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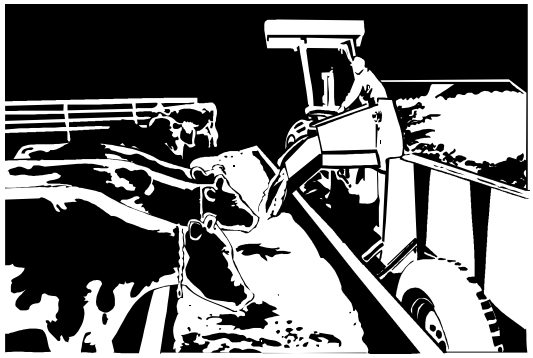
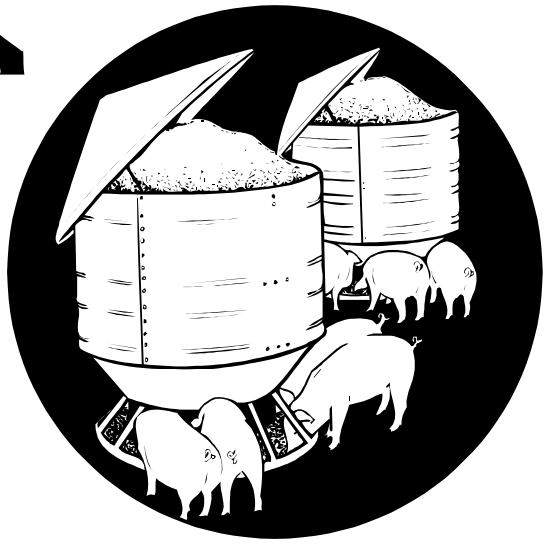
Canadian Exports of Livestock and Meat to the United States

**Jeremy W. Mattson, Cheryl J. Wachenheim,
Won W. Koo, and Timothy A. Petry**





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Abstract

Canadian exports of beef and live cattle to the United States have increased significantly since the late 1980s. Hog exports have increased since the mid-1990s. Major factors affecting exports of beef, pork, cattle, and hogs from Canada to the United States include the exchange rate, increased Canadian production, U.S.-Canada price differentials, and trade liberalization under the Canada - United States Free Trade Agreement (CUSTA) of 1989. Increased Canadian exports have resulted in small but significant reductions in U.S. domestic prices of beef, pork, and hogs.

Key Words: beef, bilateral trade, Canada - United States Free Trade Agreement, cattle, free trade agreement, pork, hogs, prices

Highlights

Canadian exports of beef and live cattle to the United States have increased substantially since the late 1980s. Hog exports have increased since the mid-1990s. U.S. producers allege that the increase in Canadian exports has been harmful to them because increased supplies have lowered prices. The increase in beef and live cattle imports from Canada coincided with the implementation of the Canada - United States Free Trade Agreement (CUSTA). Trade liberalization contributed to an increase in trade volume between the United States and Canada. Other factors, such as the exchange rate, have also had effects on trade flows.

Beef imports from Canada have increased every year since 1989. Imports of live cattle from Canada have also been greater during the last decade than previously, though the increase has not been continuous as in the case of beef. Canadian exports of live hogs to the United States started to increase substantially in 1994. Imports of pork from Canada have remained relatively constant over the last twenty years, although they increased somewhat in 1998 and 1999.

Objectives of this study were to determine the factors affecting the flows of Canadian exports of beef, live cattle, pork, and live hogs to the United States and to determine the effects of Canadian exports of these commodities on U.S. prices. An econometric model was developed and estimated. Two equations were specified and solved simultaneously. One equation is an export supply equation and the other is a price equation. These two equations were estimated using three-stage least squares estimation with monthly time series data for 1981-1999.

The estimated model indicates that trade liberalization under CUSTA has had a significant influence on live cattle and beef exports to the United States. Hog exports to the United States increased significantly since 1994 after accounting for all other influencing factors. Canadian pork exports to the United States were not affected by CUSTA. The appreciation of the U.S. dollar relative to the Canadian dollar has had a significant positive effect on Canadian exports. Increased Canadian production has also had a positive influence on the amount of imports from Canada for pork and hogs. Price differences between Canada and the United States influence Canadian exports of live cattle to the United States.

The estimated model indicates that increased Canadian exports to the United States have negatively affected U.S. prices. The price flexibility coefficients for Canadian exports to the United States are -0.082 for beef, -0.092 for cattle, -0.285 for pork, and -0.072 for hogs. Thus, for example, the estimate shows a 1% increase in Canadian exports causes the U.S. beef price to decrease 0.082%. Average yearly reductions in U.S. domestic prices due to increases in Canadian exports since the inception of CUSTA were 1.5% for wholesale beef, 1.5% for hogs, and 0.8% for pork. There has been virtually no effect on cattle prices.

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Introduction

The United States and Canada are two of the world's largest exporters of agricultural goods and compete with each other in major foreign markets. They share a common interest in reducing government interference in world agriculture and encouraging international 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 objective of CUSTA was to phase out agricultural tariffs over a ten-year period and decrease the use of domestic subsidies affecting trade flows. CUSTA and NAFTA mandated that trade flows of meat and livestock within North America be based on competitive factors (Brester and Marsh).

Prior to and during the CUSTA period, trade tensions have resulted from increased trade volume of livestock and meat between the United States and Canada and depressed prices. U.S. producers have at times alleged that increased exports from Canada have been harmful to them because resulting increased domestic supplies have lowered prices (e.g., see Brester and Marsh).[1] The effect of imports on domestic prices can be a particularly contentious issue because, in the short run, domestic livestock and meat supplies are quasi-fixed and cannot, therefore, easily or quickly respond to market forces (Young).

Objectives of this study were to determine the factors affecting the flows of Canadian exports of livestock and meat to the United States and to determine the effects of Canadian exports on U.S. prices. Livestock and meat are segregated into live cattle and live hogs, and beef and pork, respectively. Background information on livestock and meat trade between the United States and Canada, particularly since the implementation of CUSTA, is first provided. Theoretical and evidentiary support for factors included in the econometric models used to

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[1] Trade tensions have involved a number of agricultural commodities including livestock. For example, for two weeks in September 1998, the state governments of South Dakota, North Dakota, and Montana blockaded or increased inspections of Canadian trucks with imports of beef, hogs, and grain. In November 1998, the Ranchers-Cattlemen Action Legal Foundation (R-CALF) filed a countervailing duty suit against Canada and antidumping duty suits against both Canada and Mexico. These petitions were filed with the Department of Commerce under Sections 701 and 731 of U.S. trade law. The intent of Section 701 is to provide relief from subsidized imports through imposition of countervailing duties. The intent of Section 731 is to provide relief from products dumped in the United States through imposition of antidumping duties. During the time of the dispute, cattle and beef prices were very low, while beef imports from Canada were increasing. R-CALF claimed that Canadian exports of beef and cattle to the United States significantly damaged the incomes of U.S. cattlemen. The finding of the U.S. International Trade Commission (USITC) in this case was that Canada was in fact dumping cattle in the United States, but they found that the dumping did not cause material injury. The antidumping action was terminated, as was the countervailing action by the determination that there was no significant subsidization.

estimate imports and their impact on prices is then presented. Next, results of selected previous investigations of trade flows are discussed. Estimation procedures and data used in the current study are detailed. Results and conclusions follow.

Background – Changes in Trade Patterns under CUSTA

The United States and Canada Free Trade Agreement

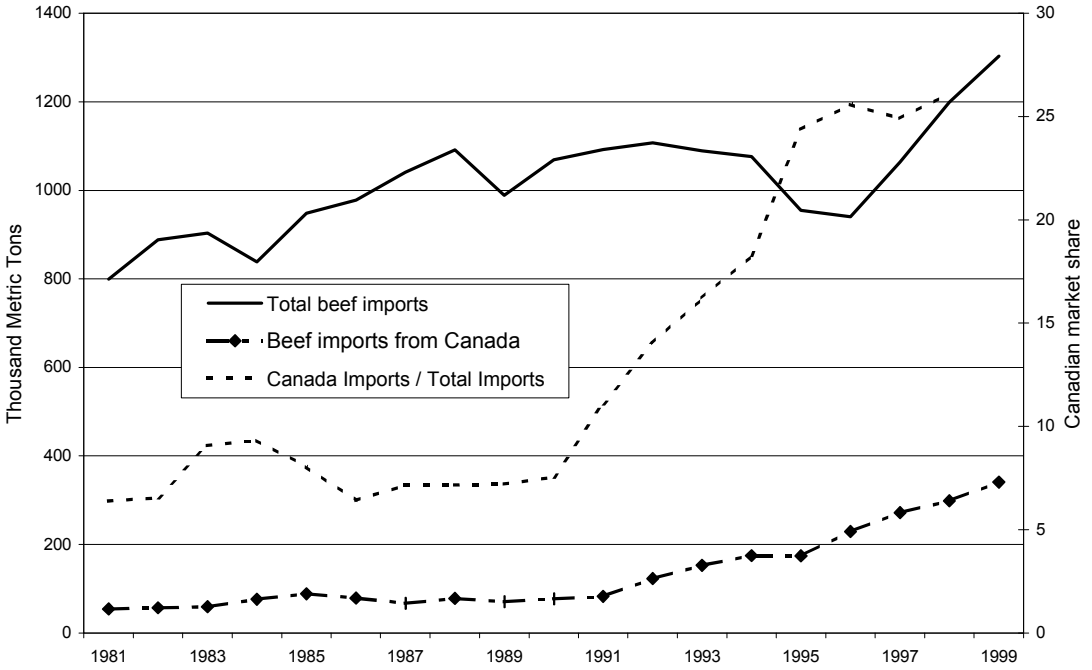
Livestock and meat trade between Canada and the United States was relatively free prior to CUSTA (Hobbs and Kerr). Tariff levels on live cattle and beef were relatively low and, with minor exceptions, neither country charged tariffs on live hog or pork exports from the other (Crawford). Some non-tariff barriers existed before and still exist after CUSTA including differences in grading systems, countervailing actions on Canadian pork imports to the United States, and complaints and actions by both the United States and Canadian beef industries because of alleged subjective border inspections, product dumping, and subsidization of production.

Prior to CUSTA, the base rate of duty for U.S. cattle imports from Canada and U.S. exports to Canada was zero for purebred breeding animals and dairy cattle; all other bovine animals faced a duty of 2.2 cents/kg [U.S. Department of Agriculture, Foreign Agricultural Service (USDA/FAS)]. Tariff rates on all fresh chilled and frozen beef exports into Canada were 4.41 cents/kg. Similar rates applied to fresh and frozen beef imports into the United States (USDA/FAS). The CUSTA agreement between Canada and the United States eliminated tariffs on live cattle and beef products and quota restrictions on beef, facilitating their movement across the border. U.S. cattle trade with Canada has been duty free since January 1, 1993 (USDA/FAS). By July 1993, most U.S. fresh, chilled, or frozen beef trade with Canada was duty free due to accelerated duty elimination agreements under CUSTA. However, it is likely that quantitative restrictions on U.S. beef imports under the Meat Import Act (MIA) of 1979 had been a more significant deterrent to trade for Canadian beef exporters than changes in tariffs (Young and Marsh; Link and Zahniser). Under CUSTA, each country eliminated import restrictions for beef that existed under their respective domestic meat import laws (USDA/FAS; Young and Marsh). CUSTA has had little effect on trade of pork and hogs because there were no tariffs or quotas on pork or live hogs between the United States and Canada before CUSTA.

Trade Flows of Agricultural Commodities and Products

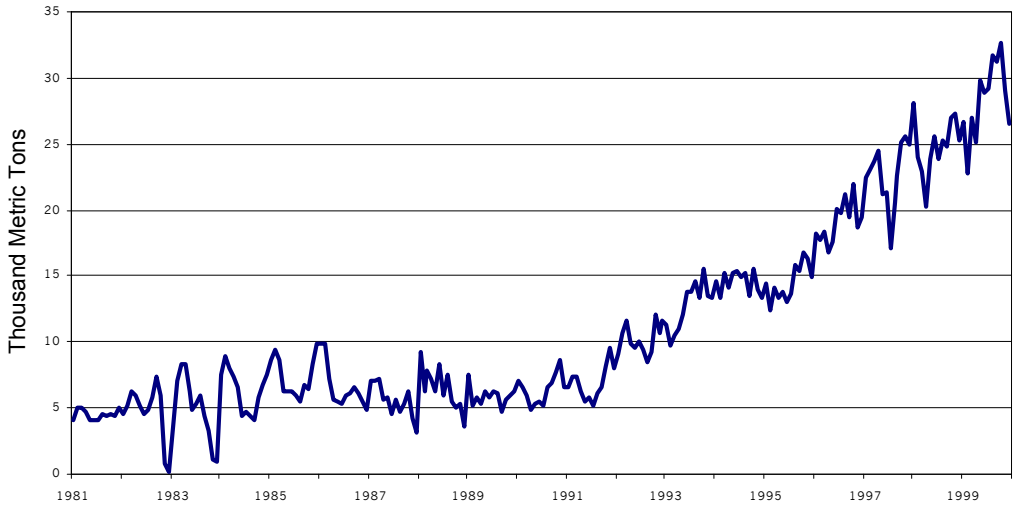
Cattle and Beef. Live cattle and beef trade between the United States and Canada consists of slaughter animals (85 to 95% of live cattle) and feeder cattle (5 to 15%) and carcass and boxed beef (Marsh 1999). Total U.S. beef imports from all sources remained relatively constant during the late 1980s and early 1990s, although the composition of their origin has changed (Figure 1). In particular, imports from Australia have decreased as imports from Canada have increased. Beginning in 1996, total U.S. beef imports began to increase substantially.

Figure 1. U.S. Beef Imports



Canadian exports of beef to the United States have increased from 0.6% to 2.5% of total U.S. beef supply since the implementation of CUSTA (Figure 2). Brester and Marsh report that U.S. net imports of live cattle and beef from Canada converted to carcass weight equivalents increased 130% and 210%, respectively, from 1989 to 1998. Since the CUSTA agreement, however, total beef imports to the United States from all sources increased only slightly. The majority of the increase in the U.S. beef supply was due to increased domestic production, specifically increased productivity of the U.S. herd (Brester and Marsh).

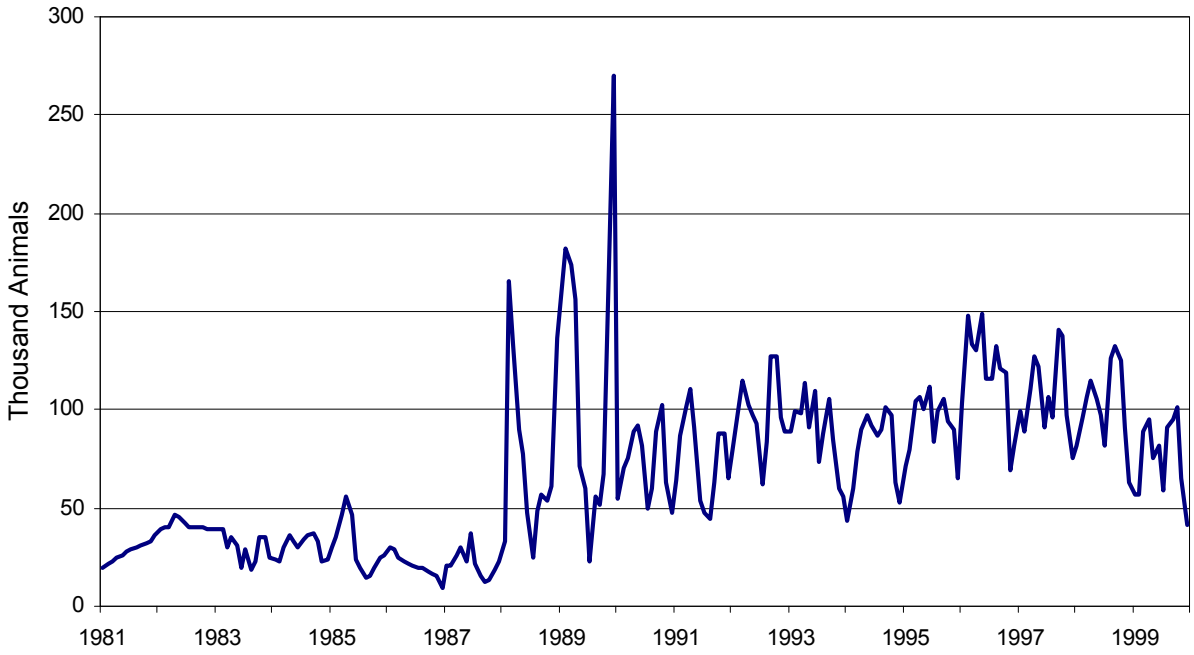
Figure 2. U.S. Monthly Beef Imports from Canada



From 1981 to 1988, annual Canadian beef exports to the United States averaged 70 thousand metric tons. Although there were sometimes substantial within-year variations, annual beef imports from Canada did not vary substantially during this period. Imports averaged 77 thousand metric tons from 1989 to 1991; 156 thousand metric tons from 1992 to 1995; and 285 thousand metric tons from 1996 to 1999. Canadian beef exports to the United States totaled 341 thousand metric tons in 1999. Beef imports from Canada have increased every year since 1989, when they equaled 71 thousand metric tons. Boxed beef imports have increased four-fold since the implementation of CUSTA (Loyns, Young, and Carter).

Imports of live cattle from Canada were also greater during the last decade than during the previous decade, although the increase better represents a shift rather than a gradual increase (Figure 3). Annual Canadian exports of live cattle to the United States averaged 419 thousand animals from 1981 to 1988 and 1.13 million animals from 1989 to 1999. There has been substantial between-year variability during this period, particularly since 1989. Live cattle imports have trended down since 1996 when they reached a high of 1.42 million animals. Live cattle imports from Canada totaled 909 thousand animals in 1999. Canadian live cattle imports as a percent of total U.S. inventory have always been small. From 1981 to 1987, approximately 1% of the cattle slaughtered in the United States were imported from Canada. Since the late 1980s, live cattle imports from Canada have averaged about 3 to 4% of total U.S. slaughter.

Figure 3. U.S. Monthly Live Cattle Imports from Canada



The composition of live cattle imports from Canada to the United States has evolved. Prior to the mid-1980s, almost all U.S. live cattle imports from Canada were feeder cattle. Thereafter, market (slaughter weight) cattle imports began to increase. Currently, most U.S. live cattle imports from Canada are market weight. The United States has excess market cattle slaughter capacity while that in Canada has been insufficient (Brester and Marsh). As trade barriers have decreased, north-south trade has increased and more cattle have been imported from the western Canadian provinces to otherwise underutilized feedlots and packing plants in the western United States (Young and Marsh).

Hogs and Pork. CUSTA had little effect on trade of pork and hogs because there were no tariffs or quotas on pork or live hogs between the United States and Canada before CUSTA. However, tensions because of changes in trade flows have been recurrent. In late 1983, pork producers in the United States expressed concern about an increase in live hog imports from Canada (Higginson, Hawkins, and Adamowicz). In particular, producers claimed Canadian subsidies provided an unfair advantage to Canadian producers and, therefore, contributed to increased imports, decreased domestic prices, and low farm incomes. Initial countervailing duty investigations favored U.S. producers, and countervailing duties were placed on imports of Canadian swine and pork in the early 1990s (Anderson, Mintert, and Brester). Subsequent investigation found that Canadian producers, but not processors, were being subsidized. The duty on pork was thus abolished and that on swine was increased. The need and demand for these duties were eventually eliminated with changes in Canadian farm policy (Anderson, Mintert, and Brester). The United States dropped the countervailing duty on Canadian hogs after Canadian subsidies to producers ended in 1997 (Kelly).

After an initial increase in the early 1980s, Canadian hog exports to the United States averaged 850 thousand animals per year from 1983 to 1994. Annual imports did not vary substantially during this period but began a rather dramatic increase in 1994 (Figure 4). Live hog imports from Canada increased every year from 1994, when they totaled 915 thousand animals, to 1999, when they totaled 4.14 million animals. Canadian hog imports averaged 0.9% of U.S. hogs slaughtered from 1981 to 1994 and 3.1% from 1995 to 1999. Canadian live hog imports comprised 4.1% of the hogs slaughtered in the United States in 1999.

The United States imports both feeder and market hogs from Canada. Live hog import data from Canada segregated into weight classes were not available. Recent publications indicate that the percent of live hogs imported to the United States from Canada as feeder (versus market weight) pigs has increased. Anderson, Mintert, and Brester reported that 31% of Canadian hog exports to the United States in 1997 were feeder pigs fed to market weight in the United States and the remainder were market hogs shipped directly to U.S. packers. Kelly reported that approximately 36% of hog imports from Canada in 1998 weighed less than 110 pounds but half weighed less than 110 pounds in 1999.

The United States is and always has been Canada's largest export market for pork (Kelly). Anderson, Mintert, and Brester estimated that exports to the United States account for 70% of non-processed and 80% of processed pork exports from Canada. [Rice argues that this figure is substantially lower.] The United States imported substantial amounts of pork, up to 8% of its production, just prior to CUSTA (Crawford). However, imports from Canada were in fact slightly lower throughout most of the 1990s than they were in the mid- to late 1980s (Figure 5).

Figure 4. U.S. Monthly Swine Imports from Canada

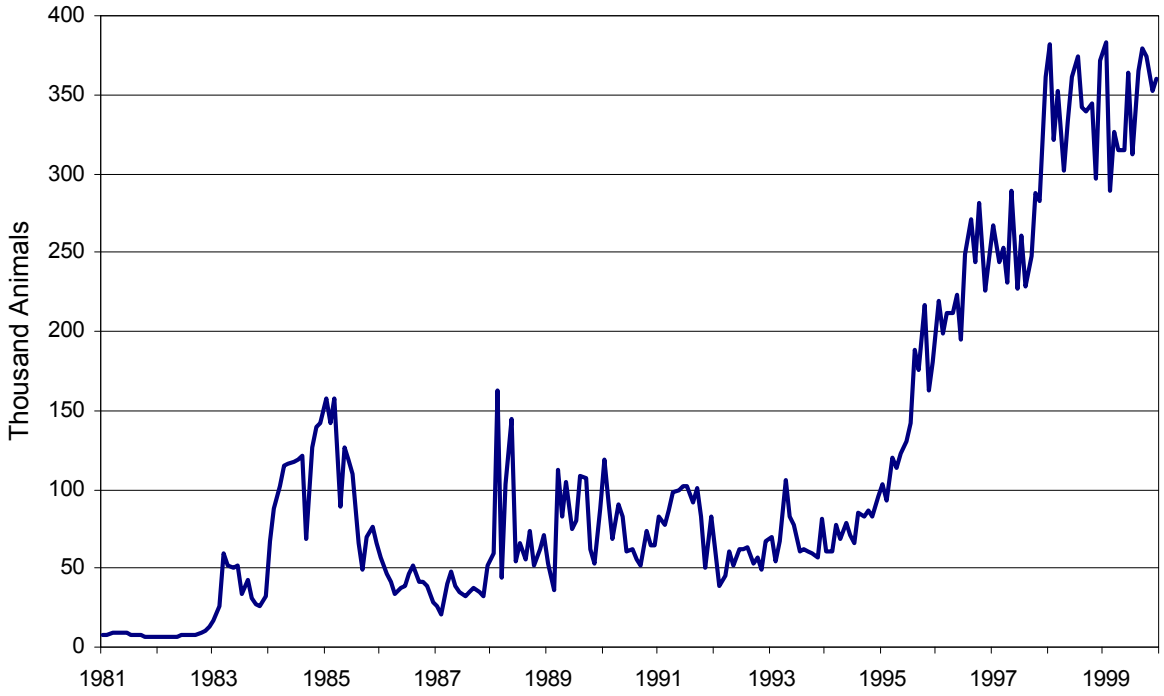
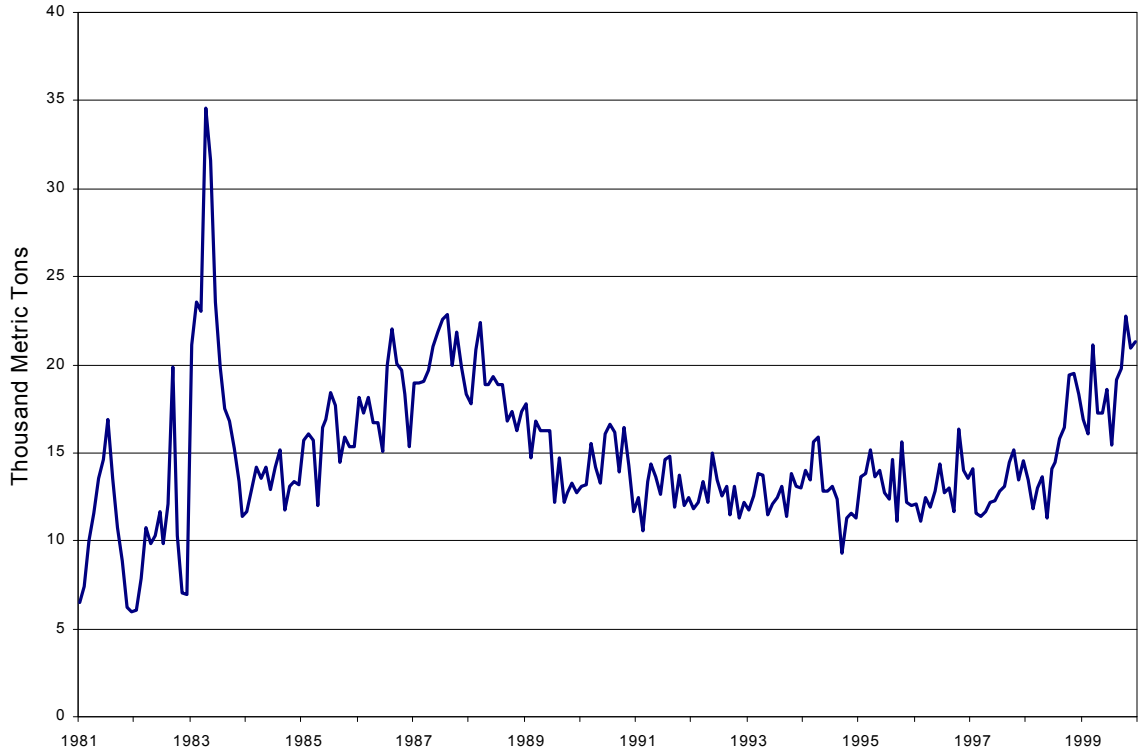


Figure 5. U.S. Monthly Pork Imports from Canada



An increase in Canadian pork exports to the United States during the CUSTA period did not begin until the removal of the countervailing duty that was imposed after the beginning of CUSTA (Crawford). Canadian pork imports averaged only 2.3% of total U.S. pork supply from 1981 to 1999.

Factors Affecting U.S. - Canada Livestock Trade Flows

In general, trade flows of livestock and meat between the United States and Canada are consistent with economic forces (Loyns, Young, and Carter).[2] A number of economic factors have influenced the direction and level of bilateral trade flows of livestock and meat between the United States and Canada under the CUSTA. Included are production levels, the exchange rate, relative prices, trade policies and disputes, domestic policy (e.g., subsidies of livestock or grain production or transport), and changes in domestic infrastructure and its impact on marketable surpluses (Hughes; Brester and Marsh; Marsh 1999).

Canadian Production

The U.S. market for agricultural commodities is substantially larger than its Canadian counterpart. The U.S. beef industry, for example, is approximately ten times larger than Canada's and is less dependent on trade (Young and Marsh). The size and proximity of the United States makes it an attractive export market for Canada. Thus, changes in the level of livestock and meat production in Canada are expected to affect the volume of exports to the United States.

Annual Canadian beef production has continually increased since 1993, increasing the country's reliance on exports (Figure 6). Pork production in Canada has also been slowly increasing since 1993 although production was higher in 1995 than in either 1996 or 1997. The significant jump in Canadian hog exports to the United States from 1983 to 1985 can be, in large

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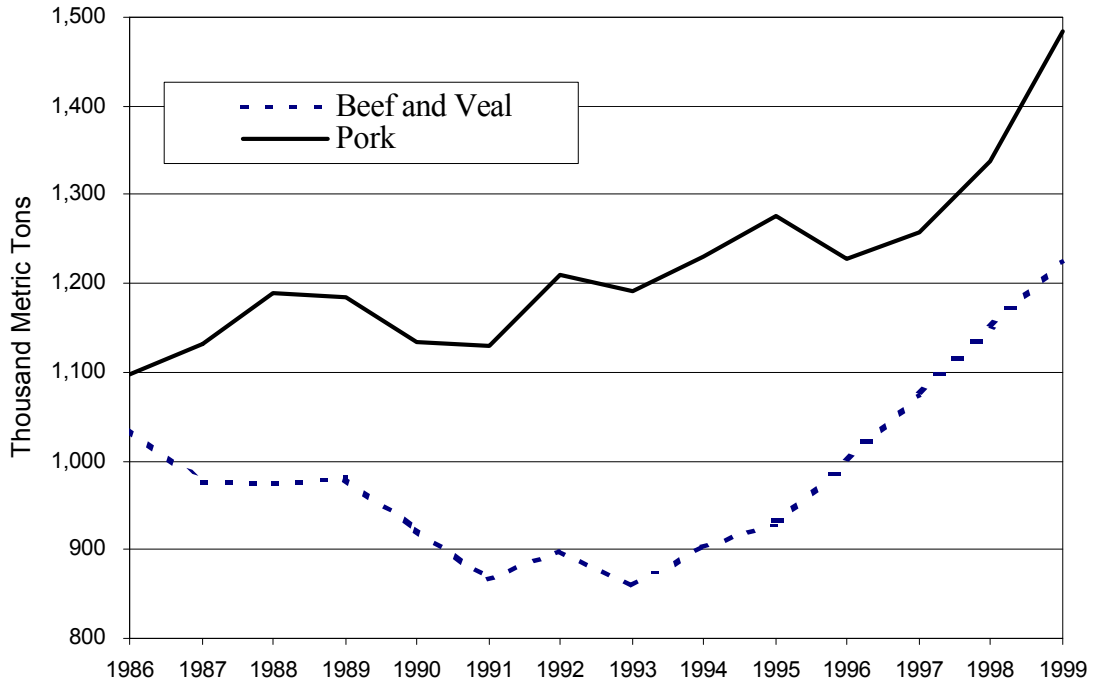
[2] Remaining trade barriers and unresolved issues affecting livestock and meat trade flows between the United States and Canada include differences in grading standards, sanitary and phytosanitary regulations, and country of origin labeling (Hughes). A primary issue for beef is grade equivalency. In 1999, 90% of U.S. beef heifer and steer slaughter was quality graded (up from 67% in 1986) (Hughes). Canada modified their quality grading system in 1992 to include marbling (also used in the U.S. system), and in 1998, the equivalent grade to U.S. prime was added. The resulting beef grading systems in the United States and Canada are similar although some differences still exist (Young and Marsh). Specifically, consideration of maturity, color, muscling, and fat differ. The result of the non-reciprocal grading standards has been an increase in exports of Canadian beef carcasses to the United States (versus box beef) for grading and processing (Anderson, Mintert, and Brester). Researchers predict that unification of grading standards for beef would reduce slaughtering/processing/distribution costs in North America and lead to greater trade flows between the United States and Canada. Beef imports into the United States from western Canada, primarily boxed middle cuts of select and choice beef, would likely increase as would exports of lean beef to eastern Canada (Young and Marsh).

Sanitary and phytosanitary regulations constitute a trade barrier between the United States and Canada because they increase the cost of trading animals and meat between the two countries (Anderson, Mintert, and Brester). For example, U.S. regulations require that cattle imported from Canada, except those imported for slaughter, be tested for brucellosis and tuberculosis. Canada requires tests for amaplasmosis, brucellosis, and tuberculosis. Work on reducing trade barriers is ongoing, although removing non-tariff barriers is a slow process. For example, the Restricted Feeder Cattle Project (previously called the NW Pilot Project) has resulted in reduced sanitary requirements for feeder cattle exports from the United States into Canada (Young).

part, attributed to the increase in Canadian production resulting from Canadian subsidies of, and price supports for, domestic livestock production. As well, into and throughout the 1990s, Canadian slaughter capacity has not kept pace with the increase in livestock production, creating an excess supply of live animals. Increased Canadian hog marketings also corresponded with a dramatic increase in live hog exports to the United States from 1991 to 1997 (Anderson, Mintert, and Brester)[3]. The shortage of slaughter capacity was accentuated when grain transportation subsidies were eliminated under the Western Grain Transportation Act of 1995. Feed availability increased, reducing feed grain prices in the western Canadian Plains. Cattle and hog feeding consequently increased (Anderson, Mintert, and Brester). Existing Canadian packing plants were, in general, old and outdated and not well equipped to accommodate the increase in Canadian production. U.S. plants, on the other hand, had excess capacity, creating a demand for imports. U.S. packing and processing plants with excess capacity rely on imports to reduce average slaughtering costs (Brester and Marsh).

Figure 6. Canadian Beef and Pork Production



[3] Live hog exports also increased noticeably during 1997, likely because of a work stoppage at a major Ontario slaughter plant. Anderson, Mintert, and Brester reported the expectation that this would result in a one-time boost in Canadian exports to the United States. However, the level of exports did not decrease in 1998 or 1999.

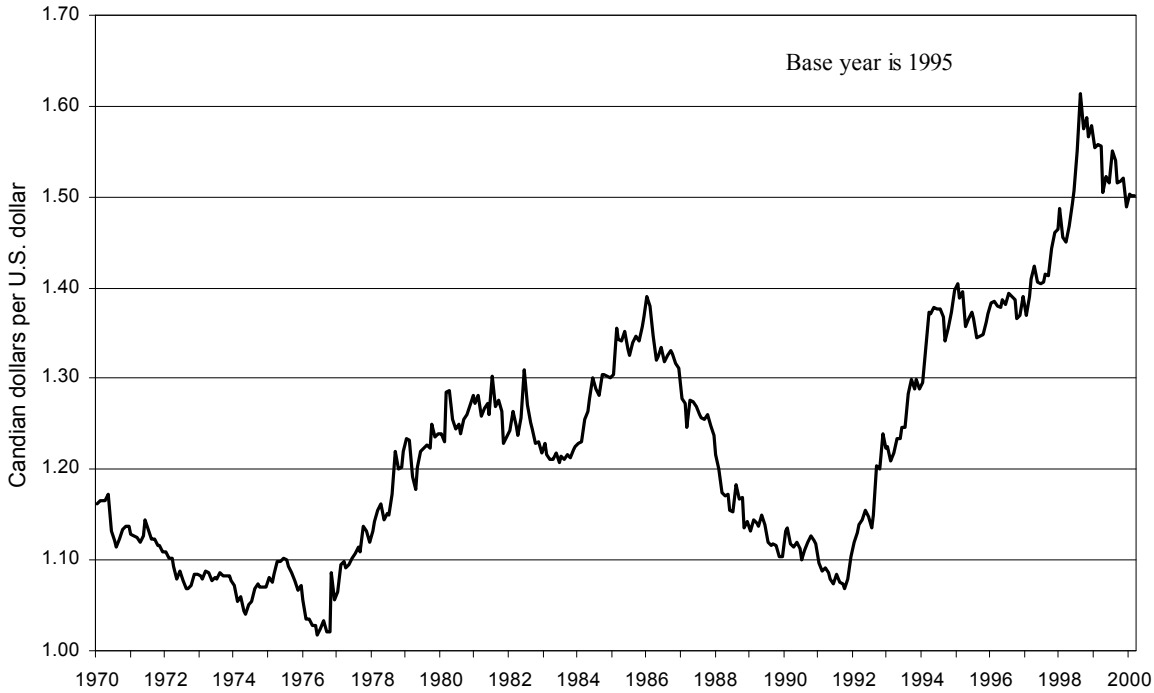
In recent years, Canadian slaughter capacity has started to expand with the addition of new plants (Young and Marsh). Investment clauses in CUSTA and Canada's unilateral change in foreign investment policies have facilitated U.S. investment in, or acquisition of, packing plants in Canada (Hobbs and Kerr). The initial impact of planned increased investment in cattle slaughter facilities in Alberta was an expansion of beef herds as feedlot operators anticipated increased demand for feeder cattle (USDA/FAS). Delays in the start-up of these packing operations were in part responsible for the peak in U.S. cattle imports from Canada in 1997. Other factors included the cattle cycle, short-term margins between Canadian and U.S. cattle prices, and soft beef import demand in Asia. Eventually, Canada's expansion of beef and pork packing could reduce fed cattle and hog exports to the United States unless their domestic production increases relatively more. Increased slaughter capacity and cheaper grains in western Canada may lead to increased demand for feeder cattle in the region reducing Canadian feeder cattle exports to the United States and perhaps increasing U.S. feeder cattle exports to Canada.

Exchange Rate

The exchange rate plays an important role in bilateral trade of agricultural commodities and products (Coleman and Meilke; McClatchy, Cahill, and Surry; Johnson and Janzen). There is some evidence that this is particularly true for livestock and meat trade (McClatchy, Cahill, and Surry). The Canadian dollar has been inconsistently declining in value relative to the U.S. dollar since the mid-1970s (Figure 7). This trend continued from late 1976 to early 1986. Coleman and Meilke suggest that this led to significant increases in Canadian net exports of beef and to small increases in net exports of pork. The Canadian dollar then appreciated from 1986 to November 1991 when 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 relatively stronger than its Canadian counterpart and the Canadian dollar has continued to depreciate relative to the U.S. dollar. Currently, the U.S. dollar is stronger relative to the Canadian dollar than it ever was during the Canadian devaluation during the 1980s. In fact from 1989 to 2000, the relative value of the Canadian dollar has fallen approximately 25%.

Devaluation of the Canadian dollar during the 1990s coincided with the increase in agricultural exports from Canada to the United States under CUSTA. Cattle movements to the United States and growth in the Canadian cattle feeding industry in the early to mid-1990s have been attributed to a considerable weakening of the Canadian dollar (Anderson, Mintert, and Brester).

Figure 7. Canada / United States Real Exchange Rate



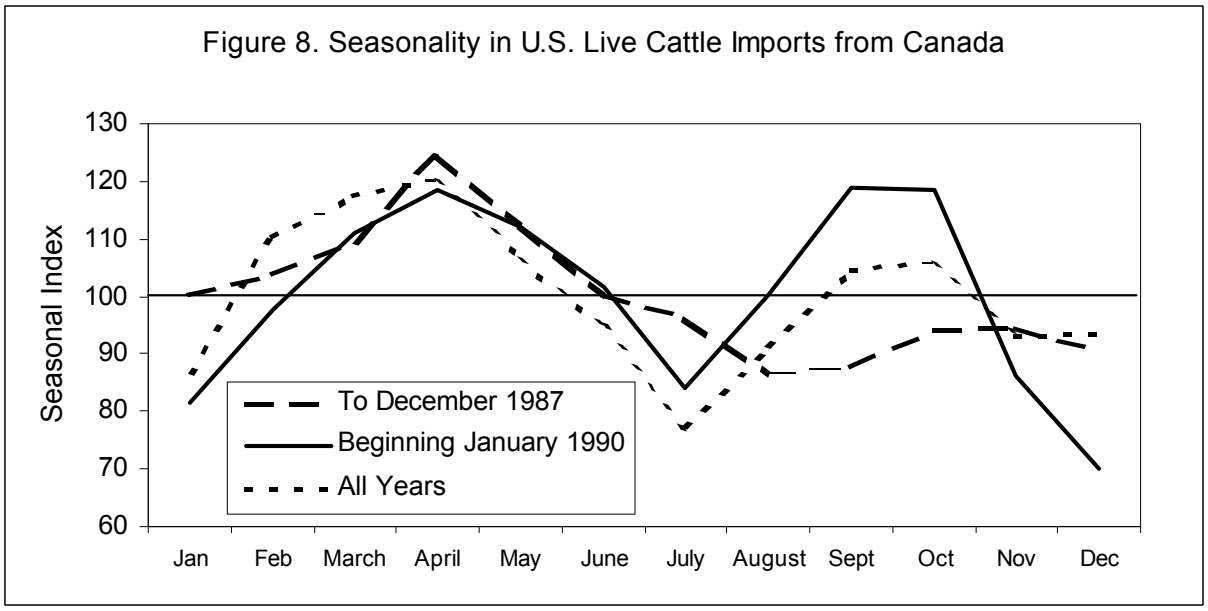
Price Differential Variations

When trade flows are relatively free, variations in the price differential between the markets of trade partners should affect trade flows. Because U.S. prices are, in general, higher than those in Canada, Canadian exports to the United States should increase when the price differential increases. Interdependence between the United States and Canadian livestock and meat markets is reflected in the high correlation between their relative prices. The correlation between monthly market steer prices in the Nebraska and Alberta markets from 1981 to 1999 was 0.94. The correlation between the monthly Iowa/southern Minnesota and Manitoba market hog prices during this period was 0.92. The correlation between U.S. and Canadian pork prices is also significant although not as strong. The correlation between Montreal and central U.S. pork loin prices from 1988 to 1999 was 0.62. While differences between U.S. and Canadian prices do not vary substantially, short-term price differences may influence trade flows.

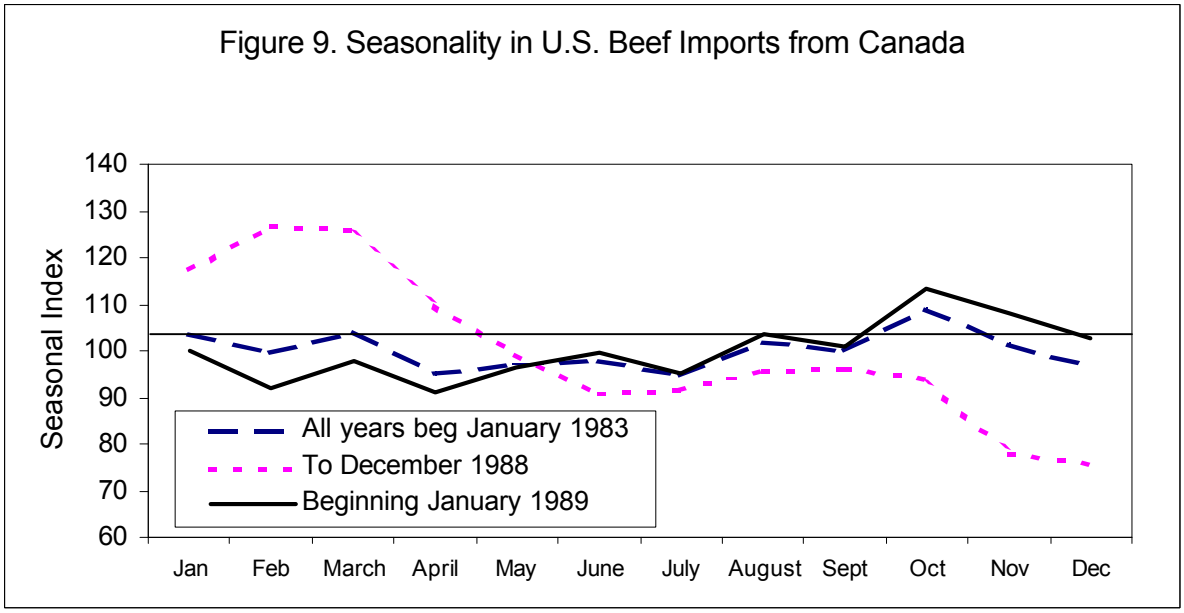
Responsiveness of the Canadian hog export market to changes in the price differential likely increased in the mid-1990s when the marketing boards in Manitoba, Saskatchewan, and Alberta lost their monopoly power over the marketing of live hogs (Anderson, Mintert, and Brester). This may have contributed to the concurrent increase in live hog exports from Canada to the United States. Although U.S. prices have been declining for a number of years, prices in Canada have been lower, encouraging Canadian producers to ship hogs to the United States for slaughter.

Seasonality

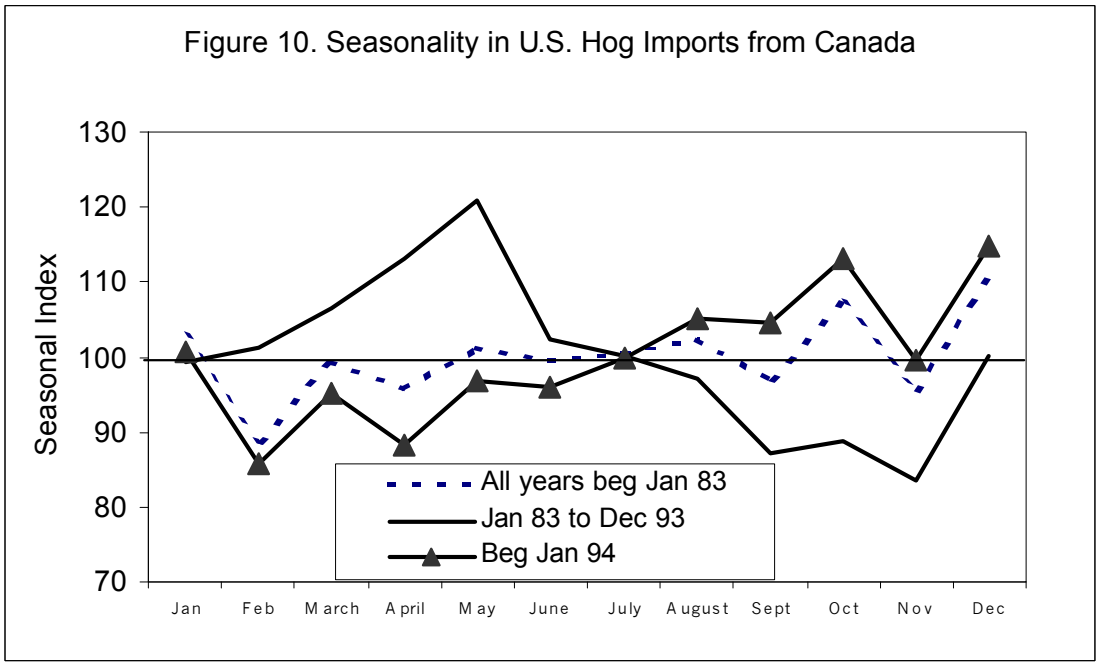
Imports of meat and livestock to the United States from Canada exhibit seasonality. It is most notable in live cattle imports. Over the past two decades, Canadian live cattle exports to the United States have tended to be highest in the spring (particularly in March and April) (Figure 8). During the 1990s, they have also been high in the fall. Considered since 1980, exports have tended to increase from a low in January to a high in April, decrease to a low in July, increase until September and October, and then decrease. Canadian feeders have fewer backgrounding opportunities and thus place calves in feedlots at a lighter weight (Anderson, Mintert, and Brester). The higher volume of live cattle exports during the spring months is consistent with the timing with which these lighter weight cattle reach market weight. The high number of exports in the fall may be when feeder cattle are exported, though most of the imports from Canada are now market cattle.

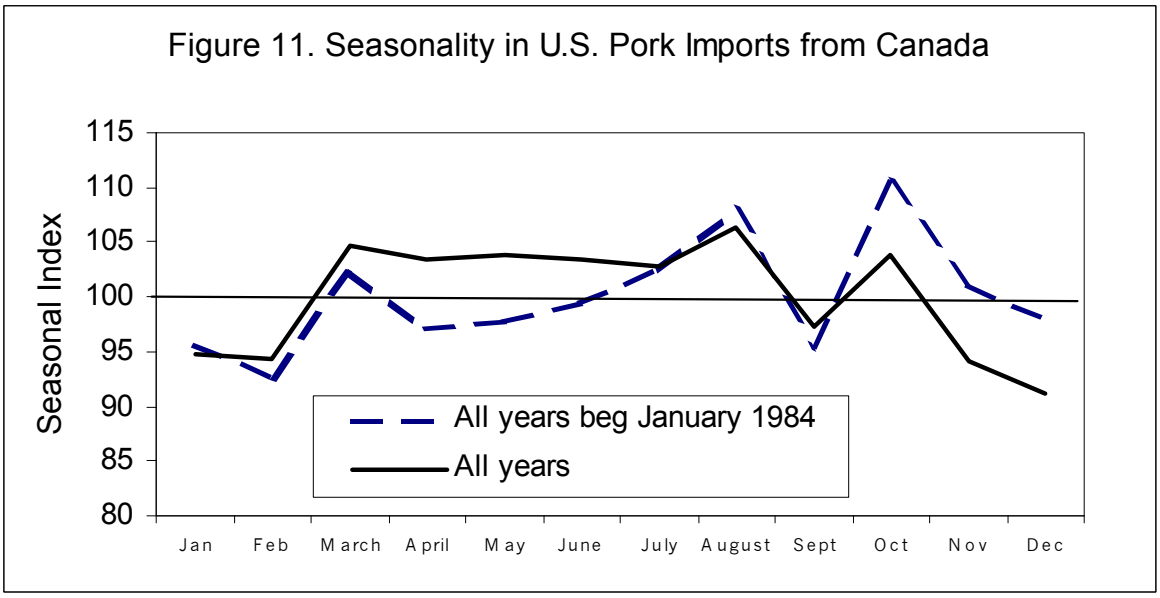


Beef, pork, and hog exports to the United States do not exhibit as much seasonality. Beef imports from Canada exhibited much more seasonality prior to 1989 than thereafter (Figure 9). From 1981 through 1998, beef imports from Canada were high from January through March, decreased until June, and remained fairly constant until November and December when they were seasonally low. Since 1989, there has been little seasonality and beef imports have actually been highest during the fall.



Considered from 1983 to 1999, hog imports did not exhibit much seasonal variation (Figure 10). Seasonality was much greater when Canadian hog exports to the United States were considered from 1983 to 1993. Over this period, exports increased from a low in November to a high in May, and thereafter decreased. More recently, from 1994 to 1999, hog exports have been lower in the spring and higher in the fall months. During this period, Canadian hog exports to the United States increased from a low in February to highs in October and December. Pork imports to the United States from Canada have been lowest in the winter months (December, January, and February) and highest in August and October during the past two decades and, in particular, since 1984 (Figure 11).





Previous Work

There has been substantial attention in the literature to trade flows between the United States and Canada. Mathematical programming and econometric models have commonly been used to estimate and predict trade flows and their effects on domestic prices under a variety of existing and potential economic and legal environments (e.g., see Worley, Baldwin, and Thraen; Boyd, Doroodian, and Abdul-Latif; Mohanty). A majority of the existing literature focuses on grains. For example, Wilson and Johnson and Mao, Koo, and Krause considered trade flows for barley under selected marketing and policy scenarios. Studies by Sumner, Alston, and Gray; USDA/FAS; U.S. International Trade Commission; and Koo considered the price effects of Canadian wheat exports. Each concluded that increased Canadian wheat exports to the United States have reduced U.S. wheat prices. Koo found that barley prices have also been affected. These and other studies, however, disagree on the magnitude of the effect. In fact, Mohanty concluded that increased imports from Canada have not significantly decreased U.S. wheat prices.

A number of studies have focused specifically on livestock and red meat trade and the influence of such on domestic prices. Brester, Marsh, and Smith estimated U.S. import demand for Canadian live cattle as a function of the prices of Canadian live cattle, U.S. boxed beef at the retail level, by-products, and of lagged U.S. market cattle marketings and dummy variables representing U.S. trade restrictions on Canadian live cattle imports and seasonality. Their findings were consistent with those predicted by economic theory. On the supply side, increased Canadian market cattle prices, lagged U.S. fed cattle marketings, and the tariff reduced U.S. imports from Canada. On the demand side, increased prices for U.S. boxed beef increased imports. Their estimates predicted that the effect of a potential tariff on live cattle imported from Canada would be small but would significantly decrease Canadian feeder and market cattle prices because Canada exports a significant percentage of its live cattle production to the United States.

Brester and Marsh considered the effect of increased Canadian live cattle and beef exports to the United States on U.S. market cattle price. They attributed only $0.35 of the $8/cwt decline in U.S. market price during the 1990s (about 4.4% of the decline) to increased imports from Canada. The remainder was attributed primarily to increases in dressed weights, cattle slaughter, pork and poultry production, and decreases in consumer beef expenditures. The cattle market received support from increased beef exports, reduced marketing costs, and relatively strong by-product values.

Marsh (1997) found that U.S. market steer prices were directly affected by imports of Canadian market cattle and indirectly affected by meat imports at the wholesale level. Included in his estimation were U.S. cattle slaughter, cattle imports from Canada and Mexico, dressed weights of beef, U.S. beef imports, pork and poultry production, channel marketing costs, by-product values, beef exports, and consumer spending on red meat. These factors explained most of the variability in market cattle prices ($R^2 = .96$). Brester applied the same model to the 1989 to 1997 period. He found that the impact of net imports from Canada on U.S. market cattle prices was minimal but noted that short-term anomalies may affect individual sellers in specific markets at specific times.

Marsh (1999) estimated that the increase in net exports of beef and live cattle from Canada from 1990 to 1998 resulted in a $2.55/cwt reduction in U.S. market cattle price; $3.40/cwt from 1985 to 1998. Although he did not find the United States had experienced price gains in net trade with Canada, he did attribute positive benefits from trade with other countries such as Japan and Mexico and from trade overall. He argued that because the U.S. - Canadian beef market is highly integrated, any increase in our trade deficit with Canada would have little impact on U.S. market prices.[4] However, he also noted that the viewpoints of market participants depend on their location and place in the marketing channel and net income experienced by the sector.

Hayes, Hayenga, and Melton considered the potential effect of equivalency of beef grades on trade flows between, and prices in, the U.S. and Canadian beef markets. The importance of the market participant's location and place in the marketing channel was again emphasized. Hayes, Hayenga, and Melton concluded that equivalency of beef grades would result in increased flow of beef from western Canada to the United States and from the United States to eastern Canada. Thus, price effects would differ by geographic location. They concurred with Brester, Marsh, and Smith that the effect on Canadian prices would be greater because of the relatively larger importance of the U.S. market. They predicted that costs for the packing industry would decrease because the slaughtering, fabricating, and marketing of beef would move the most economical locations. This supports Worley, Baldwin, and Thraen who found that the effects of CUSTA on the red meat and grain industries would benefit consumers in both the United States and Canada at the expense of producers.

Higginson, Hawkins, and Adamowicz considered the impact of Canadian swine exports into U.S. markets from 1982-1985 on U.S. prices and assessed the impact of the countervailing

[4] Young argues that, in general, U.S. cattle producers and their commodity organizations do not perceive the U.S. and Canadian markets as one.

duty on pricing efficiency in Canadian hog markets. They concluded that Canadian swine exports into U.S. markets did not have an effect on U.S. prices.

Empirical Model

An econometric model was developed to estimate the effects of different factors on the flow of Canadian livestock and meat exports to the United States and to determine the effect of Canadian exports on U.S. prices. An export supply equation and a price equation were specified and simultaneously solved for live cattle, beef, live hogs, and pork.

Export Supply Equation

Canadian exports to the United States was specified as a function of the Canada/U.S. exchange rate, relative prices, Canadian production or inventory levels, and CUSTA. The model for each commodity varies slightly. Each model includes dummy variables to capture effects uniquely affecting U.S. imports of that commodity from Canada.[5] Models also differ as necessitated by data availability. Each model is based on Equation 1.

(1) $EX_{it} = f(ER_t, PDIFF_{it}, CPROD_{it}, CUSTA_t, D)$

where EX_{it} = exports of good i in time t from Canada to the United States
ER_t = Canada/U.S. exchange rate in time t
$PDIFF_{it}$ = difference between the United States and Canadian price of good i in time t
$CPROD_{it}$ = Canadian production of good i in time t
$CUSTA_t$ = dummy variable for the CUSTA agreement (beginning January 1989)
D = Seasonal and other dummy variables specific to each commodity

Economic theory predicts that Canadian exports to the United States will increase when the U.S. dollar strengthens relative to the Canadian dollar. As the U.S. dollar gains strength, U.S. exports become more expensive in the Canadian market and Canadian exports become less expensive in the U.S. market. A positive coefficient is therefore expected on the exchange rate variable (U.S. dollars/Canadian dollars).

Canadian exports to the United States are expected to increase when the U.S. price for the commodity increases relative to the Canadian price. It has been frequently argued that livestock and red meat prices are determined in the U.S. market with Canadian prices reflecting adjustments for the exchange rate and cost of transportation. Young and Marsh, for example, demonstrated that U.S. and Canadian prices for beef and cattle move together and have the same turning points. However, it is expected that exports from Canada will be influenced by short-term (i.e., monthly) changes in the price differentials between the two markets. The differential

[5] This model includes dummy variables to represent seasonality. Brester, Marsh, and Smith used quarterly dummy variables to represent existing seasonality in live cattle. However, in this model, quarterly seasonal dummy variables did not well represent existing seasonality in live cattle, beef, live hogs, or pork imports and prices for the time period considered. Seasonal dummy variables included, therefore, more specifically reflect import and price seasonality.

between U.S. and Canadian prices was used in the live cattle and hog models.[6] Market steer price in Nebraska, less market steer price in Alberta (in U.S. dollars) represented the price differential in the live cattle model. A positive coefficient is expected on this variable. The market hog price in Manitoba (U.S. dollars), less that reported for Iowa/southern Minnesota, was used in the live hog model. Canadian hog prices were, in general, higher than their U.S. counterparts. Thus, a negative coefficient is expected on this variable. Monthly data for Canadian beef and pork prices for the period under consideration were not available, although Canadian beef and pork price index data were available. The Montreal wholesale beef price for May 2000, comprised of an unweighted average of four weekly reported prices, was used to convert the index to a time series of monthly price data for 1981 to 2000. The U.S. wholesale beef price minus Canadian beef price (in U.S. dollars) represented the price differential in the beef model. A positive coefficient is expected. Canadian pork price time series prices could not be determined because price data represented by the Canadian pork price index was not available for any time period. The U.S. pork price was converted to an index analogous to the Canadian pork price index (1992 = 100). A ratio of the U.S. pork price index to the Canadian pork price index was used in the pork model to reflect relative price movements in the U.S. and Canadian pork markets.[7] A positive coefficient is expected.

Imports from Canada are expected to increase with increases in Canadian production. Canadian beef production is used in the beef model. Because of data limitations, Canadian swine slaughter is used in the pork model to represent Canadian pork production. Canadian hog inventory is used in the hog model. Canadian cattle inventory is not used in the cattle model.

CUSTA is expected to have a positive effect on Canadian beef and live cattle exports to the United States because its implementation reduced existing trade barriers. The effect of CUSTA is measured using a dummy variable. CUSTA was initially implemented in 1989. In the beef model, a trend variable is multiplied with the CUSTA dummy because beef imports from Canada have trended upwards during the 1990s. The CUSTA dummy is not included in the live hog and pork models because the free trade agreement did not substantially change trade policies for these commodities. In the live hog model, a trend variable is multiplied with a dummy variable representing the period beginning in January 1994 to reflect changes influencing Canadian hog exports occurring in the mid- and late 1990s such as the elimination of the U.S.

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[6] During the 1981 to 1999 period, the Alberta market steer price was higher than the Nebraska price only during the first three months of 1981. The negative price differential in these three months ranged from $1.08 to 3.88/cwt. A negative number could not be used because the double log form was selected for estimation (the log of a non-positive number cannot be calculated). During these three months, a price differential of 0.01 was used (the negative numbers were converted to 0.01 prior to model estimation). U.S. beef prices were always higher than Canadian beef prices. Canadian hog prices were higher than the U.S. price in all but the last six months of 1999. The price difference for hogs was calculated as Canadian price minus U.S. price. The negative price differential in the last six months ranged from $1.48 to 5.12/cwt. A value of 0.01 was used during these months.

[7] The model was initially specified using the U.S. pork price. The U.S. pork price was estimated to have a positive and significant effect on Canadian exports to the United States ($p = .0001$). Evidence supported the positive sign of the coefficient as due to the U.S. price increasing more or decreasing less than the Canadian price. Specifically, monthly pork prices in Montreal were obtained for 1988 to 1999. The U.S. pork price was estimated as a function of the ratio of the U.S. price to the Montreal price. The sign on the price ratio was positive which suggests that when the U.S. price increases, the price differential widens (U.S. prices increase relatively more). When the U.S. price decreases, the price differential narrows (U.S. prices decrease relatively less).

countervailing duty on hogs, aging Canadian packing plants, and the loss of the provincial hog marketing boards' monopoly power over hog marketing. These changes are expected to have a positive effect on Canadian exports. An additional dummy variable is included in the hog model for the period prior to 1983. This coefficient for this variable is expected to be negative. Hog imports from Canada were nearly non-existent prior to 1983, but increased in 1983 due to the Canadian government's increased support of their hog industry.

An additional dummy variable is included in the live cattle model to account for high Canadian exports to the United States during a few months in 1988 and 1989, likely the result of drought which reduced feed availability in Canada. It represents the months of February through May of 1988, December though April of 1988 and 1989, and November and December of 1989. The coefficient on this dummy variable is expected to be positive.

Seasonal dummy variables are included in each model. In the live cattle import equation model, one dummy variable was used for the months of February through April when imports from Canada were seasonally high, and a second dummy variable is used for July when Canadian exports were seasonally low. A dummy variable was used in the beef model for January through March when imports from Canada were seasonally high. Another dummy variable was used for the months of November and December when imports from Canada were seasonally low. The seasonal dummy variables in the beef model are only used for months prior to January 1989 because seasonality diminished significantly thereafter. A seasonal dummy variable was used in the hog model for April and May when imports from Canada were high, and another for September through November when imports from Canada were low. These two variables were used only for 1983-1993 when seasonality was stronger and counter to that exhibited beginning in 1994. In the pork model, a dummy variable was used for January and February when imports from Canada were seasonally low and another for August and October when imports from Canada were high. The seasonal dummy variables were used for the period beginning in January 1984.

Price Equation

A price equation was simultaneously estimated. Economic theory dictates that price is a function of supply and demand. Under true pricing efficiency, prices are determined at the retail level and are transmitted up the supply chain. Demand factors such as disposable income, market conditions for competing meats, and consumer tastes and preferences should influence price. However, in the short to intermediate run, the time period over which slaughtering and processing capacity are quasi-fixed, meat, and especially livestock, prices are determined in large part by supply. Assuming that domestic demand is constant, the domestic price is a function of total supply (Equation 2).

(2) $P_{it} = f(TS_{it})$

where TS_{it} = total supply of good i in time t.

In Equation 3 total supply is delineated into domestic production (including non-Canadian imports) and Canadian imports.

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

where EX_{it} = exports of good i in time t from Canada to the United States
S_{it}^{d} = U.S. domestic supply of good i in time t.

Increased U.S. production and imports from Canada should reduce U.S. price. Plots depicting quarterly U.S. beef production and fed cattle prices (Figure 12) and pork production and fed hog prices (Figure 13) demonstrate this relationship for the U.S. beef and pork industries. A portion of live hog and cattle imports from Canada include feeder pigs and feeder cattle, respectively, animals that are not ready for slaughter. The effect of Canadian exports of these animals on the domestic market livestock price was lagged to represent the feeding period. Variables representing Canadian exports of feeder animals are included in the live cattle (exports lagged six months) and live hog (exports lagged four months) models.

Figure 12. US. Beef Production and Cattle Price

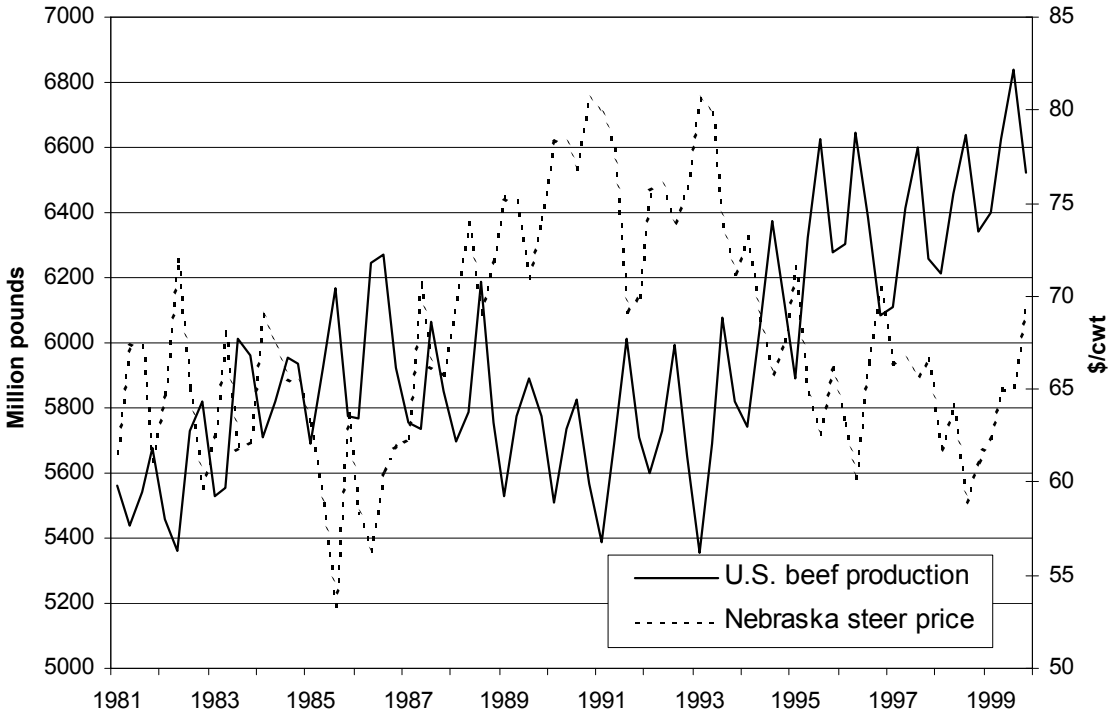
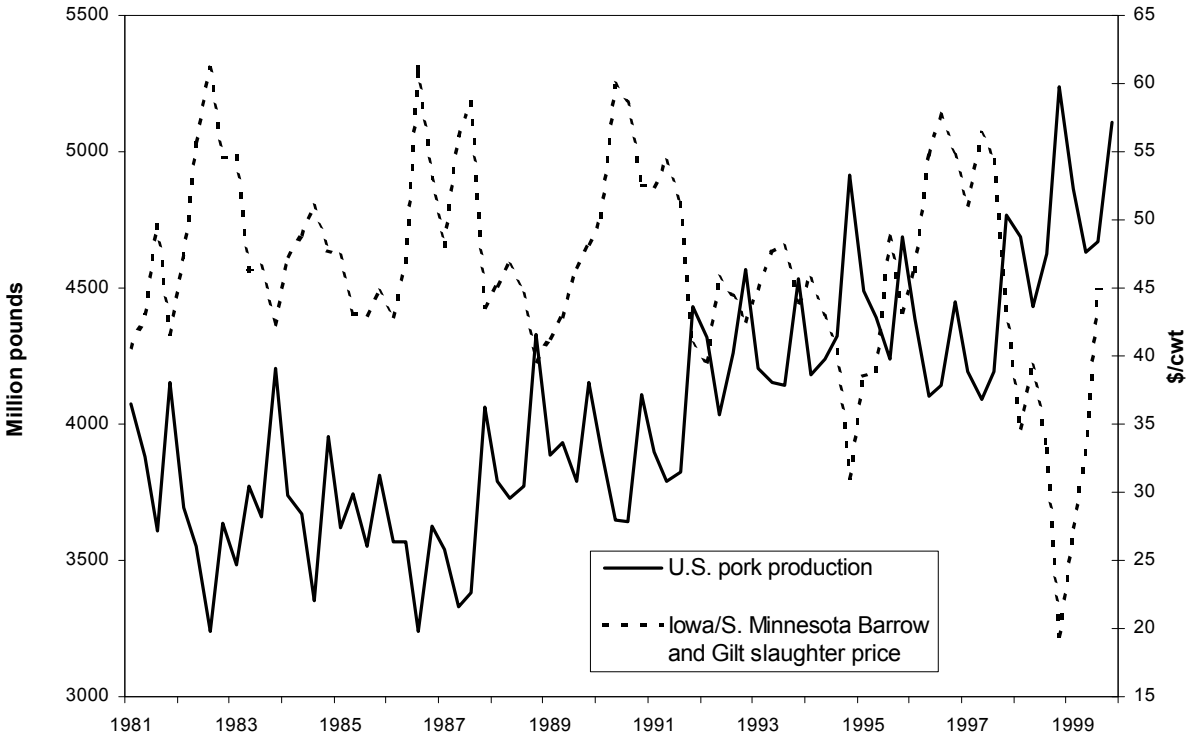


Figure 13. U.S. Pork Production and Hog Price



U.S. production is specified as total cattle slaughter in the live cattle model and total hog slaughter in the live hog model (number of animals). Brester and Marsh point out that USDA slaughter numbers include live animals imported from Canada and other countries and slaughtered in the United States. Therefore, live animals imported for slaughter in the United States must be subtracted to obtain actual U.S. production. In this study, the objective was to identify only the impact of Canadian imports on U.S. prices. The effect of imports from other sources is not considered, but rather they are included in the variable representing U.S. production. The number of animals imported from Canada were subtracted from the total number of animals slaughtered in the United States to obtain domestic production less imports from Canada. [Recognizing that some portion of domestic production was in fact imported from countries other than Canada for slaughter.] The adjustment was made assuming all cattle imports from Canada were fed cattle and slaughter occurred in the current time period. It was assumed that two-thirds of the hog imports from Canada were slaughtered immediately and the remainder were slaughtered four months later. Although these assumptions are estimates, their specification had little effect on the results. In the beef and pork models, beginning stocks and imports from countries other than Canada are added to U.S. production to obtain total supply less imports from Canada (pounds).

Seasonal dummy variables are included in the live cattle and beef models. In the live cattle model, a dummy variable is used for the spring months of March through May, when prices were seasonally high (Figure 14). A dummy variable was used in the beef model to represent the months of April through June when prices were also seasonally high (Figure 15). The coefficient on both seasonal price dummy variables is expected to have a positive sign.

The beef price is included in the pork price model and the pork price is included in the beef price model. If, as demonstrated by others, the goods are substitutes, positive coefficients are expected (e.g., see Henley and Henneberry; Seleka and Henneberry).

Data

Monthly data are used in the analysis, except in a few cases where only quarterly or annual data were available. Data are used for 1981-1999 in each model. Monthly data for exports from Canada to the United States were obtained from Statistics Canada. Data for the real exchange rate were obtained from the USDA, Economic Research Service. The real exchange rate 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.

U.S. and Canadian live animal and meat prices used in the model were chosen, in part, to reflect data availability. The live cattle model uses the Nebraska direct 1,100 - 1,300 lb. choice, yield grades 2 - 4 market cattle price. The beef model uses the U.S choice yield grade 3 beef wholesale value. The live hog model uses the Iowa/southern Minnesota 230 - 250 lb., yield grades 1 - 3 price for barrows and gilts. The pork model uses the U.S. wholesale pork value. Monthly price data were obtained from the *Red Meat Yearbook* published by the USDA, Economic Research Service. Prices were adjusted for inflation using the *Beef and Veal Consumer Price Index* and the *Pork Consumer Price Index* obtained from the *Red Meat Yearbook*. To calculate price differences between the United States and Canada, the Alberta direct sales market steer price and the market hog price in Manitoba were used. Monthly Canadian steer and hog prices were obtained from Statistics Canada. Canadian monthly pork and beef price index data were obtained from Statistics Canada. Wholesale beef prices in Montreal for May 2000 were obtained from Alberta Agriculture, Food and Rural Development.

U.S. monthly cattle and hog slaughter data measured as the number of animals slaughtered and beef and pork production measured in pounds were obtained from the *Red Meat Yearbook*. Beginning stocks and total import data were also obtained from the *Red Meat Yearbook*, these data are quarterly. Annual Canadian beef production was obtained from Statistics Canada, and monthly Canadian hog slaughter was obtained from Agriculture and Agri-Food Canada. Because monthly hog slaughter varies significantly from month to month, a three-month moving average was used in the analysis. Quarterly Canadian hog inventory numbers were obtained from Statistics Canada.

Figure 14. Seasonality in U.S. Live Cattle Market Prices
1980 to 1999

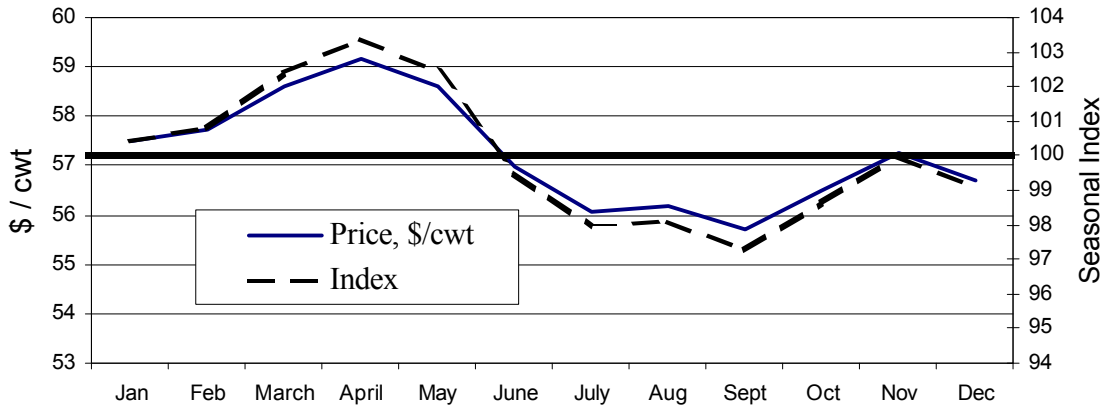
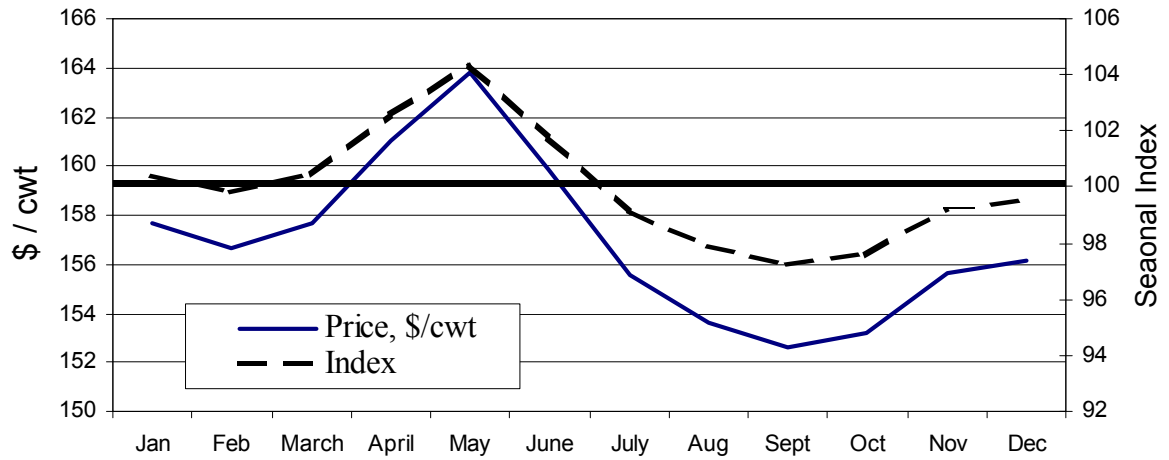


Figure 15. Seasonality in U.S. Wholesale Beef Prices
1980 to 1988



Estimation Procedures

The PE test was conducted to determine the correct functional form for the estimation. The test was used to determine if the linear or the double-log form was correct. The results of this test, however, did not clearly specify a preferred form. The double-log form was used. It imposes the assumption that the elasticities are constant over time.

The two equations in each model were estimated simultaneously. Structural coefficients of the two equations in the system were estimated 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).

Results

Estimated Export Supply Equations

The estimated models are presented in Tables 1 to 4. Because the estimated models are double log models, the estimated coefficients are elasticities. The system-weighted R^2s are 0.736 for cattle, 0.831 for beef, 0.881 for hogs, and 0.708 for pork. The R^2s indicate the estimated models are a good fit. All coefficients in each model that are statistically significant carry signs consistent with economic theory.

The results suggest that CUSTA has positively influenced the flow of beef and live cattle from Canada to the United States. The dummy variable representing the period since CUSTA was first implemented is positive and significant in the live cattle model (á = .0001). A 1.03% increase in live cattle imports is attributed to CUSTA. The CUSTA dummy multiplied with the trend variable is positive and significant in the beef model (á = .0001) and indicates that imports from Canada have been trending upwards 0.34% annually since the inception of CUSTA after accounting for the influence of other factors. The coefficient on the dummy variable in the live hog model for the period beginning January 1994 multiplied with a trend variable is positive, indicating that hog imports from Canada have been trending upwards 0.095% annually since 1994 after accounting for the influence of other factors (á = .0191). The free trade agreement has not significantly affected Canadian exports of pork to the United States.

The real exchange rate is shown to affect Canadian exports to the United States. As expected, Canada increases exports to the United States as the U.S. dollar appreciates relative to the Canadian dollar. The relative increase in value of the U.S. dollar is an important factor explaining the recent increase in agricultural imports from Canada, especially for beef. Results indicate that Canadian beef exports to the United States increase by 3.7% ($\alpha = .0001$), cattle exports increase by 1.0% ($\alpha = .0001$), and hog exports increase by 0.6% ($\alpha = .0883$) when the real exchange rate increases by 1%. The coefficient is negative in the pork model but is small in magnitude and not significant.

Table 1. Estimated Model for Live Cattle

Variables	Coefficient (p value)
EXPORT EQUATION	
Intercept	9.747 (0.0001)
Price difference = U.S. market steer price (USDA choice yield grade 2-4, Nebraska direct 1,100 to 1,300 lb.) minus Alberta direct sales market steer price (U.S. $/lb.)	0.174 (0.0001)
Real Exchange Rate Ratio (U.S.$/Canada $)	1.036 (0.0001)
CUSTA, beginning January 1989	1.032 (0.0001)
D1, dummy variable representing the months of February through May, 1988, December through April of 1988 and 1989, and November and December of 1989	1.015 (0.0001)
D2, dummy variable representing seasonality in February to April	0.150 (0.0026)
D3, dummy variable representing seasonality in July	- 0.150 (0.0423)
PRICE EQUATION	
Intercept	9.057 (0.0001)
U.S. Production, total cattle slaughter less Canadian imports for U.S. slaughter	- 0.518 (0.0001)
Imports from Canada	- 0.092 (0.0001)
Imports from Canada lagged 6 months	- 0.085 (0.0001)
D1, dummy variable representing seasonality in March to May	0.035 (0.0214)

System Weighted $R^2 = 0.736$. Canadian live cattle production data were not available for the 1981 to 1999 period.

Table 2. Estimated Model for Beef

Variables	Coefficient (p value)
EXPORT EQUATION	
Intercept	11.843 (0.0023)
Price difference = U.S. wholesale beef price less Canadian beef price, Montreal	- 0.236 (0.1428)
Real Exchange Rate Ratio (U.S.$/Canada $)	3.719 (0.0001)
Canadian Production (metric tons)	- 0.828 (0.4084)
CUSTA trend, beginning January 1989	0.343 (0.0001)
D1, dummy variable representing January through March in years prior to 1989	1.201 (0.0115)
D2, dummy variable representing November and December prior to 1989	- 0.398 (0.0001)
PRICE EQUATION	
Intercept	4.670 (0.0001)
U.S. Beef Supply less Canadian imports	- 0.456 (0.0001)
Imports from Canada	- 0.082 (0.0001)
Pork Price	0 .256 (0.0001)
D1, dummy variable representing seasonality in April to June	0.024 (0.0106)

System Weighted $R^2 = 0.831$

Table 3. Estimated Model for Live Hogs

Variables	Coefficient (p value)
EXPORT EQUATION	
Intercept	59.305 (0.0001)
Price difference = Manitoba market hog price (U.S. $/lb.) minus U.S. market hog price (U.S. #1 and 2, 230 to 250 lb., Iowa/southern Minnesota)	- 0.006 (0.7745)
Real Exchange Rate Ratio (U.S.$/Canada $)	0.634 (0.0883)
Canadian Hog Inventory	7.593 (0.0001)
D1, dummy variable representing months prior to 1983	- 1.635 (0.0001)
D2, dummy variable representing months beginning January 1994 multiplied by trend	0.095 (0.0191)
D3, dummy variable representing seasonality in April and May (1983 to 1993)	0.220 (0.0076)
D4, dummy variable representing seasonality in September through November (1983 to 1993)	- 0.266 (0.0006)
PRICE EQUATION	
Intercept	20.296 (0.0001)
U.S. Production, total hog slaughter less Canadian imports for U.S. slaughter	- 1.229 (0.0001)
Imports from Canada	- 0.053 (0.0291)
Imports from Canada lagged 4 months	- 0.112 (0.0001)

System Weighted $R^2 = 0.881$

Table 4. Estimated Model for Pork

Variables	Coefficient (p value)
EXPORT EQUATION	
Intercept	- 9.174 (0.0221)
Price Index Ratio, U.S. price index/Canadian price index	0.241 (0.0473)
Real Exchange Rate Ratio (U.S.$/Canada $)	- 0.279 (0.2068)
Canadian Hog Slaughter	1.343 (0.0001)
D1, dummy variable representing seasonality, January and February	0.036 (0.4461)
D2, dummy variable representing seasonality, August and October	0.078 (0.1009)
PRICE EQUATION	
Intercept	9.388 (0.0001)
U.S. Pork Supply less Canadian imports	- 0.925 (0.0001)
Imports from Canada	- 0.285 (0.0001)
Beef Price	0.542 (0.0001)

System Weighted $R^2 = 0.708$

The price difference between U.S. and Canadian market cattle has had a significant influence on live cattle exports from Canada to the United States (á = .0001). When the U.S. price advantage increases 1%, Canadian live cattle exports to the United States increase 0.17%. The U.S./Canadian pork price index ratio is significant (α = .0473) and positive, in the pork equation, as expected. When the U.S./Canadian pork price index ratio increases 1%, Canadian exports to the United States increase 0.24%. The price difference was not found to have a significant effect on beef or live hog imports from Canada.

Canadian inventory and production influence the level of Canadian hog and pork exports to the United States. Canadian hog slaughter has a positive and significant effect on pork imports from Canada (α = .0001). The estimation shows that Canada increases pork exports to the United States 1.3% when Canadian hog slaughter increases 1%. Canadian hog inventory has a positive and significant effect on live hog exports to the United States (α = .0001). Results indicate that Canadian hog exports to the United States increase by 7.6% when inventory increases by 1%. [Although in the expected direction, the magnitude of influence was surprisingly large.] Canadian beef production did not significantly affect beef exports to the United States. Live cattle inventory numbers were not available for Canada.

The dummy variable in the live cattle model for the months affected by drought is positive and significant, as expected (α = .0001). Canadian exports in these months were 1.02% higher accounting for all other influencing factors. The dummy variable in the hog model for 1981 and 1982 is negative and significant, as expected (α = .0001). Canadian live hog exports to the United States were 1.6% lower in 1981 and 1982 than thereafter. The seasonal dummy variables are significant in the cattle, beef, and hog model (α < .05) and insignificant in the pork model. All of the seasonal dummy variables that were found significant have the expected signs.

Estimated Price Equations

Results from the simultaneously solved price equation for each commodity show effects of Canadian exports on U.S. domestic prices. The positive coefficients on pork price in the beef model (α = .0001) and beef price in the pork model (α = .0001) also support expected substitutability between the two red meats.

Canadian exports have negatively and significantly affected U.S. prices, although in general the effects have been small in magnitude. The estimated coefficients of the Canadian export variable represent price flexibility coefficients associated with Canadian exports (Table 5). They represent the estimated percentage changes in U.S. prices resulting from a 1% increase in Canadian exports. The coefficient for live cattle is -0.092, indicating that a 1% increase in Canadian exports of live cattle to the United States results in a -0.092% decrease in the U.S. market cattle price (á = .0001). The price flexibility coefficient for live cattle imports lagged six months is -0.085 (á = .0001). A 1% increase in cattle imports from Canada causes a 0.085% decrease in the U.S. market cattle price six months later. The price flexibility coefficient for beef is -0.082 (á = .0001). The coefficient is -0.053 for live hog imports (α = .0291) and is -0.112 for live hog imports lagged four months (α = .0001). A 1% increase in hog imports from Canada results in a .053% decrease in the price of U.S. market hogs in the current period and a 0.112% decrease in the market price for hogs four months later. The price flexibility coefficient

for Canadian pork exports is highest at -0.285 ($\alpha = .0001$). The U.S. pork price decreases by 0.285% when Canadian pork exports to the United States increase by 1%.

Table 5. Effect of Canadian Exports on U.S. Livestock and Meat Prices

	Beef	Live Cattle	Pork	Live Hogs
Price Flexibility Coefficient	- 0.082	- 0.092	- 0.285	- 0.072
Percentage Price Changes				
1989 to 1990	- 0.7	3.7	0.3	0.6
1990 to 1991	- 0.6	- 0.3	2.9	- 1.4
1991 to 1992	- 4.0	- 2.7	0.9	2.6
1992 to 1993	- 2.0	0.8	- 0.1	- 1.8
1993 to 1994	- 1.2	1.0	- 0.2	- 0.7
1994 to 1995	0.0	- 1.5	- 1.4	- 6.6
1995 to 1996	- 2.6	- 2.5	0.9	- 4.3
1996 to 1997	- 1.5	0.8	- 0.1	- 1.0
1997 to 1998	- 0.8	0.5	- 4.5	- 2.1
1998 to 1999	- 1.2	2.3	- 7.1	0.0
Average	- 1.5	0.2	- 0.8	- 1.5

These price flexibility coefficients are significantly different than zero, indicating that Canadian exports do have an impact on U.S. prices. The impact in most cases, though, is not large in magnitude as indicated by the small values of the price flexibility coefficients. This result may be because Canadian exports to the United States are small compared to the level of U.S. consumption. The price flexibility coefficients for U.S. production and supply are greater than those for imports from Canada, indicating that analogous percentage changes in U.S. production have a much greater impact on prices than imports. This is expected because of the much larger volume associated with a 1% change in U.S. production relative to a 1% change in U.S. imports from Canada. The price flexibility coefficients for U.S. production and supply are -0.518 for cattle, -0.456 for beef, -1.229 for hogs, and -0.925 for pork.

Actual price reductions for beef and live cattle due to Canadian exports to the United States were estimated using the price flexibility coefficients associated with Canadian exports to the United States (Table 5). 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 estimated price changes from the previous year because of changes in the volume of U.S. imports from Canada. For example, a 0.7% reduction in the U.S. wholesale beef price is attributed to increased beef imports from Canada from 1989 to 1990. Except from 1994 to 1995, when exports from Canada did not change significantly from the previous year, beef exports from Canada to the United States have increased each year during the CUSTA period. The largest estimated negative impact on U.S. prices was 4.0% from 1991 to 1992, when Canadian exports to the United States increased 49%. Yearly beef price reductions due to increased imports from Canada after CUSTA was implemented averaged approximately 1.5%.

Although the effect of market cattle imported from Canada as feeder cattle (represented by lagged live cattle imports) was significant, data on the mix of market weight and feeder cattle imported to the United States from Canada were not available prior to 1990. Therefore, to calculate changes in U.S. live cattle market price because of imports from Canada, it was assumed that all cattle imports from Canada were market cattle (as in Brester). As such, any effect on U.S. prices is assumed to occur in the same period. Although significant, the impact of imports of Canadian live cattle on U.S. market price has been very small. Live cattle imports to the United States are small in comparison to domestic supply and have both increased and decreased since CUSTA was implemented. In fact, live cattle imports in 1999 were only 62% of those in 1989. However, within-year and between-year variability in live cattle imports from Canada have noticeably reduced or increased U.S. market prices. The effect of between-year changes in live cattle imports from Canada on U.S. market prices ranges from -2.7% from 1991 to 1992 to 3.7% from 1989 to 1990. Yearly live cattle U.S. market price changes due to changes in live cattle imports from Canada after CUSTA averaged 0.2%.

Pork imports from Canada have not been increasing during most of the 1990s and in fact inconsistently slightly decreased until 1998. The estimate shows that the recent increase in Canadian pork exports to the United States resulted in a 4.5% reduction in the U.S. pork price in 1998 and a 7.1% reduction in the pork price in 1999. This was particularly worrisome to the U.S. pork industry during this period of record low prices. The average annual price decrease from 1989 to 1999 because of changes in Canadian pork exports to the United States was only 0.8%. However, because pork exports were variable, the between-year price change attributable to changes in Canadian pork imports varied considerably, from a 2.9% price increase from 1990 to 1991 because pork exports decreased 10.2%, to a 7.1% price decrease from 1998 to 1999 because pork imports increased 25%. Despite the increased imports from Canada in 1998 and 1999, Canadian pork exports to the United States in 1999 were still lower than they were in either 1983 or 1987.

Both market weight hogs and feeder pigs, and, increasingly, newly weaned pigs, are imported to the United States from Canada. Feeder and weaned pig imports are fed to market weight in U.S. feedlots. Estimated price flexibility coefficients indicate that a percentage change in feeder pig imports has had a greater impact on U.S. prices when they reach market weight than the same percentage change in market weight imports in the current period. Data indicating the portion of live hog imports by weight were not available. Based on the more recent estimates noted previously, it was assumed that two-thirds of the Canadian hog exports to the United States were market weight hogs, and the remainder were feeder pigs slaughtered four months later. The price flexibility coefficient used to calculate price effects is a weighted average of the market hog

(-0.053) and feeder pig (-0.112) price flexibility coefficients (-0.072). From 1989 to 1999, an increase in imports from the previous year reduced U.S. market hog prices in all but three years. The effect was particularly high in 1995 and 1996 when decreases in U.S. market price of 6.6 and 4.3%, respectively, could be attributed to increased imports from Canada. However, because, in general, live hog imports did not vary much from one year to the next, the year-to-year change in U.S. market price attributable to changes in Canadian exports to the United States was not large. The average yearly price reduction for market weight hogs because of imports from Canada during the 1989-1999 period was 1.5%.

Conclusions

Evidence from the estimated models supports the hypothesis that trade liberalization under CUSTA has had a significant influence on trade flows, facilitating movement of Canadian beef and live cattle to the United States. Canadian hog exports to the United States have increased substantially since 1993. Appreciation of the U.S. dollar relative to the Canadian dollar appears to have been an important contributor to increased Canadian beef, live cattle, and live hog exports to the United States. Canadian pork production (hog inventory) has affected the level of pork (live hog) imports from Canada. Relative prices also appear to have influenced Canadian exports to the United States. Canada increases cattle and pork exports to the United States when the U.S. price advantage increases.

With few exceptions, the estimated model aligns with predictions based on economic theory and is supported by existing literature. Notable exceptions are that Canadian pork exports to the United States were not significantly influenced by the exchange rate and that Canadian exports of beef and live hogs were not significantly influenced by relative price changes between the U.S. and Canadian markets. Insensitivity of beef to relative price changes may be related to outstanding differences in grade equivalency between the United States and Canada. Beef imports sold with a USDA grade must be imported as carcasses (versus boxed beef). Existing market arrangements accommodating imports of carcasses and boxed beef may reduce sensitivity to shorter term price changes. This may also, in part, explain the unexpected result that the influence of Canadian production on beef imports from Canada was not significant.

The estimated model indicates that increased exports from Canada to the United States have negatively affected U.S. prices. The current study supports the conclusions of previous work in finding these effects to be small in magnitude. Although between-year effects are relatively small in magnitude, it is conceded that monthly or more frequent changes in imports from Canada may have a relatively large, albeit short-lived, influence on U.S. prices. Average yearly reductions in U.S. domestic prices due to increases in Canadian exports since the inception of CUSTA were 1.5% for wholesale beef. Changes in live cattle imports from Canada has had virtually no effect on cattle prices, although Canadian beef exports to the United States likely have had some effect on U.S. cattle prices. Canadian carcass beef imports are processed by U.S. packers. Price reductions due to increased Canadian exports to the United States during the 1989-1999 period averaged 0.8% for pork and 1.5% for hogs. The magnitude of the price impact caused by Canadian exports is quite small for cattle and pork, but somewhat more important for beef and hogs.

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