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Canadian Exports of Wheat and Barley to the United States and its Impacts on U.S. Domestic Prices

Jeremy W. Mattson
Won W. Koo

Department of Agribusiness and Applied Economics
Northern Plains Trade Research Center
North Dakota State University
Fargo, ND 58105

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ABSTRACT

Canadian exports of wheat and barley to the United States have increased significantly since the late 1980s. The objectives of this study are to determine the factors that affect trade flows of hard red spring wheat, durum wheat, malting barley, and feed barley from Canada to the United States and to evaluate the impacts of Canadian wheat and barley exports on the U.S. domestic prices of these commodities.

Major factors affecting trade flows of these commodities from Canada to the United States include the exchange rate, quality differences, differences in market size, the U.S. Export Enhancement Program, the elimination of Canadian rail subsidies, and trade liberalization under the Canada - United States Free Trade Agreement of 1989 (CUSTA). These factors have positively influenced Canadian exports, resulting in major increases in Canadian exports of agricultural commodities to the United States. The increased Canadian exports have resulted in reduced U.S. domestic prices of wheat.

Keywords: bilateral trade, free trade agreement, wheat, barley, farm price

HIGHLIGHTS

The Canada - United States Free Trade Agreement (CUSTA) and the North American Free Trade Agreement (NAFTA) became effective in 1989 and 1994, respectively. When NAFTA is fully implemented, these two agreements will create the largest single market in the world. CUSTA has been fully implemented for bilateral trade between the United States and Canada.

Under CUSTA, trade volume between the United States and Canada has increased. For agricultural commodities and products, the increase has been greater for Canadian exports to the United States than U.S. exports to Canada. Since the implementation of CUSTA**,** Canadian exports of wheat and barley to the United States have increased dramatically. U.S. producers allege that the increase in Canadian exports has been harmful to them because increased supplies have lowered prices.

Objectives of this study are to identify factors affecting the flows of Canadian exports of wheat and barley to the United States and to analyze the effects of Canadian exports on U.S. prices. Two commodities are analyzed in this study - wheat and barley. Wheat is divided into hard red spring (HRS) wheat and durum wheat. Barley is divided into malting barley and feed barley. An econometric model is developed and estimated. The model includes two equations: 1) an export supply equation of Canadian wheat and barley to the United States; and 2) a price equation. These two equations are estimated using three-stage least squares estimation with quarterly time series data for wheat and monthly data for barley.

This study finds that trade liberalization under CUSTA has had a significant influence on trade flows, making it easier for Canada to export grains to the United States. The exchange rate, U.S. grain quality, size of the U.S. market, the U.S. Export Enhancement Program (EEP), and Canadian rail subsidies have all significantly affected flows of wheat and barley from Canada to the United States. The U.S. dollar's appreciation in value relative to the Canadian dollar has been an important factor influencing trade flows. The United States' use of the EEP, which was eliminated in 1995, caused increased imports of HRS wheat and feed barley from Canada. The elimination of the Canadian rail subsidy in 1995 had a positive effect on exports of HRS wheat from Canada to the United States. The size of the U.S. market and poor U.S. grain quality have also had major effects on trade flows.

This study also finds that increased exports from Canada have negatively affected U.S. prices of wheat, but have not significantly affected barley prices. Results show that a 1 percent increase in Canadian exports of durum to the United States results in a 0.23 percent decrease in the U.S. durum price, and a 1 percent increase in Canadian exports of HRS wheat to the United States results in a 0.017 percent decrease in the U.S. HRS price. Average yearly reductions in U.S. domestic prices due to increases in Canadian exports since the inception of CUSTA were 2.9 percent for HRS wheat and 8.6 percent for durum wheat.

CANADIAN EXPORTS OF WHEAT AND BARLEY TO THE UNITED STATES AND ITS IMPACTS

Jeremy W. Mattson and Won W. Koo*

Introduction

The United States and Canada are two of the world's largest exporters of wheat and barley and compete with each other in major foreign markets. They share a common interest in reducing government interference in world agriculture and encouraging world trade. The Canada–United States Free Trade Agreement (CUSTA) and the North American Free Trade Agreement (NAFTA) became effective in 1989 and 1994, respectively. When NAFTA is fully implemented, these two agreements will create the largest single market in the world. CUSTA has been fully implemented for bilateral trade between the United States and Canada.

The CUSTA agreement has contributed to an increase in trade volume between the United States and Canada. For agricultural commodities and products, the increase has been greater for Canadian exports to the United States than for U.S. exports to Canada. Since the implementation of CUSTA, Canadian exports of wheat and barley to the United States have increased dramatically. At the same time, U.S. exports of these commodities to Canada have not changed significantly. Wheat exports from Canada to the United States prior to 1987 were nearly non-existent and became significant only in the early 1990s. For the 1992-1999 period, Canadian exports of hard red spring (HRS) wheat to the United States averaged 1.4 million metric tons. In 1989, the first year of CUSTA, Canada exported only 18 thousand metric tons of HRS wheat to the United States. Durum exports from Canada to the United States averaged 232 thousand metric tons for the 1987-1991 period and 413 thousand metric tons for the 1992-1999 period. Exports of malting barley from Canada to the United States averaged 255 thousand metric tons for the 1990-1993 period and 659 thousand metric tons for the 1994-1999 period. U.S. producers allege that the increase in Canadian exports has been harmful to them because increased supplies have lowered prices. The decrease in prices, U.S. producers further allege, has had a harmful effect on their incomes.

Objectives of this study are to determine the factors affecting the flows of Canadian exports of wheat and barley to the United States and to determine the effects of Canadian exports on U.S. prices. Two main commodities are analyzed in this study - wheat and barley. Wheat is divided into HRS wheat and durum wheat. Barley is divided into malting barley and feed barley.

Previous Studies

There is a large body of literature regarding trade issues between the United States and Canada. These studies are generally divided into two groups: one focusing on trade flows of

*Research Assistant and Professor and Director, respectively, in the Northern Plains Trade Research Center, Department of Agribusiness and Applied Economics, North Dakota State University, Fargo.

agricultural commodities between the United States and Canada using mathematical programming models, and the other using econometric models to analyze the effects of Canadian exports of agricultural commodities on U.S. domestic prices and to analyze factors affecting trade flows from Canada to the United States.

Gibson et al. (1991) used a linear programming model to solve for the optimal allocation of milling capacity in North America under free trade. This study indicated that free trade did not impose an immediate problem for the Canadian flour milling industry, but that opportunities created by CUSTA for increased Canadian wheat and flour exports to the United States were limited.

Worley et al. (1991) used a quadratic programming model to determine the effects of CUSTA in the red meat and grain industries on producer and consumer surpluses for seven U.S. production and consumption regions, two Canadian regions, and the two countries as a whole. Their results showed that consumers in all regions would benefit at the expense of producers.

Boyd et al. (1993) used a quadratic programming model to determine the effects of tariff removals on the North American lumber trade. The United States, Canada, and Mexico were divided into a number of smaller lumber-supplying and lumber-demanding regions. Various scenarios were simulated to quantify the effects of different levels of protection on lumber shipments and economic welfare in different geographic regions. The results of their model indicated that lumber shipments would be affected significantly by trade liberalization, but the overall level of welfare would not change appreciably.

Wilson and Johnson (1995) analyzed the effects of changing selected marketing policies on barley trade flows. Factors they analyzed included the restrictions on the distribution of malting barley varieties in Canada, malting barley selection rates in Canada, Canadian feed barley yields, Canadian handling costs, and Canadian malting barley exports to offshore markets (which may increase because beer production is increasing faster in the rest of the world than it is in North America). Johnson and Wilson (1995) quantified effects of U.S. import restrictions, removal of Canadian rail subsidies, different EEP subsidy levels, restoration of CRP acres to U.S. production, and retention of Canadian Wheat Board (CWB) control over Canadian barley sales.

Mao et al. (1996) analyzed world feed barley trade and international competition among Australia, Canada, the European Union (EU), and the United States under current and alternative trade policy scenarios. The study evaluated the impacts of the elimination of export subsidies and trade barriers on trade flows for feed barley. Results showed that eliminating the U.S. Export Enhancement Program (EEP) would reduce U.S. exports by 26 percent, while decreasing exports from Canada to the United States by 23 percent. Eliminating the Canadian rail subsidy would decrease Canadian offshore exports, but greatly increase its exports to the United States. NAFTA was found to increase feed barley trade within North America. Canada would increase exports to both the United States and Mexico; and the United States would increase exports to Mexico. NAFTA, however, was shown to have little effect on world trade flows of barley. Canada was

found to benefit most from the freer world trade under the Uruguay Round Agreement of GATT through significantly higher exports to the United States and to offshore markets.

Other studies have used econometric analysis to evaluate factors affecting trade flows and the economic effects of Canadian exports of agricultural commodities. Mohanty (1995) developed a structural econometric model of wheat production, consumption, and trade including four regions, the United States, Canada, the European Union, and the rest of the world. The model incorporated product differentiation of wheat by country of origin and end-uses. It also included important government interventions in major trading regions. Mohanty's model was used to analyze the causes and consequences of trade flows of durum and hard spring wheat between the United States and Canada. Results suggested that the EEP was not a major factor leading to increased imports from Canada. Mohanty suggested that eliminating the EEP would actually result in an increase in imports from Canada based on the assumption that Canada acts competitively and eliminates its own subsidy. His results showed that elimination of the EEP would reduce both U.S. wheat exports and prices, but eliminating export subsidies in both countries would have the effect of lowering Canadian prices slightly more than U.S. prices, resulting in increased wheat imports from Canada.

Several studies focused on the effects of exchange rates on bilateral trade flows of agricultural commodities. Coleman and Meilke (1988) analyzed the effects of exchange rates on the trade of red meat between Canada and the United States. Their results suggest that the devaluation of the Canadian dollar leads to significant increases in Canadian net exports of beef and to small increases in net exports of pork. Their analysis was based on the devaluation that occurred between the mid 1970s and the mid 1980s.

McClatchy et al. (1989) analyzed the importance of exchange rates under conditions of agricultural free trade. They concluded the following: some countries' mixes of agricultural production and trade under free trade would be more sensitive to exchange rate changes than those of other countries; some commodities would be more affected by exchange rate changes than others; exchange rate variations would have a major impact on net trade volumes and directions; the extent of world price variability, induced by exchange rate changes, would differ greatly depending on the currency in which world prices were expressed; and some bilateral exchange rates would be more important than others as determinants of the equilibrium pattern of free trade.

Johnson and Janzen (1999) incorporated exchange rates in a comparison of barley production costs for five states and three Canadian provinces. They estimated cost of production and ran a stochastic simulation to incorporate uncertainties regarding yield and exchange rates. The results of this analysis show that the Canadian Prairie provinces are often low-cost suppliers to U.S. markets, despite a large freight disadvantage. Additional simulations were run with a stronger Canadian dollar. Specifically, the mean value was raised by 10 percent relative to the base case, which was the 1997 average value. The appreciation of the Canadian dollar substantially reduced cost advantages of Canadian producers. U.S. producers were more likely to be low-cost suppliers under this scenario, resulting in less Canadian barley exports to the United States.

Several studies have analyzed the effects of increased Canadian exports to the United States on U.S. prices. A study by Sumner et al. (1994), submitted to the U.S. International Trade Commission on behalf of the CWB, imposed on its model a restriction of Canadian exports to the United States equal to 50 percent of the 1993/94 level, and then projected 1994/95 export levels. Their results suggest that such a decrease in exports from Canada to the United States would induce an increase in the annual U.S. market price of 0.4 to 0.5 cents/bushel. This increase in price could result in savings in federal wheat program outlays of $8 million to $9.9 million from reduced deficiency payments.

The USDA (1994) examined whether U.S. wheat imports influenced average market price. Results suggest that imposing a quota over the 1991/92 to 1994/95 period, where imports are restricted to half of the average levels over the 1987/88 to 1991/92 period, would increase the average market price from 4 to 12 cents/bushel per year or by an average 9-cent rise annually; would lessen added deficiency payment outlays from $64 million to $230 million annually or by an average $171 million annually; and would reduce total federal wheat deficiency payment outlays by $682 million over the four years ending 1994/95.

The U.S. International Trade Commission (USITC) staff (1994) conducted an analysis to determine the effects of wheat imports on prices. Their results suggest that annual declines in prices due to imports grew from 1.34 cents/bushel in 1989/90 to 4.41 cents/bushel in 1993/94. Further, deficiency payment increases averaged $44 million per year over the five years.

Results from the CWB study, the USDA study, and the USITC study differed considerably due to different assumptions made and models used (Babula et al., 1996). Babula et al. (1996) note that the CWB appeared to use expert opinion to have their model understate import-induced wheat price and program cost effects and the USDA appeared to use expert opinion to overstate the import-induced price and program cost effects.

Koo (1998) evaluated the impacts of Canadian exports of durum wheat and barley to the United States on the U.S. domestic prices of these commodities and on farm income in durum wheat and barley growing regions in the United States. Koo found that increases in Canadian exports of durum wheat and barley to the United States lowered the domestic prices of the two commodities in the United States. Average price reductions were found to range between 6.5 and 15.3 percent for durum wheat and between 1.3 and 4.4 percent for barley. A decrease in prices would result in serious consequences for producers in the United States. The results of Koo's (1998) analysis showed that since the inception of CUSTA in 1989, increased imports from Canada reduced U.S. domestic prices and caused average reductions of farm income ranging between $47 million/year and $64 million/year for durum wheat producers in the United States and between $73 million/year and $128 million/year for barley producers. Koo estimated that the impact on the general economy of North Dakota ranged between $130 million/year and $250 million/year during 1994-1996.

Not all studies, though, have supported the allegation that increased imports from Canada have significantly decreased U.S. prices. Mohanty (1995) concluded that increased imports from Canada have not significantly decreased U.S. wheat prices. Higginson et al. (1988) conducted a

study to determine if Canadian swine exports into U.S. markets from 1982-1985 had a significant effect on U.S. prices and also to assess the impact of the countervailing duty on pricing efficiency in the Canadian hog markets. They used VAR analysis and found that Canadian swine exports into U.S. markets did not have an effect on U.S. prices. They also found that pricing efficiency declined following enforcement of the countervailing duty.

This study builds upon these previous studies by specifically analyzing HRS wheat and durum wheat, and by dividing barley into malting barley and feed barley. It also uses an econometric approach to determine factors affecting the level of exports from Canada to the United States. Most previous studies have used a mathematical programming model to analyze trade flows.

Changes in Trade Patterns under CUSTA

The United States and Canada Free Trade Agreement

The CUSTA agreement is likely a major reason for increases of Canadian exports. This agreement has eliminated trade barriers between the two countries, facilitating an easier movement of agricultural commodities across the border. Prior to 1989, tariffs imposed by the United States were $7.70/ton for wheat, $2.30/ton for malting barley, and $3.40/ton for other barley. Tariffs imposed by Canada were C$4.40/ton for wheat and C$2.30/ton for all barley (Koo, 1998). Tariffs on wheat and barley were placed on a schedule of elimination in 10 equal segments. They were eliminated completely on January 1, 1998. In addition to tariffs, Canada had an import license on wheat and barley which was eliminated under CUSTA. In 1991, however, Canada instituted a legal regime that American wheat destined for processing in Canada must be accompanied by an end-use certificate (EUC). Canadian processors importing American wheat must request the EUC from the Canadian Grain Commission. Subsequently, the U.S. government, in 1995, instituted an EUC requirement for Canadian wheat entering the United States.

Trade Flows of Agricultural Commodities and Products

Prior to 1986, exports of wheat from Canada to the United States were virtually non-existent. Canadian durum exports to the United States increased dramatically from 1986 to 1993. There were fluctuations in Canadian durum exports from quarter to quarter, but there was a strong upward trend until 1994 (Figure 1). Canada exported 13 thousand metric tons of durum to the United States in 1986. In 1987, Canada exported 136 thousand metric tons of durum to the United States. The export total increased each year until 1992 when Canada exported 507 thousand metric tons of durum to the United States. Exports dropped in early 1993, but reached a high point of 189 thousand metric tons in the fourth quarter of 1993. Canadian durum exports to the United States decreased slightly in 1994, and then more so in 1995 and 1996. This reduction may be partly due to the Wheat Peace Agreement between the United States and

Canada. The import surge in the early 1990s led to the negotiation of a temporary agreement to limit Canadian durum wheat exports to the United States during September 12, 1994, to September 11, 1995 (U.S. Trade Representative). In 1997, Canadian durum exports to the United States increased again, and reached an all-time high in 1999 at 624 thousand metric tons.

Canadian exports of HRS wheat to the United States followed somewhat similar patterns (Figure 1). U.S. imports of HRS wheat from Canada were either minimal or non-existent until late 1990. From 1986 to 1989, shipment of spring wheat from Canada to the United States averaged 28 thousand metric tons per year. Canada shipped 137 thousand metric tons of spring wheat to the United States in 1990, 948 thousand metric tons in 1992, 1.3 million metric tons in 1993, and 2.1 million metric tons in 1994. From 1995 to 1999, Canadian exports of spring wheat to the United States averaged 1.4 million metric tons per year.

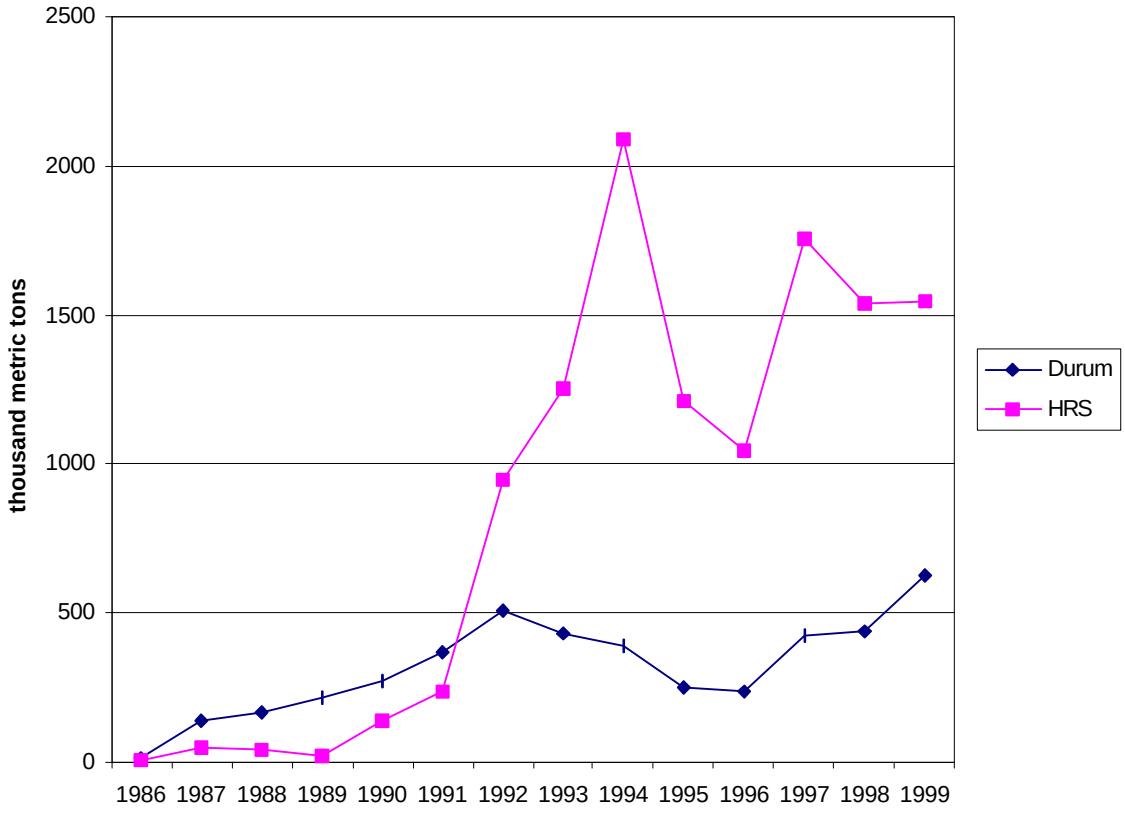

Figure 1. Canadian Wheat Exports to the United States

Canadian barley exports to the United States have also been significant. In 1990, Canadian malting barley exports to the United States equaled 203 thousand metric tons (Figure 2). Exports of feed barley were 13 thousand metric tons. Malting barley exports increased some in 1991, but remained fairly constant from 1991 to 1993, ranging from 238 thousand to 308 thousand metric tons per year. Canadian feed barley exports during this period increased substantially; equaling 96 thousand metric tons in 1991, 173 thousand metric tons in 1992, and 337 thousand metric tons in 1993. A dramatic increase in barley exports occurred in 1994. Canada exported 711 thousand metric tons of malting barley to the United States in 1994, and 1.23 million metric tons of feed barley. The dramatic increase in feed barley exports was a one-time spike, but the increased level of malting barley exports have been mostly sustained. Canadian exports of malting barley between 1995 and 1999 ranged from 592 thousand metric tons to 708 thousand metric tons per year. Canadian feed barley exports to the United States have continually decreased since the high in 1994, and were only 22 thousand metric tons in 1999. The sharp decrease in Canadian feed barley exports is due to a growing Canadian livestock industry, low U.S. prices, and competition from U.S. feed grains. In fact, U.S. barley is now being exported to Canada to satisfy demand in Alberta feedlots.

Figure 2. Canadian Barley Exports to the United States

Factors Affecting Trade Flows of Agricultural Commodities Between the United States and Canada

Bilateral trade flows of wheat and barley between the United States and Canada under CUSTA could be influenced by differences in resource endowments, marketing systems, availability of marketable surpluses, differences in crop quality, and farm policies between the two countries.

Characteristics of the markets of the trading partners can have a significant effect on trade flows. The U.S. market for agricultural commodities is substantially larger than the Canadian market. The size of the domestic markets for wheat and barley in Canada are much smaller than those in the United States, however, Canada produces a large amount of these commodities, similar to production in the United States. As a result, Canada has a substantial marketable surplus of wheat and barley and, therefore, is more dependent upon export markets than the United States. On average, Canada exports 75 percent of its wheat and 15 percent of its barley (Koo and Uhm, 2000). The U.S. market is attractive to Canadian producers because it is the closest and largest market.

In Canada, wheat and barley exports are marketed by the CWB. The CWB pays producers an initial price when the grain is delivered and returns any revenue surplus to producers as final payments. In the United States, grain is marketed by individual trading firms. U.S. wheat and barley in the world market often compete with CWB grain. The CWB controls grain exports to both offshore and U.S. markets through export licenses. Some Canadian producers of wheat and barley in proximity to the United States believe the limited access to the U.S. market arising from the actions of the CWB works to their detriment. Nevertheless, it is perceived in the United States that the CWB may distort trade flows. They argue that the CWB has monopsony power in purchasing agricultural commodities from producers and at the same time is a single desk seller that has the exclusive right to make marketing decisions regarding prices and quantities. Thus, it is argued that the CWB is able to exercise price discrimination to maximize profits in world markets and has an unfair advantage over private firms in the United States. However, the WTO, under Article XVII:1, allows a state trading enterprise to charge different prices between markets provided it is done for commercial reasons based on market conditions in export markets. It is also argued that the CWB does not provide sufficient information regarding its general operation. This is especially true regarding purchase and sales price information for agricultural commodities. Schmitz and Koo (1996) argue that these practices by the CWB represent an unfair advantage over their U.S. competitors.

The U.S. EEP is a factor that could influence levels of imports from Canada. This program played an important role in maintaining U.S. competitiveness of wheat and barley exports in off-shore markets. The purpose of the EEP, which was created under the 1985 Farm Bill, is to provide U.S. agricultural exporters with bonuses that allow them to lower their export prices in selected markets characterized by unfair competition. Several studies indicated, however, that the EEP has resulted in adverse effects on bilateral trade of the crops between the United States and Canada (Johnson and Wilson, 1995; Mao et al., 1996). The EEP raised the U.S. domestic prices of these crops, relative to world prices, which made the U.S. market

relatively more attractive to Canadian exporters. The U.S. government, however, has not used the EEP since 1995 (Figure 3).

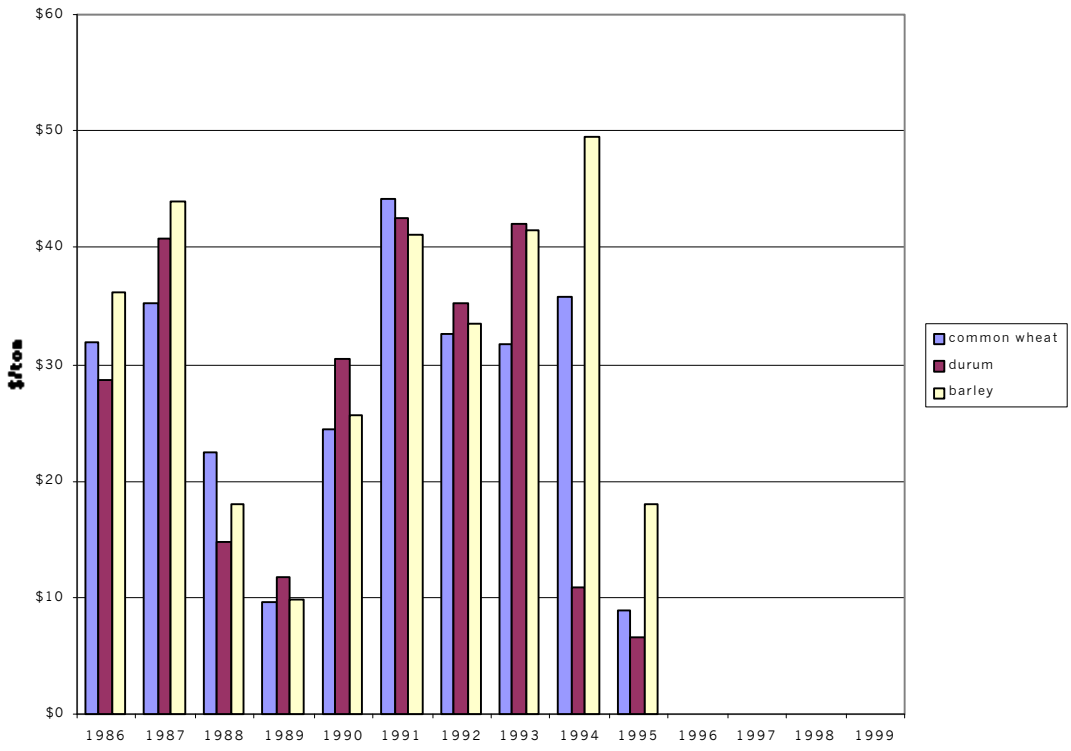

Figure 3. Average EEP Payments

The Canadian rail subsidy was an indirect subsidy provided by the Canadian government under the Western Grain Transportation Act (WGTA) to farmers for shipments of grains from producing regions to export ports. U.S. grain producers argued that under the Act, Canadian grains were more competitive in offshore markets. Canada eliminated the controversial rail subsidy in 1995. While the elimination of the rail subsidy has made Canadian exports less competitive in offshore markets, it has induced larger inflows of grains into the United States. The elimination of the WGTA has ultimately made the U.S. market more attractive for Canadian producers because transportation costs from the Canadian prairies to the United States are lower than those from the Canadian prairies to most offshore markets (Johnson and Wilson, 1995).

The exchange rate between the two currencies plays an important role in bilateral trade of agricultural commodities and products (Coleman and Meilke, 1988; McClatchy et al., 1989; Johnson and Janzen, 1999). A depreciating currency can have a positive effect on exports. Likewise, an appreciating currency can have a negative effect on exports, and a positive effect on

imports. The Canadian dollar has been declining in value relative to the U.S. dollar since the mid 1970s (Figure 4). This trend continued from late 1976 to early 1986. In 1986, the Canadian dollar started to gain in value versus the U.S. dollar, and continued to appreciate until November 1991, where it was as strong, relative to the U.S. dollar, as it was in the mid 1970s. Since late 1991, the U.S. economy has been stronger than the Canadian economy and the Canadian dollar has continued to depreciate relative to the U.S. dollar. Currently, the ratio of Canadian dollars per U.S. dollar is higher than it ever was during the Canadian devaluation in the 1980s. The devaluation of the Canadian dollar relative to the U.S. dollar in the 1990s has coincided with the increase in agricultural exports from Canada to the United States under CUSTA. The U.S. dollar appreciation makes U.S. agricultural commodities more expensive in the Canadian market and Canadian agricultural commodities less expensive in the U.S. market. The change in the exchange rate may have some effect on trade flows between the United States and Canada.

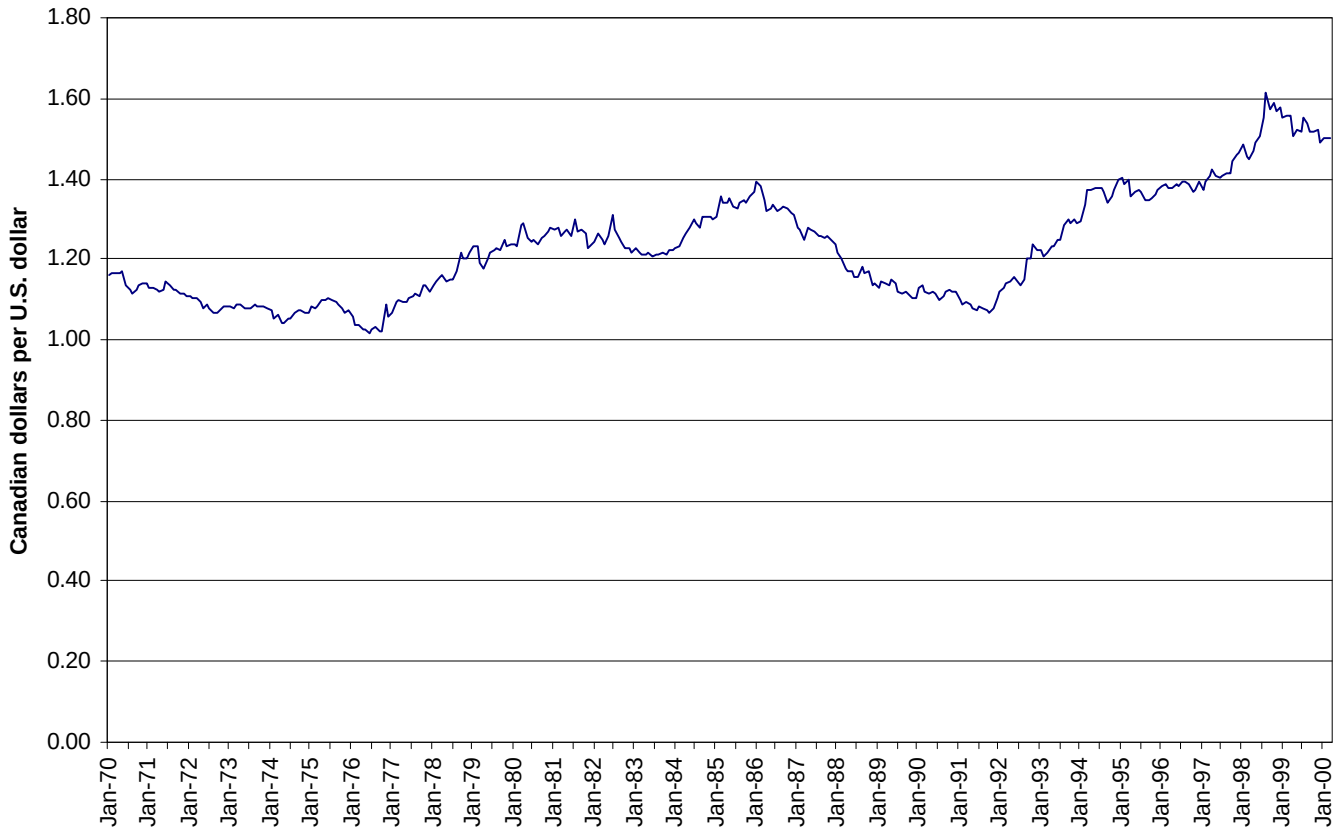

Figure 4. The Canada/United States Real Exchange Rate

Differences in quality of grain produced in the countries is another important factor affecting trade flows. U.S. millers demand high quality wheat. Whenever the United States cannot produce enough high quality wheat to meet domestic demand, due to weather conditions and diseases during the growing season, U.S. millers have imported high quality wheat from Canada. U.S. durum quality has generally declined since 1992 (Figure 5). After relatively good quality in the late 1980s and early '90s, both HRS wheat and durum wheat experienced poor quality in 1993. Hard red spring wheat quality in the United States has increased slightly since 1993, with good quality in 1996 and 1998. Durum quality was also better in 1996, but otherwise has not improved. Some U.S. millers prefer Canadian wheat due to inconsistency and poor quality of U.S. wheat. The Canadian regulatory system exerts more control over quality than the U.S. system, resulting in greater consistency of quality. Similarly, Canadian malting barley is desired by some U.S. maltsters because of its attributes. Canadian feed barley, on the other hand, competes with other feedstuffs such as corn and sorghum. U.S. barley crops in the early to mid 1990s were poor due to high levels of DON (Figure 6). DON is a toxic byproduct of fusarium head blight (FHB), a fungal disease of small grains. Beginning in 1993, a prolonged outbreak of FHB occurred in the Upper Midwest. The barley crop improved in 1999.

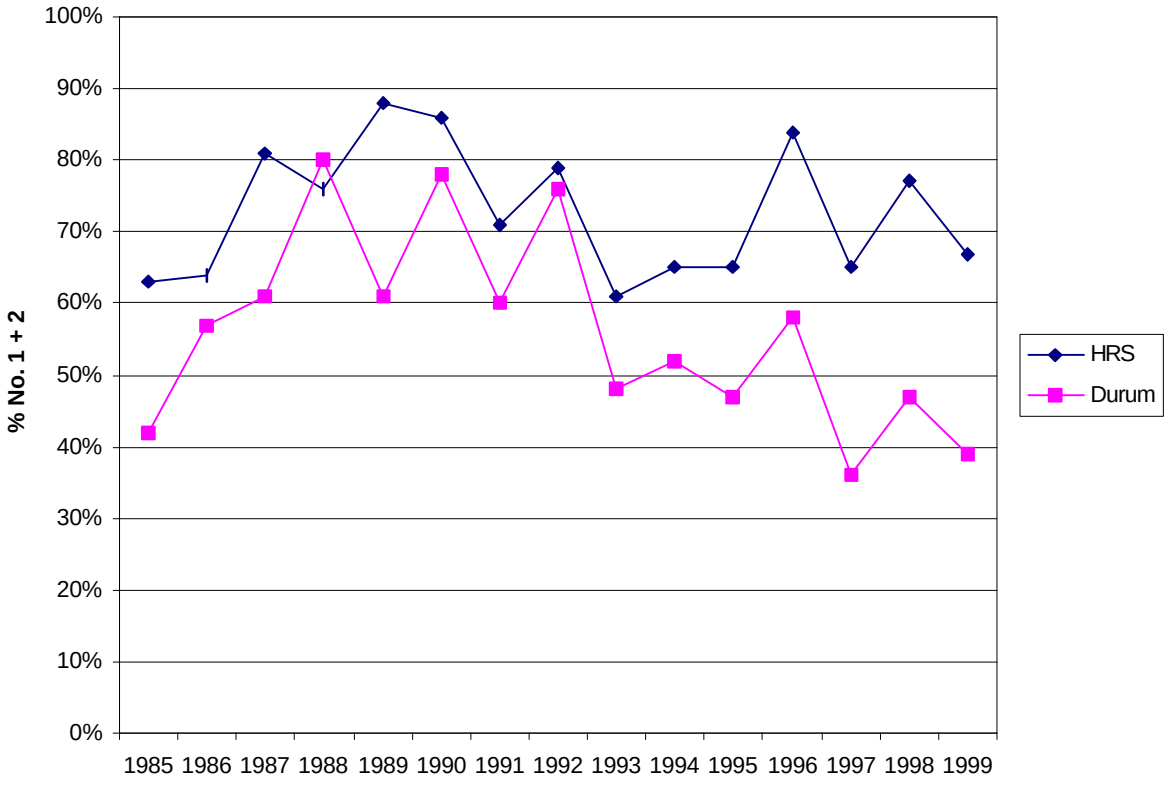

Figure 5. Quality of U.S. Wheat

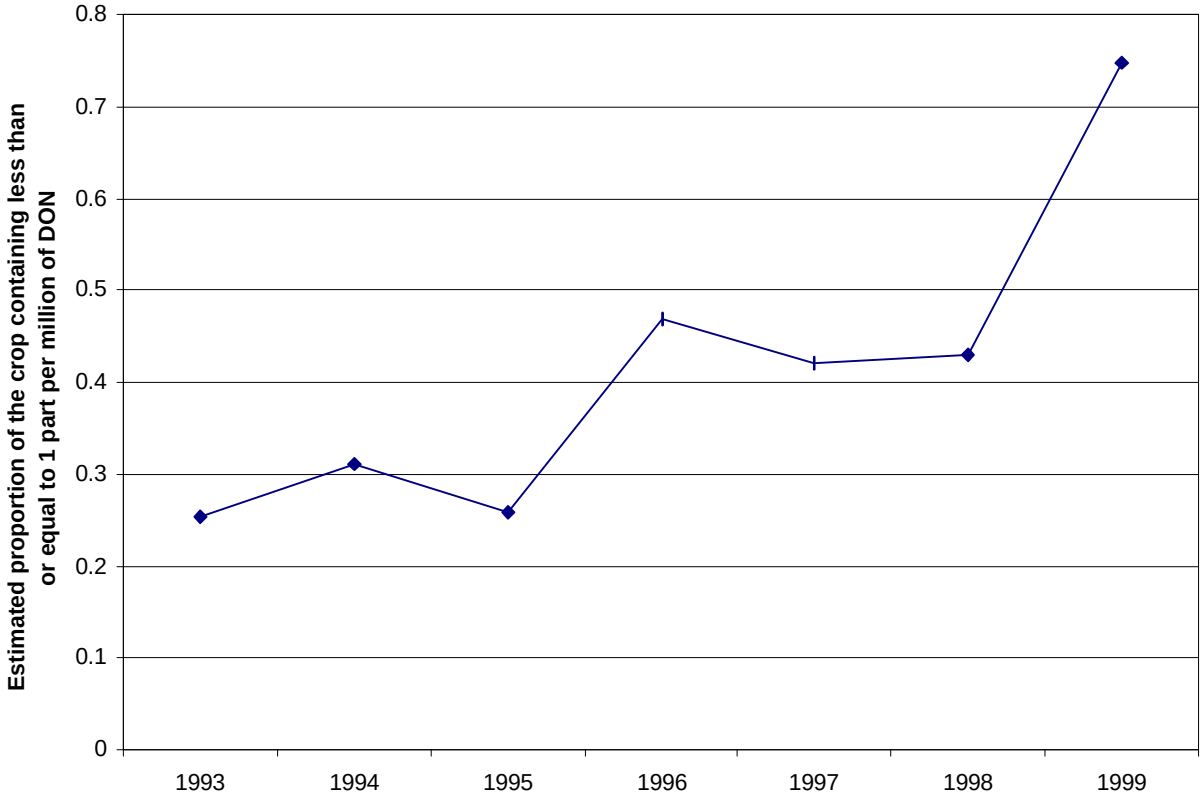

Figure 6. Quality of U.S. Midwestern Barley

Development of Empirical Model

An econometric model is developed to estimate the effects of different factors on the flows of Canadian wheat and barley exports to the United States. Canadian exports to the United States is specified as a function of the Canada/U.S. exchange rate, U.S. prices, U.S. grain quality, U.S. demand, the EEP, Canadian rail subsidies, the Wheat Peace Agreement, and CUSTA. Wheat is divided into durum and HRS wheat, and barley is divided into malting and feed barley. The specified model for a commodity is

$$EX_{it} = f(ER_t, P_{it}^{U.S.}, Q_{it}^{U.S.}, D_{it}^{U.S}, EEP_t, RAIL_t, WPA_t, CUSTA_t) \quad (1)$$

where EX_{it} = exports of commodity i in time t from Canada to the United States
ER_t = Canada/U.S. exchange rate in time t
$P_{it}^{U.S.}$ = price at the U.S. market of commodity i in time t
$Q_{it}^{U.S.}$ = quality of U.S. grown commodity i in time t in the United States
$D_{it}^{U.S}$ = U.S. demand for commodity i in time t
EEP_t = EEP payments in time t
$RAIL_t$ = dummy for the Canadian rail subsidy
WPA_t = dummy for the 1994/95 Wheat Peace Agreement
$CUSTA_t$ = dummy for the CUSTA agreement.

It is expected that Canadian exports to the United States are positively related to the exchange rate. As the U.S. dollar becomes strong against the Canadian dollar, U.S. goods become more expensive in the Canadian market and Canadian goods become less expensive in the U.S. market. As a result, Canada can increase its exports to the United States when the U.S. dollar becomes stronger. The U.S. domestic price of a commodity is expected to be positively related to Canadian exports, indicating that Canada increases its exports when the U.S. domestic price increases. It is expected that the quality of a commodity in the United States has a negative relationship with Canadian exports. U.S. millers and maltsters increase their imports from Canada when the quantity of high quality domestic wheat or barley is not large enough to meet domestic demand. The EEP variable is expected to have a positive sign. The EEP lowered offshore prices, making shipments to the United States more attractive. It is hypothesized that Canadian exports are negatively related to the use of the rail subsidy under WGTA and positively related to the CUSTA. For durum wheat trade, the Wheat Peace Agreement restricted Canadian durum exports. Thus, the variable is expected to be negatively related to Canadian exports to the United States.

The second equation developed for this analysis is an inverse excess demand equation. In general, the U.S. domestic price is determined by excess demand. Assuming that domestic demand is fairly constant, the domestic price is a function of total supply as

$$P_{it} = f(TS_{it}) . \quad (2)$$

Total supply is divided into supply from Canada (Canadian export) and domestic production plus carry-in. Equation 2 can be re-written as

$$P_{it} = f(EX_{it}, S_{it}^{d}) . \quad (3)$$

Equation 3 is re-specified by adding the lagged dependent variable to capture a dynamic relationship between price and exports and a quality variable to capture the effects of barley quality on malting barley prices as follows

$$P_{it} = f(EX_{it}, S_{it}^{d}, Q_{it}^{U.S.}, P_{it-1}) . \quad (4)$$

As Canadian exports to the United States increase, it is expected that U.S. prices will decrease. Increases in imports increases total supply, which should result in decreased prices. Malting barley prices are also affected by barley quality. If barley quality decreases, the quantity of barley that is of high enough quality for malting decreases. A decrease in overall barley quality will likely have a positive effect on malting barley prices. The quality variable in Equation 4 is used only in the malting barley model.

Data

Quarterly data were used in the wheat analysis. Data were used for 1986-1999 for the wheat model and 1990-1999 for the barley model. Monthly data were used in the barley model. Data for wheat exports from Canada to the United States were obtained from the CANSIM database from Statistics Canada. Barley export data from Canada to the United States were obtained from U.S. Customs. The time frames and the use of monthly or quarterly data were determined by the availability of data.

Data for the real exchange rate were obtained from the Economic Research Service. This is measured as Canadian dollars per U.S. dollar. An increase in this variable indicates an appreciation of the U.S. dollar relative to the Canadian dollar. The real exchange rate was used to adjust for inflation. Average prices received by farmers in the United States were used for all commodities. These data were obtained from the National Agricultural Statistics Service. Prices were adjusted for inflation using the Consumer Price Index.

Wheat quality in the United States is measured as the percent of the grain graded number 1 or number 2. Annual data for this variable were obtained for durum and HRS wheat. An increase in this variable indicates a higher quality crop. Barley quality was measured as the estimated proportion of the Midwestern crop containing less than or equal to 1 part per million of DON. An increase in this variable indicates a higher quality crop and a higher percentage of barley that is of malting quality. Annual data were available for DON in the upper Midwest.

The EEP is measured as the average of the low payment and the high payment for the commodity over the time period, which is monthly for barley and quarterly for wheat. These data were obtained from *World Grain Statistics 1992, 1995/96*, International Grains Council.

Total domestic use is used as a measure of demand. These data are available from the marketing year supply and disappearance tables from the Economic Research Service and the National Agricultural Statistics Service. Only yearly data are available for wheat when it is divided into class. These yearly data were disaggregated into quarterly data by dividing the data by four. The supply and disappearance tables also include data for beginning stocks, production, and imports for each wheat class by marketing year. Beginning stocks were added to production to obtain total domestic supply, which is included as an explanatory variable to estimate price. Table 1 provides a summary of Canadian export, U.S. supply and demand, U.S. farm price, exchange rate, and quality data.

Table 1. Summary of Data[1], 1990-1999					
Variable	Unit	Mean	Std Dev	Minimum	Maximum
Canadian Exports to U.S.					
HRS Wheat	thousand metric tons	1176	620	137	2087
Durum Wheat	"	395	120	239	624
Malting Barley	"	497	215	203	711
Feed Barley	"	260	358	13	1231
U.S. Consumption					
HRS Wheat	"	7344	833	5852	8809
Durum Wheat	"	2256	294	1855	2805
Barley	"	7959	831	6684	9052
U.S. Domestic Supply					
HRS Wheat	"	19338	1380	17890	22796
Durum Wheat	"	3930	560	3226	4699
Barley	"	11229	1307	9221	13057
U.S. Farm Price[2]					
HRS Wheat	$/bu.	$3.48	$0.66	$2.40	$5.68
Durum Wheat	"	$3.89	$1.10	$2.17	$5.87
Malting Barley	"	$2.51	$0.36	$1.88	$3.52
Feed Barley	"	$2.01	$0.41	$1.40	$3.57
Real Exchange Rate	Can$/U.S.$	1.32	0.15	1.07	1.61
U.S. Quality					
HRS Wheat	% graded #1 or #2	72%	9%	61%	86%
Durum Wheat	"	54%	14%	36%	78%
1. Exchange rate and price data are monthly, all other data are annual.					
2. Prices are nominal.					

The effect of CUSTA is measured using a dummy variable. CUSTA became effective in 1989. A dummy variable is included in the model that equals 1 during the time this agreement has been in effect, and 0 for the time prior to its inception. The CUSTA variable could not be included in the barley models because barley export data prior to the inception of CUSTA were not used.[1] The effect of CUSTA on barley imports from Canada, therefore, could not be estimated.

The effect of the Canadian rail subsidy is also measured with a dummy variable. This subsidy was eliminated in 1995. A dummy variable is included in the model that equals 1 during the time the subsidies were in effect, and 0 after they were eliminated. A dummy variable was also included to measure the effect of the Wheat Peace Agreement that was in effect for the 1994/95 crop year. This variable equals 1 for the time that it was in effect and 0 otherwise.

[1]U.S. Customs data prior to 1990 are not available.

Estimation Procedures

The PE test was conducted to determine a functional form of Equations 1 and 4. To test if the equations are a linear or double-log function, the equations are respecified as

$$EX_{it} = \beta_1 + \beta_2 ER_t + \beta_3 P_{it}^{U.S.} + \beta_4 Q_{it}^{U.S.} + \beta_5 D_{it}^{U.S} + \beta_6 EEP_t + \beta_7 RAIL_t + \beta_8 WPA_t + \beta_9 CUSTA_t + \beta_{10} V_{it} + e_{it} \quad (5)$$

$$P_{it} = \alpha_1 + \alpha_2 EX_{it} + \alpha_3 S_{it}^{d} + \alpha_4 Q_{it}^{U.S.} + a_5 P_{it-1} + \alpha_6 U_{it} + \varepsilon_{it} \quad (6)$$

where V_{it} and U_{it} are estimated errors from double-log specifications of Equations 1 and 4. The null hypotheses are $\beta_{10} = 0$ for Equation 5 and $\alpha_6 = 0$ for Equation 6. Accepting the null hypotheses would mean that the linear form is correct. If the t-ratios for β_{10} and α_5 are larger than the critical values of the t-distribution, the null hypothesis is rejected, indicating that the functional forms of Equations 1 and 4 are not linear.

The PE test was re-run with null hypotheses that the double-log form is correct. The equations are respecified as

$$\ln EX_{it} = \beta_1 + \beta_2 \ln ER_t + \beta_3 \ln P_{it}^{U.S.} + \beta_4 \ln Q_{it}^{U.S.} + \beta_5 \ln D_{it}^{U.S} + \beta_6 EEP_t + \beta_7 RAIL_t + \beta_8 WPA_t + \beta_9 CUSTA_t + \beta_{10} V_{it} + e_{it} \quad (7)$$

$$\ln P_{it} = \alpha_1 + \alpha_2 \ln EX_{it} + \alpha_3 \ln S_{it}^{d} + \alpha_4 \ln Q_{it}^{U.S.} + \alpha_5 \ln P_{it-1} + \alpha_6 U_{it} + \varepsilon_{it} \quad (8)$$

where V_{it} and U_{it} are estimated errors from linear specifications of Equations 1 and 4. Accepting the null hypotheses, which are $\beta_{10} = 0$ for Equation 7 and $\alpha_6 = 0$ for Equation 8, would mean that the double-log form is correct. If the t-ratios are larger than the critical values of the t-distribution, the null hypothesis is rejected. The PE tests indicate that the functional form is neither the linear nor the double-log form. However, the t-ratios suggest that the double-log form exhibits a better fit.

Seasonal dummy variables are added to capture seasonality in Canadian exports of wheat and barley to the United States and in U.S. prices. Quarterly dummies are included in both the wheat and barley models. Thus, the empirical models developed are

$$\ln EX_{it} = \beta_1 + \beta_2 \ln ER_t + \beta_3 \ln P_{it}^{U.S.} + \beta_4 \ln Q_{it}^{U.S.} + \beta_5 \ln D_{it}^{U.S} + \beta_6 EEP_t + \beta_7 RAIL_t + \beta_8 WPA_t + \beta_9 CUSTA_t + \beta_{10} D_{1t} + \beta_{11} D_{2t} + \beta_{12} D_{3t} + e_{it} \quad (9)$$

$$\ln P_{it} = \alpha_1 + \alpha_2 \ln EX_{it} + \alpha_3 \ln S_{it}^{d} + \alpha_4 \ln Q_{it}^{U.S.} + \alpha_5 \ln P_{it-1} + \alpha_6 D_{1t} + \alpha_7 D_{2t} + \alpha_8 D_{3t} + \varepsilon_{it} . \quad (10)$$

Structural coefficients of the two equations in the system are estimated by using the three-stage least squares (3SLS) estimator. When disturbance terms are correlated among equations, 3SLS could be more efficient than 2SLS in estimating parameters (Kennedy, 1998). The system of two equations are estimated for HRS wheat, durum wheat, malting barley, and feed barley.

Results

Estimated Export Supply Equations

The estimated models are presented in Table 2. The weighted-system R^2s range between 0.64 and 0.89, indicating that the estimated models are generally robust. The results suggest that CUSTA has positively influenced the flow of wheat from Canada to the United States. The dummy variable for CUSTA is positive and significant for both durum and HRS wheat.

The real exchange rate has a significant influence on imports of HRS wheat, malting barley, and feed barley from Canada. This variable is positive and significant at the 5 percent level, indicating that a stronger U.S. dollar, relative to the Canadian dollar, leads to increased imports from Canada. The real exchange rate also has a positive effect on imports of durum from Canada, but exhibits low significance.

U.S. real farm prices have a positive effect on exports of feed barley from Canada to the United States and are significant at the 5 percent level, indicating that Canada increases exports of feed barley to the United States as U.S. domestic prices increase. U.S. real prices of other commodities have positive effects on Canadian exports, but are not significant. This implies that U.S. domestic prices of commodities are not the most important factor influencing Canadian exports.

Wheat quality is an important factor influencing U.S. imports of HRS wheat from Canada. This variable is negative and significant at the 5 percent level; Canadian exports of HRS wheat increase when the quantity of high quality HRS wheat decreases in the United States, and vice versa. This relationship is weak for durum. The quality variable of U.S. barley has a negative relationship with Canadian exports and is significant at the 5 percent level, which indicates that when the quantity of high-quality barley in the United States increases, Canadian exports of malting barley decrease. This outcome is expected because an increase in domestic barley quality increases the quantity of malting-quality barley, reducing the need for maltsters to import malting barley.

Market size, or domestic consumption, has a significant effect on imports of malting barley from Canada. The United States imports more malting barley from Canada when demand for barley is high. It should be noted, though, that the use of barley for food and industrial uses (including malting) has some seasonal fluctuations, but is fairly constant through time. There is also a positive relationship between U.S. barley demand and Canadian exports of feed barley to the United States, but with low significance. Consumption of wheat in the United States has no significant effect on Canadian wheat exports to the United States.

Table 2. Estimated Models for HRS Wheat, Durum, Feed Barley, and Malting Barley

Variables	HRS	Durum	Malting Barley	Feed Barley
Export Equation				
Intercept	-2.977 (-0.443)	8.321 (3.760)	6.753 (6.222)	-1.130 (-0.678)
Exchange Rate	6.865 (2.798)	1.131 (1.174)	3.024 (3.326)	15.646 (7.680)
U.S. Price	1.143 (1.124)	-0.170 (-0.483)	1.021 (1.472)	4.139 (4.504)
U.S. Quality	-3.664 (-2.720)	0.036 (0.103)	-0.430 (-2.398)	
U.S. Domestic Consumption	1.525 (1.238)	0.507 (1.097)	0.561 (2.458)	0.645 (1.409)
EEP	0.730 (3.004)	0.084 (1.407)		1.051 (5.501)
Canadian Rail Subsidy	-2.254 (-2.788)	-0.161 (-0.672)		-0.751 (-1.148)
Wheat Peace Agreement		-0.314 (-1.257)		
CUSTA	2.486 (6.751)	0.837 (4.005)		
Quarter 1	-0.648 (-1.839)	-0.324 (-1.738)	-0.223 (-1.187)	-0.161 (-0.421)
Quarter 2	-0.261 (-1.486)	0.024 (0.257)	0.110 (1.091)	-0.254 (-1.261)
Quarter 3	-0.011 (-0.091)	-0.045 (-1.257)	-0.289 (-4.035)	-0.136 (-0.927)
Price Equation				
Intercept	1.441 (1.946)	6.030 (2.274)	-0.079 (-0.276)	0.250 (2.913)
Candian Exports	-0.017 (-2.028)	-0.232 (-2.396)	0.012 (0.564)	-0.003 (-0.657)
U.S. Domestic Supply	-0.157 (-1.535)	-0.574 (-2.047)	0.016 (0.642)	-0.041 (-2.539)
Lagged U.S. Price	0.826 (10.421)	0.562 (2.889)	0.838 (17.199)	0.969 (40.851)

Results support the claim that the EEP led to increased imports of HRS wheat and feed barley from Canada. The EEP has a positive and significant (at the 5 percent level) effect in the HRS wheat model and the feed barley model. The EEP also has a positive effect on Canadian durum exports to the United States, but with low significance.

The elimination of the Canadian rail subsidy led to increased imports of HRS wheat from Canada. A negative relationship with Canadian exports indicates that exports have increased after the subsidy was eliminated. This relationship is negative and significant at the 5 percent level in the HRS model, but is insignificant in the other models.

Estimated Price Equations

Results from the second equation show effects of Canadian exports of wheat and barley on U.S. domestic prices of the commodities. Canadian exports have negatively and significantly affected HRS wheat prices and durum prices in the United States. Canadian exports, on the other hand, have had no significant effect on U.S. barley prices. The estimated coefficients of the export variable represent price flexibility coefficients, which show percentage changes in prices resulting from a one percent change in Canadian exports. These price flexibility coefficients are presented in Table 3. The coefficient for HRS wheat is -0.017, indicating that a 1 percent increase in Canadian exports of HRS wheat to the United States results in a 0.017 percent decrease in the U.S. HRS wheat price. The price flexibility coefficient for durum is -0.23, indicating that a 1 percent increase in Canadian exports of durum to the United States results in a 0.23 percent decrease in the U.S. durum price. U.S. durum prices are much more sensitive to Canadian exports than HRS wheat mainly because durum wheat cannot be substituted with other wheat types, but HRS wheat can be substituted with hard red winter wheat.

Actual price reductions due to Canadian exports to the United States can be calculated using the price flexibility coefficients and the Canadian export data (Table 3). Price changes were calculated for each year that CUSTA has been in effect. These price changes are calculated by multiplying the percentage change in imports from Canada with the price flexibility coefficient. Results show how the price changed based on what it would have been had the level of imports from Canada remained unchanged from the previous year. Increased imports from Canada from 1989 to 1990 caused a 11.4 percent reduction in the HRS wheat price and a 6.2 percent reduction in the durum price in 1990, compared to what prices would have been had imports from Canada remained unchanged from the previous year. Increased Canadian imports in 1992 caused a 5.0 percent reduction in the HRS wheat price and a 8.4 percent reduction in the durum price. A 17.7 percent reduction in the durum price was caused by an increase in Canadian durum exports to the United States in 1997. In most years, an increase in Canadian exports led to a reduction in price. In some years, Canadian exports decreased, which led to price increases. Yearly price reductions averaged about 2.9 percent for HRS wheat and 8.6 percent for durum wheat.

Table 3. Effect of Canadian Exports on U.S. Prices

	HRS Wheat	Durum
Price Flexibiliy Coefficient	-0.017	-0.232
Percentage Price Changes		
1989-90	-11.4%	-6.2%
1990-91	-1.2%	-8.6%
1991-92	-5.0%	-8.4%
1992-93	-0.5%	+3.3%
1993-94	-1.1%	+2.3%
1994-95	+0.7%	+8.4%
1995-96	+0.2%	+1.0%
1996-97	-1.1%	-17.7%
1997-98	+0.2%	-1.0%
1998-99	0.0%	-9.8%
average	-2.9%	-8.6%

Domestic supply, which is the summation of production and beginning stocks, also has a negative and significant effect on wheat prices and feed barley prices. Domestic supply data are available only for all barley, not malting barley or feed barley in particular. Domestic supply of all barley may not be expected to significantly effect malting barley price. Barley quality may in fact be more important because it effects the supply of malting-quality barley. Results show that neither the barley quality variable nor domestic supply significantly affect malting barley price.

Conclusions

The purpose of this study is to determine the factors that have led to an increase in Canadian exports of wheat and barley to the United States and to estimate the effect of increased Canadian exports on U.S. wheat and barley prices. Two equations were specified. One equation is an export supply equation of Canadian wheat and barley to the United States. The other equation is a price equation. These two equations were estimated using 3SLS with quarterly time series data for wheat and monthly data for barley.

The estimated model indicates that trade liberalization under CUSTA has had a significant influence on trade flows, making it easier for Canada to export grains to the United States. The exchange rate, U.S. grain quality, the size of the U.S. market, the Export Enhancement Program, and Canadian rail subsidies have also significantly affected flows of wheat and barley from Canada to the United States. The U.S. dollar's appreciation in value relative to the Canadian dollar and poor U.S. grain quality have been important factors leading to increased Canadian exports. The United States' use of the EEP, which was eliminated in 1995, caused increased imports of HRS wheat and feed barley from Canada, while the elimination of the Canadian rail subsidy in 1995 had a positive effect on exports of HRS wheat from Canada to the United States. The size of the U.S.

market also has some effect on trade flows. The U.S. market is large and imports from Canada tend to increase when U.S. demand increases.

The estimated model also indicates that increased imports from Canada have negatively affected U.S. prices of wheat, but have not significantly affected U.S. barley prices. Results show that a 1 percent increase in Canadian exports of durum to the United States results in a 0.23 percent decrease in the U.S. durum price, and a 1 percent increase in Canadian exports of HRS wheat to the United States results in a 0.017 percent decrease in the U.S. HRS price. Average yearly reductions in U.S. domestic prices due to increases in Canadian exports since the inception of CUSTA were 2.9 percent for HRS wheat and 8.6 percent for durum wheat.

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