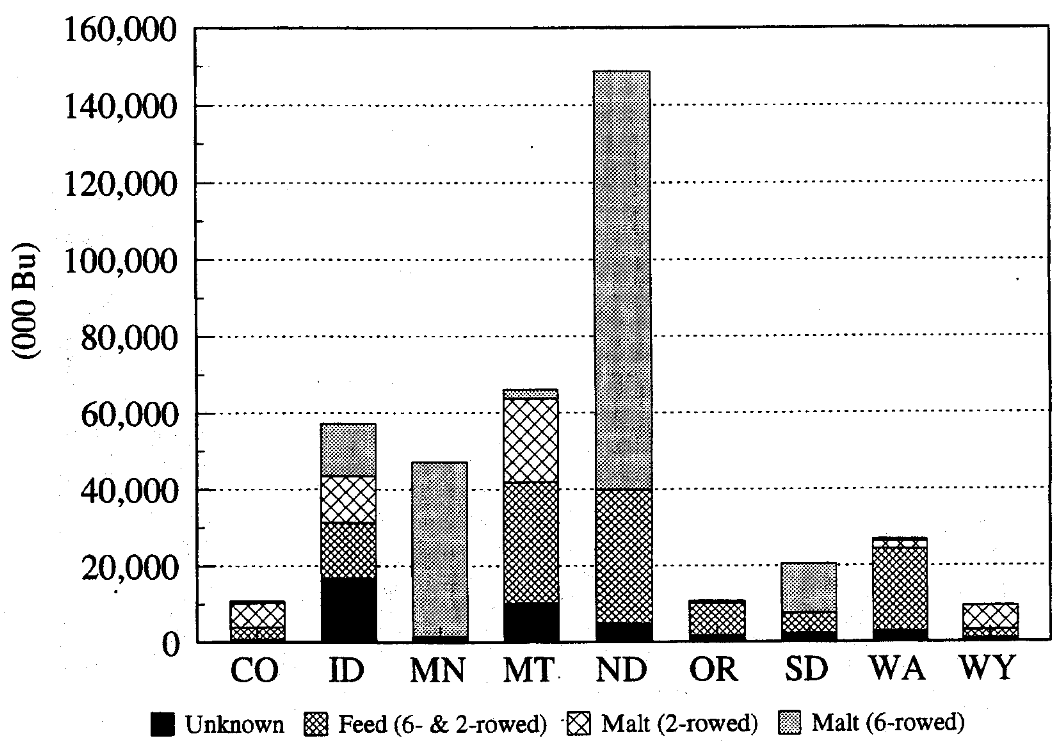


Figure 3.1. U.S. Barley Production by Type: Across State (4-Year Average 1989-92)

Malting varieties are grown predominantly in the Midwest states (Figure 3.1), with 6-rowed malting varieties accounting for approximately 55% of the acres grown and 2-rowed malting varieties accounting for approximately 12% (Figure 3.2) in 1992. Area planted to 6-rowed malting varieties has increased more than have areas for 2-rowed malting and feed varieties.

Important institutional differences affect quality regulations in the United States and Canada. In the United States, the AMBA approves varieties for malting by state. Other varieties are classified as barley and are produced and sold for non-malting use. In the United States, both 6-rowed and 2-rowed malting varieties are white aleurone.

The variety approval process differs in Canada. Of particular importance is that varieties not approved for malting may still be produced, but only under contract (or for feeding purposes). Traditionally, all varieties approved for malting in Canada have been either 2-rowed white aleurone or 6-rowed blue aleurone. Other 6-rowed white aleurone varieties are grown under contract.[12]

The area planted to malting varieties indicates the proportion that is potentially available for malting. The proportion of the crop that is graded to be of malting quality, or sold for malting, is smaller. To put this in perspective, data were compiled on barley grade factors. Barley samples are collected annually in some states for quality evaluation. Some of those analyses estimate the proportion of crop grading as malting barley or as *No. 3 or better* malting barley.[13] State averages of these figures for the 5 principal producing states are shown in Figure 3.3. These figures vary substantially through time (Figure 3.2).

Minnesota and North Dakota malting barley typically grades No. 3 or better 60% of the time, and the South Dakota average is about 50%. Malting barley in Montana grades No. 3 or better about 30% of the time. Malting quality in Idaho is substantially greater than in the Midwest, reflecting the more controlled growing environment.

These figures were combined with other production data to derive estimates of malting barley production (grading No. 3 or better) for each of these states. Estimates were derived from the product of acres harvested, yield (including a lower yield for malting barley in Idaho), the percent of acres planted to malting varieties, and the percent of production grading No. 3 or better malting (from Figure 3.2). As illustrated, North Dakota is the largest malting barley- producing state, with production of nearly 100 million bushels. Minnesota and Idaho each produce between 20 and 40 million bushels, and Montana and South Dakota each produce less than 10 million bushels.

Components of these figures are shown in Table 3.1, using averages for 1990-1992. Estimates were not publicly available for Colorado, Montana, Oregon, Washington, and Wyoming. Figures used for these states were taken from discussions with industry participants. State production estimates were derived for malting barley, either grading No. 3 or better or sold as malting barley (depending on the reporting system).

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[12]Carter (p. 9-10) documents the percent of barley sold for malting (p. 10) and discusses factors affecting variety planting decisions.

[13]Nongrade factors (such as protein) may also determine a particular shipment's acceptability for malting.

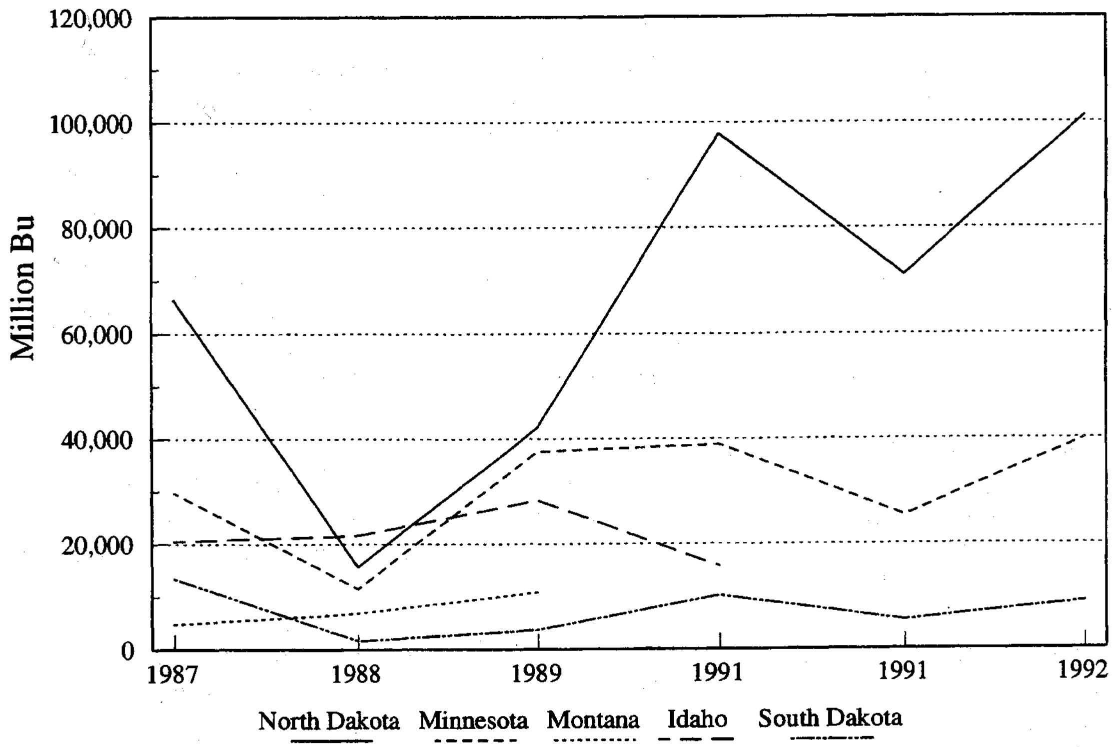
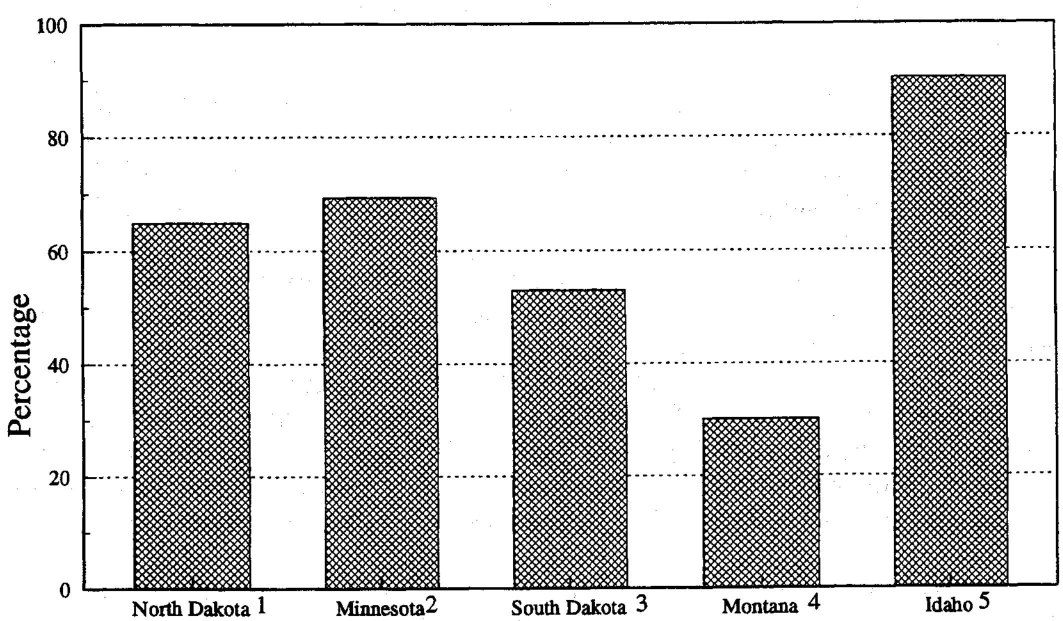


Figure 3.2. Production of Malting Barley Grading No. 3 or Better: By State



1 North Dakota, 1987 to 1992 average.

2 Minnesota, 1987 to 1992 average.

3 South Dakota, 1987 to 1992 average.

4 Montana, 1989 to 1991 average.

5 Idaho, 1989 to 1992 average.

Figure 3.3. Average Percentage of Malting Varieties Grading No. 3 or Better Malting: By State

TABLE 3.1. U.S. PRODUCTION ESTIMATES OF MALTING BARLEY

State	Harvest Acres (000)	Yield Malting bu/acre	6-rowed %	2-rowed %	Grade 3 %	State Production (000 bu) 6-rowed	2-rowed
CO	133.3	78	7	63	90	655	5,933
ID	763.3	74	26	21	91	13,247	10,988
MN	783.3	63	96	0	69	32,810	0
MT	1,410.0	46	4	34	80	2,076	17,382
ND	2,643.3	54	80	0	65	74,823	0
OR	151.6	68	4	2	80	346	132
SD	446.7	46	62	0	53	6,760	0
WA	466.7	56	2	9	90	447	2,140
WY	133.3	78	0	68	90	0	6,357
		----------average------------					
9-State Total	6,932	63	31	22	79	131,163	42,933

For comparison, U.S. malt demand is about 104 and 40 million bushels for 6- and 2-rowed, respectively. Generally, the United States produces a large surplus of 6-rowed malting varieties grading No. 3 or better. In contrast, 2-rowed varieties are in relatively short supply. On average, production of 6-rowed malting barley is adequate, though periodic shortages of sufficient quality may occur due to weather vagaries. There is a greater chance of this occurring for 2-rowed malting barley than for 6-rowed malting barley. The relatively low level of 2-rowed malting barley suggests that this would be the type most likely imported.

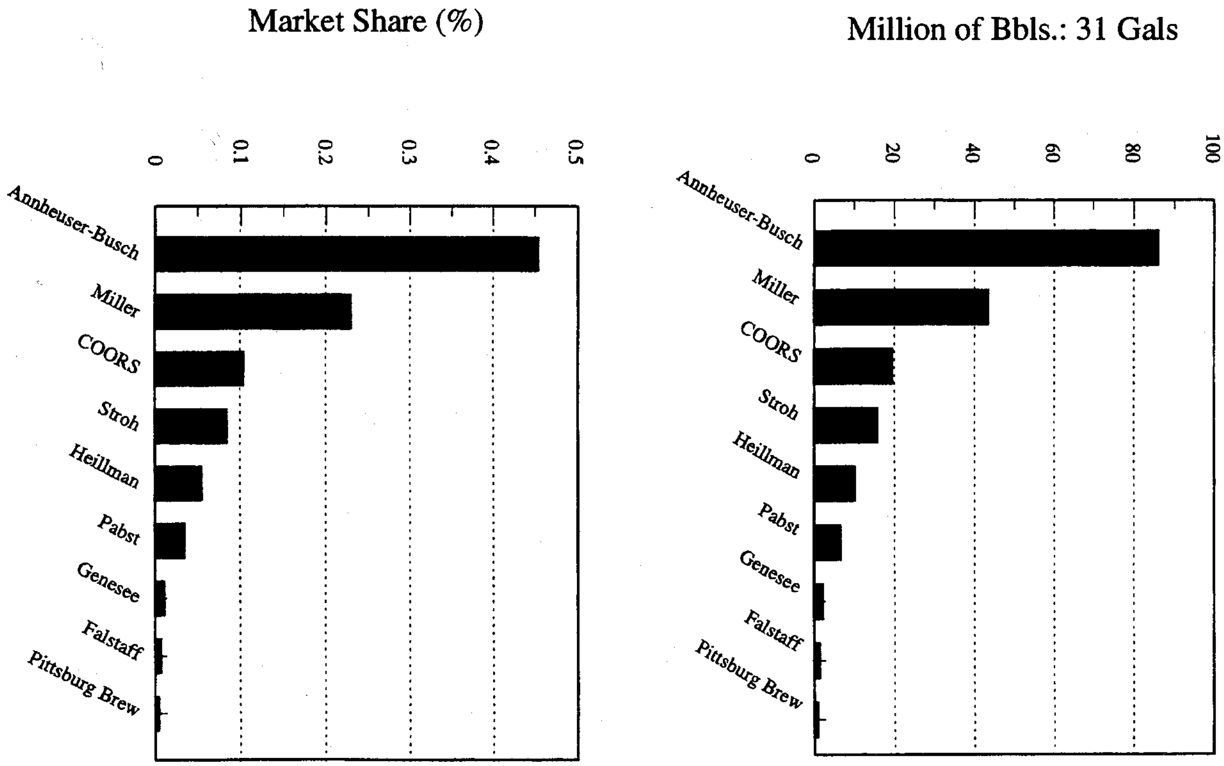
4. U.S. Malt Demand and Utilization[14]

This section provides a description of the U.S. beer industry in the United States with particular focus on issues relating to malt consumption. Structural characteristics of the beer industry are presented, and malt utilization in the U.S. beer industry is analyzed.

Structural Characteristics of the U.S. Beer Industry

A few large firms dominate the U.S. beer industry. Sales of the largest 20 brewery firms in the United States are shown in Figure 4.1. Anheuser-Busch is the largest with

[14]The Canadian beer and malting industry is discussed in Carter (pp. 13-14).



4.1. Market Share and Capacity of the Largest Brewing Companies: 1991

nearly twice the sales volume of the next largest firm, Miller. Table 4.1 provides a description of the structural characteristics of this industry in recent years. The number of beer companies has increased,[15] following many years of decline. This largely reflects the emergence of *micro-breweries*, a major trend in this industry. However, micro-breweries remain a small market segment (in comparison to the largest 20 breweries) in terms of sales and malt utilization.

Two important structural measures of this industry are shown in Table 4.1. First is the 4-firm market share, a standard measure of concentration. This has increased in the past 10 years from 64% to 87% of sales. However, the Herfindahl index is a more revealing measure of potential market power since it reflects the market share distribution. When there are few, similarly sized firms in an industry, competitive forces are greater than when there are few firms of disparate size; the Herfindahl index captures this effect.[16] During the past 10 years, the Herfindahl index has increased from 1,617 to 2,818, reflecting an increase in the concentration of market power.

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[15]The data reported in Table 4.1 are firm data, not plant data. Many of the largest firms shown in Figure 4.1 are multiplant brewers.

[16]The Herfindahl index is derived as $H = \sum_{1}^{n} S_i^2 * 10,000$ where S_i is the market share of firm i. H ranges from 0, reflecting a perfectly competitive market, to 10,000, reflecting a pure monopoly.

TABLE 4.1. STRUCTURAL CHARACTERISTICS OF THE U.S. BREWING INDUSTRY

	1981	1990	1991
Number of Beer Companies		142	169
Sales (mill barrels)		190	189
Average		1.34	1.12
Minimum (barrels)		166	77
Maximum (mill barrels)		86.5	86
Structural Characteristics			
4-Firm Market Share %	64	86	87
Herfindahl Index	1,617	2,807	2,818

SOURCE: Derived from data in Modern Brewery Age.

Malt Utilization

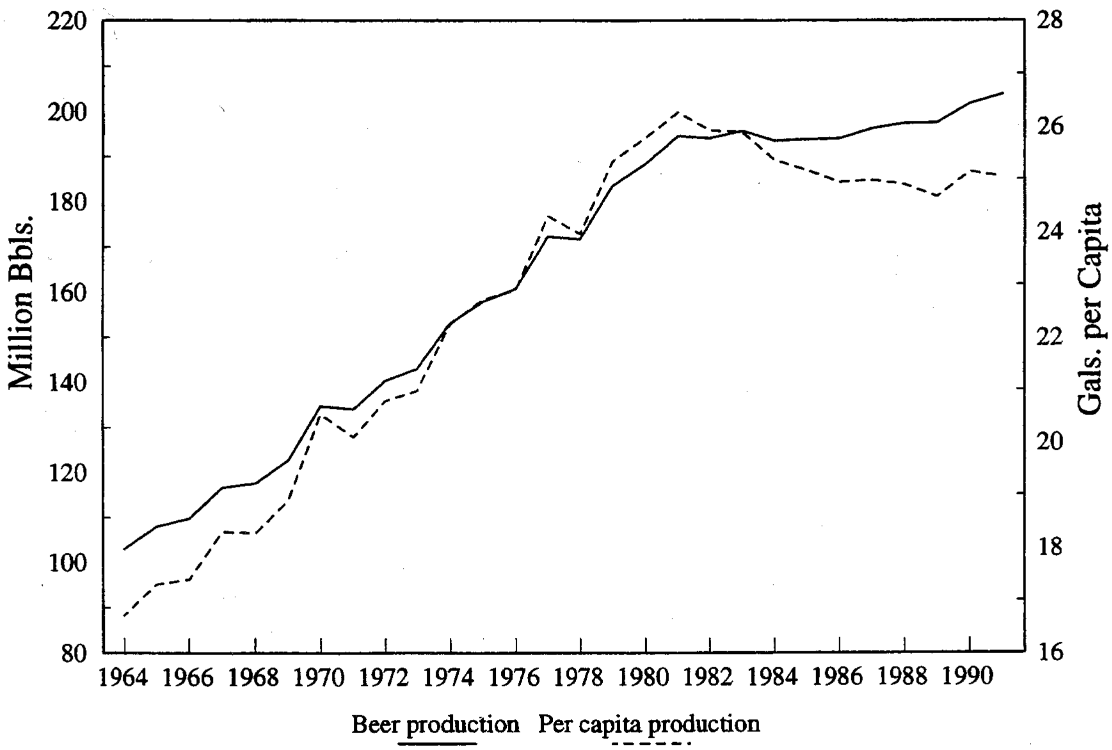
Beer consumption grew rapidly in the United States through the 1970s. During that period, beer production increased at about 4.6% annually. However, beer production has stabilized since 1980, while per capita consumption has decreased (Figure 4.2). Reasons for the decrease include changing population demographics, drunken driving laws, and increasing health consciousness.[17]

Malt utilized in beer production and use of other principal adjuncts are shown in Figure 4.3. The growth rate of malt utilization in the U.S. beer industry has slowed, as has that for corn. Utilization of rice has increased. Estimated growth rates evaluated at 1991 for these three ingredients are Malt, -.02% per year; corn, -.09% per year; and rice, +3% per year.[18] Thus, negligible growth in beer production and reduced utilization of malt have resulted in a declining domestic malt market.

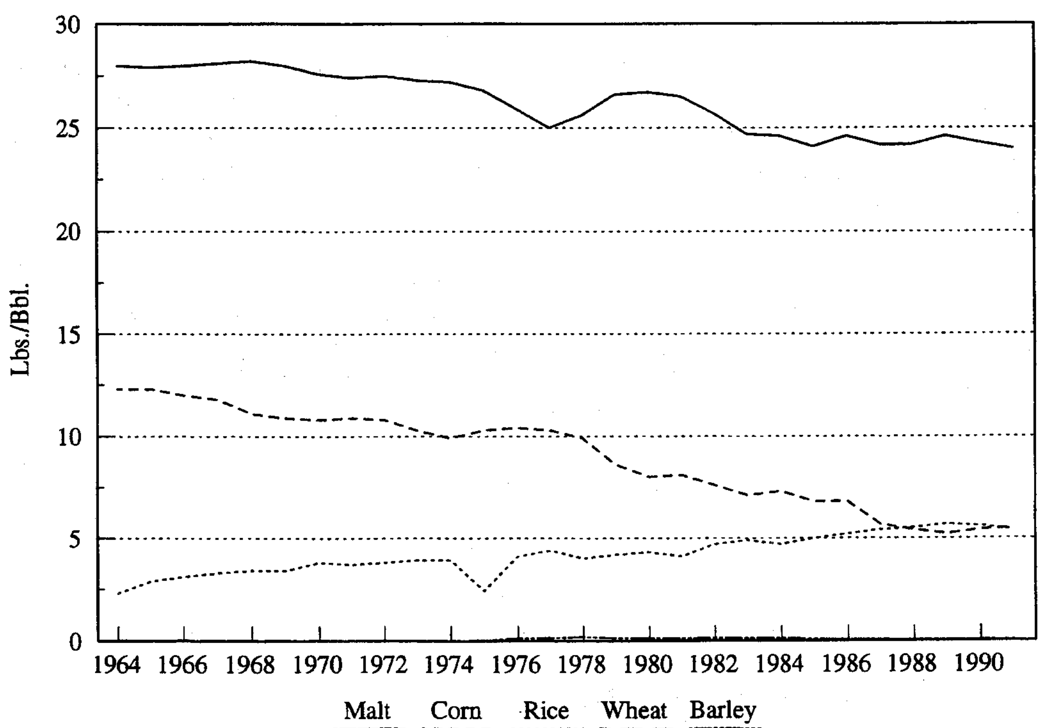
The reduced utilization rates of both malt and corn in U.S. beer production and increased use of rice are attributable to many factors, including 1) increased production and consumption of light beers, and 2) greater extraction rates from malt produced with new varieties. Malt comprised about 69% of ingredients in 1991. In Canada this figure is about 85%, implying utilization of 15% non-malt adjuncts.

[17]Similar trends have occurred in Canada. See the annual reports of the Brewers Association of Canada for a graphical depiction.

[18]Derived from regression of total utilization of each ingredient in beer production from 1964 to 1991, using a regression model of the following general form: $U=\alpha +\beta_1T+\beta_2T^2+\beta_3T^3$ where U is total utilization of each ingredient and T is a time trend with T=1 in 1968.



4.2. U.S. Beer Production, 1964-1991

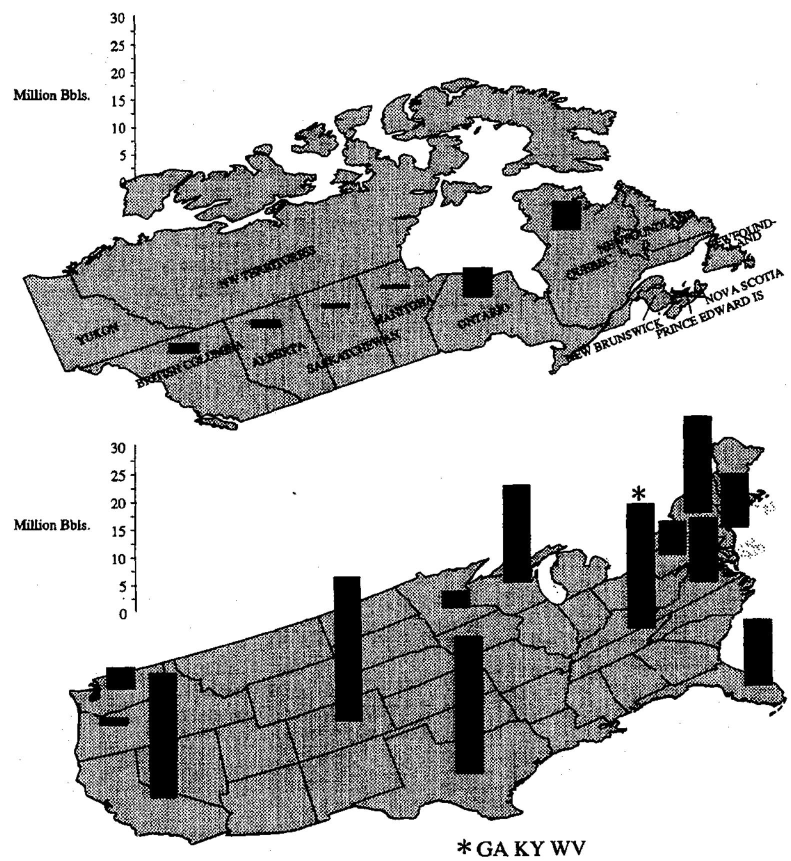


4.3. Ingredients Used in Beer Production: Per Barrel

Technical changes have encouraged ingredient substitution in beer production. These were estimated using a basic elasticity of substitution model, with trend term.[19] Estimated trend coefficients were -.03 and +.026 for malt/rice and malt/corn, respectively. Each coefficient was significant, and R^2s were .84 and .87, respectively. Trend coefficients measure changes in input utilization ratios through time. Malt utilization is decreasing relative to rice, but is increasing relative to corn.

Regional Estimates of Malt Demand

Beer production is geographically dispersed, but is generally concentrated near consumption regions. The geographical dispersion of production is shown in Figure 4.4. Some states are aggregated for disclosure reasons. The largest states (regions) for beer production and malt demand in 1991 were Arizona-Missouri-Idaho (reported as a single region), followed by Texas, California, and Georgia-Kentucky-West Virginia.



4.4. Beer Production by State and Province, 1991

[19]To evaluate substitutability among these ingredients in beer production, a basic elasticity of substitution model was estimated, using these prices and utilization levels. The model was specified as: $log(U_m/U_i)=\alpha_i+\beta_i[log(P_m/P_i)]+\beta_t[logT]$ where U and P are utilization and price, respectively, m is for malt and i is for other inputs and T is a time trend. In this basic model, β_i is the elasticity of substitution, measuring the response of input ratios to changes in relative prices.

5. U.S. Malting Industry

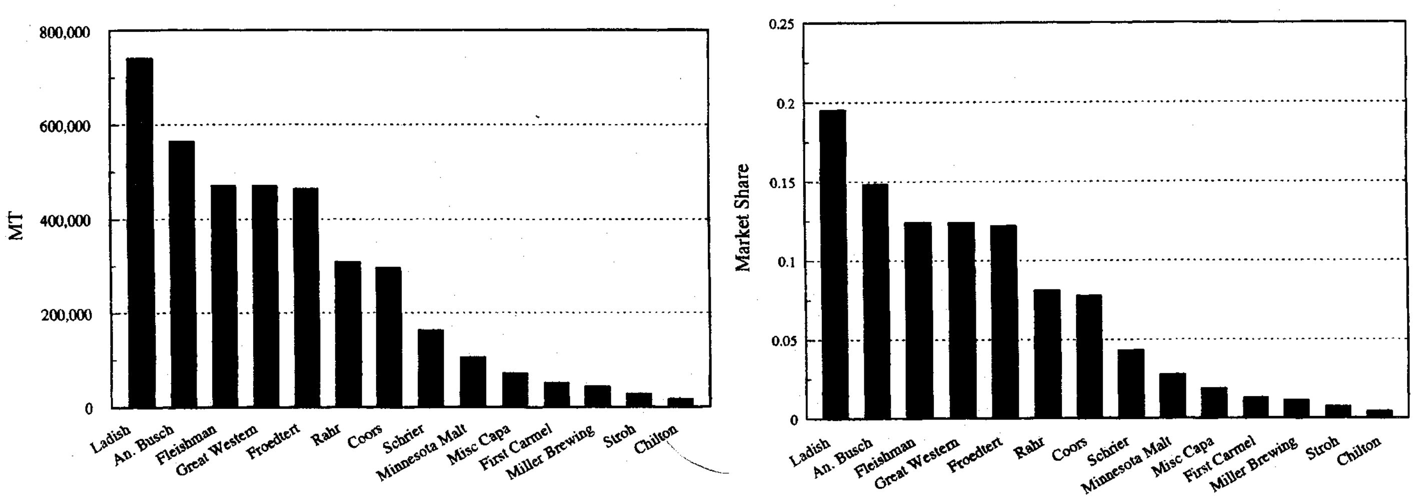
Structural Characteristics

The distribution of estimated capacities for the U.S. malting industry is shown in Figure 5.1. The industry is dominated by a few large privately held firms; however, their size differences are not as great as in the beer industry. Ladish has always been the largest maltster, followed in recent years by Anheuser-Busch, Fleischman-Kurth (a division of ADM), Great Western and Froedtert. Others are small, typically operating single-plant units.[20]

Structural characteristics of the North American industry are shown in Table 5.1. Industry capacity increased rapidly during the 1970s, generally coinciding with increases in malt demand by the beer industry. However, growth in capacity was minimal during the 1980s. The largest 4 firms control about 59% of capacity, up from about 37% in 1968. Brewer-controlled capacity has also increased from 16% in 1968 to about 27% in 1992.

The Herfindahl index rose from 687 in 1968 to 1208 in 1990, indicating increased concentration in the malting industry. However, the largest firms in the industry are of similar size, which intensifies competition in sales and procurement.

For comparison, the Herfindahl index calculated for Canada is 4010. If the malt industry is viewed within a combined North American geographical market, structural characteristics are similar to those for the United States alone.



5.1. Malt Industry: Firm Capacity and Market Share

[20]Detailed information of individual plants is shown in Canadian Wheat Board, p. 56. The data used here differs only slightly. The CWB data show an industry capacity in 1992 of 174 million bushels malt, whereas it is more readily accepted that the U.S industry is about 186 million bushels. The latter figures are used here.

TABLE 5.1. STRUCTURAL CHARACTERISTICS OF THE NORTH AMERICAN MALTING INDUSTRY

Item	1968 United States	1980 United States	1992 United States	1992 Canada	1992 North America
Number of Plants	na	37	23	6	29
Number of Firms	31	26	13	4	16
Industry Capacity *(million bu malt)*	96	178	186	39	225
Structural Characteristics					
Brewer Controlled	16%	20%	27%	59%	43%
4-Firm Market Share	37%	51%	59%	100%	60%
Herfindahl Index	687	1,009	1,208	4,010	1,178

Malting Capacity by State/Region

The geographic distribution of malt plants is illustrated in Figure 5.2 with comparisons to malt demand by breweries. Historically, the industry developed in Wisconsin and Minnesota, and these states still dominate the industry. In the early 1970s, Ladish expanded with a new plant in North Dakota. Other new capacity in recent years has been added in Idaho to capture the expected growth in west coast demand for beer and barley production in those states.

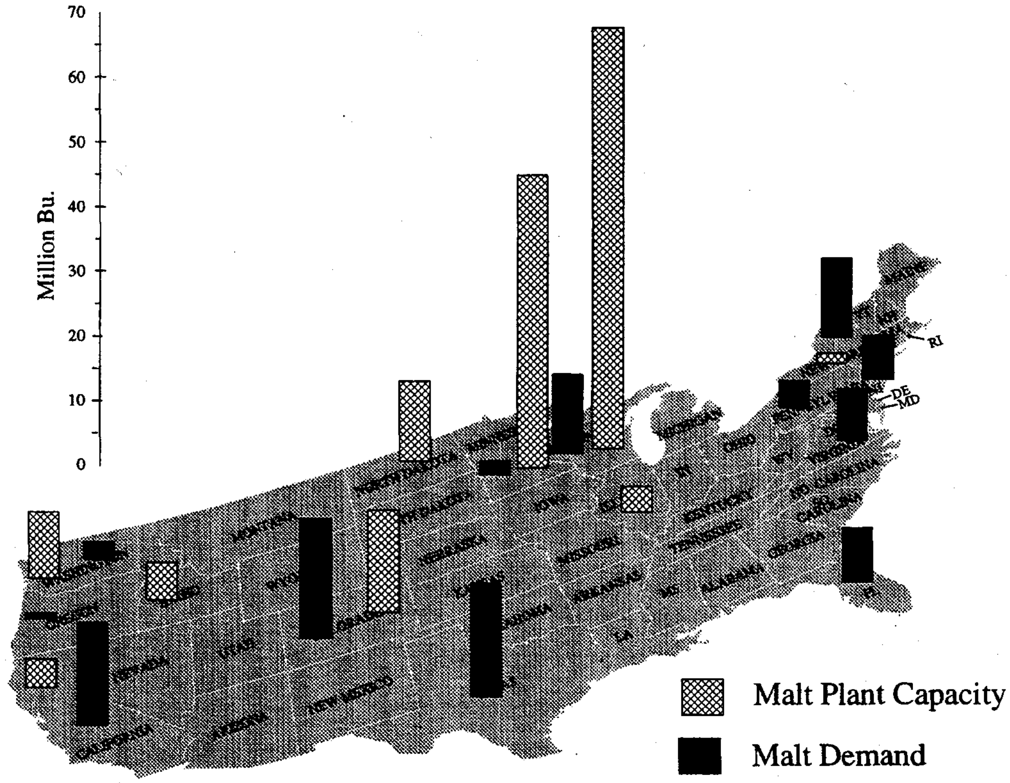
Firm Strategies

The U.S. malting industry is relatively concentrated. However, demand is stagnant, and excess capacity exists. At least 4 elements of broader firm strategies are apparent:

Globalization. The U.S. industry has been dominated by large single-plant private firms. However, over the past decade numerous changes generally have reflected a more global industry.

Cargill entered into a joint venture with Ladish in 1991. This represents Cargill's first entry into the U.S. malting industry, though it remains the largest maltster company in France and the world. Froedtert, previously owned by Harvest States Cooperative, was sold to a consortium of firms, who eventually sold to a large French malting firm.

At least 3 significant changes have occurred within North America in the past few years: 1) Great West Malting Company, previously a subsidiary of Univar, was acquired by Canada Malting, the largest malt company in Canada, making Canada Malting the largest malt firm in North America; 2) Schrier purchased 51% of Prairie Malt (along with 42% by Saskatchewan Wheat Pool and 7% by employees) in September 1989; 3) ADM,



5.2. U.S. Malt Plant Supply and Demand

which owns Fleischman Kurth, the second largest non-integrated maltster in the United States, bought 65% of Dominion Malt in September 1990[21]; and 4) Rahr has entered into a joint venture to build a new plant in Alix, Alberta.

Vertical Coordination. Before the early 1970s, brewery firms were not extensively integrated into malting in the United States. However, beginning with the expansion of Anheuser-Busch into malting in the early 1970s, interfirm rivalry has intensified. Anheuser-Busch and Coors are extensively integrated into malting. Other brewers have malt plants (e.g., Miller, Genesea, Stroh), but on a lesser scale. In 1992, 28% of the capacity in the United States was owned and operated by brewery firms, up from about 16% in 1970. In addition, a common practice is for brewers to enter into "toll-malting" arrangements.[22]

Some brewers are also actively involved in the country elevator business, farmer contracting and variety development. Anheuser-Busch began integrating into the country elevator business in 1983. All brewers are involved in variety development through their industry associations. However, Anheuser-Busch and Coors each have seed companies to develop varieties, and to clean and distribute seed to growers under contract.

Procurement Strategies. An important element of strategy is barley procurement. Two of the top three brewers have been actively involved in contracting programs. Anheuser-Busch has been involved in breeding programs since the early 1970s. Coors develops its own varieties and has contracted with producers for virtually all of its needs.

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[21]A minor share is held by a Japanese group.

[22]Brewers supply maltsters with barley and the maltsters collect a toll for processing services. This gives brewers complete control over barley selection.

However, Coors has recently announced cutting its contracting program, and Anheuser Busch has changed its approach to contracting.

Exports. Until recently, the United States has not been an active exporter of malt. However, the U.S. malting industry is pushing to expand exports with assistance from the Export Enhancement Program (see below).

Industry Capacity Utilization Rates

Table 5.2 shows elements of supply and demand for capacity in the U.S. domestic malt industry[23] with comparisons to Canada.[24] These are also shown in Figure 5.3. Imports and exports are minimal, though exports have grown rapidly in the past several years. Exports comprised only about 5% of 1992 malt production in the United States, compared to 41% in Canada. Capacity utilization in the U.S. industry is about 81%, down sharply from the late 1960s.

Important points demonstrated in this table are 1) there is a greater use per barrel in Canada; 2) exports comprise a greater share of production in Canada than in the United States; and 3) capacity utilization is somewhat greater in Canada than in the United States.

U.S. Malt Trade

The United States has routinely imported malt since the mid-1940s. In some years, imports were as great as 60,000 mt. However, malt imports have been declining since the early 1980s (Figure 5.4). Virtually all malt imports are from Canada. The United States has also been an exporter of malt since the 1940s. However, the volume decreased from about 100,000 mt per year in the late 1940s, to less than 20,000 mt in the late 1970s. Since then, malt exports have expanded rapidly, nearly tripling during the 1980s.

Principal destinations for malt exports are shown in Figure 5.5. The largest markets in recent years are Mexico, the United Kingdom, Japan, and the Philippines. Numerous other small markets exist, primarily in the Caribbean and South America.

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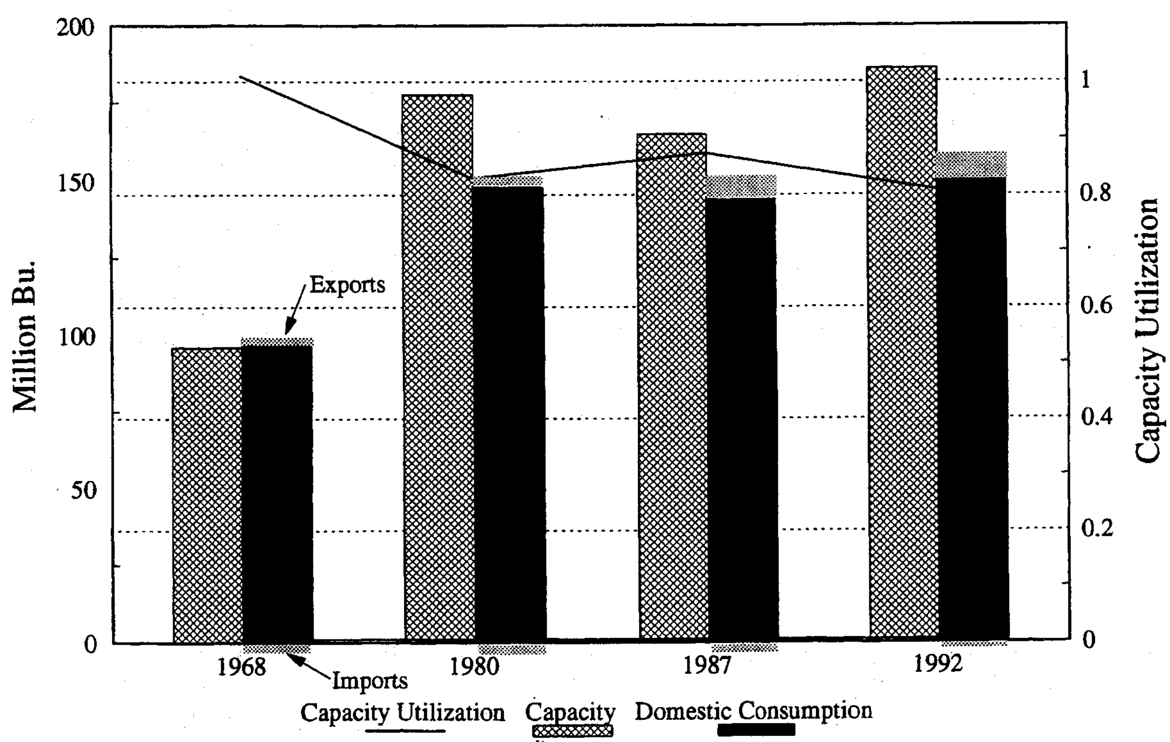
[23]Industry estimates vary but generally suggest that Coors requires 100% 2-Rowed, while Anheuser-Busch utilizes about 70% 6-Rowed, and 30% 2-Rowed. Miller utilizes up to 20% 2-Rowed and other brewers utilize virtually all 6-Rowed malts. Combining these figures with industry sales indicate that U.S. demand for 2-Rowed malt is about 40 million bushels.

[24]Some Canadian plants reportedly are in the process of expanding due to anticipated exports to Asia and Japan and/or to increase efficiency.

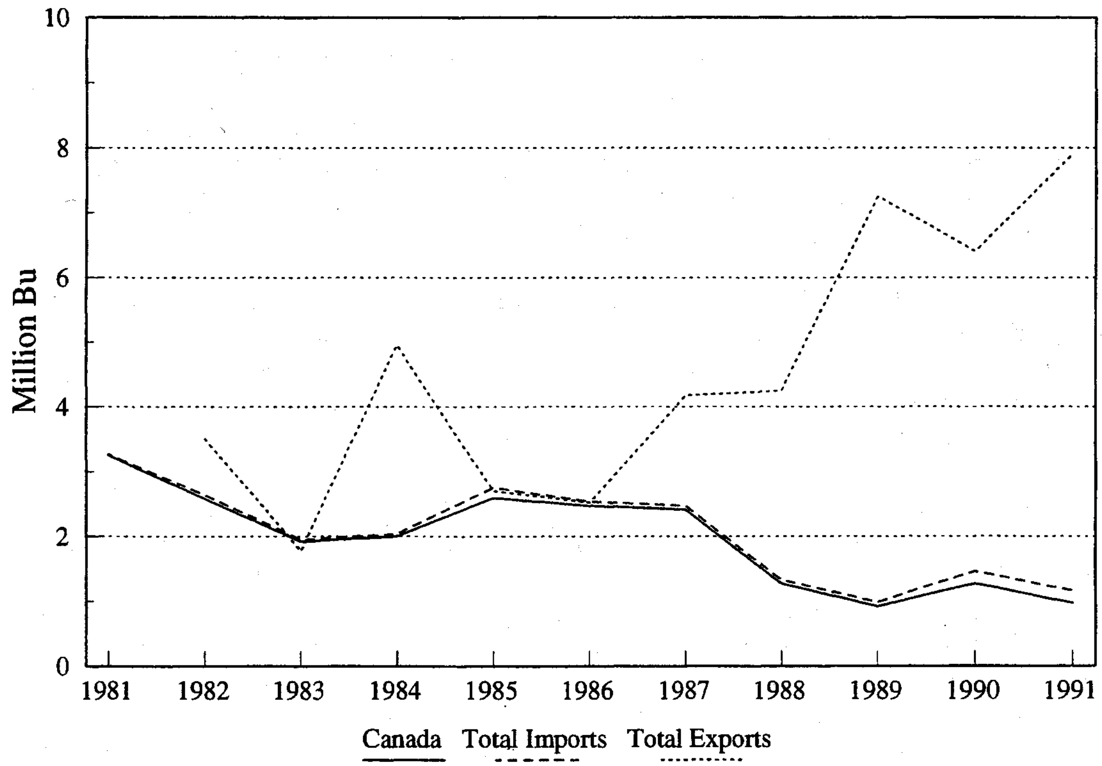
TABLE 5.2. COMPARATIVE STATISTICS: U.S. AND CANADIAN MALTING

	Units	United States 1968	United States 1980	United States 1992	Canada 1992	N.Am 1991
Malt Beverage Production	mill brl	117	188	203	17	220
Use Per Barrel	lb/brl	28.2	26.7	24.0	39.5	
Domestic Malt Used	mill bu	97	148	144	19.5	164
Malt Export	000 mt	36	39	122	205	
Malt Import	000 mt	36	45	18		
% Production Exported		2	2	5	41	
Total Malt Production	mill bu malt	97	148	150	32.8	183
Total Capacity	mill bu malt	96.05	178	186	39	225
Capacity Utilization		1.00	0.83	0.81	0.84	

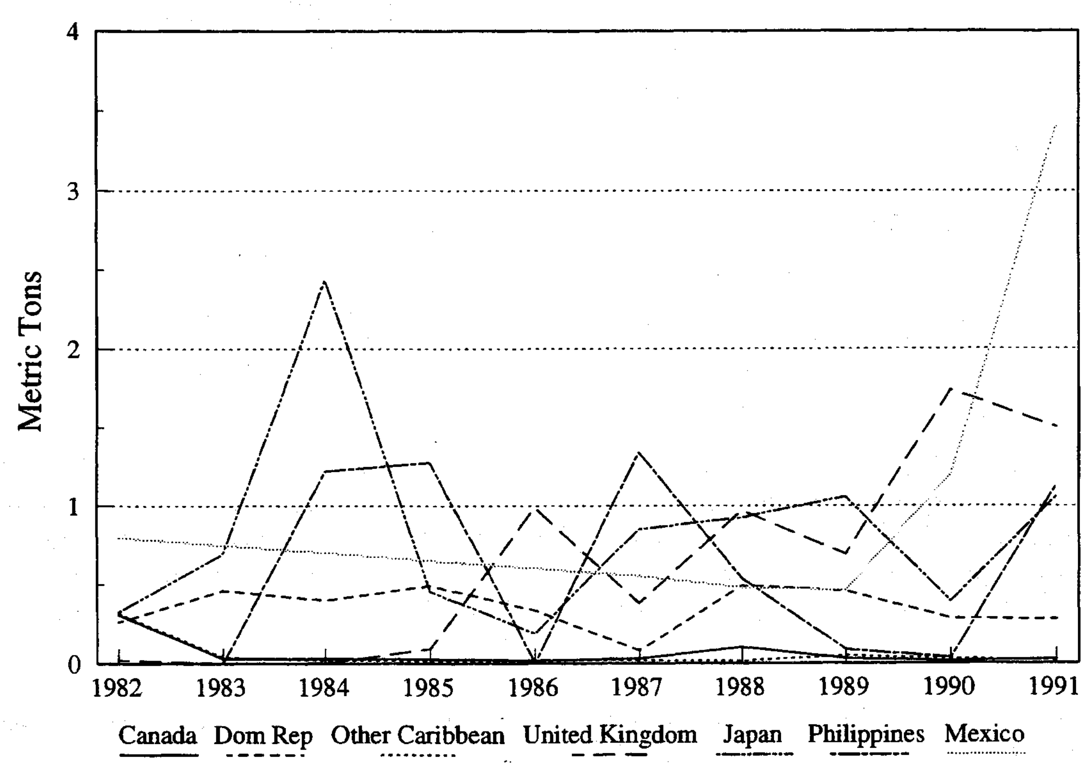
SOURCES: Derived from data contained in Brewers Almanac, U.N. FAO Commodity Trade Statistics, Trade Yearbook, various years, Canada Grains Council Statistical Handbook, and Canadian Wheat Board (December 1992). Industry capacity in Canada includes Westcan Malt in Alix, Alta.



5.3. Capacity Utilization and Distribution of U.S. Malt Plants



5.4. U.S. Malt Imports



5.5. U.S. Malt Exports

China is a major importer and potential growth market for malt and/or malting barley. However, as is true for many malt importers, China has a strong preference for 2-rowed varieties.[25] U.S. maltsters have been working with some Chinese brewers. In general, these brewers are "impressed and comfortable" with U.S. 2-rowed barley, although they "still have some concerns about 6-rowed barley (primarily the fear of higher protein levels)" (Barley Bulletin, December 1992).

Malt has been targeted in numerous EEP initiatives, beginning in 1986. Since then, nearly 300,000 mt of malt have been sold through this program. The Targeted Export Assistance (TEA) program has also been used to promote U.S. malt exports. Sample shipments are sent to buyers, primarily in Latin America, to familiarize them with U.S. malt varieties.

A summary of the use of EEP in the U.S. barley sector is shown in Table 5.3. All figures are for the crop years from 1985/86 through 1991/92. Barley sales under EEP during this period were 11.4 mmt, compared to 257,000 mt of malt. Barley sales under EEP have a greater chance of being consummated relative to those of malt, with 78% for barley versus 33% for malt.[26] The average bonus on malt is nearly 3 times as great as that for barley. Barley sales ranged from 397,000 mt in 1985/86 to a high of 2.9 mmt both in 1986/87 and 1987/88. Malt exports increased from 43,919 mt in 1985 to 122,244 mt in 1991. From 1985/86 to 1991/92, percentages of U.S. exports sold under EEP have been 84% and 41%, respectively, for barley and malt (Table 5.3).

TABLE 5.3. SUMMARY OF EEP IN U.S. BARLEY SECTOR (1985/86 TO 1991/92)

	Barley	Malt
Initiatives (000 mt)	14,650	780
Sales Under EEP (000 mt)	11,436	257
Sales of Initiatives (%)	78	33
Total Exports (1985/86 to 1991/92) (000 mt)	13,586	625
Sold Under EEP (%)	84	41
EEP Bonus Weighted Average ($/mt)	$32	$97

Derived from USDA data sources.

In October 1992, breaking convention, Colombia (50,000 mt) and Turkey (100,000 mt) were targeted specifically for "malting barley"; however, no sales were consummated. Targeted countries for barley include Algeria, Bulgaria, Cyprus, Hungary, Iraq, Israel, Jordan, Malta, Morocco, Poland, Romania, Saudi Arabia, Switzerland, Tunisia, Turkey, and FSU. Targeted countries for malt include Algeria, Brazil, Burundi, Cameroon,

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[25]This is due to tradition. Europe dominates the world malt market and has trained brewers to use its 2-rowed varieties.

[26]For malt, the sum of initiatives include those that were canceled as well as those that did not result in transactions.

Philippines, and Venezuela. Important non-EEP customers include Denmark, the United Kingdom, and Japan.

6. Overview of the Spatial Equilibrium Model

A mathematical programming model was developed to analyze North American barley flows. The United States and Canada are divided into different producing and consuming regions; to these are added several export markets for barley and malt. The objective is to maximize the sum of producer and consumer surplus in feed barley markets less the cost of satisfying fixed regional demands for malt. This formulation treats malt demand as completely inelastic, while allowing feed barley prices and quantities fed (by region) to vary. By design, conditions of competitive spatial equilibrium are satisfied in the model solution.[27]

The model analyzes barley flows within a marketing year and with fixed supplies. For each barley-producing region, available supplies are based on average annual production (acres times yield). The model does not incorporate storage activities; all barley demand is for current use, either for feed or production of malt. Equivalently, we assume no net change in stocks (and no spatial redistribution of stocks) during the marketing year.

Figure 6.1 provides a description of the disposition of barley and malt in the model. Barley is shipped from producing regions to feed demand regions, including export markets. Malting barley is shipped to malt plants where, subject to capacity constraints, it is converted into malt for reshipment to malt demand regions (i.e., North American breweries and offshore malt markets).

Barley Supplies

There are 30 barley supply regions, including 23 in the United States and 7 in Canada. Supply regions are identified with crop reporting districts in selected states (the Dakotas and Minnesota). Montana is divided into eastern and western sections, while other Western states are left whole. Manitoba and Saskatchewan are divided into southern and northern sections, while Alberta is divided into southern, central, and northern sections. This permits refinement of north/south shipping costs, an important determinant of trade flows in model simulations.

Barley supplies include four distinct types: feed barley (varieties not suitable for malting), 6-rowed white malting, 6-rowed blue malting, and 2-rowed malting. For each producing region, supplies are divided among the four types, based on (a) average acres planted to individual varieties and (b) an assumed yield differential between feed and malting varieties. In base-case simulations, the yield for feed varieties is assumed to be 10% higher yield than for malting varieties.

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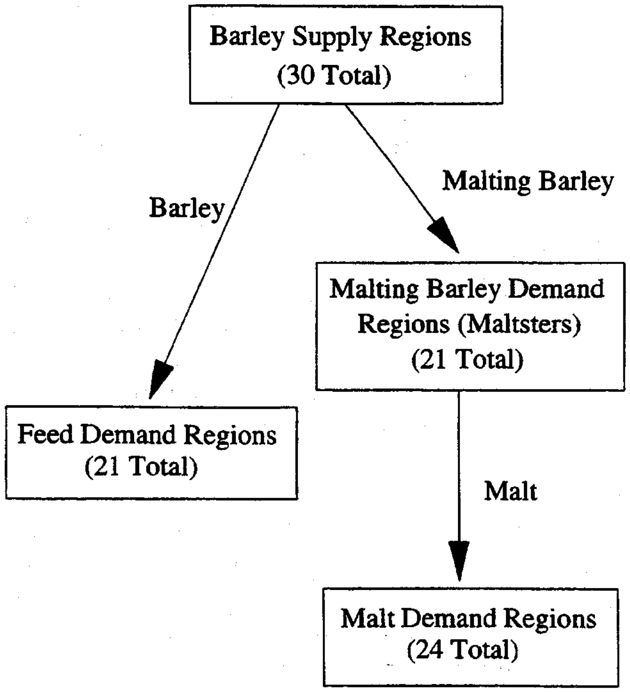
[27]See Takayama and Judge for background on quadratic programming applications to spatial equilibrium.



6.1. Barley and Malt Flows in the Model

Malting barley supplies also reflect adjustments for crop quality. For U.S. producing regions, the availability of malting barley is adjusted to reflect average crop quality, as indicated by state-level quality data. In North Dakota, for example, 67 percent of the production of malting varieties is assumed to be of "malting quality." That is the average percentage of North Dakota samples graded as U.S. No. 3 or better, based on annual crop quality surveys from 1987-91. Different percentages apply to other producing states.

Quality adjustments for Canada take into account the regional pattern of malting barley deliveries during 1987-91.[28] Because historical selection rates understate the true amount of malting-quality barley in Canada, we use modified rates. The modifications ensure that 2.5 million metric tons of Canadian barley are available for malting.[29]

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[28]See Carter, p. 10, for malting deliveries relative to total deliveries by Canadian crop district.

[29]Let s_i represent the historical acceptance rate (percentage) for Canadian region i, and let M_{ij} represent the quantity of malting type j produced in region i. The adjusted rate, f_i, is given by $f_i = s_i + \theta(90 - s_i)$, where $0<\theta<1$ and

$$\sum_i \sum_j f_i M_{ij} = 2.5 \text{ million mt}$$

For practical purposes, 90 percent is the maximum acceptance rate. Adjustments in each region are proportional to $(90 - s_i)$; hence, they are larger, in percentage terms, for regions where historical selection rates have been low. However, traditional supply regions (where s_i values are high) retain a quality advantage.

For each region, supplies of malting barley are calculated as follows. Let M_{ij} denote the supply in region i of malting type j (6-rowed white, 6-rowed blue, or 2-row). Let A_i denote the total planted acreage in region i; V_{ij}, the fraction of acres planted to malting type j; Y_i, the average (planted) yield; and G_i, the fraction of production that grades as malting. Regional supplies are given by

$$M_{ij} = A_i \cdot V_{ij} \cdot Y_i \cdot G_i$$

The supply of feed barley is calculated as a residual: total barley production in a region less malting barley. Regional supply parameters are shown in Table 6.1.

Quality differences in supply are important because demand requirements vary across brewers. The four types of barley are assumed to be perfectly substitutable in feed demand. The model allows malting barley to be sold for feed; supplies of feed barley, however, have no alternative use. Figure 6.2 shows aggregate barley supplies by type for the United States and Canada under base-case assumptions.

Regional Feed Demand

There are 21 feed demand regions in the model, including 13 in the United States, 6 in Canada, and 2 export markets. The North American regions are states (western and midwestern) and provinces with significant feed demand.

Data on feed use are not published on a regional or state level.[30] Consequently, it was not possible to estimate regional demand functions using econometric techniques. State and province-level demand functions for feed barley were synthesized from an optimization model. Specifically, we used the regional least-cost feed model developed by Johnson and Varghese. That model combines diet formulations for several classes of livestock in a single linear-programming problem. Using 1992 livestock inventories as scaling factors, the LP model was adapted for 13 individual states and 6 provinces. Prices of substitute feeds were those observed in each region in April, 1993.[31] Synthetic demand schedules were derived by varying the price of barley incrementally, holding other prices constant. Demand schedules were linearized for insertion into the spatial model.

Results of this analysis are shown in Table 6.2. Demand schedules for selected regions are also compared in Figure 6.3. A quantity limit is established for each region, corresponding to estimated total consumption of feed grains. By this criterion, California holds the largest potential as a market for feed barley. California is also a high-priced barley market, owing to costs of substitute feed grains. States in the Pacific Northwest

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[30]Barley feed use is only estimated on a national basis--and then only indirectly, based on current production, stock levels, trade, and food and industrial (malting) uses.

[31]Canadian prices were converted at an exchange rate of US $.79 per Canadian dollar.

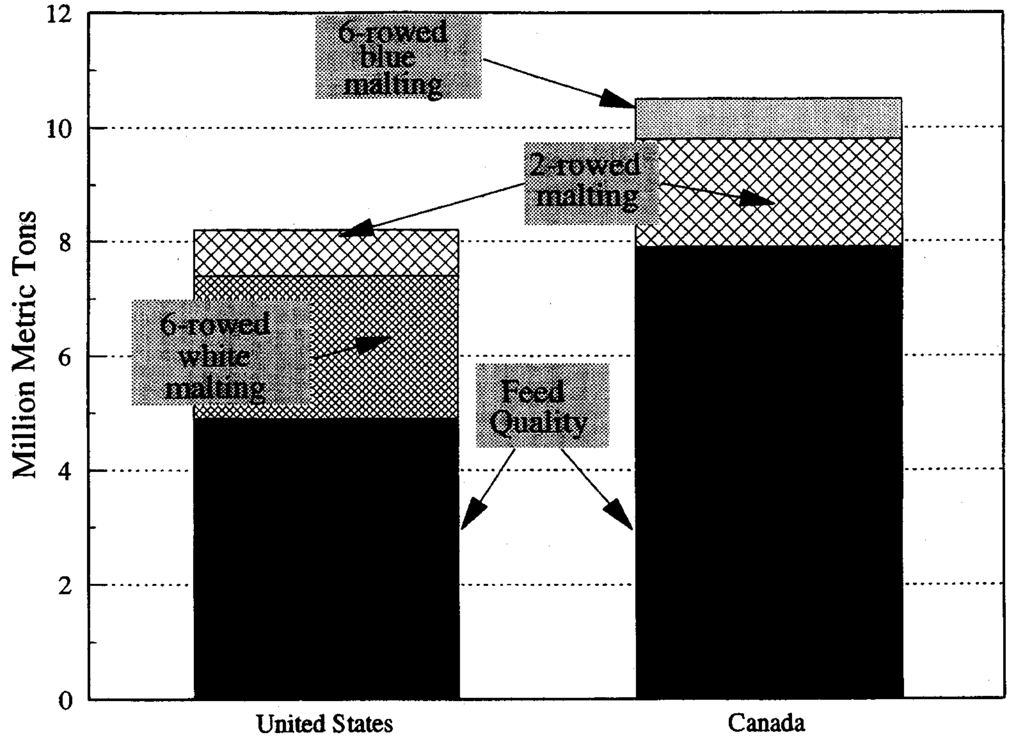
TABLE 6.1. SUPPLY PARAMETERS FOR SPATIAL EQUILIBRIUM MODEL

Supply Region	Basing Point for Calculation of Freight Costs	Total Acres, '000	Malting Acres as % of Total Acres	Distribution of Malting Acres by Type, %			% Graded as Malting †	Average Yield for All Barley, bu/a
				2-Rowed Malting	6-Rowed White Malting	6-Rowed Blue Malting		
U.S. Supply Regions								
California	Fresno	220	0	0	0	0	0	60
Colorado	Denver	147	51	89	11	0	90	75
Idaho	Moscow	798	41	46	54	0	91	70
Minnesota, CRD-1	Crookston	642	97	0	100	0	71	56
Minnesota, CRD-4	Morris	123	95	0	100	0	71	48
Eastern Montana	Culbertson	248	5	86	14	0	80	29
Western Montana	Shelby	1,168	40	90	10	0	80	44
North Dakota, CRD-1	Minot	287	69	0	100	0	67	37
North Dakota, CRD-2	Rugby	343	89	0	100	0	67	43
North Dakota, CRD-3	Larimore	721	97	0	100	0	67	51
North Dakota, CRD-4	Beulah	103	26	0	100	0	67	36
North Dakota, CRD-5	Jamestown	181	87	0	100	0	67	42
North Dakota, CRD-6	Hunter	509	96	0	100	0	67	54
North Dakota, CRD-7	Scranton	114	5	0	100	0	67	32
North Dakota, CRD-8	Linton	84	21	0	100	0	67	34
North Dakota, CRD-9	Hankinson	203	73	0	100	0	67	46
Oregon	Pasco	167	6	31	69	0	80	70

TABLE 6.1. (CONTINUED)

Supply Region	Basing Point for Calculation of Freight Costs	Total Acres, '000	Malting Acres as % of Total Acres	Distribution of Malting Acres by Type, %			% Graded as Malting †	Average Yield for All Barley, bu/a
				2-Rowed Malting	6-Rowed White Malting	6-Rowed Blue Malting		
			- Continued -					
South Dakota, CRD-2	Selby	162	68	0	100	0	45	42
South Dakota, CRD-3	Bristol	118	87	0	100	0	45	35
South Dakota, Other	Wosley	188	45	0	100	0	45	29
Utah	Salt Lake City	111	52	82	18	0	90	80
Washington	Spokane	490	9	78	22	0	90	58
Wyoming	Powell	123	67	100	0	0	90	73
			Canadian Supply Regions					
Central Alberta	Edmonton	2,117	49	70	0	30	8	55
Northern Alberta	Grande Prairie	1,152	37	62	0	38	7	51
Southern Alberta	Lethbridge	1,752	63	93	0	7	55	52
Northern Manitoba	Winnipeg	454	43	18	2	80	13	52
Southern Manitoba	Kilarny	936	53	12	0	88	21	51
Northern Saskatchewan	Saskatoon	2,720	87	74	1	25	31	43
Southern Saskatchewan	Weyburn	562	84	81	0	19	42	38

† For U.S. regions, percent of malting variety production grading as No. 3 or better; for Canadian regions, average selection rates. The latter are modified in model simulations; see text.



6.2. Barley Production by Type, U.S. and Canada, Base-case Assumptions

also have high-priced barley markets relative to those in the Midwest. Among Prairie provinces, Alberta is the largest potential market for feed barley, followed by Saskatchewan.

None of the other studies on North American barley explicitly model regional demands (as distinct from total feed grain use), so it is not possible to compare our regional demand elasticities with those of other studies. However, the finding that regional demand schedules for barley are highly price elastic is consistent with expectations, given the availability of corn and other substitutes for barley in livestock rations.[32]

An important institutional relationship exists in some Prairie provinces. In particular, Alberta has subsidized local barley feeding under the *Crow Benefit Offset Program*. In Saskatchewan, the *Feed Grain Market Adjustment Program* is used to the offset the competitive disadvantage of Saskatchewan livestock producers vis-a-vis other provinces. For model simulations, we capture the effects of these programs through assumptions on transport and handling costs for intra-provincial barley flows.[33]

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[32]The Carter report also supports the view that U.S. markets are highly elastic. The price elasticity of U.S. demand for Canadian barley was estimated at -19 (p. 59).

[33]Specifically, we reduce the transportation and handling costs for intraprovincial flows in Alberta and Saskatchewan by U.S. $7.9/mt. This adjustment encourages feed use within those provinces in the base case. In alternative model simulations, when compensatory rail rates are assumed, we eliminate these local feed subsidies.

TABLE 6.2. DEMAND PARAMETERS FOR REGIONAL FEED BARLEY MARKETS

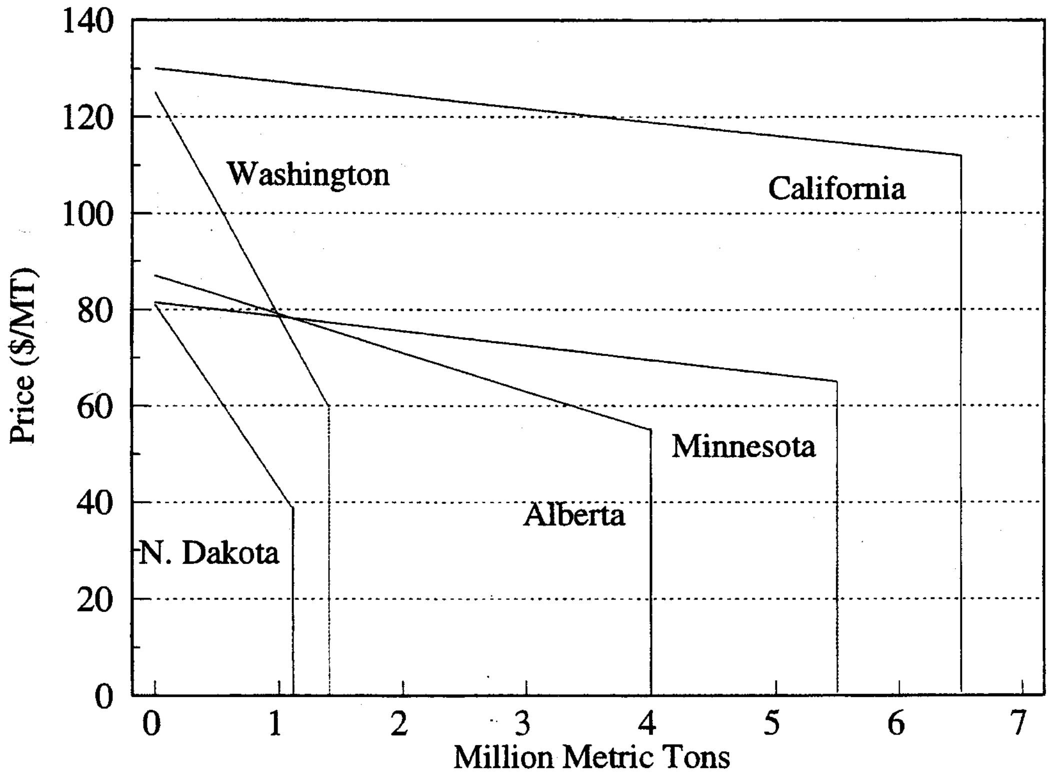
State or Province	Constant †	Slope †	Max. Barley Quantity ('000 mt)	Price Elasticity of Demand ‡
Arizona	119.2	-.02515	676	-13.0
California	128.5	-.00391	6,453	-9.2
Colorado	98.9	-.00684	2,686	-9.7
Idaho	114.7	-.03726	1,351	-3.6
Minnesota	82.4	-.00318	5,500	-8.4
Montana	108.1	-.04919	962	-3.6
North Dakota	81.5	-.03983	1,100	-2.7
Nevada	128.7	-.15724	350	-3.7
Oregon	122.1	-.02352	973	-9.7
South Dakota	86.3	-.00622	2,500	-10.1
Utah	110.4	-.02911	550	-12.8
Washington	124.4	-.04502	1,434	-2.9
Wyoming	99.4	-.07780	543	-3.7
Alberta	86.9	-.00804	4,000	-4.4
B. Columbia	99.7	-.06357	500	-5.3
Manitoba	70.2	-.01376	1,000	-9.2
Ontario	82.0	-.00984	2,000	-6.6
Quebec	87.6	-.00833	1,600	-12.1
Saskatchewan	73.1	-.01257	2,000	-4.8

† Parameters from regression equation: $P = \alpha + \beta \cdot Q$ where P is the feed barley price and Q is demand quantity (derived from regional feed model).
* Estimated total consumption of feed grains (Carter report and authors' estimates).
‡ Evaluated at midpoints of derived demand schedules.

Export Demand

The two export markets represent aggregates of two groups of countries: those that receive U.S. export subsidies under the EEP program ("subsidized" markets) and those that do not ("nonsubsidized" markets). All exports are assumed to be made through the Pacific ports, Portland and Vancouver.[34]

[34]The vast majority of North American barley exports have been made through West Coast ports.



6.3. Feed Demand in Selected Regions

For the subsidized market, we estimated a single demand equation for North American barley exports. Annual data from 1973-91 were used to estimate the following regression (t-statistics in parentheses):

$$ABP = 15.29 + .9021\ PC - .0129\ QX \qquad \text{Adj. R-sq: .902}$$
$$(.947) \qquad (6.651) \qquad (-5.959) \qquad \text{DW: 1.796}$$

where ABP is the adjusted barley price (Portland price, adjusted for average EEP bonus in 1986-91), PC is the export corn price (Gulf ports), and QX is the volume of North American barley exports ('000 metric tons) to countries that received EEP subsidies during 1986-91.

This equation yielded an estimated price elasticity of demand of -3.1, evaluated at mean prices and trade volumes for the period when EEP was used. We were unable to obtain satisfactory statistical results for the nonsubsidized market; for simplicity, we use Carter's elasticity (-1.9) for Canadian exports to Japan. Trade volumes used to construct offshore demand parameters are shown in Table 6.3.

The model reflects several features of the current policy regime affecting exports. EEP bonuses ($32 per metric ton under the base case) apply to all U.S. shipments to the subsidized export market.[35] Export prices, measured at Pacific ports, reflect the EEP

[35]The model does not allow Canadian barley to earn the EEP subsidy after transshipment through the United States.

TABLE 6.3. OFFSHORE DEMAND FOR NORTH AMERICAN FEED BARLEY

	Subsidized (EEP) Markets	Nonsubsidized Markets
Price Elasticity of Demand for Barley	-3.1	-1.9
Avg. Export Price, 1986-91 ($/mt))	81	113
Avg. N. American Exports, 1986-91 (million mt)	2.0	2.2

subsidy and the Canadian Wheat Board's control over shipments to offshore markets. In particular, the export price to nonsubsidized markets is constrained to be less than or equal to the subsidized price plus EEP bonus. This is consistent with price discrimination by the Canadian Wheat Board in its offshore sales and Canadian success in capturing unsubsidized export markets.[36]

Malting Barley Demand

Demand for malting barley is derived from the demand for malt, which is fixed by region. Barley is converted into malt at a fixed ratio: 1 ton of barley yields .75 tons of malt. Malt production location is endogenous in the model, and malt sourcing by brewers reflects their variety requirements, transportation differentials, plant capacities, and vertical integration in the brewing industry.

There are 19 malt plant locations in the model: 13 in the United States and 6 in Canada. Capacity constraints (equal to those reported by the Canadian Wheat Board) are applied to each malting location.

An important feature of the malting industry is that several of the larger brewers have pursued strategies of vertical integration into the malting sector. This structural characteristic was built into the analytical model in the form of constraints. First, malt produced by brewer-owned plants is shipped exclusively to breweries within the same company. Second, brewer-owned malt plants are constrained to use 100% of their capacity.

The two major export markets for malting barley are China and Mexico. These are representative of export markets served by different transportation linkages. U.S. barley is shipped by rail via El Paso to Mexico and via Portland to China. Export volumes of malting barley from the United States and Canada are fixed at recently observed levels.

[36]In practice, U.S. exports to nonsubsidized markets have not been significant.

Malt Demand

Malt demand is fixed by region. There are 24 malt demand regions in the model: 16 in the United States, 6 in Canada, and 2 offshore markets. North American regions are identified with states or provinces, and demand quantities are based on annual beer production.

Different conversion factors apply for malt usage by Canadian and U.S. brewers. In Canada, each barrel of beer requires 39.5 lbs of malt; in the United States, each barrel requires 24 lbs of malt due to greater use of adjuncts.

U.S. and Canadian brewers also have different malt quality requirements. In general, U.S. beers make extensive use of malt produced with 6-rowed white aleurone barley, while Canadian beers rely heavily on 2-rowed varieties. These requirements vary by brewer, and the model accounts for this in demand specifications for individual regions. Malt requirements for individual brewers were identified through discussions with industry representatives. These are shown in Table 6.4. Aggregate domestic requirements, by type, are shown in Figure 6.4.

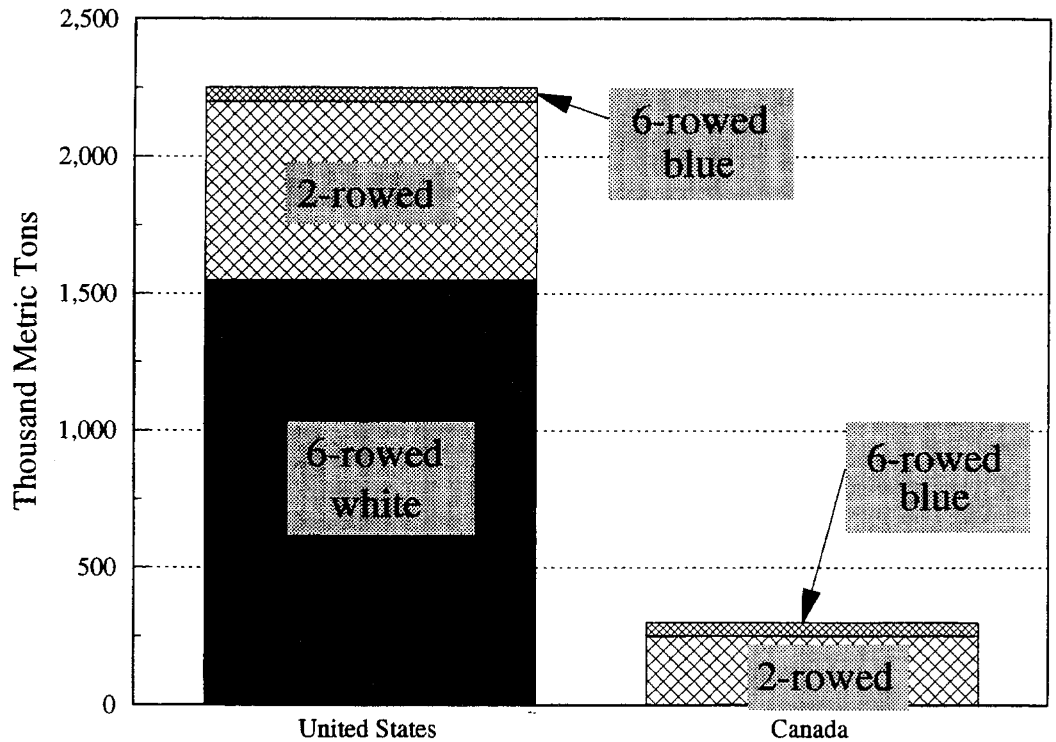
TABLE 6.4. MALT REQUIREMENTS OF BREWERS

Company	6-rowed White	6-rowed Blue	2-rowed
		Percent	
Anheuser-Busch	70		30
Miller	80-100		0-20
Coors			100
Other U.S.	90-100	0-10	
Labatts		50	50
Other Canadian			100

For each region, malt requirements reflect market shares of individual brewers. Market shares are calculated on the basis of local production capacity. For example, malt requirements for Colorado reflect a weighted average of requirements for Coors and Anheuser-Busch, the two brewers with significant capacity in that state.

Tariffs

The U.S. import duty for barley is $1 per metric ton, while that for malt is $3 per metric ton. Canada does not impose import duties. In individual model simulations, imports from the United States can be constrained to mimic the effects of Canada's import license requirements.



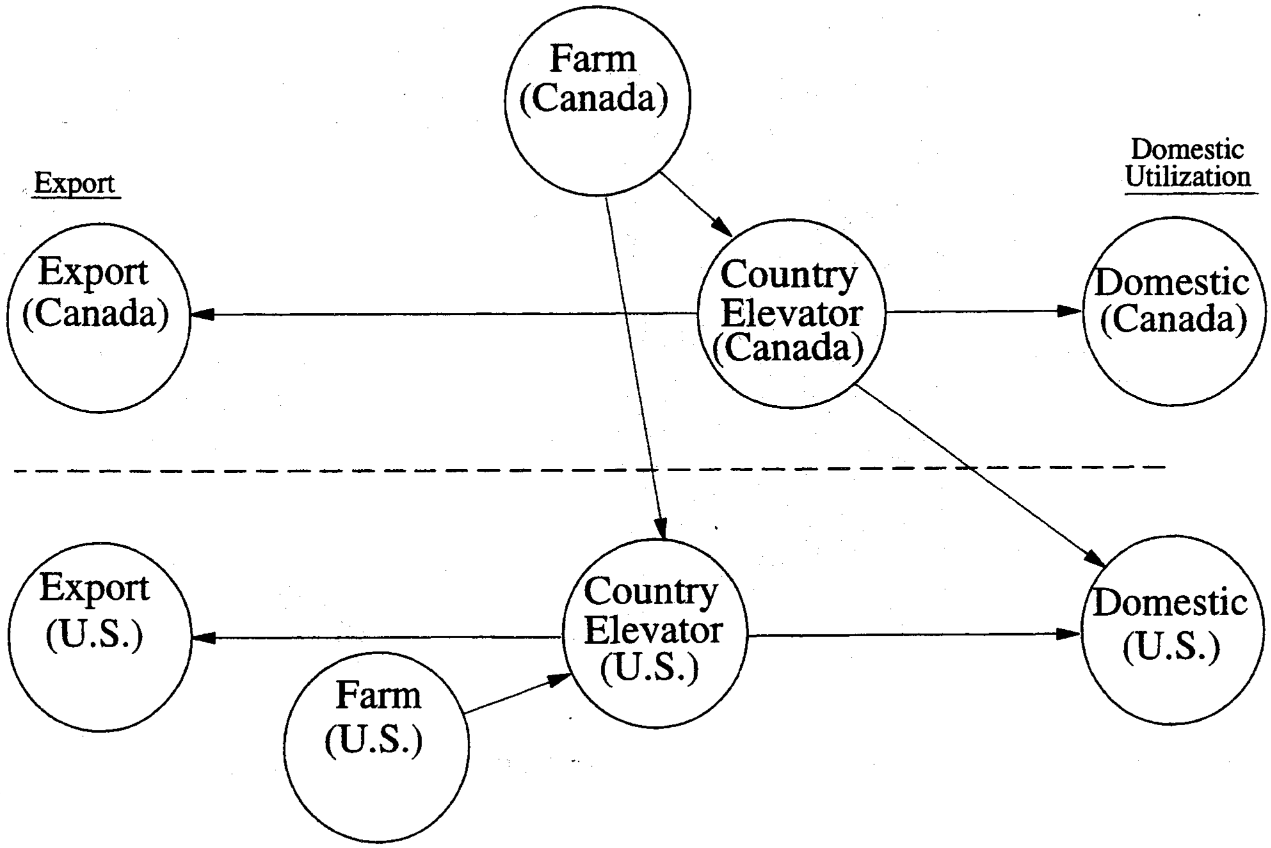
6.4. Domestic Malt Use by Type, U.S. and Canada, Base-case Assumptions

Transportation and Handling Costs

Barley Shipping Rates and Costs. An important feature of barley spatial flows is what we refer to as prairie-border-crossing trade. Some barley trade flows across prairie borders, and some of the anticipated changes could result in greater flows through this network.[37] In this study, we allow for prairie-border-crossing trade explicitly as an alternative flow. Inclusion of handling costs in each country as well as direct shipment to U.S. shipping stations (implicitly, transshipment points) provide a more realistic explanation of the spatial competitive environment that has emerged. Shipment alternatives from prairie shipping points are illustrated in Figure 6.5.

Different flows are allowed in alternative simulations. Table 6.5 defines cost components used in this study and specifies those included in alternative movements. C_c and C_e are Canadian country and export elevation costs, respectively, U_c and U_e are the same for U.S. elevators. An *Administrative charge*, A_F, is applied for all shipments direct from Canadian farms, F_c, to U.S. shipping points. This is intended to reflect merchandising charges under the *ex-farm-truck* program introduced in early 1993.

[37]Other studies using spatial equilibrium modeling of North American grain flows (e.g., Faminow; Golz, Koo and Yang) do not allow for prairie-border-crossing trade and, therefore, do not allow for this effect. In addition, recent studies of Continental barley ignored these differences. However, one of the principal conclusions of the Carter report was that "a continental market would provide incentives for the industry to become more efficient, ..." (p. 35).



6.5. Alternative Shipping Routes From Farm Origins

TABLE 6.5. ELEMENTS OF SHIPPING COSTS FOR EXPORTS FROM CANADIAN ORIGINS TO U.S. AND THIRD COUNTRIES

Movement	U.S. Shipments East	U.S. Shipments West	Third Countries
T: All Truck	C_c+T_{AD2}	C_c+T_{AD2}	$C_c+T_{AD2}+C_e$
R^1: Rail (Rail Subsidized)	$C_c+R^s+R^{usp}$	C_c+R^c	$C_c+R^s+C_e$
TR: Truck/Rail	$A_F+T_{FU}+U_c+R^{usg}+R^{usp}$	$A_F+T_{FU}+U_c+R^{us}$	$A_F+T_{FU}+U_c+R^{us}+U_e$
R^2: Rail (Shipper Subsidized)	$C_c+R^c+R^{usp}$	C_c+R^c	$C_c+R^c+C_e$

Specifically, this is an intake fee charged by accredited exporters to execute these transactions. Trucking is allowed directly from Canadian farms to U.S. shipping points, T_{FU}, and from Canadian elevators to U.S. destinations, T_{AD2}. The shipper portion of rail rates from Canadian origins is defined as R^s, and the assumed compensatory rate level is R^c. Gathering rates for U.S movements are defined as R^{usg}, and the proportional rail rate for eastern U.S. shipments is R^{usp}. R^{us} is used to refer to a direct point-to-point rate.

Four alternative transport and handling regimes for Canadian shipments were defined and are illustrated, using this notation. The alternative most reflective of current and past marketing practices includes Min(T, R^1). This assumes that the CWB controls exports via licenses, and likely results in a lesser amount shipped to (via) the United States.

The *free trade* solution uses elements in a shipping matrix for these origins as Min(T, R^1, TR). This implies that the routing allows for either direct rail, using the R^s; an all-truck movement; or a truck/rail combination via U.S. shipping points. A different configuration of handling costs exists, depending on the routing. In most cases, particularly for the central and northern regions, R^1 is the optimal routing. However, TR applies in some southern origins, implying shipments by truck through the U.S. marketing system.

Solutions using *compensatory rates* use elements defined as Min(T, R^2, TR). This allows for diversion of traffic from the Canadian handling and rail transport system to either an all-truck movement or a TR combination.

Interior Barley Trucking. The transport matrix allowed for shipment by either rail or trucks, depending on relative rates and routings. Truck rates were developed in the United States from industry sources and were 45¢ and 150¢ per loaded mile for movements with and without backhauls, respectively. For Duluth the rate was 75¢ per loaded mile. Trucks were assumed to ship 1,100 bushels.

Canadian trucking rates were computed as a linear function of distance, using a formula from industry sources. Trucking rates were applied to all prairie-border-crossing movements and to intra-provincial movements. For movements within a province for feed use, a distance of 50 miles was assumed.

Malt Shipping Rates. All intra-U.S. movements were assumed to be shipped by rail. Rail tariffs were used where they existed, primarily for movements on BN and CP/Soo. For others, rates were approximated in one of two ways. First, if a rate representative of that movement was shown in the 1991 Waybill Data, that rate was used. If not, a rate function was estimated, using regression techniques. Specifically, nonlinear regression equations between rates and distance were estimated for each of four interregional movements.

Rates for intra-Canadian movements were similarly derived. The tariff rate for movements with published rates (mostly to Vancouver and Thunder Bay under WGTA) were used. Intra-provincial movements from malt plants to breweries are mostly by truck, and the trucking cost was used with adjustments to account for the weight differential between malt and barley.

The model allows for intercountry movements of malt, which in practice is by rail. However, these rates either are under contract or are not available (i.e., because there are no movements to particular locations). For these movements, the estimated malt rate function for the contiguous U.S. region was used. The implicit assumption is that if a cross-border malt movement occurs, it would involve rail costs similar to those of the contiguous U.S. region.

Mathematical Specification

The model is specified as a quadratic programming problem. The objective is to maximize the sum of producer and consumer surplus in feed barley markets minus the costs of satisfying fixed regional demands for malt.

Formally, let X_{ijk} denote a shipment ('000 mt) from producing region i to feed demand region j. The index k denotes barley type. There are 4 types of barley: feed, 6-rowed white malting, 6-rowed blue malting, and 2-rowed malting. The 4 types are perfect substitutes in feed demand; however, only malting types are shipped to malt plants. For notational convenience, we use the index h to refer to the subset of malting types. Shipments from producing regions to malt plants ('000 mt) are denoted Y_{imh}, where m identifies the malt plant location. Shipments of malt ('000 mt) to beer production regions are denoted Z_{mnh}, where n identifies the malt destination and h the malt type. The objective function is defined:

$$W = \sum_j \int_0^{Q_j} (\alpha_j - \beta_j Q_j) dQ_j \quad - \quad \sum_i \sum_j \sum_k X_{ijk} Tx_{ij}$$

$$- \quad \sum_i \sum_m \sum_h Y_{imh} Ty_{im} \quad - \quad \sum_m \sum_n \sum_h Z_{mnh} Tz_{mn}$$

where Q_j is total barley feed use in region j

$$Q_j = \sum_i \sum_k X_{ijk};$$

α_j and β_j are regional feed demand parameters; and Tx_{ij}, Ty_{im}, and Tz_{mn} are transportation cost parameters ($/mt). The latter include freight costs and handling margins, as well as applicable import tariffs and export subsidies. Because barley supplies are fixed, total producer and consumer surplus is represented by the area under regional demand schedules less transportation costs. The objective function is maximized subject to constraints on regional feed use, barley supplies, malt plant capacities, brewer ownership of selected malt plants, and malt requirements in beer production regions.

Prices for feed barley in consuming regions and quantities used as feed are endogenous. The model does not include producer prices *per se*; however, producer prices can be computed as a weighted average of the shadow prices associated with supply constraints in producing regions. Similarly, there are no malt prices in the model other than the shadow prices associated with demand constraints at different points in the marketing system. These reflect the opportunity cost of malting barley (i.e., in terms of its alternative feed use) in addition to transportation and handling costs.

The solution satisfies the usual assumptions of spatial equilibrium, no excess demand in consuming regions and absence of profitable arbitrage opportunities. However, the United States discriminates between offshore markets through its use of EEP subsidies, while a constraint on price spreads ensures that Canada captures the nonsubsidized offshore market.

Data Sources

Production data used in this study were derived from several sources. Data on U.S. area planted, harvested, and yields were taken from the USDA/NASS. For Canada, the same data were from Agriculture Canada sources. Data on barley quality were developed from Know Your Barley Varieties (American Malting Barley Association) and Barley Briefs (Malting Barley Research Institute) for the United States and Canada, respectively. Grade factor data in the United States were from state-level quality reports, and Canadian acceptance rates are from Carter (p. 10).

Data for the United States brewing industry are from Brewers Almanac 1992, published by the Beer Institute (Washington, DC.) and Brewer's Digest: 1991 Buyers Guide and Brewery Directory; data for Canada are from the 1992 statistical bulletin of the Brewers Association of Canada (Ottawa). U.S. and Anheuser-Busch beer production capacities at the state level were derived from the Brewer Almanac and Anheuser-Busch capacities from an Anheuser-Busch pamphlet. U.S. and Canadian malt plant locations, ownership, and capacities are those listed in the Canadian Wheat Board report.

Transport and handling costs are from a number of sources. Rail rates were taken from Burlington Northern and CP/Soo Line Tariffs in the 1991 Waybill Data. Canadian rates were taken from CP and CN Rail Tariffs. Trucking costs and formulas and handling costs were from industry sources in each country.

7. Simulation Results

The spatial model provides a comprehensive basis for studying impacts of trade and agricultural policies, transportation rates, and supply conditions on trade flows, prices, and welfare. Given the level of spatial disaggregation and industry detail embedded in the model, we do not present all simulation results in their entirety. Rather, we examine a base-case simulation in detail and summarize results from other simulations by reference to several key variables: average producer prices, aggregate trade flows, and national and regional market shares.

Our base-case assumptions reflect a freer trade regime similar to that promoted by Alberta Agriculture and endorsed by the Carter report. Specifically, we assume 1) quantitative restrictions do not apply to cross-border flows of barley or malt; 2) Canada does not regulate imports through the granting of permits; 3) current U.S. tariffs apply to imports of barley and malt from Canada; 4) Canadian rail rates reflect current Crow subsidies; and 5) cross-border truck/rail shipments are allowed to U.S. barley destinations.

The U.S. subsidy on barley exports is set equal to $32/mt. Regional barley supplies are based on 5-year averages, as described in the Section 6. Other relevant parameters are summarized in Table 7.1. Departures from base-case assumptions are indicated where appropriate.

TABLE 7.1. SELECTED BASE-CASE PARAMETERS ('000 mt)

	United States	Canada
Domestic Malt Requirements	2,223	286
Offshore Exports:		
Malting Barley	50	200
Malt	65	200

Results Under Base-case Assumptions

Results of the base-case simulations are summarized in Table 7.2. Of particular interest is the large volume of feed barley exported from Canada to the United States: over 2.8 million metric tons. This is substantially larger than historical trade levels and much larger than previous estimates (see p. 32 of the Carter report).[38] Canada's domestic feed use (2.9 million mt) is smaller than levels observed in recent years, implying substantial substitution of other feedstuffs for barley in Canadian demand.[39]

Canada also exports nearly 700 thousand mt of malting barley to the United States. Two-row malting barley accounts for over 90 percent of these malting barley exports. The United States also exports some malting barley to Canada under base-case assumptions. U.S. exports to Canada consist of 6-rowed white varieties; these are malted in Canada for export to western U.S. breweries.

Average producer prices are substantially higher in the United States than in Canada. U.S. producer prices are $1.81/bushel (averaged over all U.S. producing regions and barley types), while Canadian producer prices are $1.47/bushel. Among other factors, this difference reflects the proximity of U.S. producing regions to high-priced feed markets and malting capacity.

Additional details on feed demand are provided in Table 7.3 and Figures 7.1 and 7.2. California, Arizona, and Nevada represent the highest-priced feed barley markets due to transportation costs and expensive substitutes. U.S. prices are lowest in

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[38]The Carter study and others were unduly conservative about trade flows. Before the September court decision that rescinded the Continental Barley Market, between .5 and 1 million tons of Canadian barley were contracted with U.S. buyers (Milling and Baking News, Sept. 28, 1993, p. 61).

[39]Regional demand schedules for feed barley were derived using prices of substitutes observed in April, 1993. In Canadian provinces, prices reflected an unusually large supply of feed wheat, a result of quality problems in the 1992 crop.

TABLE 7.2. BASE-CASE SIMULATION RESULTS

	United States	Canada
Bilateral Trade Flows ('000 mt)		
Exports		
Feed barley	0	2,878
Malting barley	134	682
Malt	0	156
Net Bilateral Trade (exports - imports)		
Feed barley	-2,878	2,878
Malting barley	-548	548
Malt	-156	156
Offshore feed exports ('000 mt)		
Subsidized markets	1,973	0
Nonsubsidized markets	0	2,971
Domestic Use ('000 mt)		
Feed use	6,691	2,909
Malting use	2,842	857
Avg. Producer Price (US $/mt)	83.3	67.4
(US $/Bu)	1.81	1.47

midwestern barley-producing states. Prices in the prairie provinces are the lowest of all regions. This is consistent with actual relationships observed during the base period used for estimating of demand schedules.

California represents the largest feed demand region, with barley feed use of 2.4 million mt. Much of California's feed demand is satisfied by exports from Canada (Figure 7.3). The northwestern states (Oregon, Washington, and Idaho), which account for an additional 1.9 million mt of feed barley demand, are also supplied extensively by Canada.

Figure 7.4 shows Canada's share of the U.S. malting barley market. Canadian exports of malting barley are especially significant to the U.S. West Coast. The U.S. Midwest, where most U.S. malting capacity is located, is principally served by U.S. producing regions.

Some specific commodity flows predicted by the model are shown in Table 7.4. Flows to individual demand regions are listed for 9 of the major producing regions, 5 in the United States and 4 in Canada.

Northwest Minnesota, northeastern North Dakota, and east central North Dakota supply the Minnesota feed market and midwestern malt plants. Northwestern North

TABLE 7.3. PRICES AND QUANTITIES IN REGIONAL FEED MARKETS UNDER BASE CASE ASSUMPTIONS

Feed Demand Region	Market Price		Barley Quantity	
	$/mt	$/Bu	'000 mt	M. Bu.
California	119.3	2.60	2,352.8	108.1
Oregon	101.4	2.21	878.4	40.3
Washington	97.7	2.13	592.8	27.2
Idaho	97.7	2.13	454.2	20.9
Wyoming	92.7	2.02	86.6	4.0
Colorado	97.9	2.13	146.6	6.7
Utah	104.8	2.28	193.3	8.9
Arizona	119.2	2.60	0.	0.
Minnesota	79.8	1.74	796.0	36.6
Montana	84.9	1.85	471.5	21.7
N. Dakota	78.9	1.72	64.3	3.0
Nevada	119.3	2.60	59.5	2.7
S. Dakota	82.6	1.80	494.7	22.7
Alberta	69.5	1.51	2,158.3	99.1
Manitoba	70.2	1.53	0.	0.
Saskatchewan	67.3	1.47	473.3	21.7
British Columbia	82.0	1.79	277.8	12.8
Ontario	82.0	1.79	0.	0.
Quebec	87.6	1.91	0.	0.
Subsidized Offshore Exports	81.4	1.77	1,972.9	90.6
Nonsubsidized Offshore Exports	92.1	2.01	2,971.5	136.5

Dakota supplies the California feed market; a substantial quantity of malting-quality barley (6-rowed white) from this region is sold for feed. Barley from Idaho is sent to the Oregon feed market or exported under the EEP program; small quantities of malting-quality barley are shipped to Idaho malt plants or exported.

Barley from northern Alberta is directed mostly to feed markets in Alberta and British Columbia. Southern Alberta supplies barley to U.S. feed markets in California and the northwest; malting barley is shipped to malt plants in Alix and Calgary, Alberta; Idaho Falls, and Los Angeles. From northern Saskatchewan, the largest flows are to

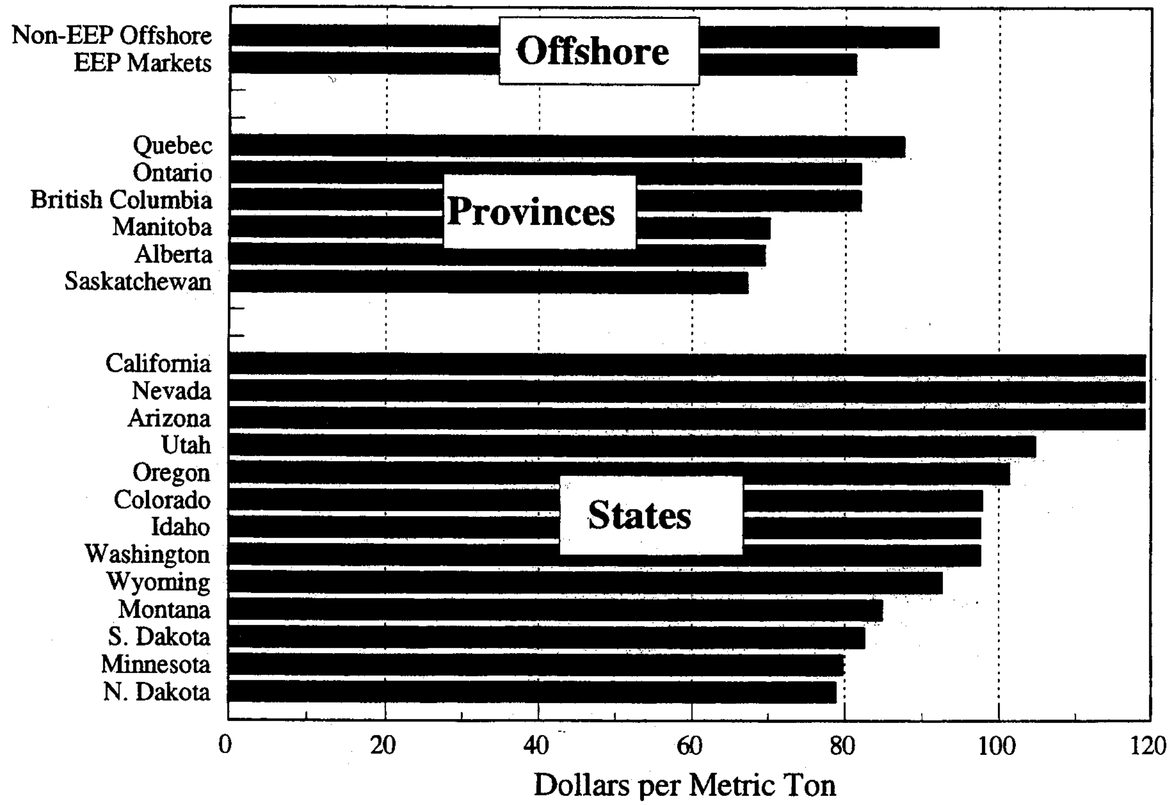

Figure 7.1. Feed Barley Prices by Market, Base-case Solution

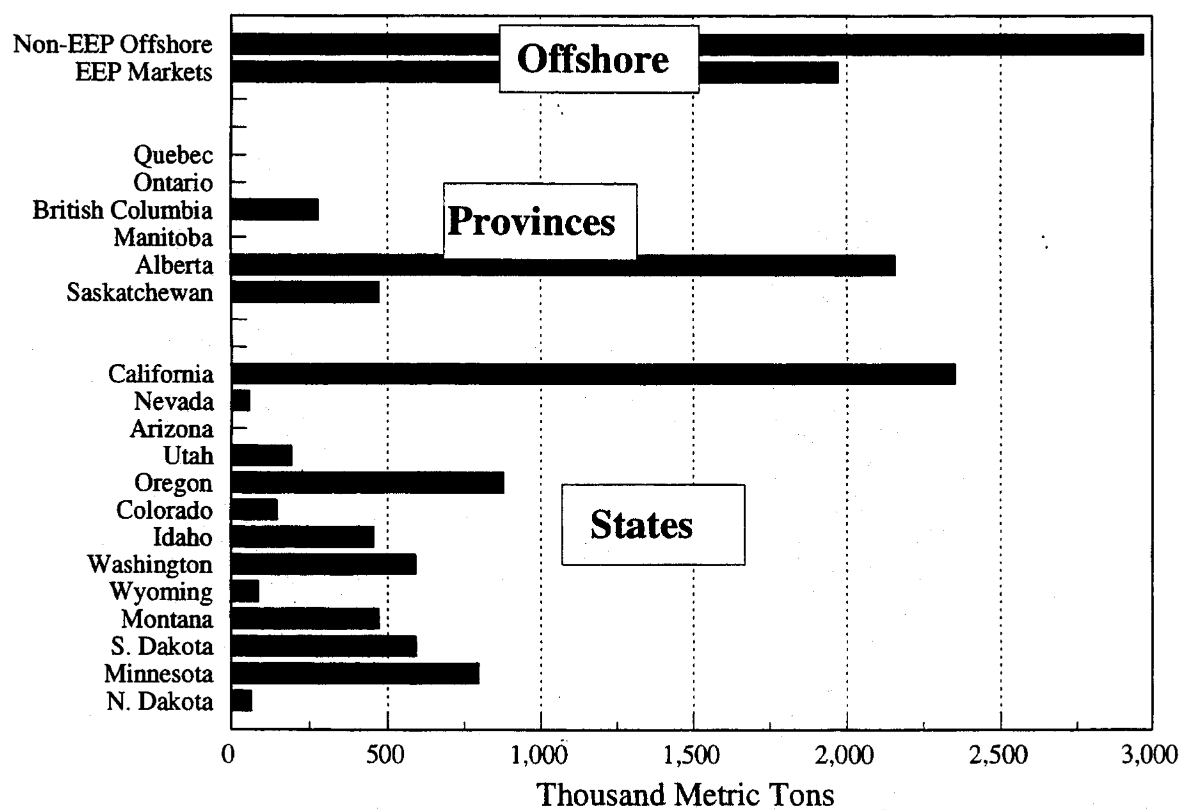

Figure 7.2. Feed Barley Quantity Sold by Market Base-case Solution

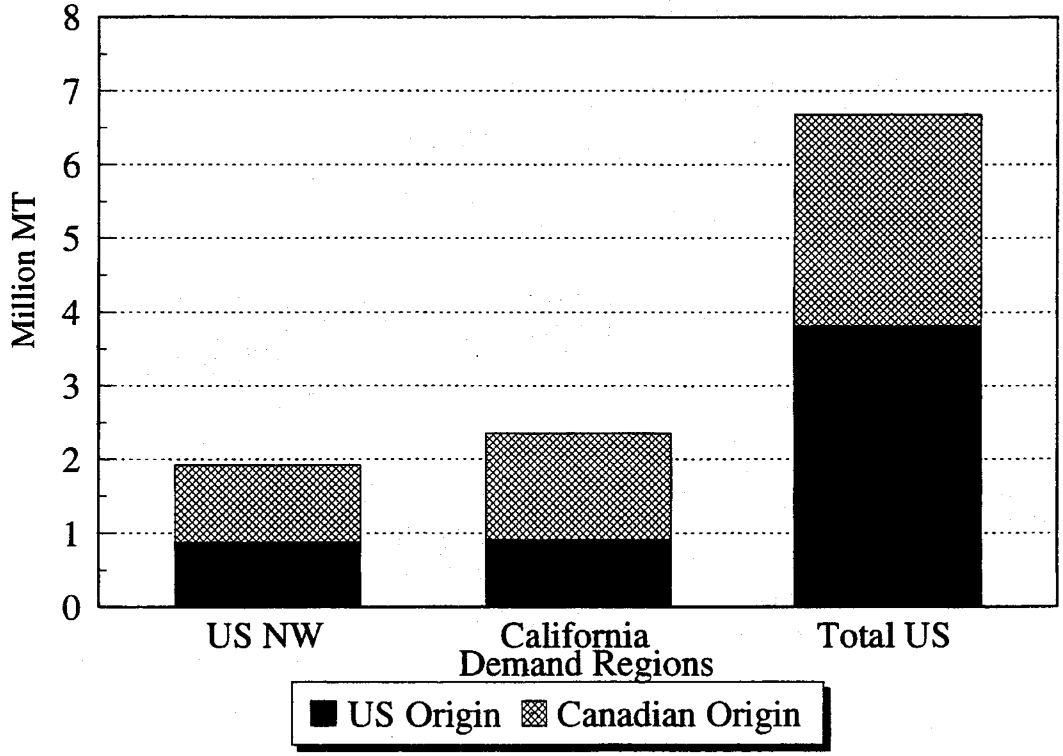

Figure 7.3. Feed Barley Market Shares, Base-case Solution

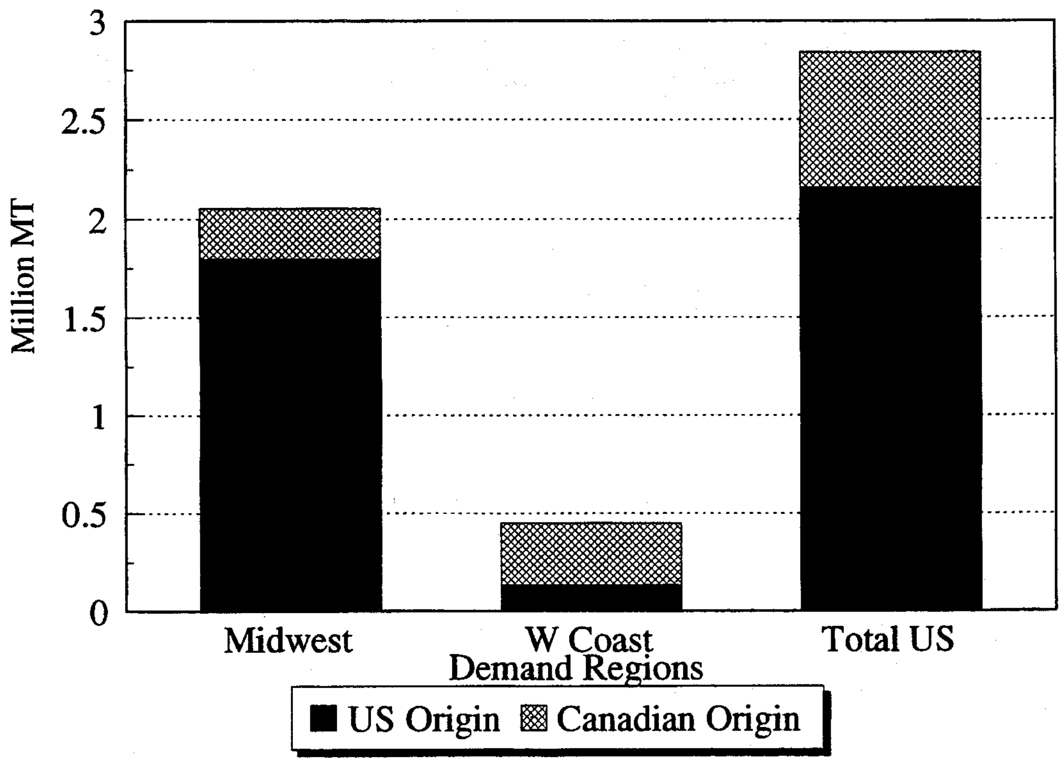

Figure 7.4. Malting Barley Market Shares, Base-case Solution

TABLE 7.4. BARLEY FLOWS FROM SELECTED PRODUCING REGIONS, BASE CASE

Shipments to Feed Markets			Shipments to Malt Plants		
Destination	Barley Type	Quantity ('000)	Destination	Barley Type	Quantity ('000)
		Producing Region: Northwest Minnesota (CRD-1)			
Minnesota	Feed	245.3	Minneapolis	6RW	426.1
--	--	--	Chicago	6RW	51.1
--	--	--	Wisconsin	6RW	60.2
		Producing Region: Northeast N. Dakota (CRD-3)			
Minnesota	FEED	281.8	Spiritwood	6RW	252.1
--	--	--	Moorhead	6RW	135.8
--	--	--	Minneapolis	6RW	130.9
		Producing Region: East Central N. Dakota (CRD-6)			
Minnesota	FEED	215.1	Wisconsin	6RW	159.4
--	--	--	AB-Wisc	6RW	224.0
		Producing Region: Northwest N. Dakota (CRD-1)			
California	FEED	127.5	--	--	--
California	6RW	103.7	--	--	--
		Producing Region: Idaho			
Oregon	FEED	543.8	Pocatello	6RW	47.3
Oregon	6RW	137.5	Idaho Falls	6RW	21.6
Oregon	2RW	197.1	Mexico	6RW	25.0
Export-EEP	FEED	244.0	--	--	--
		Barley Flows from Northern Alberta, Base Case			
Alberta	FEED	937.3	Export	2RW	64.1
B.C.	FEED	238.5	--	--	--
B.C.	6RB	39.3	--	--	--
		Producing Region: Southern Alberta			
California	FEED	606.0	Los Angeles	2RW	91.1
Washington	FEED	230.3	Alix	2RW	79.8
Washington	2RW	362.6	Idaho Falls	2RW	122.2
Idaho	FEED	402.1	Calgary	2RW	37.4
Idaho	6RB	52.2	--	--	--
		Producing Region: Northern Saskatchewan			
Offshore Export	FEED	1308.1	Wisconsin	2RW	200.8
Offshore Export	6RB	231.0	Buffalo	2RW	39.1
Sask	FEED	308.4	Biggar	2RW	155.5
--	--	--	Biggar	6RW	9.3
--	--	--	Biggar	6RB	1.5
--	--	--	Thunder Bay	2RW	153.7
--	--	--	Montreal	2RW	85.6
--	--	--	Export	2RW	53.5
		Producing Region: Southern Saskatchewan			
Montana	FEED	102.5	Pocatello	2RW	53.6
Montana	6RB	26.5	Pocatello	6RB	11.0
Sask.	FEED	164.9	Idaho Falls	2RW	18.1
--	--	--	Golden	2RW	88.5

mainly in Wisconsin. From southern Saskatchewan, barley flows to Montana and the Saskatchewan feed market; malting barley is shipped to U.S. plants in Idaho and Colorado.

Regional flows provide perspective on the U.S. EEP program. Under base-case assumptions, subsidized U.S. export shipments originate largely in Western Montana (898 tmt), Washington (584 tmt), Oregon (247 tmt), and Idaho (244 tmt). Feed markets in each of these states receive substantial inflows of barley from adjoining regions, particularly southern Alberta. This highlights the fungible aspect of barley supplies. The model does not allow Canadian barley to qualify for U.S. export subsidies; however, grain exported under EEP can be replaced in U.S. markets by imports from Canada.

Impacts of U.S. Import Restrictions

Under terms of the Canadian-U.S. Free Trade Agreement, the United States retains its rights under Section 22 of the Agricultural Adjustment Act. This allows the United States to restrict imports if they adversely affect the operation of commodity programs, e.g., to prevent imports from raising the costs of producer supports. Before the Congressional vote on NAFTA, the United States threatened to invoke Section 22 to curtail imports of Canadian wheat. U.S. barley producers urged similar action in response to a surge of imports from Canada (occasioned by the temporary relaxation of Canadian marketing controls in August, 1993). Effects of U.S. barley imports on producer prices will continue to be of policy interest, whether or not Canada undertakes major reform in its marketing system.

To evaluate implications of these potential trade restrictions, we introduce import quotas on barley in the base-case model. By varying the quota level, we gauge the impact of bilateral trade volumes on producer prices[40], domestic feed use, and offshore exports.

Figure 7.5 shows the impact of different quota levels on average producer prices in both countries. A free-trade solution is represented at 3.5 mmt of imports; U.S. import quotas are no longer binding beyond that level. With zero barley imports from Canada, the average price received by U.S. producers is $87/mt, ($1.89/bu); for Canadian producers, the average price is US $58.5/mt ($1.27/bu). With quotas no longer binding (i.e., unrestricted access to the U.S. market), the difference between U.S. and Canadian producer prices narrows substantially, by $12.6/mt ($.27/bu).

With zero Canadian barley allowed into the United States, Canada's domestic feed use is 5.3 mmt, and U.S. feed use is 4.3 mmt (Figure 7.6). Domestic feed use does not change significantly for the first 1.5 mmt of U.S. imports. Rather, the volume of offshore exports by both countries as the quota is increased (Figure 7.7): Canada shifts its exports away from offshore markets and to the United States, while U.S. exports to offshore (EEP) markets increase in step with imports from Canada. For both countries, offshore

[40]With binding trade restrictions, Canadian producer prices are calculated as a weighted average of shipment values. Returns from Canada's domestic and offshore sales have lower returns than sales to U.S. markets when U.S. quotas are binding.

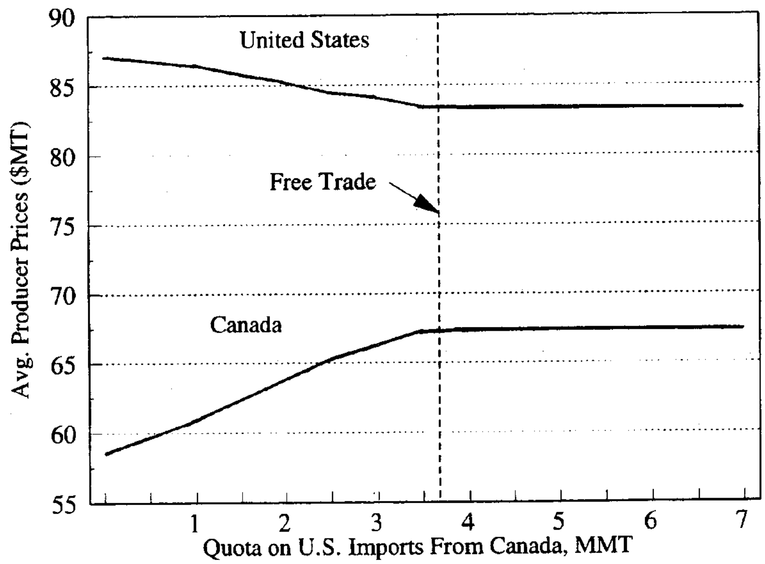

Figure 7.5. Impacts of Import Quotas on Producer Prices, U.S. and Canada

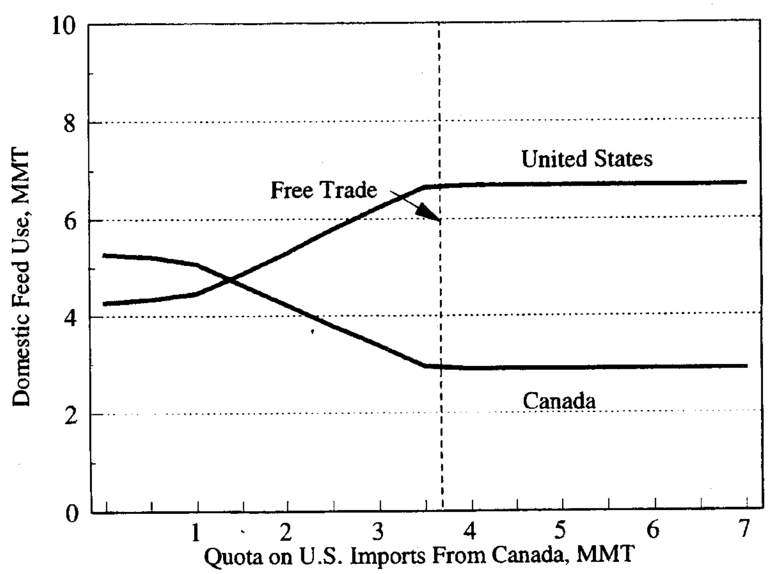

Figure 7.6. Import Quota and Feed Use, U.S. and Canada

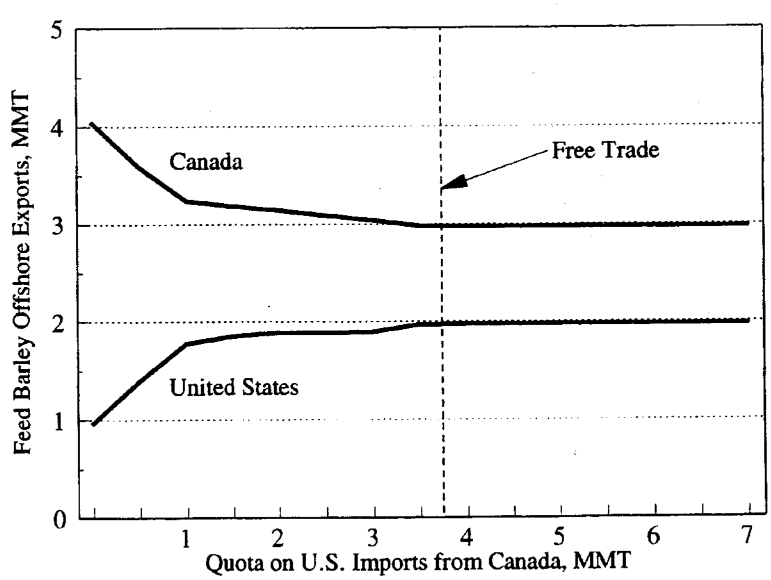

Figure 7.7. Import Quota and Offshore Exports, U.S. and Canada

exports show little change as the quota on U.S. imports rises above 1.5 mmt; beyond that point, major adjustments occur in domestic feed use.

Using its authority under Section 22, the United States could also restrict imports by increasing the tariff on Canadian barley. The current U.S. tariff is $1/mt. To evaluate the efficacy of higher tariffs (as an alternative to import quotas), additional model simulations were performed: U.S. tariff levels were raised incrementally, while other base-case assumptions were retained. Results in Figure 7.8, suggest that U.S. tariffs of approximately $25/mt would be necessary to curtail imports of barley from Canada.

Impacts of Compensatory Rail Rates

The Canadian government recently proposed changes in the method of payment for the Crow Benefit. Existing subsidies, paid by the government to the railroads, would be converted into direct payments to producers over four years.[41] The ultimate effects on rail rates are difficult to predict; railroads would be allowed to abandon some lines, but would be under some pressure to maintain rates competitive with trucking. In general, however, rates paid by shippers will increase because of this reform.

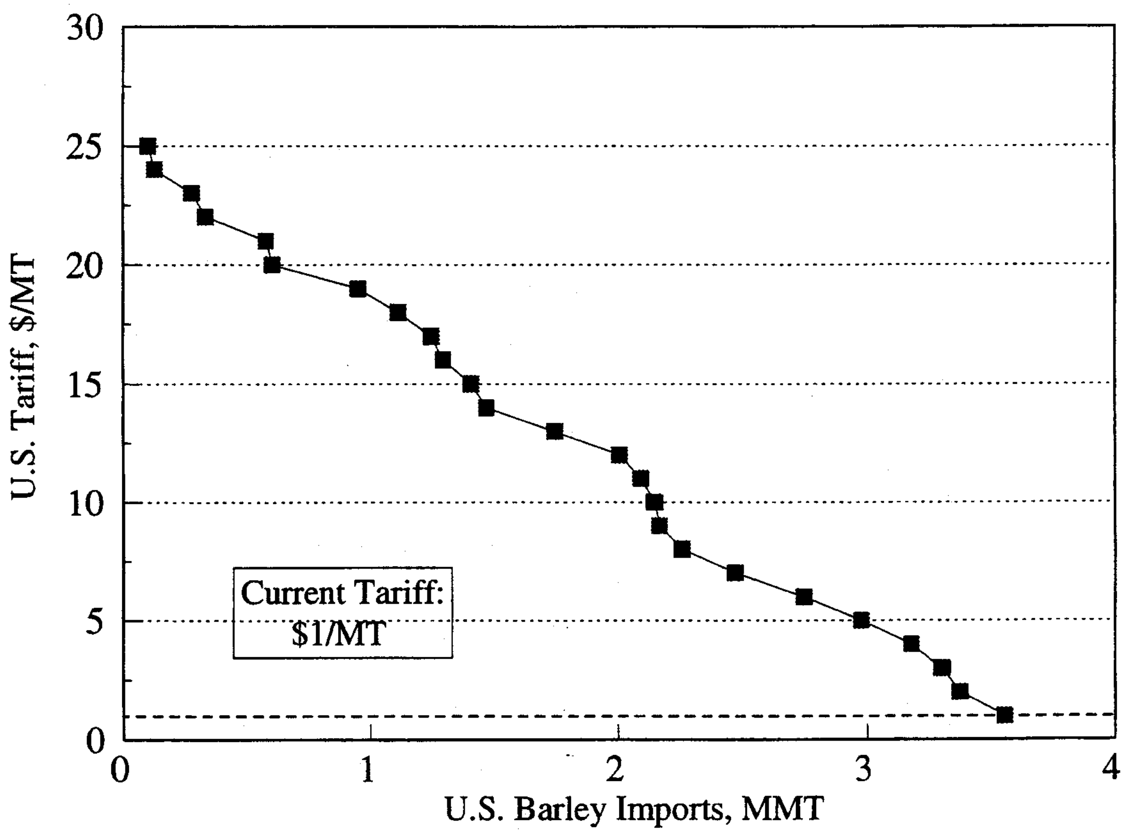

Figure 7.8. U.S. Tariffs and Imports of Canadian Barley

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[41]"Agriculture Canada proposes reform of grain transport system," *Milling and Baking News*, July 6, 1993, p. 45.

For purposes of simulation, rates for applicable Canadian rail movements are adjusted by the full amount of the Crow Benefit. With fully compensatory rates, shippers pay the (additional) portion of rail rates formerly paid by the Canadian government. This raises the shipping rate to Vancouver (for export) and Thunder Bay (for eastern destinations). In addition, these rail rates make prairie border-crossing movements more attractive.

Figures 7.9 through 7.11 are comparable to figures in Section 6; they summarize results of simulations with compensatory rail rates. Compensatory rates widen the gap between U.S. and Canadian prices (Figures 7.9 and 7.5). Canadian exports to offshore markets are reduced, relative to the base case, because of higher shipping costs to Vancouver. With unrestricted access to the U.S. market, Canada exports over 5 mmt of barley to the United States, about half of total Canadian production.

These results show that eliminating Canadian rail subsidies will not advance the interests of U.S. producers. To the contrary, as higher shipper costs depress barley prices in Canadian producing regions, cross-border price differentials will widen, inducing larger flows of Canadian barley into the United States.

Impacts of the Export Enhancement Program

The intention of the Export Enhancement Program is to stimulate U.S. exports and pressure the European Community to reduce its export subsidies. However, as demonstrated here, EEP also has an important influence on North American barley flows. U.S. export subsidies depress world prices and increase U.S. prices, thereby enhancing the attractiveness of U.S. markets relative to Canada's alternatives. From a Canadian perspective, EEP has been one of the most significant causes of ongoing bilateral disputes over grain trade.

To quantify these effects, the model was simulated with alternative levels of the EEP bonus (subsidy per metric ton). Figure 7.12 is similar to Figure 7.5, but with additional lines superimposed, indicating the impact of a $40/mt bonus (25% higher than in the base case) on producer prices in the United States and Canada. As expected, the higher EEP bonus raises average U.S. producer prices. The impact on Canadian prices is negative at low levels of bilateral trade (with U.S. imports constrained to be less than 1.0 mmt). At higher levels of bilateral trade, the higher EEP bonus has minimal impact on Canadian producer prices: depressed returns from offshore sales are roughly offset by higher returns from U.S. sales (induced by higher U.S. domestic prices).

Figures 7.13 and 7.14 illustrate impacts of different subsidy levels on trade flows and producer revenue, assuming no quotas on U.S. imports from Canada. The United States does not export significant quantities of barley until the EEP bonus rises above $20/mt; thereafter, U.S. exports increase, inducing larger imports from Canada. The United States remains a net importer of barley at all bonus levels considered (Figure 7.13). This suggests that, even if EEP were eliminated, there are substantial economic inducements for Canadian sales into the U.S. market.

Exports account for a larger share of U.S. producer revenue as the EEP bonus increases (Figure 7.14). At a bonus level of $30/mt, exports account for about one quarter

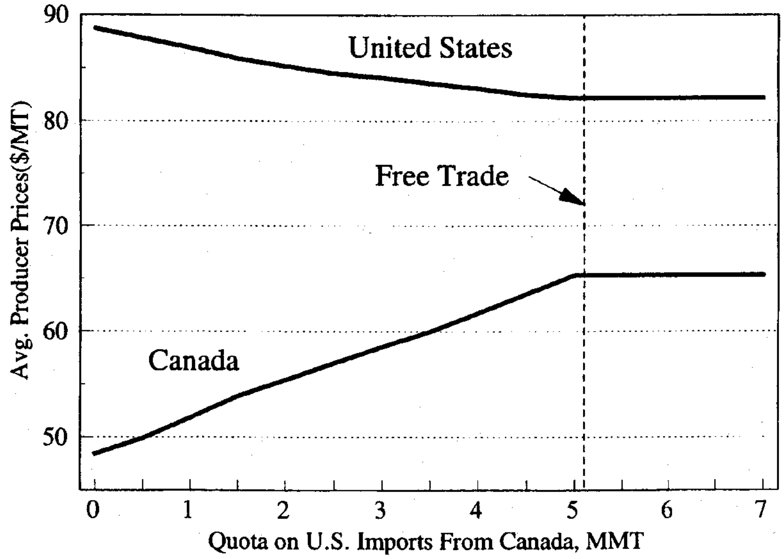

Figure 7.9. Imports and Producer Prices With Compensatory Rail

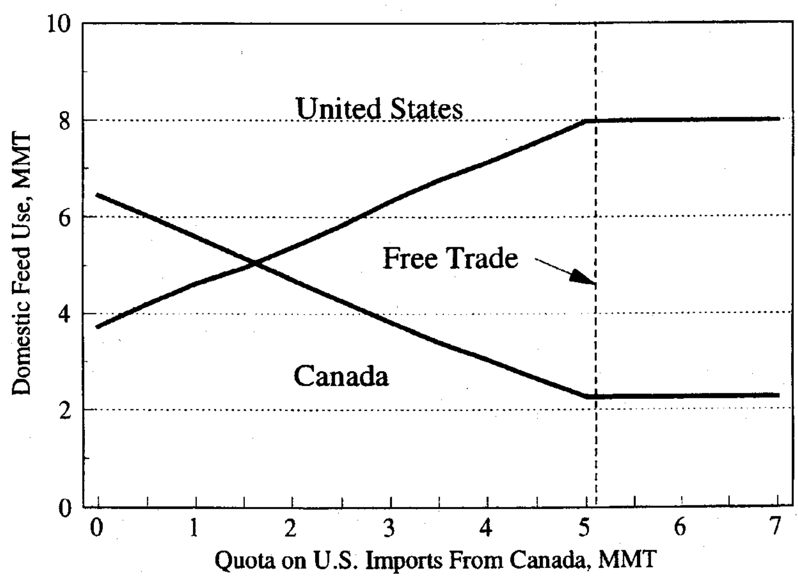

Figure 7.10. Imports and Feed Use With Compensatory Rail

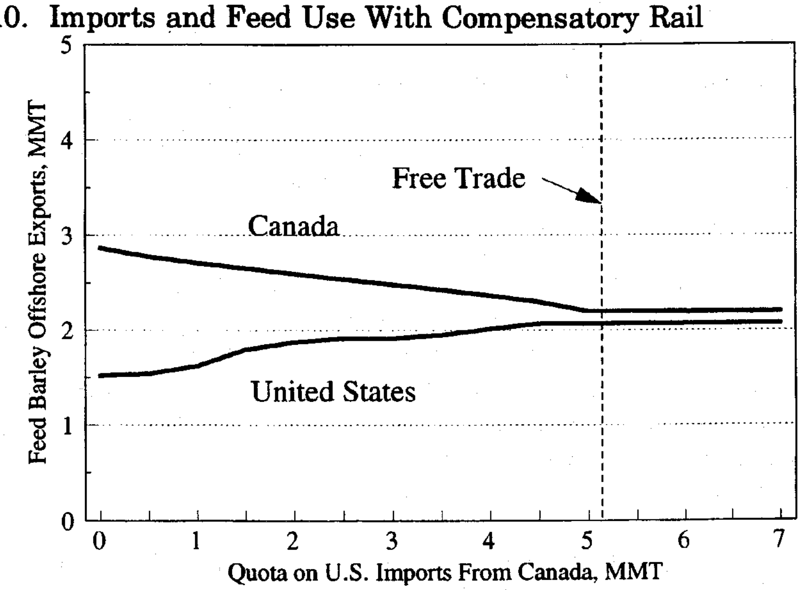

Figure. 7.11. Offshore Exports With Compensatory Rail

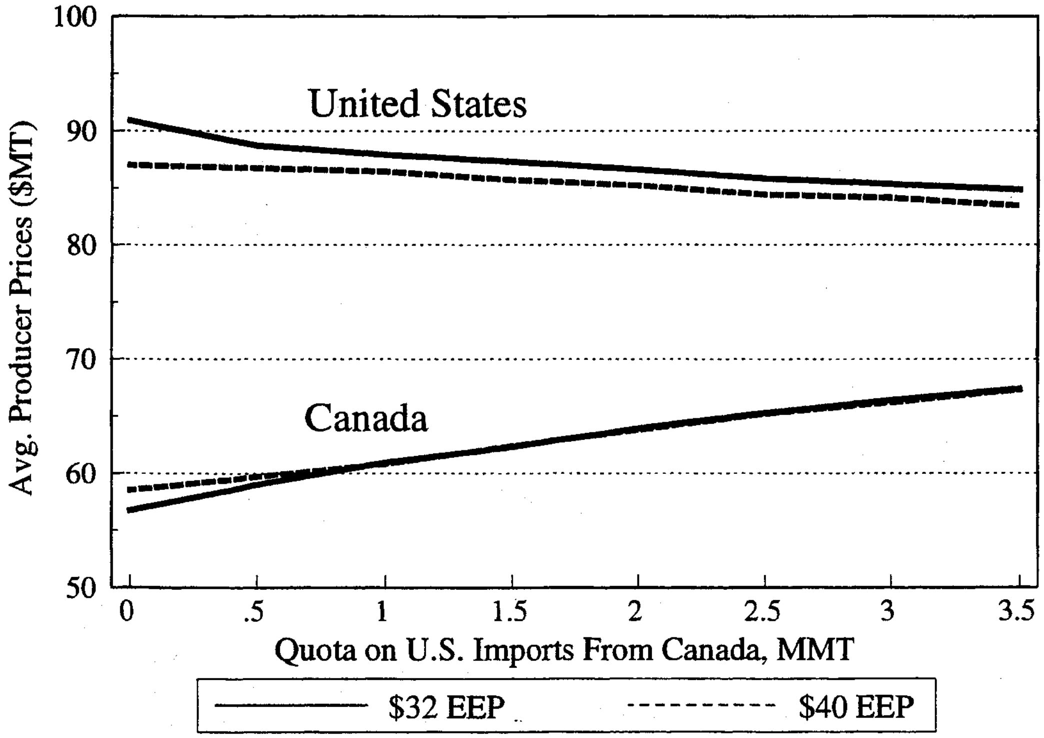

Figure 7.12. Price Impacts of Higher EEP Bonus, Various U.S. Imports Levels

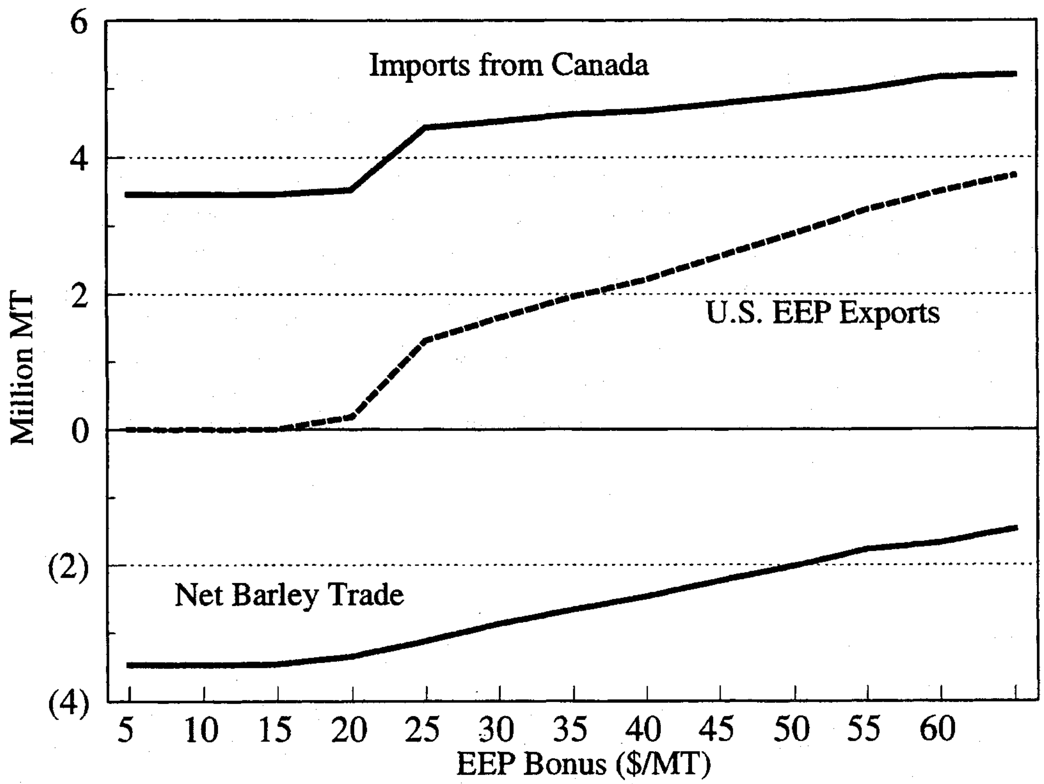

Figure. 7.13. U.S. Barley Trade, Various Bonus Levels

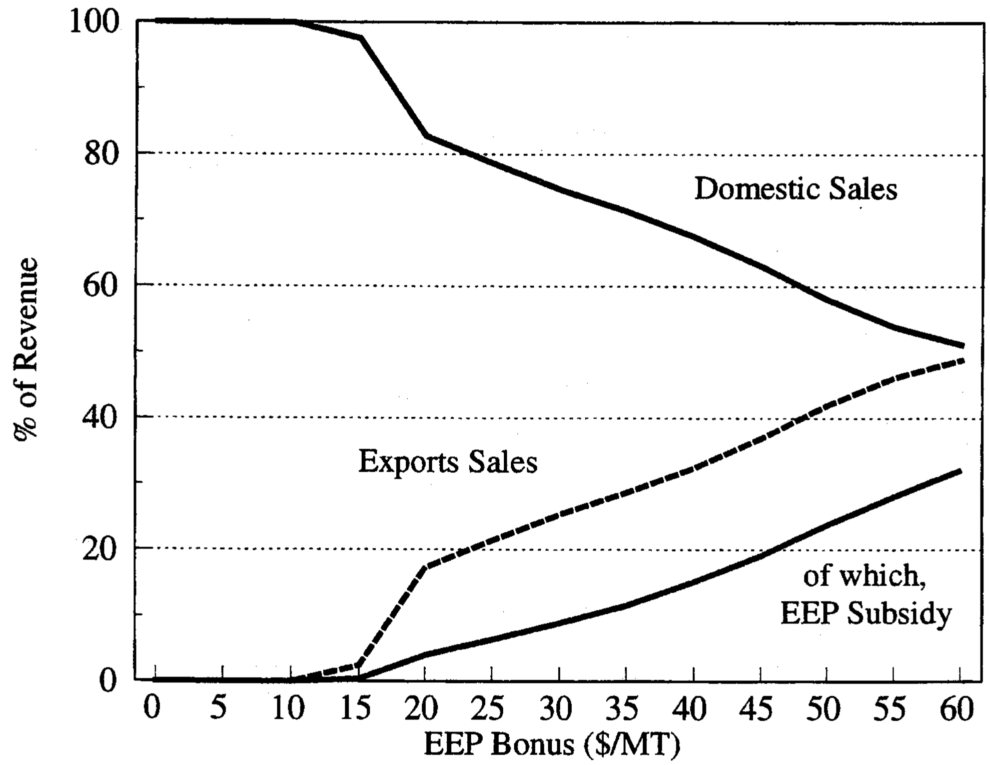

Figure 7.14. Sources of U.S. Producer Revenue, Various EEP Bonus Levels

of U.S. producer revenue; at $40/mt, they account for a third. With higher bonus levels, the subsidy represents a major share of the value of U.S. exports.

Figure 7.15 shows the impact of EEP on Canadian producer revenue under alternative assumptions about bilateral trade. When Canada's access to the U.S. market is constrained by import quota, Canadian welfare drops precipitously with increases in the EEP bonus above $25/mt. This is essentially due to the price-depressing effects of EEP in offshore markets.[42] On the other hand, when Canada enjoys unrestricted access to the U.S. market, Canadian revenue is enhanced by higher EEP bonuses (above $35/mt). Given the large volume of Canadian exports to the U.S., the positive effects of EEP on United States domestic prices are more significant than the negative impact on Canada's offshore sales revenue.

[42]With restricted access to the U.S. market, EEP bonuses in the $30-35 range appear to be slightly more damaging to Canadian revenue than higher bonuses. In model simulations, the gap in offshore prices (between nonsubsidized and EEP markets) is less than the EEP bonus; hence, Canada's offshore price does not fall in step with each increase in the U.S. export subsidy. However, higher EEP bonuses (in the $40-$60 range) raise U.S. domestic prices, augmenting returns from Canada's fixed U.S. sales.

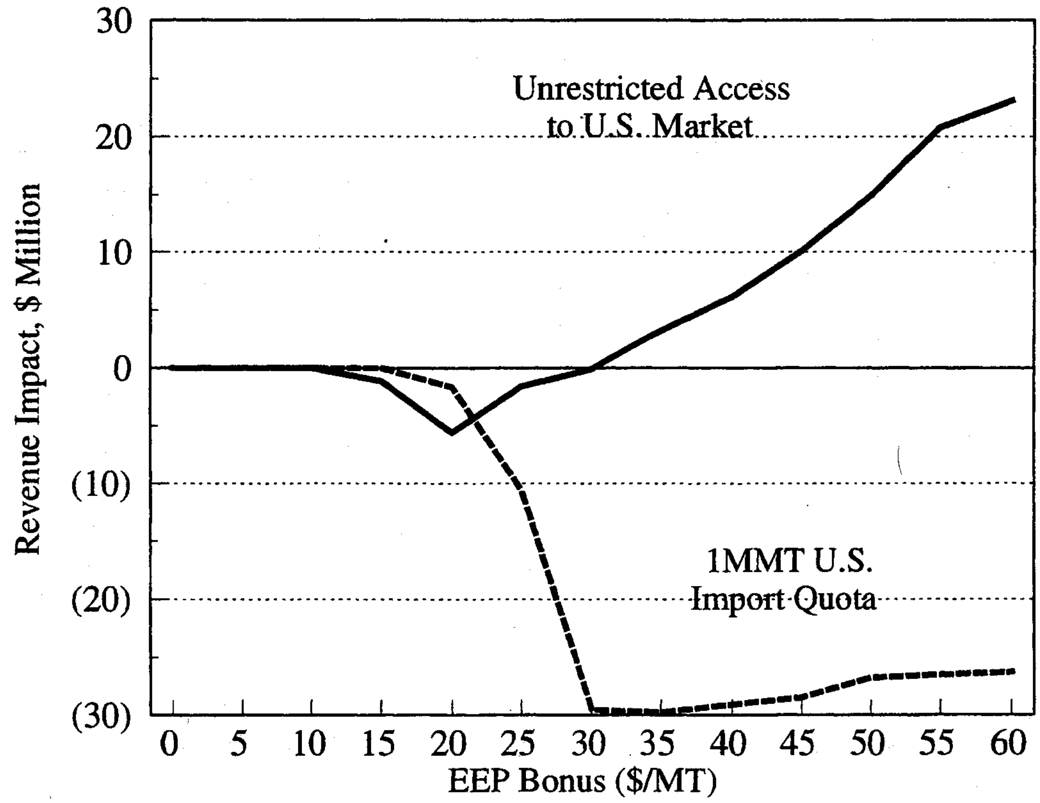

Figure 7.15. Impact of EEP on Canadian Producer Revenue, Free Trade vs. Quota

Supply Conditions: Acreage and Varieties

Simulations in this section analyze impacts of alternative supply conditions relative to the base case. First, we assess implications of the Conservation Reserve Program. Specifically, CRP acreage is returned to barley production in four major producing states (North Dakota, South Dakota, Minnesota, and Montana).[43] Second, we examine the impact of a shift in varieties planted in Canada. In particular, we assume that 25 percent of Canadian malting acreage is planted to 6-rowed white aleurone varieties. Results from these simulations are compared to the base case in Table 7.5.

Return of CRP acres to production would represent a 19% gain in total U.S. barley output relative to the base case. Total U.S. producer revenue would rise by 14% due to increased barley output. However, U.S. barley imports from Canada are reduced by only 7%, because the rise in U.S. supply is accompanied by a large increase in domestic feed use. Results suggest that the return of CRP acres to production would have little impact on aggregate trade flows, although average producer prices would fall in both countries.

Canada's barley breeding programs and regulations on variety release have limited the availability of 6-rowed white aleurone varieties in Canada. The Carter report (p. 9)

[43]Data on CRP acres were obtained from state ASCS offices. At state level, the following levels of barley base acreage had been enrolled in CRP: Minnesota (230,789), Montana (710,739), North Dakota (539,705), and South Dakota (190,042).

TABLE 7.5. SIMULATIONS WITH ALTERNATIVE SUPPLY CONDITIONS

	Base Case	Restor e CRP Acres	Canadian shift to 25% 6RW
U.S. Barley imports from Canada ('000 mt)	3,559	3,320	3,681
Canada share of U.S. Feed Barley Market (%)	43.0	34.0	38.7
Canada share of U.S. Malting Barley Market (%)	24.0	23.8	37.8
U.S. Average Producer Price ($/mt)	83.3	80.3	83.0
Canada Average Producer Price ($/mt)	67.4	66.4	67.8

identified this as an important competitive disadvantage for Canadian barley, inasamuch as most U.S. brewers have a clear preference for 6-rowed white varieties. The trend toward increased production of 6-rowed white varieties has already begun in Canada, with some varieties being licensed and others grown under contract.

The next simulation assumes that 25% of Canada's current malting acreage is shifted into 6-rowed white varieties. (Total Canadian acreage is unchanged with compensating declines in acres planted to other malting varieties, including both 6-rowed blue and 2-row.) Results indicate that Canadian exports of malting barley to the United States would increase to 1.07 million mt, from .68 million in the base case. Canada's share of the U.S. malting barley market would increase to nearly 38 percent. This shift would have little impact on aggregate barley trade flows; offsetting the rise in Canada's malting barley exports would be a decline in exports of feed barley to the United States. Average producer prices in Canada would be enhanced modestly, by the equivalent of 1 cent per bushel, and U.S. prices would decline.

Retention of Wheat Board Control Over Barley

The foregoing simulations are premised on a competitive marketing environment: without trade restrictions, shippers are free to sell barley wherever they receive the highest price net of transportation costs. As a result, for each producing region in the model, prices received (net of transportation) are equalized across shipping destinations, except when import quotas apply.

This ignores one of the principal features of Canada's current marketing system, the role of the Canadian Wheat Board. By virtue of its single-seller status in Canada, the CWB can price barley differently to U.S. and offshore markets and, so (in principle), maximize returns to Canadian producers. In fact, this a principal tenet of the Canadian marketing system. Price discrimination is closely linked to Canada's price pooling mechanism; neither feature is consistent with the type of competitive market behavior implicit in our spatial model.[44] However, the model can provide insight into the Board's pricing and sales strategies. By varying the level of exports to the United States, the optimal trade volume from the Board's perspective can be identified, i.e., that which maximizes Canadian producer revenue.

For of these simulations, Canadian imports of U.S. barley and malt are constrained to zero; this is consistent with Canada's current practice of limiting imports through a permit system. Canadian barley exports to the United States are varied incrementally, with Canadian producer revenue (aggregated across producing regions and shipping destinations) evaluated at each trade level. These are similar to earlier simulations, which concerned the effects of U.S. import quotas; however, here we also allow Canadian exports to exceed the competitive "free-trade" solution.

For reference, Figure 7.16 shows that total welfare (comprising producer and consumer surplus in all feed barley markets less costs of satisfying fixed malt demand) is maximized at about 3.5 million mt of Canadian exports into the United States. The marginal value of Canadian exports to the United States[45] is inversely related to export volume. For export volumes less than 3.5 mmt (the competitive free-trade solution), additional Canadian exports to the United States are welfare enhancing. For volumes above 3.5 mmt, additional exports detract from total welfare.

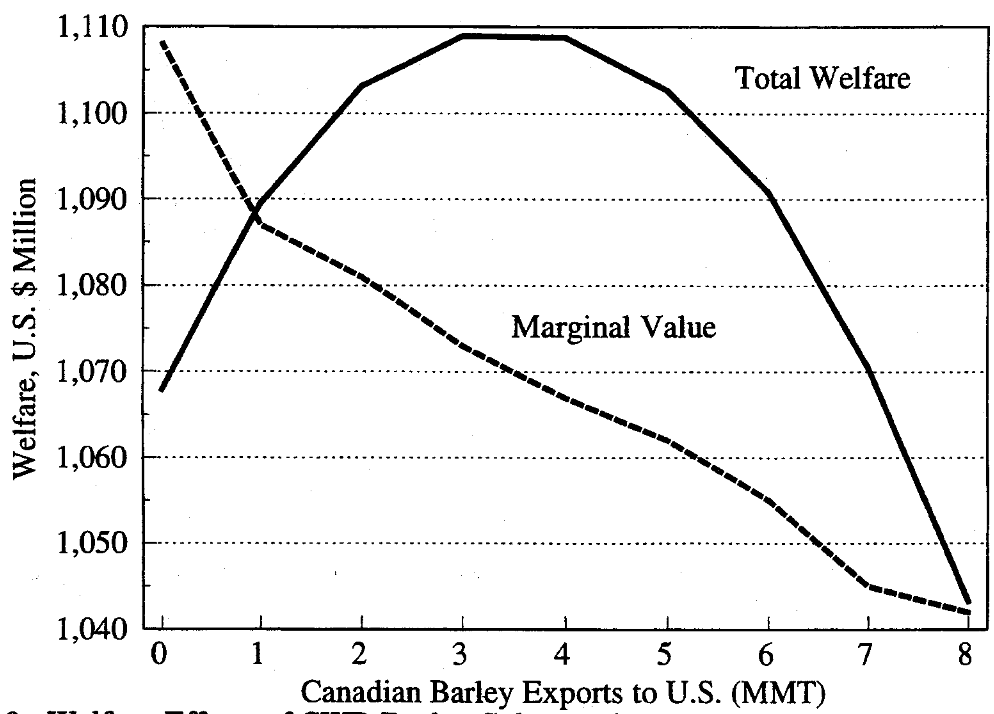

Figure 7.16. Welfare Effects of CWB Barley Sales to the U.S.

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[44]As a practical matter, the price pooling mechanism depends on the Board's monopoly position: if sales by Canadian producers were unrestricted, then barley would flow through private market channels whenever prices trended upward.

[45]This is simply the shadow price associated with the constraint fixing the volume of Canadian exports to the United States.

However, Canadian producer revenue, rather than total welfare, is the relevant criterion for CWB strategy. Figure 7.17 provides a disaggregated view of welfare effects. Canadian producer revenue is maximized at about 6 million mt of exports to the United States, far above the level consistent with competitive free-trade conditions. Increases in Canadian exports to the United States result in losses for U.S. producers and for consumers in Canadian and offshore feed markets.[46]

Sources of Canadian producer revenue are shown in Figure 7.18 for various levels of barley exports to the United States. As revenues from Canadian sales to the U.S. market increase, revenues from other Canadian sales (domestic and offshore) decrease. Tradeoffs clearly exist between Canada's external markets; the surprising aspect of these results, in view of past analyses by the Wheat Board, is that the Board's optimal strategy is so heavily weighted toward U.S. sales.

These results hinge on demand relationships embedded in the model, in particular, on relationships between prices received (net of transportation) and elasticities in U.S. and offshore feed markets.[47] Feed markets in the model are price elastic, particularly the U.S. regional markets. Elasticities in the international and Canadian markets are lower. Hence, the Board has an incentive to expand U.S. sales beyond levels consistent with competitive equilibrium, in effect, absorbing a price discount for U.S. sales relative to alternative markets.

Another feature of the model is relevant to this discussion. The price received for Canadian offshore sales (i.e., to non-EEP markets) is constrained to be less than the U.S. export price plus the EEP bonus. When this constraint is binding, U.S. and Canadian export prices are directly linked. However, when it is not binding, Canada can push barley into the U.S. market without suffering any direct, price-depressing effects in offshore markets. This is contrary to contentions by the Wheat Board (in the context of debate over the Continental Barley Market) that higher exports to the U.S. Pacific Northwest would necessarily lower Canadian returns from offshore sales. Such a result is possible, but not necessary, in the context of this spatial model.

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[46]Total welfare is smaller than the sum of components represented in Figure 7.17; missing from the figure are costs of satisfying fixed demands for malt.

[47]A discriminating monopolist equates marginal revenue across markets. In a two-market context, this leads to the familiar condition:

$$MR_1 = p_1(1 + 1/\varepsilon_1) = p_2(1 + 1/\varepsilon_2) = MR_2$$

where ε_i represents the price elasticity of demand in market i and p_i is the market price (net of transportation cost in this context). With manipulation this becomes

$$\frac{p_1}{p_2} = \frac{\varepsilon_1\varepsilon_2 + \varepsilon_1}{\varepsilon_1\varepsilon_2 + \varepsilon_2}$$

Assuming $\varepsilon_i<0$ and $|\varepsilon_i|>1$ (i=1,2), it is clear that if the first market is more price elastic (i.e., $|\varepsilon_1| > |\varepsilon_2|$), then $p_1/p_2<1$.

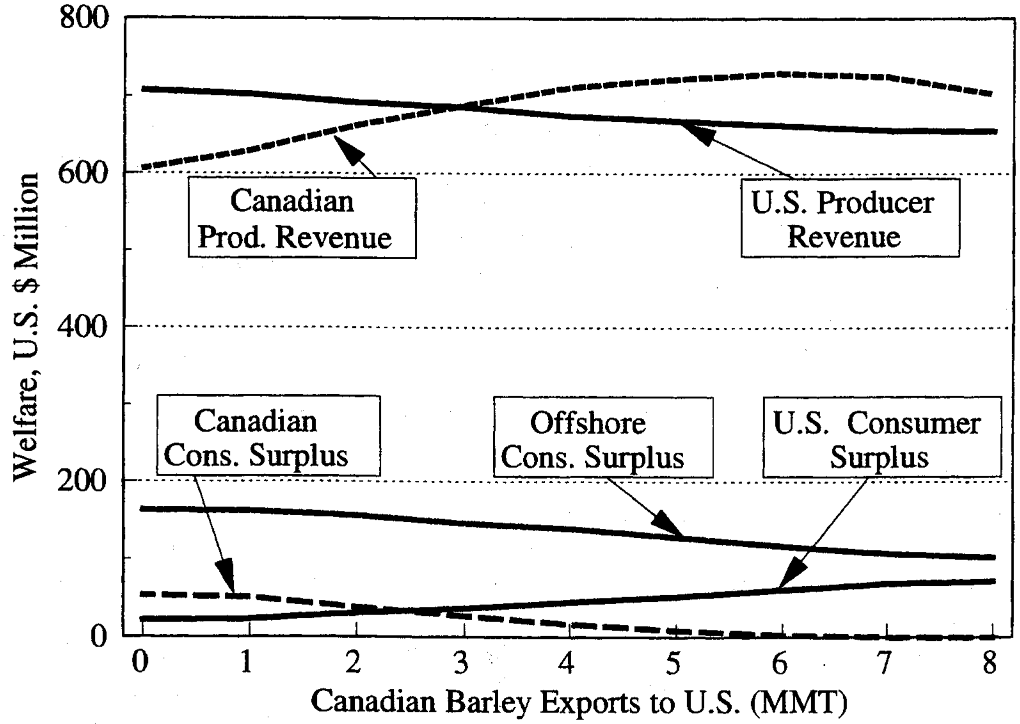

Figure 7.17. Disaggregation of Welfare Effects, Various CWB Sales to U.S.

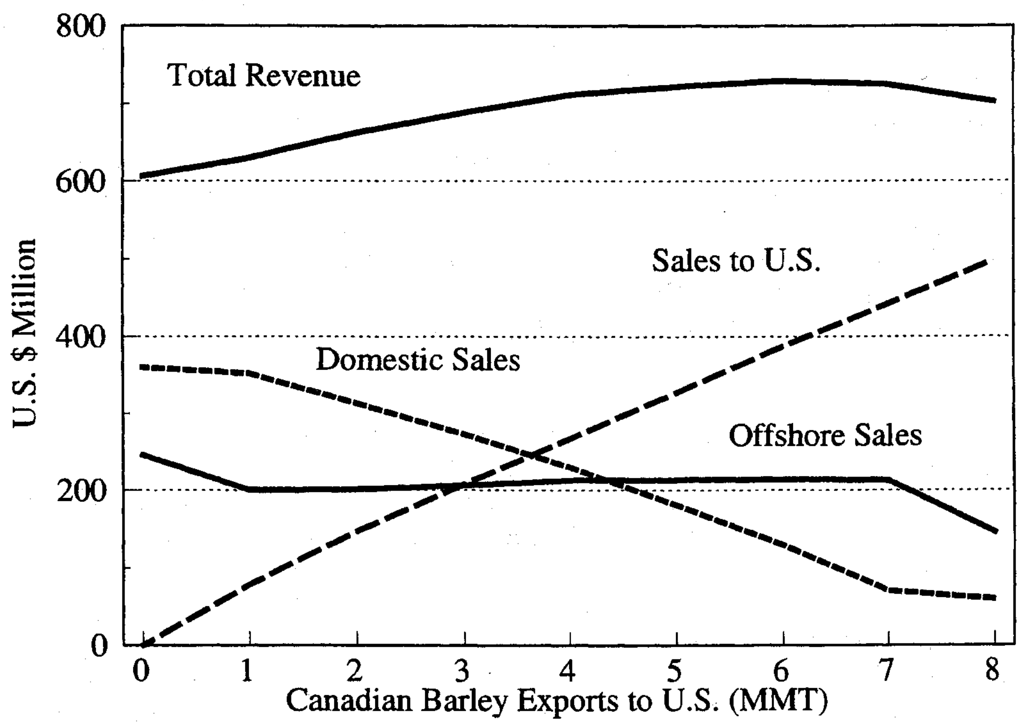

Figure 7.18. Canadian Producer Revenue, Various Levels of CWB Sales to U.S.

The main implication bears emphasis: retention of Wheat Board control may not lessen the pressure for sales of barley into the U.S. market. Indeed, to the extent that U.S. markets are more price elastic than Canada's offshore alternatives, as assumed here and as suggested in the Carter report, then the Board would have an incentive to expand U.S. sales beyond the level that would be consistent with a competitive marketing system in Canada.

8. Summary and Discussion

Barley trade between the United States and Canada has traditionally been negligible. However, recent changes in the policy, and the institutional and competitive environment have resulted in increased trade and increased tensions within and between these countries. Some of these hold potential for drastic changes in competitive relationships and spatial flows. This study has analyzed effects of selected trade, agricultural, and marketing policies on trade flows, prices, price differentials, and welfare. These include impacts of free trade in North American barley, potential trade restrictions, and the U.S. Export Enhancement Program (EEP). In addition, impacts of selected marketing policies were analyzed.

The North American market for malting and feed barley has a number of important characteristics. In general, there is surplus production of malting-quality barley; supplies above malting requirements can be sold in the feed market. The U.S. west coast is the largest market for feed barley. Competition for this market is accentuated by the distance of midwest corn supplies, and shortage of local feed grains. There are notable differences in barley quality in North America. The United States generally has a surplus of 6-rowed white aleurone malting barley, but is relatively short of 2-rowed white malting varieties. Canada has only a minor production of 6-rowed white aleurone malting barley, the type preferred by U.S. brewers, but is a large surplus producer of 2-rowed varieties. However, Canadian grading practices (and possibly sales opportunities) have restricted the quantity of barley that is sold for malting. Historical acceptance rates for Canadian malting barley have been less than in contiguous U.S. producing regions.

Several agricultural and trade policies have important effects on trade flows in the North American market. First is the U.S. EEP program. The effect of this policy is to distort U.S. domestic prices relative to international and, therefore, Canadian prices. As a result, arbitrage pressures exist to sell Canadian barley into the U.S. market. Exports from North America have been dominated by sales from Canada, with U.S. sales largely being subsidized. Second is the rail subsidy mechanism in Canada. The effect of changing this policy is to depress prairie barley prices and provide incentives to ship barley to the United States. Several policies affect acreage and the composition of barley supply in North America. The role of the Canadian Wheat Board, whose objective is to maximize Canadian producer revenue, also has important implications for trade flows.

The dynamics of the North American malt and beer industries are significant. Although the malt industry is fairly concentrated, the brewing industries have greater potential for exerting market power in North America. Both beer consumption and malt utilization per barrel have been decreasing, resulting in a declining domestic market. The malt industries in both countries have always had excess capacity relative to domestic beer demand, and this has increased in recent years, a trend likely to continue. Malt exports are of greater importance to the Canadian malting industry than to that of the United States.

Summary

A mathematical programming model was used to analyze North American barley flows. The United States and Canada were divided into different producing and consuming regions; to these were added several export markets for barley and malt. Barley supplies and domestic malt demands were taken as exogenous. The model was used to analyze impacts of policies on trade flows, prices, and welfare.

The base-case simulations assumed average supply conditions for 1987 to 1991, domestic North American demand reflecting 1992 livestock inventories and beer production, export demand functions reflecting conditions since the 1980s, and current transport rates and handling costs. Both traditional and nontraditional (e.g., crossing prairie-border) flows were allowed.

The model was used to identify optimal trade flows and corresponding prices under a freer trade regime, similar to that which would have evolved under the "Continental Barley" proposal: unrestrictive bilateral trade in barley and malt, import duties imposed by the United States, subsidized rail rates in Canada, and EEP bonuses of $32/mt for U.S. export sales. The model was also used to analyze impacts of alternative policies. These are summarized below:

- A freer trade solution would result in nearly 3.5 mmt of U.S. barley imports from Canada, including over 2.8 mmt of feed barley. Most of this is sold in western U.S. feed markets. Canadian malting exports to the U.S. consist largely of 2-rowed white varieties sold to malt plants located in the western United States. Exports to others markets are restricted to some extent because Canadian 6-rowed production is mostly 6-rowed blue, which has limited acceptance by U.S. brewers.

- U.S. import quotas would have several important effects. By definition, imports would be reduced from the base-case solution. If imports were eliminated, the price spread between United States and Canada would increase from 27c/bu in a free-trade solution to 62c/bu. The disposition of barley supplies is also changed by imposing quotas, and Canada shifts its exports from the United States to offshore markets.

  The United States could also impose a tariff to restrict imports under its Section 22 Authority. However, the tariff would have to be approximately 25$/mt to completely restrict imports from Canada.

- One of the more important policies affecting prairie-border-crossing barley flows is the rail subsidy regime used in Canada. Eliminating this policy will severely alter barley flows. In particular, increasing Canadian rail rates depresses Canadian prairie barley prices, so that prairie-border-crossing shipments become the optimal movement for a significant portion of Canadian barley. Results indicate that the equilibrium quantity of barley exported from Canada to the United States increases from 3.5 to 5 mmt under this scenario. Because of this policy change, Canadian and U.S. prices are reduced, Canadian exports to offshore markets are reduced, and those to the U.S. are increased.

- The EEP program also has an impact on both North American barley flows and producer welfare. In particular, increases in EEP bonuses increase the U.S.domestic price relative to the international market. Because of this disparity, U.S. barley imports from Canada increase.

  Simulation results indicate that even if EEP were eliminated, the United States would continue to be a net importer from Canada. With EEP bonuses less than $20/mt, U.S. exports are nil. With higher subsidy levels, gains in U.S. producer revenue from export sales are partly offset by losses in revenue from the domestic market.

  Canadian producer revenue drops sharply with EEP bonuses above $25/mt and restricted access to the U.S. export market. However, with unrestricted access to the U.S. market, Canadian revenue increases with a rise in the EEP bonus level; this is due to being able to sell in the higher priced U.S. market, replacing the U.S. barley that is exported under subsidy.

- Two important policies affect the supply and composition of barley in North America. First is the U.S. CRP program, in which an important share of barley base is removed from production. In model simulations, eliminating this program has the impact of increasing U.S. supply by 19% and increasing U.S. producer revenue by 14%. Prices are lowered in both countries. Much of the increased production is used for feed, and U.S. imports from Canada are reduced by 7 percent.

  Second, Canadian regulations on the release of barley varieties affect the composition of barley supply. Already, Canada has shifted toward 6-rowed white varieties. If 25% of Canadian area were shifted into production of 6-rowed white varieties, Canada's share of the U.S. malting barley market would increase from 24% to 37.8 percent.

- The role of the Canadian Wheat Board in a North American barley market has major implications. While this has been a source of much controversy within Canada (as evidenced by the evolution of recent policies), it also affects equilibrium trade levels.

  As sole-seller agency, the CWB has an objective of maximizing the revenue received by Canadian producers. Discriminatory pricing and strategic allocation of sales among customers are essential components of the overall CWB strategy. This requires that the CWB sell barley wherever marginal revenues are highest, in effect, equalizing marginal revenues across markets.

  In our analysis, U.S. market elasticities are greater than those in Canada's offshore and domestic markets. Under these circumstances, Canadian producer revenue is maximized with sales to the U.S. of about 6.0 mmt compared to 3.5 in the competitive base-case solution. This results in losses for U.S. producers and for consumers in Canadian and offshore feed markets, but gains to U.S. consumers.

In practice, actual conditions in a particular year may vary from those chosen for our base case. While market conditions may evolve in unforeseen ways, we have confidence in our qualitative results and in general conclusions drawn from our policy simulations.

Policy Discussion

Numerous pressures are being exerted on the North American barley market. Ultimately, these stem from policies and marketing institutions that have evolved independently in the United States and Canada. In combination, these factors have led to distortions in prices within North America, increased imports of Canadian barley into the United States, and pressures to make drastic alterations in the Canadian marketing system.

In each country, existing policies and institutions are challenged by the evolution of a more open trading environment for barley and malt. The results of this study suggest several conclusions which are important to current policy debates:

1. Given the geographical distribution of demand and supply, relative demand elasticities and transport and handling costs, economic pressures exist for increased movement of Canadian barley to the United States. This volume is greater than estimated in previous studies (which maintained fairly restrictive assumptions). A positive level of imports would exist even without the EEP program. However, the equilibrium level of imports increases in response to EEP bonuses, reductions in U.S. planted acreage due to CRP or other programs, and elimination of direct payment of the WGTA subsidy to Canadian railroads.

2. Both the CRP and EEP programs were conceived in an era when barley imports from Canada were negligible. However, under freer trade and without any mechanism for bilateral policy coordination, these programs increase imports from Canada and reduce U.S. producer revenue from domestic sales. Increased EEP bonuses expand the volume of U.S. exports; however, the impact on U.S. producer prices is mitigated by increased imports of Canadian barley. This confronts the United States with a strategic choice: whether to pursue a policy of increasing exports via EEP or to protect the U.S. domestic market.

3. Section 22 provides a mechanism to protect the U.S. market from import competition. Imposing import quotas (or significant tariffs) would increase U.S. producer revenue and lower Canadian producer revenue.

4. Changes in the Crow rate subsidy mechanism have been controversial in Canada and a focus of ongoing trade disputes. Allegations are made that

this subsidy provides an unfair trade advantage to Canada and is one reason for the increased volume of trade. However, our results demonstrate that eliminating of this subsidy (by paying growers directly) increases the flow of Canadian barley to the United States. This is due to the relative costs of alternative logistical channels and opportunities for spatial arbitrage, which were not considered under previous marketing arrangements.

5. These results also provide perspective on issues for the Canadian marketing system. First, the Canadian price pooling mechanism, as traditionally administered, is generally incompatible with high spot prices in contiguous U.S. regions. Second, the fact that past exports from Canada to the United States have been substantially less than levels indicated by the model suggests that the CWB has been underselling barley into the U.S. market. There are many potential reasons for this, but the political repercussions of large U.S. sales may be foremost. Third, the mechanisms that regulate malting barley in Canada, notably grading factors and policies for variety release, represent constraints on Canadian exports.

Two general observations are offered on the long-term prospects for North American barley trade. First, trade tensions will persist unless some effort is made to coordinate policies. The United States should not unilaterally pursue policies (i.e., acreage controls or export subsidies) without greater coordination and consultation with Canada. Without this coordination, the use of such policies by the United States should be reevaluated. Second, although the marketing systems in these two countries (including mechanisms related to pricing, transport, handling, and quality control) differ drastically, some convergence should be expected in the long run as a result of movement toward a more open trade environment.

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