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Competition and Policy Conflicts in Canada–U.S. Barley Trade

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Changes in policy, institutional and competitive environments have led to increased trade and a rise in trade tensions in the Canada–U.S. barley market. These tensions stem from policies and marketing institutions that have evolved independently in these two countries. Results from a detailed spatial equilibrium model of the Canada–U.S. barley market are presented in this article. Simulations are used to quantify effects of U.S. import restrictions; removal of Canadian rail subsidies, different Export Enhancement Program (EEP) subsidy levels, restoration of Conservation Reserve Program (CRP) acres to U.S. production, and retention of Canadian Wheat Board control over Canadian barley sales—all of which affect trade flows in the barley sector.

Key words: barley, grain trade, spatial eqiulibrium

Introduction

Barley trade between the United States and Canada has historically been negligible. However, recent changes in the policy, institutional and competitive environments have increased trade and raised trade tensions. In fact, Canadian exports of grain to the United States have become a major source of friction.[1] In the 1993–94 marketing year, U.S. producers sought protection from surging barley imports, which they blamed (in part) on Canadian rail subsidies and wheat board pricing practices. Institutional and policy changes (e.g., replacing Canadian rail subsidies with direct producer payments) may cause further drastic changes in competitive relationships and spatial flows.

The Canada–U.S. barley market presents interesting policy contradictions. In the United States barley supplies have been restricted through acreage controls, while exports have been subsidized through the Export Enhancement Program (EEP). These policies are intended, in part, to support market prices and reduce costs of deficiency payments. However, the price disparity between U.S. and subsidized offshore markets resulting from this program has encouraged an influx of Canadian grain, particularly in the more open-trade environment that emerged following the Canadian–U.S. Free Trade Agreement (CUSTA).

Canada's agricultural policies and grain-marketing institutions differ drastically. The Canadian Wheat Board (CWB) has a monopsony on barley procurement for uses other than domestic feed. This facilitates strategic behavior by the CWB, that is, its ability to target markets and practice price discrimination. Canada does not have explicit acreage controls, although quotas have been used to regulate deliveries into the marketing system. The government provides an important indirect subsidy to producers through the Western Grain Transportation Act (WGTA): railroads are subsidized for grain movements to Vancouver and Thunder Bay, reducing producers' cost of barley shipments to offshore markets and the

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[1]Similar problems exist in the wheat sector. See Alston et al. for an analysis of policy factors associated with Canada-U.S. trade in durum wheat.

eastern United States. Under terms of the CUSTA, WGTA subsidies do not apply to shipments to western states. Grain handling costs are high relative to those in the United States, creating incentives to circumvent Canadian elevators through cross-border truck shipments to U.S. elevators for shipment beyond.[2]

Opportunities for North American barley trade have inspired much debate in Canada (Carter 1993b; Gray, Ulrich, and Schmitz; Brooks; Veeman). Alberta Agriculture (Alberta) first proposed liberalized barley trade in North America, citing the cost-price squeeze for prairie producers and the need to seek new market outlets. A major liberalization of barley marketing in Canada 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, which retained control over offshore sales. This was reversed through a September 1993 court decision.

The purpose of this article is to analyze effects of selected trade and marketing policies on barley and malt trade flows, prices and price differentials, and economic welfare. There are important policy tradeoffs for the United States, such as whether the United States should pursue a policy of increasing exports through EEP, or a policy of protecting its domestic market. Canada confronts equally difficult issues, including whether to remove the CWB's monopoly over U.S. sales.

In addressing effects of policy changes, numerous complexities have to be recognized. First, the Canada–U.S. barley market comprises 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 for malting barley.[3] Third, published data on feed barley demand at the state or province level do not exist. Feed demand ultimately depends on the size and composition of livestock herds and on prices of substitute feedstuffs, which vary drastically by region.

Our results are based on a detailed, spatial equilibrium model of the North American barley market. Several policy simulations are reported. The base case corresponds to a freer trade regime in Canada. Other simulations show effects of U.S. import restrictions, removal of Canadian rail subsidies, different EEP subsidy levels, restoration of the Conservation Reserve Program (CRP) acres to U.S. barley production, and retention of CWB control over Canadian barley sales.

The next section provides a brief review of related studies. The spatial model is described in the third section. Simulation results are presented in the fourth section, and the article concludes with a discussion of policy implications.

Related Studies

Recent studies have reached sharply different conclusions about whether the CWB has been underselling barley (in volume) into the U.S. market, and whether the board should retain a monopoly over Canadian exports.[4] Magnusson and Lerohl suggested that Alberta could sell 1–1.4 mil. MT of barley into the northwestern region of the United States. Agriculture Canada reaffirmed that the CWB should remain as the sole exporter of barley to offshore

[2]See Johnson and Wilson for a detailed explanation of these mechanisms and effects.

[3]See Johnson and Wilson for a discussion of the institutional differences affecting barley quality in these two countries.

[4]Several articles are devoted to this topic in the November 1993 issue of the *Canadian Journal of Agricultural Economics*. Veeman provides a useful summary.

markets, but recommended that an intensive analysis be undertaken on alternative marketing arrangements for North American trade. The CWB argued that liberalized trade (i.e., the proposed Continental Barley Market) would result in: (*a*) increased exports to the United States and a lower U.S. barley price; (*b*) reduced returns in 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.

There have been two comprehensive analyses of the Canada–U.S. barley market. Carter (1993a) concluded that the CWB does not exert market power in either the United States or the world market, and that there are significant opportunities for expanded sales of Canadian barley to the United States. He suggested that an additional 500,000 MT of feed barley and 400,000 MT of malting barley could be sold to the United States. Producer revenues from barley could increase by up to 17% under a liberalized marketing system, with no restrictions on trade flows within North America. These results were based on Agriculture Canada's Canadian Regional Agricultural Model (CRAM).

Schmitz, Gray, and Ulrich used a trade model for feed barley comprising four markets: Canada, the United States, Japan, and other importers (EEP recipients). Demand elasticities, evaluated at representative trade volumes, were – 0.7, –1.3, – 0.2, and –1.2, respectively. Critical assumptions were made on intermarket price spreads. In particular, the U.S.–Canada price spread was specified as a linear function of bilateral trade volume, while the spread between Japan and other importers was set equal to the U.S. EEP subsidy. Results indicated that a continental barley market would lead to a modest increase in equilibrium trade flow (from 620,000 MT to 740,000 MT), but a net reduction in Canadian producer welfare due to the elimination of premiums for sales to Canadian maltsters.

The approaches used in these studies have several limitations, all of which are improved upon in our analysis. First, neither Carter nor Schmitz, Gray, and Ulrich explicitly modeled regional demands for feed barley, as distinct from feed grain use. Second, they did not incorporate details on regional malt plant capacity or characteristics of malting barley supply and demand (by region). Third, a very important component of trade is the transportation and logistical channels linking barley producing regions to malt plants and malt plants to breweries. These features are incorporated in our spatial equilibrium model, which forces all barley to be allocated among competing demands.

Empirical Procedures

A mathematical programming model was developed to explain barley trade flows and price relationships. Components of the model are described first, followed by a section presenting mathematical specifications and data sources.

Overview of the Spatial Equilibrium Model

The United States and Canada are divided into different producing and consuming regions; there are also 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 perfectly inelastic, while allowing feed barley prices and quantities fed (by region) to vary. The model is static and determines barley flows within a marketing year with supplies fixed. Available supplies are based on average annual production during 1989–92.

The model includes 30 barley supply regions (23 in the United States and seven in Canada). Barley supplies include four distinct types: feed barley (varieties not suitable for malting), six-rowed white malting, six-rowed blue malting, and two-rowed malting. For each producing region, supplies are divided among the four types based on recent production history and quality factors. Quality differences are important because demand requirements vary across brewers, as discussed below.

There are 21 feed demand regions (13 in the United States, six in Canada, and two offshore markets). State- and province-level demand functions were synthesized with an optimization model. Specifically, we used a least-cost feed model developed by Johnson and Varghese, which combines diet formulations for several classes of livestock in a single linear programming problem. Using 1992 livestock inventories as scaling factors, the least-cost feed model was adapted for individual states and provinces. Demand schedules were derived by varying the price of barley incrementally, holding other prices constant, and solving for barley quantity. For the spatial model, demand schedules were linearized by fitting regressions to these synthetic data points.[5]

An important institutional relationship exists in some prairie provinces. In particular, the Province of Alberta has subsidized local barley feeding under the Crow Benefit Offset Program. In Saskatchewan, the Feed Grain Market Adjustment Program is used to offset the competitive disadvantage of Saskatchewan livestock producers vis-à-vis other provinces. In the model simulations, effects of these programs are captured by adjusting the transportation and handling costs for intraprovincial barley flows. Specifically, we reduce the transportation and handling costs by U.S. $7.90/MT. This adjustment encourages feed use within these provinces in the base case. In alternative model simulations, when compensatory rail rates are assumed, we eliminate these local feed subsidies.

Data on barley use and trade flows do not exist on a regional basis, making it impossible to compare results with actual observations. For purposes of base-case simulations, the model was calibrated to be consistent with bilateral Canada–U.S. trade flows observed in the 1993–94 marketing year. Specifically, we adjusted the intercepts of Canadian provincial feed demand schedules so that model "predictions" of net cross-border trade matched USDA projections.[6]

Demand schedules for offshore markets (EEP and non-EEP) are based on econometric estimates.[7] Both countries export from their Pacific ports (i.e., Portland and Vancouver). EEP subsidies ($32/MT in the base case) apply to U.S. export shipments. Canada's export price to the non-EEP market is constrained to be no greater than the Portland price. This mimics strategic pricing by the CWB in its offshore sales.

There are 19 malt plant locations in the model (13 in the United States and six in Canada) with different capacity constraints. Vertical integration constraints are imposed at selected locations, reflecting brewer-owned malt plants. Malt demand regions are identified with states or provinces with significant beer production (16 in the United States, six in Canada); there are also two export markets. For each malt demand region, quality requirements

[5]In the least-cost feed model, barley demand is conditional on prices of substitute feedstuffs (e.g., corn and feed wheat), which vary substantially by region. The least-cost model is formulated as an LP problem, so that the demand for feed barley in each region is derived as a stepwise schedule. This was linearized for inclusion in the spatial model. Implied price elasticities vary with quantity demanded and hence are difficult to summarize. However, results repeated by Johnson and Wilson indicate that barley demand is generally price elastic and sensitive to the price of corn, a close substitute.

[6]Original feed demand parameters, reported in Johnson and Wilson (p. 41), were derived using market data (prices of substitutes and U.S./Canada exchange rate) from the spring of 1993. Using these parameters, the model projects a much larger volume of Canadian exports to the United States than was actually observed in 1993–94. Accordingly, intercepts for provincial feed demand were adjusted upward by U.S. $16/MT.

[7]Details are in Johnson and Wilson, pp. 42–3.

(percentages of six-rowed white, blue, and two-rowed malt) reflect market shares of major brewers with known variety requirements.

Transportation and handling costs are based on recent truck and rail rates, and handling margins at U.S. and Canadian elevators. For individual origins and destinations, several alternative movements were identified (e.g., truck, rail, or combination); least-cost movements were identified and incorporated in the analysis. In particular, the model allows prairie-border-crossing trade, an alternative to traditional Canadian east-west movements.

Mathematical Specification

The model is specified as a quadratic programming problem (Takayama and Judge). 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.

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 four types of barley: feed, six-rowed white malting, six-rowed blue malting, and two-rowed malting. The four 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 as:

(1)
$$W = \sum_j \int_0^{Q_j} (\alpha_j - \beta_j Q_f) dQ_j - \sum_i \sum_j \sum_k X_{ijk} Tx_{ij} - \sum_i \sum_m \sum_h Y_{imh} Ty_{im} - \sum_m \sum_n \sum_h Z_{mnh} Tz_{mn},$$

where Q_j is total barley feed use in region j;

(2)
$$Q_j = \sum_i \sum_k X_{ijk} \quad \forall j;$$

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 (1) 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.

Regional barley feed use, Q_j, is constrained to be less than estimated total consumption of feed grains:

(3)
$$Q_j \leq \overline{Q}_j \quad \forall j.$$

Maximum feed use parameters were taken from Carter (1993a, pp. 51–5), or derived by the authors using 1992 livestock inventories for individual states and provinces. No quantity limits were applied to offshore feed barley markets.

Barley prices in feed markets are given by

(4) $$P_j = \alpha_j - \beta_j Q_j \qquad \forall j.$$

In general, the North American demand schedules are highly elastic. Evaluated at base-case quantities, demand elasticities in western states range from −3.8 in Montana to −7.4 in Idaho and −17.6 in California (the largest barley feeding state). For comparison, demand elasticities in the prairie provinces average − 4.0 in the base case. Highly elastic demand schedules are consistent with expectations, given the close substitutability of barley for corn and other feed grains in livestock rations.[8] However, these regional elasticities are substantially greater than those used in Schmitz, Gray, and Ulrich.

Offshore prices are measured at Pacific ports, Portland and Vancouver. To mimic strategic pricing by the wheat board, offshore prices are constrained as follows:

(5) $$P_{non-EEP} \leq P_{EEP} + EEP,$$

where $P_{non-EEP}$ is the price in non-EEP markets ($/MT), P_{EEP} is the price in EEP markets ($/MT), and EEP is the U.S. export bonus ($/MT). This discourages U.S. exports to non-EEP markets.

For each barley producing region, supply constraints are specified as follows:

(6) $$\sum_j X_{ij,feed} \leq A_{i,feed} \qquad \forall i$$

and

(7) $$\sum_j X_{ijh} + \sum_m Y_{imh} \leq A_{ih} \qquad \forall i, h,$$

where $A_{i,feed}$ denotes availability of feed-quality barley ('000 MT); and A_{ih} denotes availability of malting-quality barley (type h) in region i. The latter constraint reflects the alternative destinations for malting-quality barley, that is, feed markets (indexed by j) and malt plants (indexed by m).

Material-balance and capacity constraints apply to all malt plants. These have the form:

(8) $$0.75\sum_i Y_{imh} \geq \sum_n Z_{mnh} \qquad \forall m, h,$$

and

[8] Carter (1993a, p. 59) estimated the price elasticity of U.S. demand (aggregated across barley types and regions) for Canadian barley at −19.

(9)
$$\sum_{i}\sum_{h} Y_{imh} \leq C_m \qquad \forall m,$$

where 0.75 is a barley-malt conversion factor, and C_m is the plant capacity ('000 MT barley/annum). Additional restrictions apply to selected brewer-owned malt plants; by assumption, these plants operate at full capacity and supply malt exclusively to breweries owned by the same parent (i.e., Anheuser-Busch or Coors).

For beer production regions (indexed by n), total malt requirements (TMR) are specified. These are based on 1991 beer production by region and different conversion factors for U.S. and Canadian breweries:

(10)
$$\sum_{m}\sum_{h} Z_{mnh} \geq TMR_n \qquad \forall n.$$

For U.S. beer production, the conversion rate is 24 lbs. of malt per barrel; for Canadian production, the rate is 36 lbs. per barrel. Minimum and maximum allowable percentages are also specified for each malt type, as follows:

(11)
$$\frac{MINPC_{nh}}{100} \leq \frac{\sum_{m} Z_{mnh}}{\sum_{m}\sum_{h} Z_{mnh}} \leq \frac{MAXPC_{nh}}{100} \qquad \forall n, h.$$

The allowable percentages, $MINPC_{nh}$ and $MAXPC_{nh}$, are based on known requirements of major brewers, weighted by company shares of regional production capacity.

U.S. and Canadian exports of malting barley and malt to third markets (offshore and Mexico) are fixed exogenously. The model does not include producer prices per se; producer prices can be computed as a weighted average of the shadow prices associated with supply constraints in barley 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 the constraint on price spreads allows Canada to dominate 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 U.S. Department of Agriculture, National Agricultural Statistics Service (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* (Brewing and 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 (1993a, p. 10).

Data for the United States brewing industry are from *Brewers Almanac 1992*, published by the Beer Institute 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 (Brewers). U.S. beer production capacities at the state level were derived from the *Brewers Almanac* and company sources. U.S. and Canadian malt plant locations, ownership, and capacities are those listed in the Canadian Wheat Board report and were valid in 1992. Exports of malting barley and malt to third countries were taken from Canadian Wheat Board sources and were set equal to the five-year average ending 1991.

Transport and handling costs are from a number of sources. U.S. rail rates were taken from Burlington Northern and CP/Soo Line Tariffs. Missing rail rates were estimated using data in the *1991 Waybill Data Tape* (Interstate Commerce Commission). Canadian rates were taken from Canadian Pacific (CP) and Canadian National (CN) Rail Tariffs. Trucking costs and formulas and handling costs were from industry sources in each country.

Simulation Results

Base-Case: Continental Barley Market

Our base-case assumptions reflect a freer marketing regime in Canada. Specifically, we assume the following: (*a*) quantitative restrictions do not apply to cross-border flows of barley or malt; (*b*) Canada does not regulate imports through the granting of permits; (*c*) current U.S. tariffs apply to imports of barley and malt from Canada; (*d*) Canadian rail rates reflect current WGTA subsidies; and (*e*) cross-border truck/rail shipments are allowed to U.S. barley destinations. These assumptions deviate from past marketing practices. Most important, perhaps, is that barley is allowed to move directly across the border by truck, bypassing the Canadian handling sector (but still incurring U.S. handling costs), if that is optimal.

The model projects 1.4 mil. MT of Canadian barley exports to the United States, including 0.9 mil. MT of feed barley, in the base case (table 1). This is approximately the trade level observed in 1993–94. U.S. domestic feed use (5.4 mil. MT)[9] and Canadian feed use (5.5 mil. MT) are similar to levels observed in recent years. Canada also exports about 0.5 mil. MT of malting barley to the United States. Two-row malting barley accounts for over 90% of these malting barley exports. Average producer prices are higher in the United States than in Canada. U.S. producer prices are $1.82/bushel (averaged over all U.S. producing regions and barley types), while Canadian producer prices are $1.61/bushel. Among other factors, this difference reflects the proximity of U.S. producing regions to high-priced feed markets and malting capacity.

Results confirm the importance of West Coast feed markets. California and Nevada represent the highest-priced feed barley markets due to transportation costs and expensive feed substitutes. U.S. prices are lowest in midwestern barley-producing states. Prices in the prairie provinces are the lowest of all regions. These results are consistent with recent observations.

California represents the largest U.S. feed demand region, with barley feed use of 1.8 mil. MT (fig. 1). The northwestern states (Oregon, Washington, and Idaho) account for an

[9]This is close to the actual level of U.S. barley feed use in 1993–94. For perspective, in recent years barley has accounted for no more than 3–4% of total U.S. feed use of coarse grains.

Table 1. Base-Case Simulation Results: Trade, Domestic Use, and Prices

	United States	Canada
Bilateral Trade Flows (TMT)		
Exports		
Feed barley	0	883
Malting barley	97	504
Malt	0	188
Net Bilateral Trade (exports - imports)		
Feed barley	–883	883
Malting barley	–407	407
Malt	–188	188
Offshore Feed Exports		
Subsidized markets	1,903	0
Nonsubsidized markets	0	2,695
Domestic Use (thsd. MT)		
Feed use	5,356	5,539
Malting use	2,759	871
Average Producer Price (US $/MT)	83.46	73.81

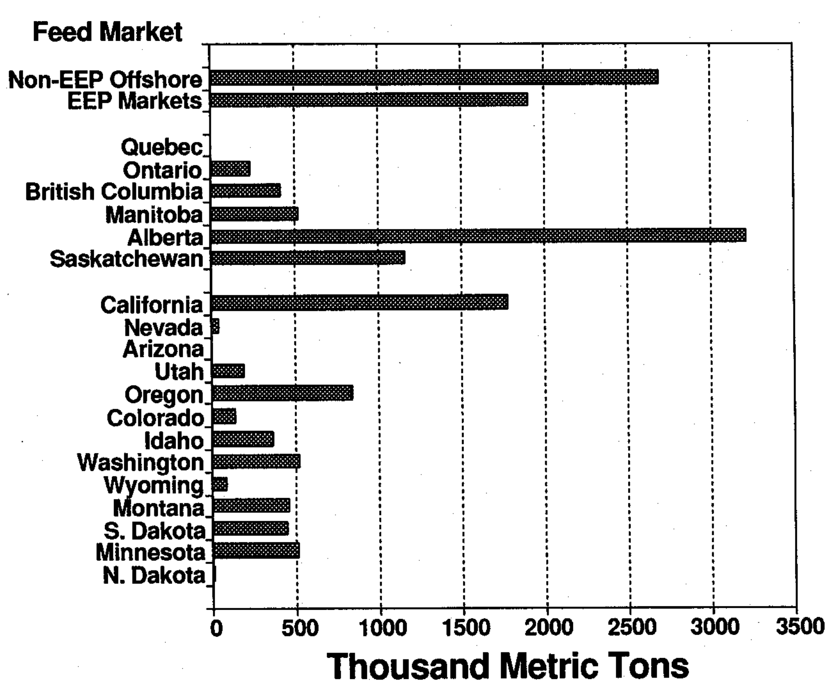

Figure 1. Feed barley quantity sold by market, base-case solution

additional 1.7 mil. MT of feed barley demand and are supplied extensively by Canada. Canada captures 16% of the U.S. feed barley market. Canadian exports of malting barley to the U.S. West Coast are particularly large. The U.S. Midwest, where most U.S. malting capacity is located, is principally served by U.S. producing regions. Canada's share of the U.S. malting barley market is 18% in the base case.

Regional flows provide an interesting perspective on the U.S. EEP program. Under base-case assumptions, subsidized U.S. export shipments originate largely in western Montana, Washington, Oregon, and Idaho. Feed markets in these states receive substantial inflows of barley from adjoining regions, including 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.

U.S. Import Restrictions

Under terms of the Canadian–U.S. Free Trade Agreement, the United States retained its rights under Section 22 of the Agricultural Adjustment Act. Section 22 empowered the secretary of agriculture to restrict imports (through ad valorem duties or quotas) if they adversely affect the operation of domestic farm programs. In early 1994, the United States threatened to invoke Section 22 to curtail imports of Canadian wheat. Similar action was urged by U.S. barley producers in response to a surge of imports from Canada.[10]

We introduced import quotas on barley in the base-case model to evaluate potential implications of U.S. trade restrictions (see table 2). With zero barley imports from Canada, the average price received by U.S. producers increases to $1.86 per bushel—about four cents higher than in the base case. For Canadian producers, the average price decreases to U.S. $1.54 per bushel—seven cents lower than in the base case. Thus, elimination of U.S. barley imports increases the cross-border gap in average producer prices from 21 to 32 cents per bushel.

With zero Canadian barley allowed into the United States, Canada's domestic feed use increases from 5.5 to 6.7 mil. MT, and U.S. feed use decreases from 5.3 to 4.4 mil. MT. As the U.S. import quota is increased from zero to 0.5 mil. MT, there are corresponding changes in domestic feed use and (to a lesser extent) offshore exports. Relaxing the U.S. import constraint causes Canadian barley to be shifted away from domestic markets and toward the United States.

The United States could also restrict imports by increasing the tariff on Canadian barley (currently $1/MT). To evaluate the efficacy of higher tariffs as an alternative to import quotas, U.S. tariffs were raised incrementally in model simulations. Results suggest that a U.S. tariff of $10/MT would be prohibitive for feed barley; however, the United States would still import 0.4 mil. MT of Canadian malting barley. To reduce malting barley imports to 0.1 mil. MT, the U.S. barley tariff would have to increase to $15/MT.

Compensatory Rail Rates

Canadian rail subsidies have been a major source of trade conflict between the United States and Canada. In response to budgetary pressures and the General Agreement on Trade and

[10]With implementation of the GATT agreement, Section 22 will no longer provide a basis for unilateral trade restrictions. Under Article 28 of the GATT, United States can still legally impose restrictions if it provides adequate compensation to affected trading partners.

Table 2. Results from Alternative Simulations: Trade, Domestic Use, and Prices

Variable	U.S. Import Quota			Compensatory Rail Rates	U.S. EEP Bonus ($/MT)			Return of CRP Acres
	Base Case	0 mil. MT	0.5 mil. MT		0	40	60	
Canadian Barley Exports (mil. MT):								
to United States	1.39	0.00	0.50	2.70	0.52	1.50	1.78	1.23
to offshore markets	2.89	3.02	2.96	1.63	3.55	2.89	2.86	2.91
Totals	4.28	3.02	3.46	4.33	4.07	4.39	4.64	4.14
U.S. Offshore Exports (mil. MT):	1.95	1.66	1.72	2.53	0.05	2.35	3.58	2.08
Domestic Feed Use (mil. MT):								
Canada	5.54	6.71	6.28	5.51	5.75	5.49	5.21	5.68
United States	5.36	4.36	4.76	6.07	6.39	5.02	4.09	6.63
Average Producer Prices:								
Canada								
(US $/MT)	73.81	70.53	72.04	68.61	73.08	74.05	74.78	73.33
($/bu.)	1.61	1.54	1.57	1.49	1.54	1.61	1.63	1.60
United States								
(US $/MT)	83.46	85.58	84.83	83.36	81.69	84.70	87.12	80.90
($/bu.)	1.82	1.86	1.85	1.81	1.78	1.84	1.90	1.76

Tariffs (GATT) rules, the Canadian government has proposed changes in the method of payment. Existing subsidies, paid by the Canadian government to the railroads, would be converted into direct payments to producers over the course of four years (*Milling and Baking News*, p. 45). For purposes of model simulations, rates for applicable Canadian rail movements are adjusted to the full WGTA level. With fully compensatory rates, shippers pay the total cost of shipping, including the portion previously paid by the Canadian government. This raises the shipping rate to Vancouver (for export) and Thunder Bay (for eastern destinations). These higher rail rates, and the concurrent elimination of subsidies for grain feeding in Alberta and Saskatchewan, make prairie border-crossing movements more attractive.

Results indicate that compensatory rates widen the gap between U.S. and Canadian producer prices. 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 2.7 mil. MT of barley to the United States—nearly two-thirds of total Canadian exports. These results illustrate that elimination of Canadian rail subsidies does not advance U.S. producer interests. To the contrary, higher shipper costs depress barley prices in Canadian producing regions, inducing larger flows of Canadian barley into the United States.

The Export Enhancement Program

The Export Enhancement Program (EEP) has an important influence on North American barley flows and has also been an important source of dispute between these two countries.

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 bilateral disputes over grain trade.

To quantify these effects, the model was simulated with alternative levels of the EEP bonus (subsidy per metric ton). As expected, a higher EEP bonus raises average U.S. producer prices. The United States does not export significant quantities of barley until the EEP bonus rises above \$20/MT; thereafter, U.S. exports increase and domestic prices rise, inducing larger imports from Canada. The United States remains a net importer of barley at all bonus levels considered (from \$0 to \$60/MT). This suggests that even if EEP were eliminated, there are substantial economic inducements for Canadian sales into the U.S. market—particularly sales of malting barley.

The impact of EEP for Canadian producer revenue depends on assumptions about bilateral trade restrictions. When Canada is denied access to the U.S. market (i.e., through zero import quota), Canadian revenue drops precipitously with increases in the EEP bonus above \$20/MT (fig. 2). This is essentially due to the price-depressing effects of EEP in subsidized offshore markets. On the other hand, when Canada enjoys unrestricted access to the U.S. market, Canadian revenue is enhanced by higher EEP bonuses. While higher bonuses displace Canadian barley from subsidized offshore markets, Canada benefits from the rise in U.S. barley prices induced by EEP sales.

Restoration of CRP Acres to U.S. Production

The Conservation Reserve Program (CRP) contributed to the loss of U.S. barley acres during the mid-1980s. To evaluate the significance of this program, simulations were conducted in which CRP acres were restored to barley production in four major producing states: Montana, North Dakota, Minnesota, and South Dakota. This leads to a 19% increase in U.S. barley output relative to the base case.

Results indicate that U.S. barley imports from Canada would be slightly reduced, from 1.39 mil. MT to 1.23 mil. MT, because the rise in U.S. supply is accompanied by a large increase in domestic feed use. While the return of CRP acres to production would have little impact on aggregate trade flows, average producer prices would fall in both countries. U.S. producer revenue would rise by 15% due to the increased barley output.

Retention of Wheat Board Control over Barley

The foregoing simulations are premised on a competitive marketing environment: in absence of quantitative 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 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. Price discrimination is closely linked to Canada's price pooling mechanism; neither feature is consistent with the type of competitive market behavior

[11] 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.

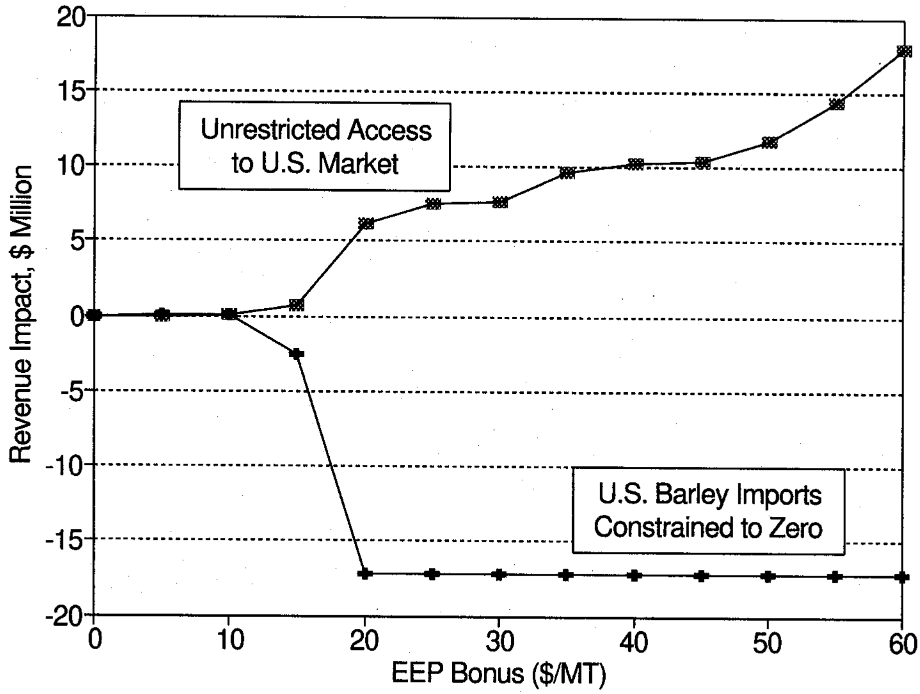

Figure 2. Impact of EEP on Canadian producer revenues, free trade vs. U.S. import quota

embedded in our spatial model.[11] However, by varying the level of exports to the United States, the optimal trade volume from the board's perspective can be identified—that is, that which maximizes Canadian producer revenue.

For purposes of these simulations, Canadian imports of U.S. barley and malt are constrained to zero, which is consistent with Canada's current practice of limiting imports through a license system. Canadian barley exports to the United States are varied parametrically, with Canadian producer revenue (aggregated across producing regions and shipping destinations) evaluated at each trade level, as shown in figures 3 and 4. Results indicate that Canadian producer revenue is maximized at about 4 mil. MT of exports to the United States—far above the level under competitive free-trade conditions (i.e., the base case). Increases in Canadian exports to the United States result in losses for U.S. producers and for consumers in Canadian and offshore feed markets.

Sources of Canadian producer revenue were identified for different 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 among Canada's external markets; the surprising aspect of these results, in view of past analyses by the CWB, is that the board's optimal strategy is so heavily weighted toward U.S. sales.

The 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. A discriminating monopolist equates marginal revenue across markets. In a two market context, this leads to the condition

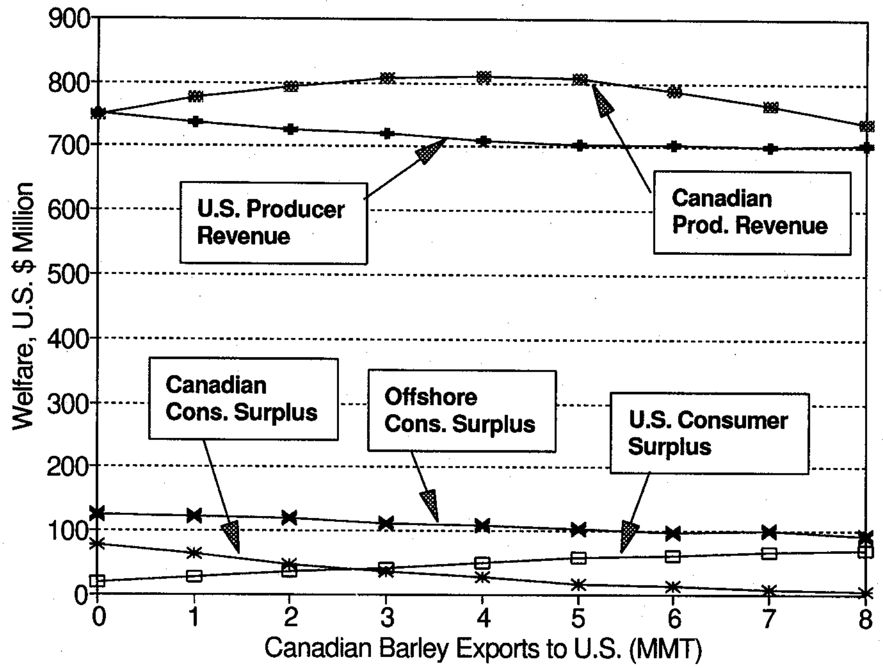

Figure 3. Disaggregation of welfare effects, various levels of CWB sales to United States

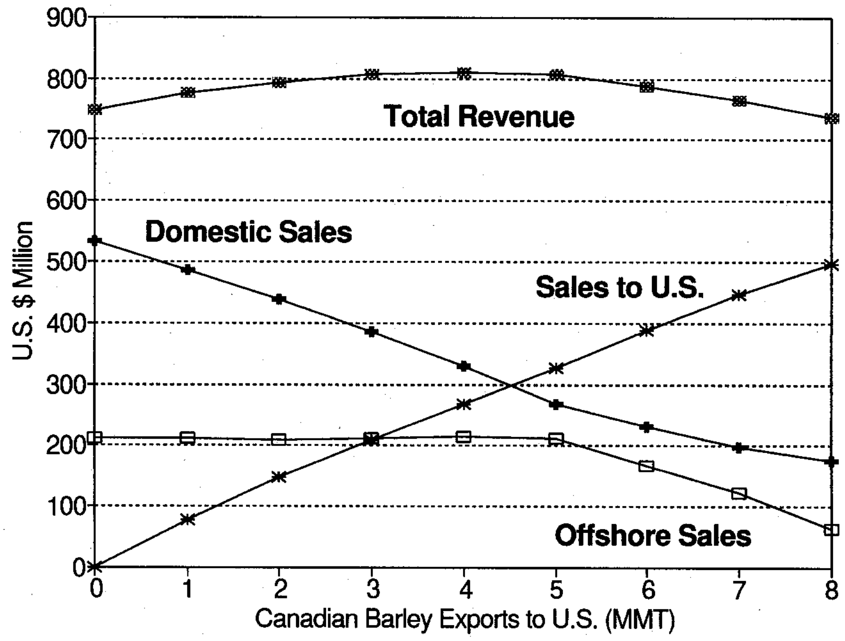

Figure 4. Canadian producer revenue, various levels of CWB sales to United States

$$MR_1 = p_1(1+1/\varepsilon_1) = p_2(1+1/\varepsilon_2) = MR_2, \tag{12}$$

where MR_i is marginal revenue in market i (i = 1, 2), 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

$$\frac{p_1}{p_2} = \frac{\varepsilon_1\varepsilon_2 + \varepsilon_1}{\varepsilon_1\varepsilon_2 + \varepsilon_2}. \tag{13}$$

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 $p_1/p_2 < 1$(price is lower in market 1).

Feed markets in the model are price elastic, particularly the U.S. regional markets. Elasticities in the international and Canadian markets are smaller (in absolute value). 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 or equal to the Portland price. When constraint (5) is binding, U.S. and Canadian export prices are directly linked. However, when it is not binding, Canada can expand sale volumes to the U.S. market without suffering any direct, price-depressing effects in non-EEP offshore markets. This is contrary to contentions by the CWB 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 spatial competition.

The main implication bears emphasis: due to U.S. markets being more price elastic than Canada's offshore alternatives (as also suggested by Carter 1993a), the board's optimal selling strategy would be to expand U.S. sales beyond the level that would be consistent with a liberalized marketing system in Canada.

Summary and Discussion

Barley trade between the United States and Canada has traditionally been negligible. However, recent changes in the institutional and policy environments have resulted in increased trade, as well as increased tensions within and between these countries. Some of these hold potential for further, drastic changes in competitive relationships and spatial flows.

A mathematical programming model was developed to analyze the North American barley market. The model was used to identify optimal trade flows and corresponding prices under alternative policy assumptions. In the base-case scenario, we assume a freer trade regime in Canada, similar to that which would have evolved under the Continental Barley proposal. Bilateral trade in barley and malt are unrestricted; import duties are imposed by the United States; subsidized rail rates apply in Canada; and U.S. export sales to offshore markets are subsidized through the EEP program.

With demand parameters calibrated to reflect the 1993–94 marketing year, the model projects 1.4 mil. MT of Canadian barley exports to the United States. This includes 0.9 mil. MT of feed barley, which is sold in western U.S. feed markets. Canada ships 0.5 mil. MT of malting barley to the United States, primarily to West Coast malting plants. If the U.S. barley imports were eliminated (e.g., through Section 22), average producer prices would be four cents per bushel higher in the United States and seven cents per bushel lower in Canada.

One of the more important policies affecting prairie-border-crossing barley flows is the rail subsidy regime currently used in Canada. 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 by 1.3 mil. MT under this scenario.

Increases in EEP bonuses raise the U.S. domestic price relative to the international market. In response, U.S. barley imports from Canada increase. 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 $20/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.

The role of the Canadian Wheat Board in a North American barley market has major implications. 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 United States of about 4.0 mil. MT, compared to 1.4 mil. MT 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.

Policy Discussion

Numerous pressures are now 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 price distortions 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. Results of this study are important to the policy debates regarding North American barley trade. First, 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. A positive level of imports would exist even in the absence of the EEP program. However, the equilibrium import level increases in response to the following factors: 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.

Second, the Export Enhancement Program was conceived in an era when barley imports from Canada were negligible. However, under freer trade and absent any mechanism for bilateral policy coordination, this program results in increased imports from Canada and reduced 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 or not to protect the U.S. domestic market by increasing exports through EEP.

Third, the WGTA subsidy mechanism has 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 elimination of this subsidy (or conversion to direct producer payments) would result in an increased 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.

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