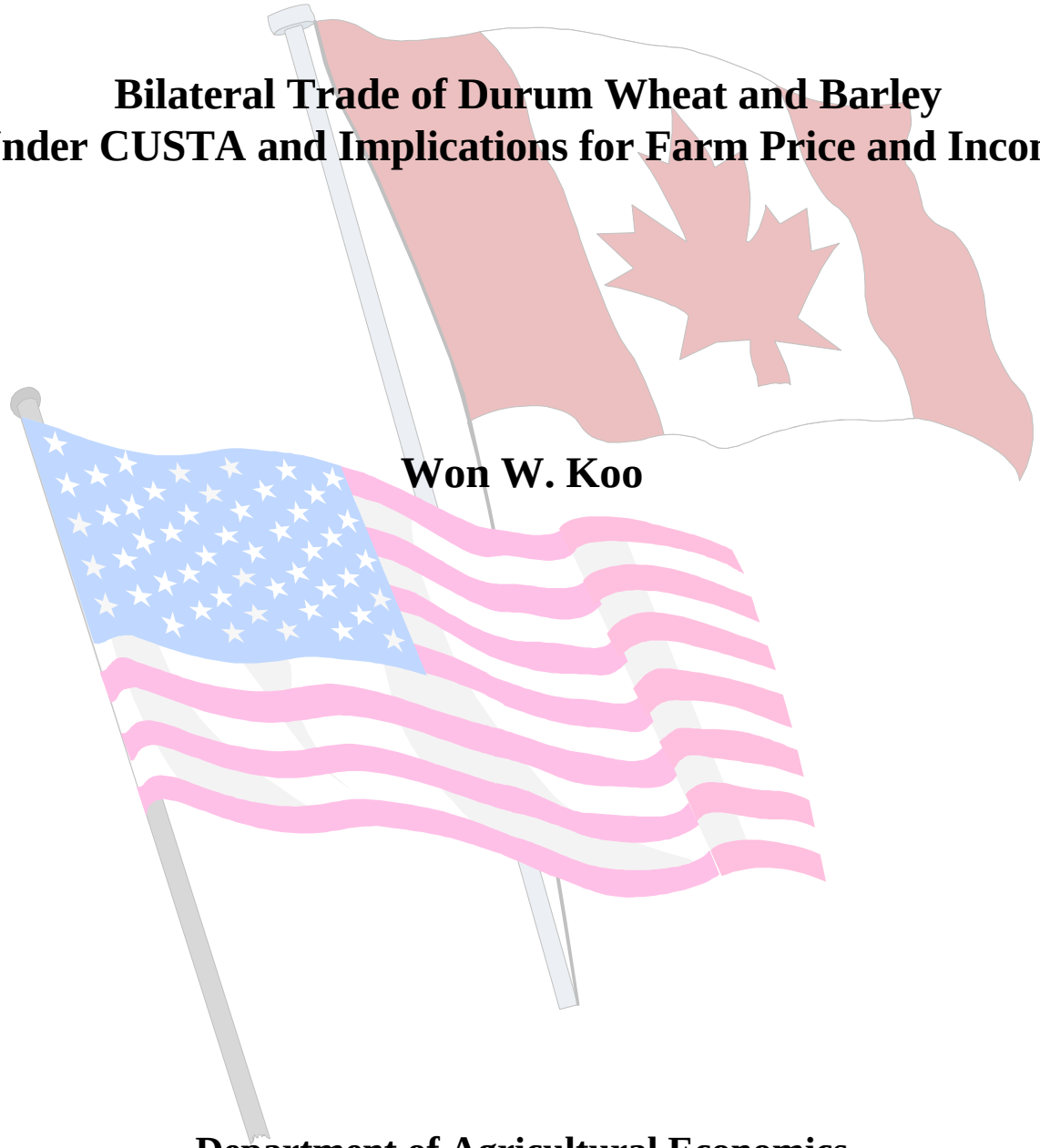
Agricultural Economics Report No. 385 **March 1998**

Bilateral Trade of Durum Wheat and Barley Under CUSTA and Implications for Farm Price and Income



Won W. Koo

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

ACKNOWLEDGMENTS

The author extends appreciation to professors, Demcey Johnson, Timothy Petry, and William Wilson for their constructive comments and suggestions. Special thanks go to Ms. Charlene Lucken, who provided editorial comments, Ms. Shelly Swandal, who helped to prepare the manuscript.

The research was conducted under USDA-CSREES-NRI research Grant (Grant No. 95-37400-1850). The report can be accessed electronically at http://agecon.lib.umn.edu/ndsu.html.

NOTICE:

The analyses and views reported in this paper are those of the author. They are not necessarily endorsed by the Department of Agricultural Economics or by North Dakota State University.

North Dakota State University is committed to the policy that all persons shall have equal access to its programs, and employment without regard to race, color, creed, religion, national origin, sex, age, marital status, disability, public assistance status, veteran status, or sexual orientation.

Information on other titles in this series may be obtained from: Department of Agricultural Economics, North Dakota State University, P.O. Box 5636, Fargo, ND 58105. Telephone: 701-231-7441, Fax: 701-231-7400, or e-mail: cjensen@ndsuext.nodak.edu.

TABLE OF CONTENTS

PAGE

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The objective of this study is to evaluate the impacts of Canadian exports of durum wheat and barley to the United States on the U.S. domestic prices of these two commodities and farm income in durum wheat and barley growing regions in the United States.

Major factors affecting trade flows of agricultural commodities between the United States and Canada are the U.S. export enhancement program, the elimination of Canadian rail subsidies, marketing power of the Canadian Wheat Board, differences in macroeconomic conditions, and differences in resource endowments. They have influenced Canadian exports positively and resulted in major increases in Canadian exports of agricultural commodities to the United States. The increased Canadian exports reduce domestic prices of durum wheat and barley and consequently lowered farm income in durum wheat and barley growing regions in the United States.

Keywords: Bilateral Trade, Farm Income, Subsidies, Resource Endowments, Durum Wheat, Barley

HIGHLIGHTS

The United States and Canada Free Trade Agreement (CUSTA) and the North American Free Trade Agreement (NAFTA), including Mexico, became effective in 1989 and 1994, respectively. These two agreements will create the largest single market in the world, a market of more than 350 million consumers and trade value at over $230 billion annually, when the agreements are fully implemented.

The United States and Canada are similar in terms of economic conditions and social structure, while Mexico differs from its trading partners. In the long run, the effects of the free trade agreement will be larger between the United States and Mexico, mainly because of the dissimilarity in their resource endowments. In addition, differences in agricultural policies, trade practices, and marketing system affect trade flows of agricultural commodities and products among the countries under CUSTA. Since the inception of CUSTA, the average Canadian exports of agricultural commodities to the United States have been much larger than the average U.S. exports to Canada. This is especially true for durum wheat and barley trade between the two countries.

This study focuses on trade of durum wheat and barley between the United States and Canada. The objective of this study is to evaluate the impacts of Canadian exports of durum wheat and barley to the United States on U.S. domestic prices of these two commodities and farm income in the durum wheat and barley growing regions in the United States.

This study found that the U.S. export enhancement program, the elimination of Canadian rail subsidies, marketing power of the Canadian Wheat Board, differences in macroeconomic conditions, and differences in resource endowments are the major factors affecting trade flows of agricultural commodities and products between the two countries. The factors have influenced Canadian exports positively since the inception of CUSTA, resulting in major increases in Canadian exports of agricultural commodities and products to the United States.

This study also 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 reductions in the domestic prices range between 6.5 and 15.3 percent for durum wheat and between 1.3 and 4.4 percent for barley. The price reductions caused major decreases in farm income for durum wheat and barley producers in the United States. The average reductions in farm income range 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.

Income losses resulting from Canadian exports of durum wheat and barley to the United States above the long-run average level in North Dakota are substantial. The losses range between $49 million/year and $94 million/year for both durum wheat and barley producers in North Dakota. The impacts on the state's general economy range between $130 million/year and $250/year for the 1994-1996 period.

BILATERAL TRADE OF DURUM WHEAT AND BARLEY UNDER CUSTA AND IMPLICATIONS FOR FARM PRICE AND INCOME

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 agricultural markets and encouraging world trade.

The United States and Canada Free Trade Agreement (CUSTA) and the North American Free Trade Agreement (NAFTA), including Mexico, became effective in 1989 and 1994, respectively. These two agreements will create the largest single market in the world, a market of more than 350 million consumers and trade value at over $230 billion annually, when the agreements are fully implemented.

Although the economies of the three countries are highly interdependent, the degree of interdependence has been asymmetric. Mexico and Canada depend much more on the United States than the reverse. Prior to the implementation of NAFTA, 75 percent of Canadian exports and 88 percent of Mexican exports were destined for the United States. On the other hand, only 22 percent of U.S. exports were shipped to Canada and 7 percent to Mexico. This is mainly because of differences in economic conditions and social structures among these countries. While the United States and Canada are similar in terms of economic conditions and social structure, Mexico differs from its trading partners. The United States has the highest per capita gross domestic product (GDP) ($28.6 thousand), followed by Canada ($19.4 thousand) (Table 1). Per capita GDP in Mexico is one-ninth of that in the United States. Farm population is approximately 27 percent of the total population in Mexico and is less than 2.5 percent in the United States and Canada. Per capita farmland in Mexico (0.6 acres) is smaller than the United States (1.7 acres) and Canada (4.1 acres). On the other hand, the United States is about 9 times larger than Canada in terms of population and about 3 times larger than Mexico. The Heckscher-Ohlin theorem indicates that the effects of the free trade agreement will be larger between the United States and Mexico mainly because of the dissimilarity in resource endowments between these two countries. The United States and Canada have more similar endowments.

The agreement has increased trade volume among the countries, especially for agricultural commodities and products between the United States and Canada. The average Canadian export of agricultural commodities and products to the United States was larger than the average U.S. export to Canada for the 1989-91 period (Table 2). In addition, Canadian exports to the United States have increased faster than U.S. exports to Canada. U.S. wheat imports from Canada increased from 633 thousand metric tons in 1990/91 to over 2.4 million

*Professor in the Department of Agricultural Economics at North Dakota State University, Fargo.

Table 1. Characteristics of the Participating Countries, 1996

	United States	Canada	Mexico
Population (million)	266.6	30.0	96.6
Per capita GDP (U.S. $)	$28,646.5	$19,442.5	$3,355.10
Population in agriculture (%)	2.5	1.6	27.0
Land (million acres)	465.0	122.0	57.3
Per capita land (acres)	1.7	4.1	0.6
Education (years in school)	11.0	12.0	7.5

Source: International Financial Statistics

Table 2. U.S. Exports to and Imports From Canada, 1990-1996 Average

	Unit	U.S. Exports	U.S. Imports
Wheat	MT	13,142	1,378,045
Barley	MT	3,599	772,050
Beef and veal	MT	89,231	147,683
Cattle and calves	Head	63,909	1,129,443
Processed food (sic-20)	Million $	3,646	4,327

metric tons in 1993/94 and then decreased to 1.3 million metric tons in 1996 (Figure 1). On the other hand, U.S. exports of wheat to Canada averaged only about 13 thousand metric tons per year during the same period. The import surge in 1993/94 led to the negotiation of a temporary agreement to limit Canadian wheat exports to the United States during September 12, 1994, to September 11, 1995. The Canadian wheat exports were mainly hard red spring and durum wheat.

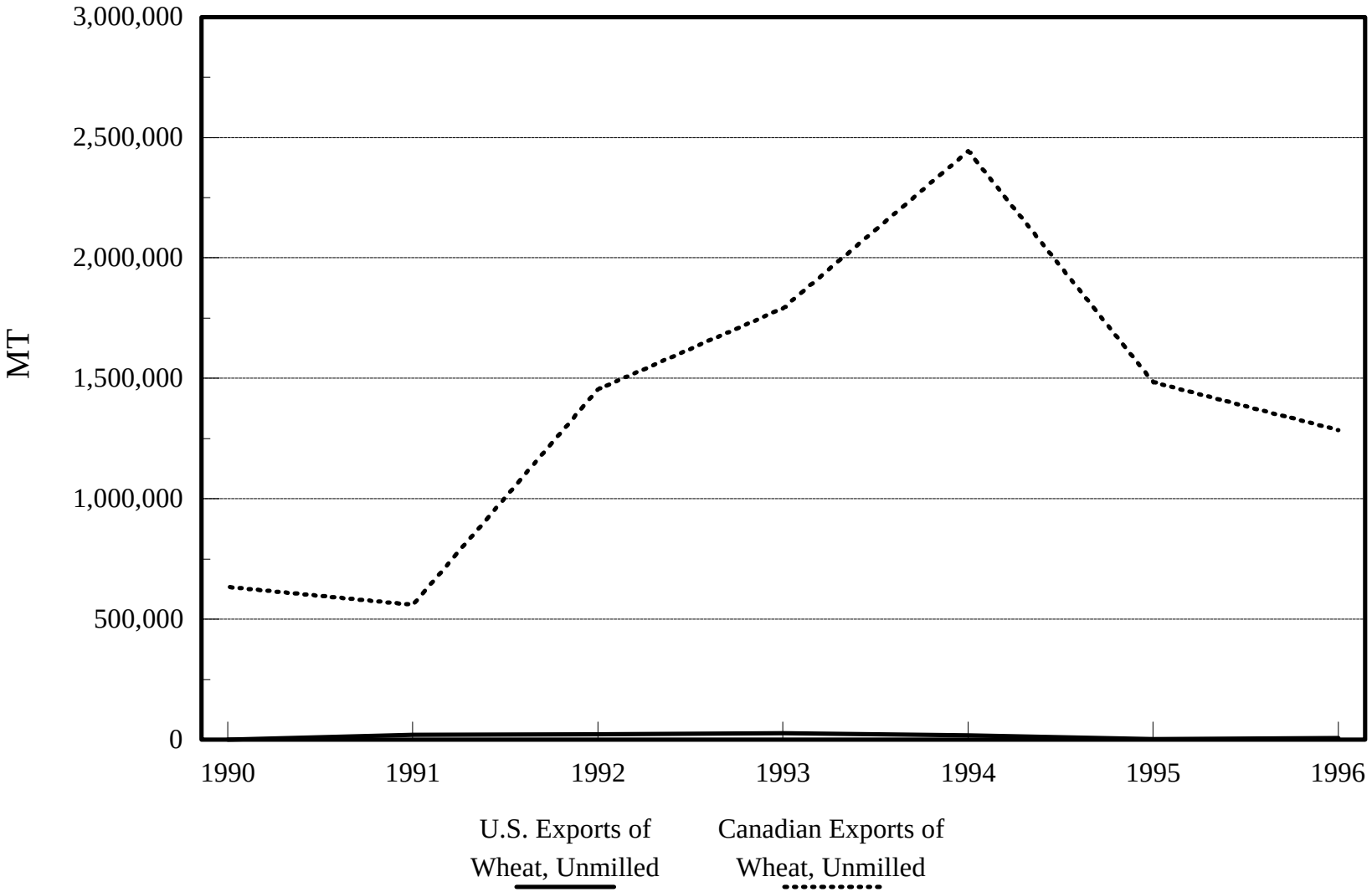


Figure 1. Trade Flows of Unmilled Wheat Between Canada and United States

U.S. barley imports from Canada also grew rapidly from 216 thousand metric tons in 1990/91 to nearly 1.9 million metric tons in 1993/94 and then decreased to 789 thousand metric tons in 1996 (Figure 2). The imports account for over 10 percent of U.S. domestic consumption. During the same period, U.S. barley exports to Canada were less than 10 thousand metric tons.

A similar trend holds for other agricultural commodities, such as cattle and beef, but to a lesser extent. Canada increased its exports of both cattle and beef for the same period, but beef exports increased faster than cattle exports (Figures 3 and 4). On the other hand, U.S. exports of cattle and beef maintained the same levels during the same period.

Canada also has trade surpluses for processed agricultural products (SIC 20) with the United States. Canadian exports of processed agricultural products to the United States increased from $5.3 billion in 1990 to $7.2 billion in 1997, while U.S. exports to Canada increased from $3.5 billion in 1990 to $5.6 billion in 1996 (Figure 5).

This study focuses on trade of wheat and barley between the United States and Canada, mainly because these are important crops produced in the Northern Plains states and Canadian exports of the crops to the United States have increased faster than any other commodities. Producers in the Northern Plains states that border Canada have raised special concerns regarding commodity trade between the two countries. They generally argue that the increased Canadian exports of wheat and barley to the United States have substantially reduced farm income of wheat and barley producers in the Northern Plains states.

The objective of this study is to evaluate the impacts of Canadian wheat and barley exports to the United States on U.S. domestic prices of these two commodities and farm income in the durum wheat and barley growing regions in the United States. Specific objectives are

1. To identify factors affecting trade flows of wheat and barley between the two countries under CUSTA.

2. To assess the impacts of Canadian wheat and barley exports on domestic prices of these two commodities in the United States.

3. To analyze the effects of changes in domestic prices of these two commodities on income of wheat and barley producers in the Northern Plains and this region’s general economy.

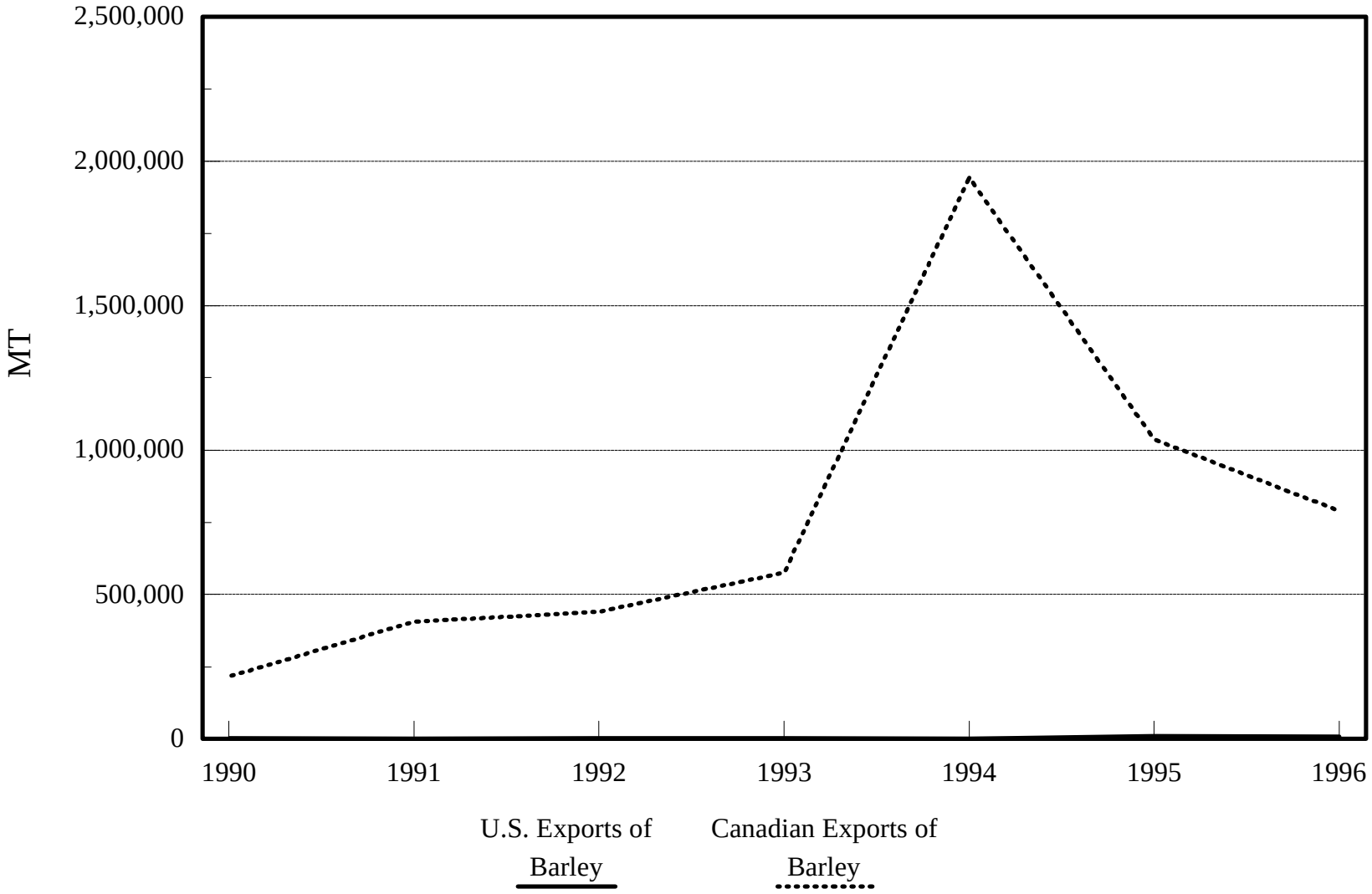


Figure 2. Trade Flows of Barley Between Canada and United States

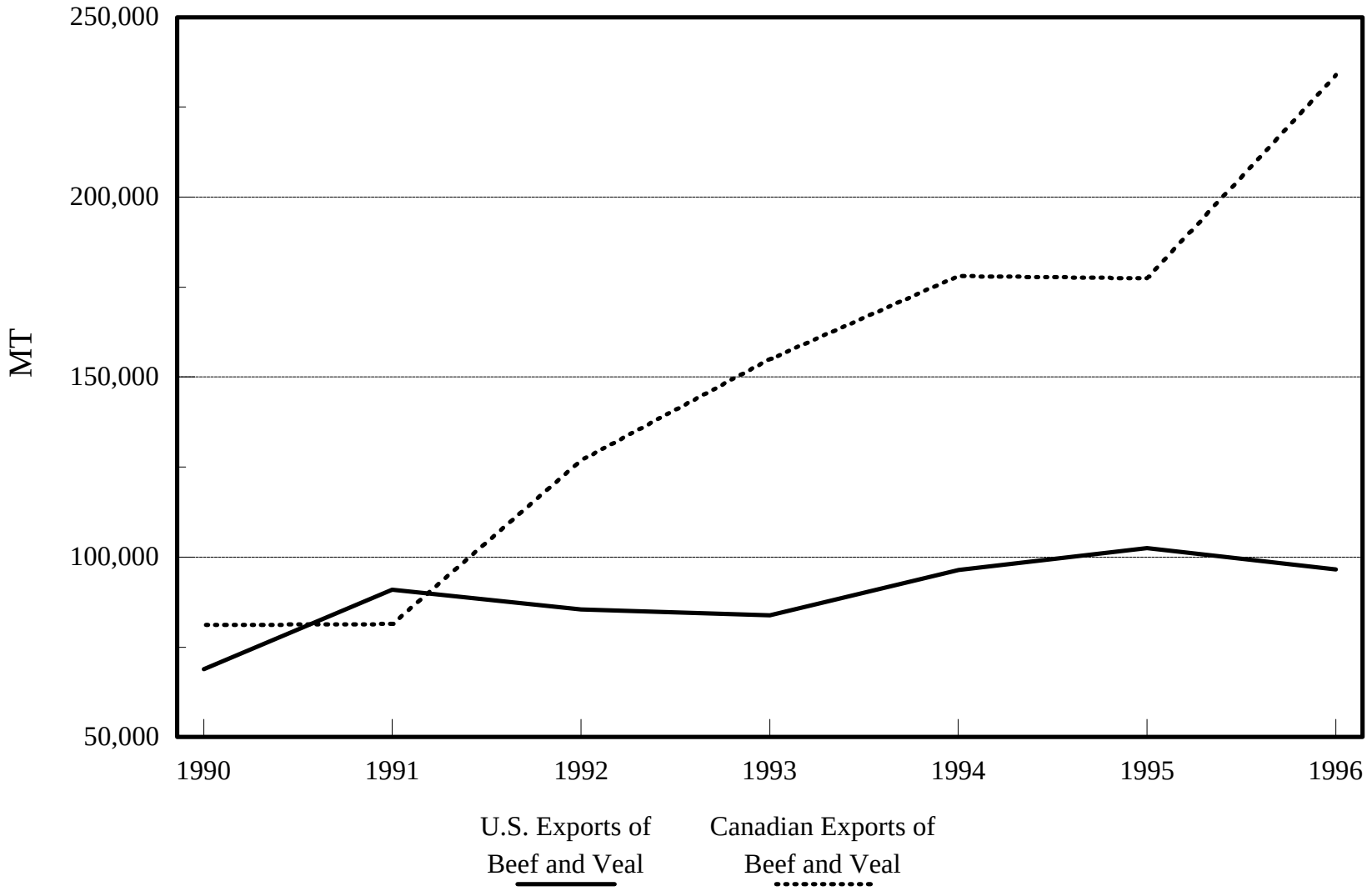


Figure 3. Trade Flows of Beef and Veal Between Canada and United States

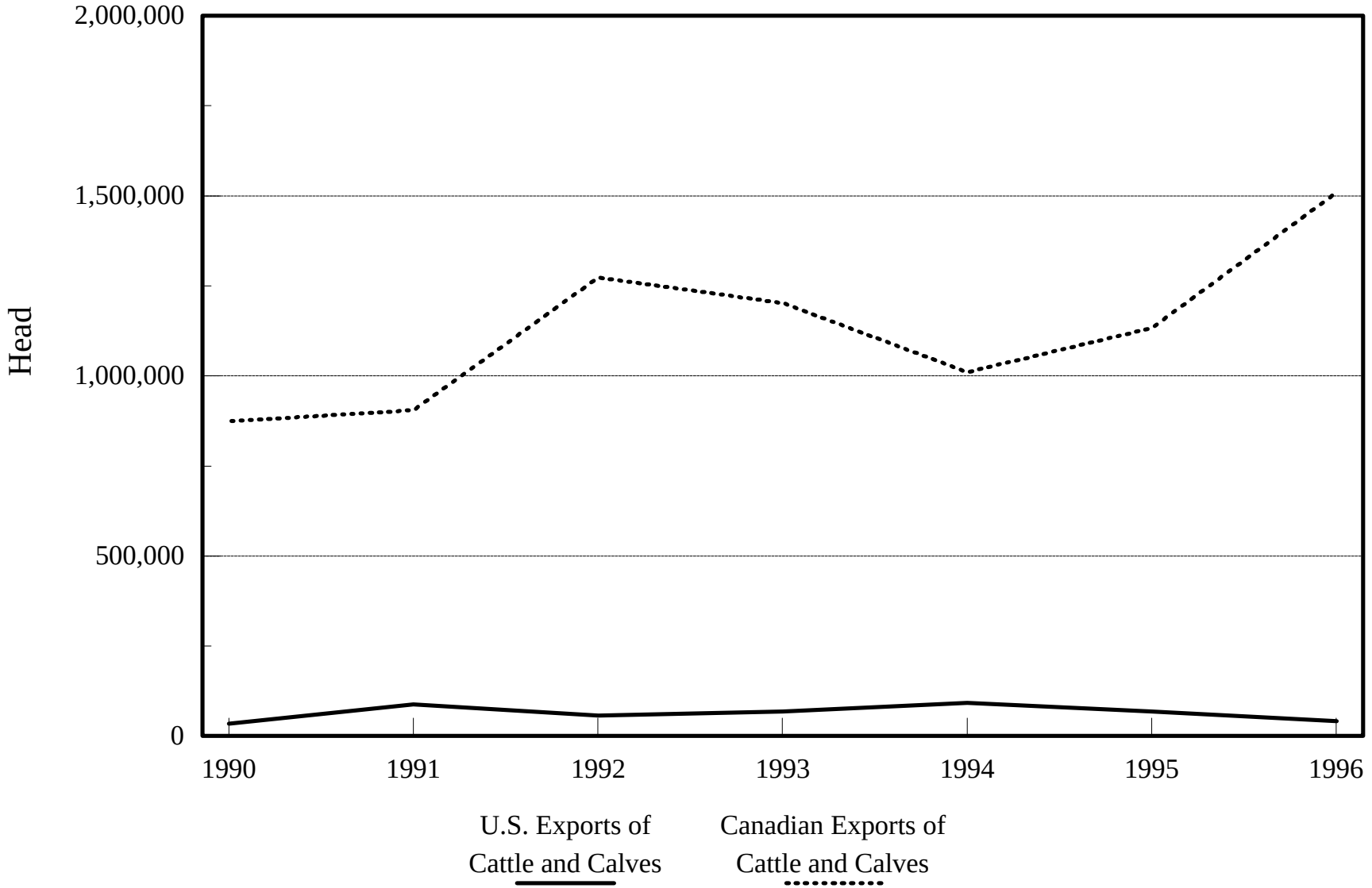


Figure 4. Trade Flows of Cattle and Calves Between Canada and United States

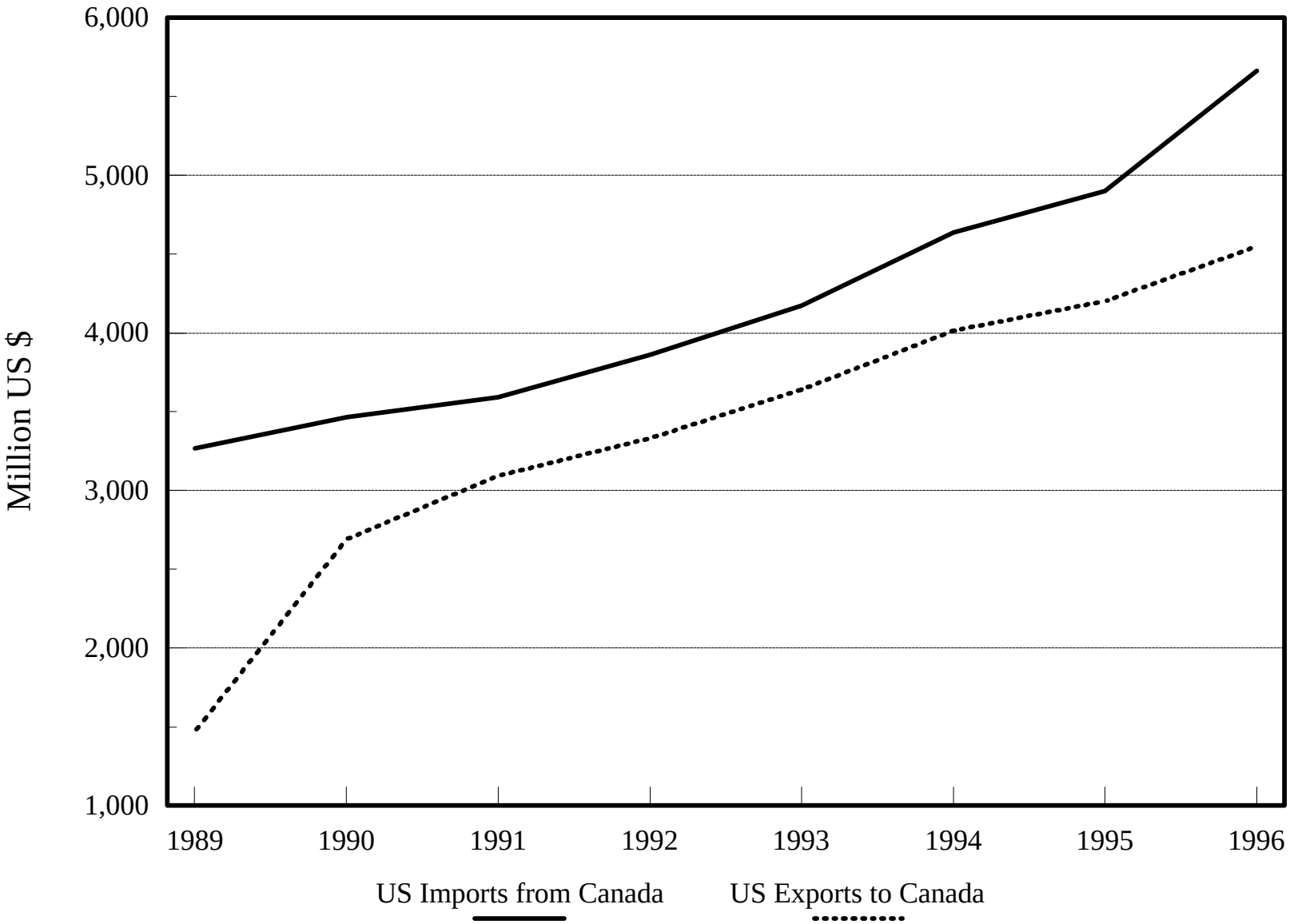


Figure 5. Trade Flows of Processed Agricultural Products (sic-20) Between United States and Canada

Many studies have examined trade issues between the United States and Canada under CUSTA and NAFTA. The Canada/U.S. Joint Commission did a comprehensive study on grain trade between the two countries, focusing on the two countries' marketing support systems for all grains and effects of those systems on trade flows of grains between these two countries and on competitiveness in off-shore markets. The Joint Commission argued that asymmetric trade flows between these two countries are influenced by differences in domestic support programs and limited access to Canadian market for U.S. agricultural commodities.

Several other studies (Alston, Gray, and Sumner; Johnson and Wilson; Mao, Koo, and Krause; Schmitz and Koo) analyzed the impacts of U.S. and Canadian policies on wheat and barley trade between the two countries. These studies concluded that the EEP and supply management programs such as CRP have increased domestic prices of wheat and barley in the United States and induced imports of the crops from Canada. The studies also found that the elimination of the Canadian rail subsidies under the Western Grain Transportation Act (WGTA) increased Canadian exports of the crops to the United States mainly because rail rates from the Canadian prairies to the United States are lower than those between Canada to off-shore markets.

The following section will discuss briefly changes in trade barriers under CUSTA. The third section will examine factors affecting trade flows of agricultural commodities and products between the United States and Canada. The analysis is mainly based on several studies focused on the issues. The fourth section will discuss a theoretical model that describes the effects of changes in agricultural prices on farm income. The next two sections will evaluate empirically the effects of increased Canadian exports of durum wheat and barley on prices of the commodities in the United States, and on farm income for durum wheat and barley producers. The last section will include a brief summary and conclusion.

Trade Barriers Under CUSTA

Tariffs imposed by the United States prior to 1989 were $7.7/ton for wheat, $2.30/ton for malting barley, and $3.40/ton for other barley; and those imposed by Canada were C$4. 40/ton for wheat and C$2.30/ton for all barley. Tariffs on wheat and barley were placed on a schedule of elimination in 10 equal segments and, therefore, were eliminated completely on January 1, 1998.

In addition to tariffs, Canada had an import license on wheat and barley. Under the UR Agreement, Canada converted the import license to tariff rate quota in 1995. Canada's import quota for wheat will be raised 67 percent to 227 thousand metric tons in 2002, and that for barley will be raised 399 thousand metric tons.

Factors Affecting Trade Flows 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, and farm policies between the two countries.

The Canadian domestic markets for durum wheat and barley are smaller than the U.S. domestic markets. However, quantities of wheat and barley produced are similar between these two countries. As a result, Canada depends more on export markets. On average, Canada exports about 75 percent of the wheat and 15 percent of barley produced in the country. Under CUSTA, the U.S. market has become attractive to Canadian producers mainly because it is the largest market for Canadian wheat and barley and also the closest to Canadian producing regions.

The U.S. export enhancement program (EEP) has played an important role in maintaining U.S. competitiveness of wheat and barley exports in off-shore markets as indicated in Alston et al., Mao and Koo, and Schmitz and Koo. However, EEP has resulted in adverse effects on bilateral trade of the crops between the United States and Canada. EEP raised the U.S. domestic prices of the crops and attracted flows of the crops from Canada. The elimination of EEP would decrease the average U.S. domestic price, reduce Canadian exports of wheat and barley to the United States, and increase the price of the grains in both EEP and non-EEP markets. However, it would significantly reduce U.S. exports of the grains to EEP markets and increase the level of carry-over stock in the United States (Schmitz and Koo).

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. Under the Act, Canadian grain was competitive in offshore markets. Canada, however, eliminated the rail subsidy in 1995. The elimination of the rail subsidies affected bilateral flows of agricultural commodities between the United and Canada. This decreased Canadian offshore exports and, at the same time, increased its exports to the United States, mainly because transportation costs from the Canadian prairie to the United States are lower than those from the Canadian prairie to most offshore markets (Johnson and Wilson, Mao and Koo, and Schmitz and Koo).

In Canada, wheat and barley exports are marketed by the Canadian Wheat Board (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 grain 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. The CWB also controls the quality of grain for export shipments. Some of the U.S. wheat millers prefer to import Canadian wheat due mainly to inconsistency in wheat quality and shortage of high quality wheat produced in the United States. Schmitz and Koo argued that the CWB could reallocate its barley exports away from off-shore markets and into the U. S. market to maximize its total revenue.

The exchange rate between the two currencies plays an important role in bilateral trade of agricultural commodities and products. Since the U.S. economy has been stronger than the Canadian economy since 1985, the U.S. dollar has appreciated against the Canadian dollar. 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. For example, assume that Canadian wheat priced at C$5.00/bushel is sold at $3.57/bushel in the U.S. market at an exchange rate of C$1.40/$1.00. If the U.S. dollar appreciates from C$1.40 to C$1.50, the price of Canadian wheat decreases from $3.57 to $3.33 in the U.S. market. On the other hand, U.S. wheat priced at $3.50 will be C$4.90 in Canada at an exchange rate of C$1.40/$1.00 and will be C$5.25 at an exchange rate of C$1.50/$1.00.

Another important factor affecting trade flows of grain between the two countries are differences in quality of grain produced in the countries. This is especially true for durum wheat trade between the two countries. U.S. millers demand high quality durum wheat. Whenever the United States could not produce enough high quality durum wheat, due mainly to weather conditions and diseases during the growing season, to meet its domestic demand, U.S millers have imported high quality durum wheat from Canada. EEP has been inactive for the last 2-3 years, but imports of durum wheat from Canada have increased. One of the main reasons is a shortage of high quality durum wheat produced in the United States due to diseases, such as scab in North Dakota.

Prices and Income Effects of Increased Supply

In general, supply of a commodity has a negative relationship with the price of the commodity. Increased supply of a commodity reduces the price of the commodity if demand for the commodity remains the same and vice versa. The relationship is shown in Figure 6. With the given demand and supply schedules in Figure 6, equilibrium price is op_1 and quantity demanded is oq_1. If supply schedule shifts from S to S* due to changes in exogenous factors, price decreases from op_1 to op_2 and quantity demanded increases from oq_1 to oq_2. In the case that the increased supply is due to increases in foreign import, the total quantity supplied at price, op_2, can be divided into domestic supply (oq_3) and foreign supply ($q_2 q_3$). The total losses in farm income resulting from the increased supply are the sum of area p_1eap_2 and area baq_1q_3. Area p_1eap_2 is income loss resulting from a decrease in price (price effect), and area bcq_1q_3 is income loss resulting from import substitution (substitution effect).

If demand is perfectly inelastic, increased supply decreases prices as shown in Figure 7. The total quantity demanded remains the same at oq_1. The total supply (oq_1) is divided into domestic supply (oq_2) and foreign supply (q_1q_2). The total losses in income are the sum of area p_1efp_2 (price effect) and area fcq_2q_1 (substitution effect).

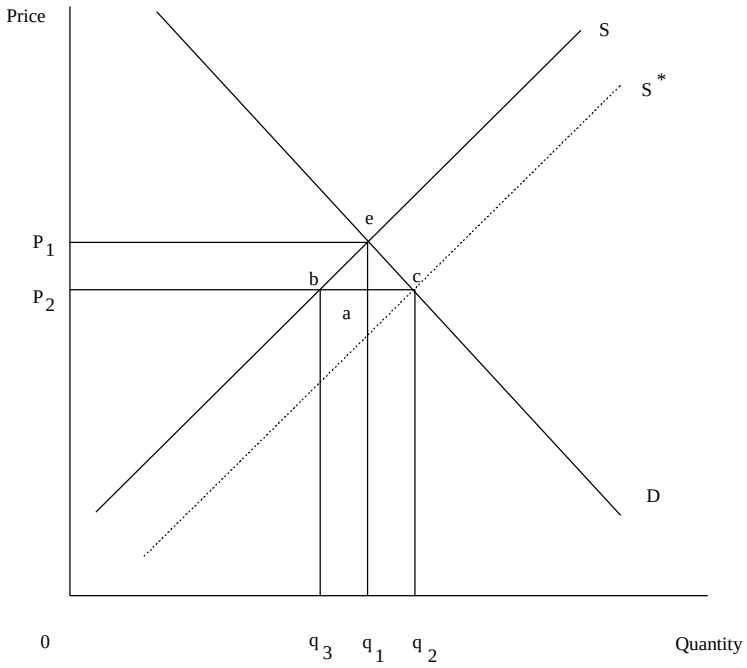


Figure 6. Income Changes With Increased Supply

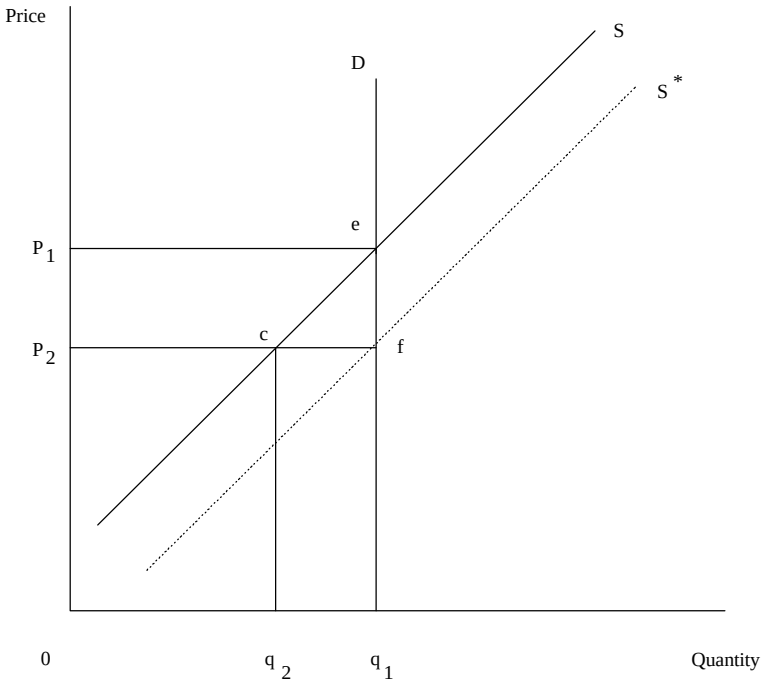


Figure 7. Changes in Income With Increased Supply and Perfectly Inelastic Demand

Effects of Canadian Exports on U.S. Domestic Prices

In general, an inverse demand relationship under an equilibrium condition yields the relationship between domestic price and total supply of a commodity as follows:

$$P_t = \alpha_0 + \alpha_1 S_t + e_t \quad (1)$$

where P_t = the price of the commodity, and

S_t = total supply of the commodity.

It is hypothesized the coefficient (α_1)of the total supply (S_t) is negative, indicating that the price of the commodity is inversely related to the total supply of the commodity. Since the total supply is divided into domestic supply (S_t^d) and imports from foreign countries (S_t^m) and domestic supply is differentiated from imports, Equation 1 can be rewritten as

$$P_t = \beta_0 + \beta_1 S_t^d + \beta_2 S_t^m + e_t \quad (2)$$

In this equation, the coefficients of domestic and foreign supplies are all negative, indicating that the price of the commodity has an inverse relationship with both domestic and foreign supplies of the commodity.

Assuming a dynamic relationship between the price and both domestic and foreign supplies on the basis of the Nerlove's partial adjustment hypothesis, Equation 2 is expressed as

$$P_t^* = \beta_0 + \beta_1 S_t^d + \beta_2 S_t^m + e_t \quad (3)$$

$$P_t - P_{t-1} = \lambda(P_t^* - P_{t-1}) \quad (4)$$

where P_t^* = desired price of the commodity and λ = adjustment coefficient. The value of the coefficient ranges between 0 and 1.0. Combining Equations 3 and 4 yields a dynamic price equation as follows:

$$P_t = \lambda\beta_0 + \lambda\beta_1 S_t^d + \lambda\beta_2 S_t^m + (1-\lambda)P_{t-1} + \lambda e_t \quad (5)$$

Equation 5 is applied to the U.S. durum and barley industries to investigate the relationship between the prices of the commodities and imports of these commodities from foreign countries. The durum wheat and barley price equations are estimated with annual time series data from 1975 to 1996. The data used to estimate these two equations are obtained from USDA publications. The estimated price equations of durum wheat and barley are shown in Equations 6 and 7, respectively, as follows:

$$P_{dt} = 6.194 - 0.0195 S_{dt}^d - 0.086 S_{dt}^m + 0.49 P_{dt-1} + et \quad (6)$$
$$\quad (3.53) \quad (3.14) \quad (2.54) \quad (2.46)$$

$R^2 = 0.717$
$\bar{R}^2 = 0.661$
F-statistics = 13.49

$$P_{bt} = 1.964 - 0.0014\ S_{bt}^{d} - 0.0091\ S_{bt}^{m} + 0.552\ P_{bt-1} + et \quad (7)$$
(2.23) (1.60) (1.46) (3.62)

$R^2 = 0.752$
$\bar{R}^2 = 0.702$
F-statistics = 15.16

where P_{dt} = the price of durum wheat received by farmers in time t,

S_{dt}^{d} = the total supply of durum wheat in time t,
S_{dt}^{m} = the total import of durum wheat from Canada in time t,
P_{bt} = the price of barley received by farmers in time t,
S_{bt}^{b} = the total supply of barley in time t.
S_{bt}^{m} = the total import of barley from Canada in time t.

The prices of durum wheat and barley were deflated by the consumer price index to covert nominal prices to real prices. These equations were estimated by using the ordinary least squares estimator. The Durbin-h test indicates that the error terms in both equations do not have a serial correlation problem. Numbers in parentheses are t-statistics for the corresponding parameters. R^2 for durum wheat price model is 0.717, and that for barley model is 0.752, indicating that variations of both durum wheat and barley prices are relatively well-explained by independent variables used in the equations.

Both domestic supply and import variables in the durum wheat price model are statistically significant at the 5 percent level and have a negative sign. This implies that the increased domestic supply and foreign import of durum wheat in the United States lower the price of the commodity as hypothesized in Section 5. Since the United States imports durum wheat mainly from Canada, the negative coefficient of the foreign import variable clearly indicates that the increased Canadian exports of durum wheat lower the U.S. domestic price of durum wheat.

Price flexibility coefficients for domestic supply and foreign import are calculated from the estimated durum wheat equation. The estimated price flexibility coefficient for the foreign import of durum wheat is 0.24 at mean levels of price and quantity, indicating that the price of durum wheat decreases by 2.4 percent when the import increases by 10 percent and vice versa. The estimated price flexibility coefficient for domestic supply is 0.765, which is larger than that for foreign imports. The difference in the price flexibility coefficients is mainly because domestic wheat and imported wheat are differentiated in the U.S. domestic market. The domestic price of durum wheat is more sensitive to domestic supply than to imports from Canada mainly because durum wheat imported from Canada is higher quality. The lagged dependent variable is positive

and also significant at the 5 percent level. This implies that domestic supply and imports affect not only prices in the same year, but also those in the near future.

The statistical relationship between price and supply in the barley price model is less significant than that in the durum wheat price model. The domestic supply variable is significant at the 13 percent level, and foreign import is significant at the 16 percent level in the barley price model. Both variables have negative signs, indicating that the domestic price of barley decreases when domestic supply and imports are increased as hypothesized in Section 4. The estimated price flexibility coefficient for domestic supply are 0.414 and that for foreign import is 0.075, indicating that domestic price of barley decreases by 4.14 percent and 0.75 percent, respectively, when both domestic supply and imports increase by 10 percent. The price flexibility coefficients indicate that domestic prices are more sensitive to domestic supply than to imports.

Effects of Canadian Exports on Farm Income

A decrease in the domestic price of a commodity generally decreases farm income while benefitting consumers. In the case of wheat and barley trade between the United States and Canada, the increased Canadian exports of wheat and barley under CUSTA have decreased the domestic prices of these two crops as shown in Section 5, and have decreased income of wheat and barley producers in the United States. On the other hand, the lower rices have benefitted processors and consumers. This study focuses on changes in farm income resulting from changes in domestic prices.

The losses in farm income are calculated on the basis of the following assumptions: (1) total domestic demand for durum wheat and barley is not affected by Canadian exports of the two crops (U.S. domestic demand for durum wheat is nearly inelastic), and (2) U.S. export prices of durum wheat and barley are not affected by Canadian exports of the two crops. The first assumption is introduced mainly because millers' demand for wheat has been inelastic. Millers purchase wheat to produce wheat flour which is used as inputs to produce wheat products such as bread, noodles, and pasta. Since wheat is a primary input in the food industry, its demand is known to be inelastic. The second assumption indicates that the quantity of Canadian wheat and barley exported to the United States is large enough to influence the domestic price in the United States, but is not large enough to influence the world price.

Losses in U.S. farm income resulting from increased Canadian exports are equal to the sum of area p_1efp_2 and area fcq_2q_1 in Figure 7 under assumptions stated above. However, Canadian exports of wheat and barley tend to increase U.S. exports of the commodities to off-shore markets. As Canada diverts its exports from offshore markets to the U.S. market, the United States tends to expand its exports to the offshore markets to meet their demand. Therefore, the increased export revenue should be subtracted from the income losses shown in Figure 7. The net farm income losses from a commodity are calculated as follows:

$$I = (P^{*}_{mt} - P_{mt}) * Q^{d}_{t} + P_{mt} * Q^{m}_{t} - P_{xt} * Q^{x}_{t} \quad (8)$$

where P^{*}_{mt} = projected U.S. farm price of a commodity without Canadian exports to the United States.

P_{mt} = U.S. farm price of the commodity

Q^{d}_{t} = the quantity of the commodity consumed in the United States

Q^{m}_{t} = the quantity of the Canadian commodity exported to the United States

P_{xt} = U.S. export price of the commodity

Q^{x}_{t} = the quantity of the commodity increased from the United States to off-shore markets resulting from Canadian exports to the United States.

The first term of the equation represents area p_1efp_2 in Figure 7, and the second term represents area fcq_2q_1 in Figure 7. The last term represents increased export revenue in the United States resulting from Canadian exports to the United States.

The projected farm prices (P^{*}_{mt}) of durum wheat and barley are calculated from the estimated price equations and represent the expected price if the United States reduces its imports of durum wheat and barley to their long-run average levels, which are 10.1 million bushels for durum wheat and 17.6 million bushels for barley. The increases in U.S. exports (Q^{x}_{t}) are calculated on the basis of the equilibrium conditions for the U.S. durum wheat and barley industries. U.S. expected export is calculated in the basis of the equilibrium condition, when Canadian exports are equal to zero, as follows;

$$Q^{ex}_{t} = S_{t} + Q^{p}_{t} - Q^{d}_{t} - S_{t-1}. \quad (9)$$

where Q^{ex}_{t} = expected exports in time t,

S_{t} = carry-in stock from the previous period (t-1),

Q^{p}_{t} = production in time t,

S_{t-1} = carry-out stock to the next period (t+1).

Then, changes in U.S. exports resulting from Canadian exports to the United States are calculated by subtracting the actual exports (Q^{ax}_{t}) from the expected exports (Q^{ex}_{t}) as

$$Q^{x}_{t} = Q^{ex}_{t} - Q^{ax}_{t}. \quad (10)$$

Three scenarios are developed on the basis of the estimated price flexibility coefficients to investigate a range of income effects stemming from Canadian exports of the commodities. The scenarios are

1. Using the price flexibility coefficients calculated from the estimated parameters for the import variable of durum wheat and barley price models (the base scenario).

2. Using the price flexibility coefficients calculated from the estimated parameters for the import variable of the models plus one standard error corresponding with the variable (high price effect scenario).

3. Using the price flexibility coefficients calculated from the estimated parameters for the import variable of the models minus one standard error corresponding with the variable (low price effect scenario).

Table 3 shows changes in gross farm income in the United States resulting from Canadian durum wheat and barley exports to the United States. The second, third, and fifth columns show historical data for U.S. domestic consumption, imports from Canada, and U.S. market prices, respectively. The fourth column shows increases in U.S. exports to offshore markets resulting from Canadian exports to the United States. The projected domestic prices in the seventh column were calculated from the price flexibility coefficients and the losses in farm income resulting from Canadian exports to the United States were calculated from Equation (8).

The projected prices in the seventh column indicate the prices that U.S. farmers would receive if Canada exported the long-run average levels to the United States. The average price of durum wheat would be $5.44 bushel if Canada exported 10.1 million bushels (long-run average Canadian export) rather than 24.7 million bushels during the 1993-95 period, implying that U.S. domestic prices of durum wheat are reduced by about 13 percent because of increased Canadian durum wheat exports to the United States. Similarly, the U.S. barley prices are reduced by about 4.4 percent because of increases in Canadian barley exports to the United States. Income effects resulting from the reductions in prices are shown in the last column of Table 3. Average farm income loss is estimated to be $148 million/year for both U.S. durum wheat and barley producers, $47 million/year for durum wheat producers, and $101 million for barley producers.

Under the high price effect scenario, average farm income loss is estimated to be $192 million/year for both durum wheat and barley producers in the United States; $64 million/year for durum wheat producers, and $128 million/year for barley producers (Table 4). This resulted from a 15.3 percent reduction in durum wheat price and a 4.4 percent reduction in barley price in the United States. Under the low price effect scenario, average income loss is estimated to be $104 million/year for both durum wheat and barley producers in the United States; $31 million/year for durum wheat producers, and $73 million/year for barley producers (Table 5). Price reductions resulting from increased Canadian exports under this scenario are 6.5 percent for durum wheat and 1.3 percent for barley.

Assuming that North Dakota produces 78 percent of the U.S. durum wheat and 35 percent of the barley, gross income losses in North Dakota resulting from Canadian durum wheat and barley exports are $72 million/year ($37 million/year for durum wheat producers and $35 million/year for barley producers) under the base scenario, $94 million/year under the high price effect scenario, and $49 million/year under the low price effect scenario.

Table 3. Changes in Prices and Farm Income in the Base Scenario

Year	Domestic Demand (Q^d_t)	Import from Canada (Q^m_t)	Changes In U.S. Exports[a] (Q^x_t)	U.S. Farm Price (P_{mt})	U.S. Export Price (P^x_t)	Projected U.S. Price (P^*_{mt})[b]	Changes in Farm Income[c]
	----------Million Bushels----------			----------$/bu.----------			
Durum Wheat							
1993/94	68	31	23	4.48	5.48	5.10	55.1
1994/95	81	22	17	4.62	5.62	5.07	42.4
1995/96	88	21	18	5.64	6.62	6.15	44.1
Average	79	24.7	19.3	4.91	5.92	5.44	47.2
Barley							
1993/94	416	71	43	1.99	1.89	2.08	100.2
1994/95	401	66	40	2.03	1.91	2.12	95.5
1995/96	390	55	33	2.67	2.52	2.78	106.3
Average	402	64	38.6	2.23	2.11	2.33	100.7

[a/]Increases in U.S. exports to off-shore markets resulting from Canadian exports to the United States.
[b]/Projected U.S. farm prices when Canada exports at the long-run average level to the United States.
[c]/Formula used: $I=(P^*_{mt}-P_{mt}) \bullet Q^d_t + P_{mt} \bullet Q^m_t - P^x \bullet Q^x_t$.

Table 4. Changes in Prices and Farm Income in the High Price Effect Scenario

Year	Domestic Demand (Q^d_t)	Import from Canada (Q^m_t)	Changes In U.S. Exports[a] (Q^x_t)	U.S.Farm Price (P_{mt})	U.S. Export Price (P^x_t)	Projected U.S. Price (P^*_{mt})[b]	Changes in Farm Income[c]
	----------Million Bushels----------			----------$/bu.----------			
Durum Wheat							
1993/94	68	31	23	4.48	5.48	5.36	72.6
1994/95	81	22	17	4.62	5.62	5.26	57.6
1995/96	88	21	18	5.64	6.62	6.36	62.8
Average	79	24.7	19.3	4.91	5.92	5.66	64.3
Barley							
1993/94	416	71	43	1.99	1.89	2.15	127.6
1994/95	401	66	40	2.03	1.91	2.19	121.3
1995/96	390	55	33	2.67	2.52	2.85	135.3
Average	402	64	38.6	2.23	2.11	2.40	128.1

[a/]Increases in U.S. exports to off-shore markets resulting from Canadian exports to the United States.
[b]/Projected U.S. farm prices when Canada exports at the long-run average level to the United States.
[c]/Formula used: $I=(P^*_{mt}-P_{mt}) \bullet Q^d_t + P_{mt} \bullet Q^m_t - P^x \bullet Q^x_t$.

Table 5. Changes in Prices and Farm Income in the Low Price Effect Scenario

Year	Domestic Demand (Q^d_t)	Import from Canada (Q^m_t)	Changes In U.S. Exports[a] (Q^x_t)	U.S.Farm Price (P_{mt})	U.S. Export Price (P^x_t)	Projected U.S. Price (P^*_{mt})[b]	Changes in Farm Income[c]
	----------Million Bushels----------			----------$/bu.----------			
Durum Wheat							
1993/94	68	31	23	4.48	5.48	4.85	38.5
1994/95	81	22	17	4.62	5.62	4.89	28.2
1995/96	88	21	18	5.64	6.62	5.95	26.5
Average	79	24.7	19.3	4.91	5.92	5.23	31.1
Barley							
1993/94	416	71	43	1.99	1.89	2.02	72.9
1994/95	401	66	40	2.03	1.91	2.06	69.7
1995/96	390	55	33	2.67	2.52	2.70	77.3
Average	402	64	38.6	2.23	2.11	2.26	73.3

[a/]Increases in U.S. exports to off-shore markets resulting from Canadian exports to the United States.
[b]/Projected U.S. farm prices when Canada exports at the long-run average level to the United States.
[c]/Formula used: $I=(P^*_{mt}-P_{mt}) \bullet Q^d_t + P_{mt} \bullet Q^m_t - P^x \bullet Q^x_t$.

The impact of Canadian durum wheat and barley exports on the North Dakota economy is estimated to be $192 million annually under an assumption that the economic multiplier is 2.67 (Leistritz et al), indicating that North Dakota income was reduced by $192 million/year as a result of Canadian exports of the two crops in the last three years (1993/94 - 1995/96). The impacts on the North Dakota economy under the high price effect and low price effect scenarios are estimated to be $250 million and $130 million, respectively.

Concluding Remarks

This study focuses on trade of durum wheat and barley between the United States and Canada. The overall objective of this study is to evaluate the impacts of Canadian exports of durum wheat and barley to the United States on U.S. domestic prices of these two commodities and farm income in the durum wheat and barley growing regions in the United States.

The U.S. export enhancement program, the elimination of Canadian rail subsidies, marketing power of the Canadian Wheat Board, differences in macroeconomic conditions, differences in resource endowments, and differences in grain quality are the major factors affecting trade flows of agricultural commodities and products between the two countries. The factors have influenced Canadian exports positively since the inception of CUSTA, resulting in major increases in Canadian exports of agricultural commodities and products to the United States.

This study found that increased Canadian durum wheat exports above the long run average export level reduced the domestic price of durum wheat in the United States. The price reductions range between 6.5 percent under the low price effect scenario and 15.3 percent under the high price effect scenario. Price reduction is estimated to be 13 percent under the base scenario. Reductions in the average income for durum wheat producers in the United States as a result of decreases in the domestic prices of durum wheat range between $31 million under the low price effect scenario and $64 million under the high price effect scenario. Average annual loss in farm income is estimated to be $47 million in the base scenario.

The study found that Canadian barley exports above the long run average level reduced the domestic price of barley and, consequently, reduced farm income of barley producers in the United States. The reductions in the domestic price of barley resulting from increased Canadian barley exports range between 4.4 percent under the high price effect scenario and 1.3 percent under the low price effect scenario. The price reduction is 2.2 percent under the base scenario. Losses in farm income range between $73.3 million under the low price effect scenario and $128.0 million under the high price effect scenarios. Loss in farm income is $100.7 million under the base scenario.

Total income losses for both durum wheat and barley producers resulting from Canadian exports of these two crops range between $104 million and $192 million. Income loss is $148 in the base scenario.

Income losses resulting from Canadian exports of durum wheat and barley to the United States above the long-run average levels in North Dakota are substantial: $72 million in the base scenario. The maximum loss in farm income is $94 million, while the minimum loss is $49 million. The income losses on the North Dakota economy reduced the state's general economy, ranging between $130 million and $250 million annually for the 1993-1995 period.

REFERENCES

Abel, Martin E. 1995. *A Comparison of the U.S. and Canadian Marketing Systems for Wheat and Barley: Transparency, Differential Pricing, and Monopolistic Behavior*. Prepared for the Canada/ U.S. Joint Commission on Grains, New Orleans, February 22-23.

Alston, J.M., R. Gray, and D. Sumner. 1994. "The Wheat War of 1994," *Canadian Journal of Agricultural Economics*. Vol.42:231-251.

Canada/U.S. Joint Commission on Grains. 1995. Canada/U.S. Joint Commission Final Report, Vol. 1-II. Washington, DC , October.

Futan, W. H. 1995. *Transparency and Differential Pricing: An Analysis of Canadian and American Grain Handling Systems*. Prepared for the Canada/U.S. Joint Commission on Grains, New Orleans, February 22-23.

Gray, Richard and Bruce Gardner. 1995. *The Impact of Canadian and U.S. Farm Policies on Grain Production and Trade.* Prepared for the Canada/U.S. Joint Commission on Grains, New Orleans, February 22-23.

International Monetary Fund. 1997. International Financial Statistics. Washington, DC.

Johnson, D. and W. Wilson. 1995. "Canadian Rail Subsidies and Continental Barley Flows: A Spatial Analysis." *Logistic and Transportation Review*, Vol. 31:31-46.

Leistritz, L., W. Koo, M. Duncan, R. Taylor, and D. Aakre. 1995. *Economic Impact of Alternative Farm Program Scenarios on the North Dakota Economy*, AE 95008, Department of Agricultural Economics, North Dakota State University, Fargo.

Mao, Weining, Won Koo, and M. Krause. 1996. *World Feed Barley Trade Under Alternative Trade Policy Scenarios*, Agricultural Economic Report No. 350, Department of Agricultural Economics, North Dakota State University, Fargo.

Schmitz, Troy C. and W. Koo. 1996. *An Economic Analysis of International Feed and Malting Barley Markets: An Econometric Spatial Oligopolistic Approach*, Agricultural Economics Report No. 357, Department of Agricultural Economics, North Dakota State University, Fargo.

Young, Linda M. 1996. *Changing Canadian Grain Policies: Implications for Montana's Grain Industry.* Policy Issues Paper No. 1, Northern Plains and Rockies Center for the Study of Western Hemisphere Trade, Bozeman, Montana.