Effects of Market and Policy Shocks on the Canadian and U.S. Cattle and Beef Industries

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ABSTRACT

The paper examines the impact of four exogenous shocks – exchange rate appreciation, feed price escalation, mandatory country of origin labeling, and economic recession – on the Canadian and U.S. beef cattle industries using a multi-market partial equilibrium model. Impacts on the U.S. industry are found to be relatively small compared to those on the Canadian industry. Country of origin labeling, and feed price escalation account for the largest decline in the welfare of Canadian cattle producers.

Key words: Canadian and U.S. beef cattle industries, exogenous shocks, partial equilibrium model

JEL codes: Q11, Q13, Q17

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1. Introduction

Over the last ten years, the relative competitiveness of the highly integrated and interdependent Canadian and U.S. beef cattle industries has been affected by a series of international market and policy shocks. These have included appreciation of the Canadian dollar, the surge in feed prices due to the emergence of a bio-fuels market, the global economic recession, and the introduction of mandatory country of origin labeling (COOL) by the U.S. government. These shocks have had a negative impact on the competitiveness of Canada's hog and pork industry (Rude, Gervais and Felt, 2010; Rude, Wang and Unterschultz, 2010), and have probably impacted the beef cattle industry in the same way.

Concurrent with or consequent to these shocks is the downturn in cattle inventories that has been observed in both industries in each of the last four years. Between January 2009 and January 2010, the Canadian beef cattle herd dropped to 11 million head, down 1.4 percent and the lowest in 15 years (U.S. Department of Agriculture, 2010a). Between July 2010 and July 2011, Canadian and U.S. cattle inventories declined by 2% and 1%, respectively; combined, the decline is estimated at 1% (U.S. Department of Agriculture, 2011a). Although U.S. cattle prices for all cattle types reached record highs in the first half 2011, high feed prices and uncertainty in the macroeconomic environment continue to constrain cow-herd expansion (U.S. Department of Agriculture, 2011b). Moreover, the currently high retail beef prices are not high enough to guarantee the necessary margins and profits that processors and feedlots require in order to maintain herd expansion (U.S. Department of Agriculture, 2011c).

As both industries enter a contraction phase, it is informative to determine the relative impacts of exchange rate adjustments, feed cost, economic recession, and mandatory country of origin labeling on the industries, and their implications for recovery. The purpose of this study is to determine the impacts of the four shocks on the competitiveness of Canadian and U.S. beef cattle industries. The study will analyze the relationships among these shocks, and the relative importance of each shock to each industry. In section 2, each shock is examined in order to determine its magnitude and the mechanism through which it impacts the industries. The economic model is described in section 3, and the empirical analysis is in section 4. Results are presented and discussed in section 5, and section 6 concludes the paper.

2. Background on Exogenous Shocks

Exogenous shocks, which may be described as sudden events that have significant impacts on an economy or an industry or group of industries, often lead to abrupt changes in demand, regulation, and cost structure (Gorbenko and Strebulaev, 2010). They may be classified as temporary or permanent depending on their duration, and may have both short- and long-term negative and/or positive impacts.

Mandatory Country of Origin Labeling

In information theory, country of origin of a product is an extrinsic informational cue that may influence the quality perception of a product (Bilkey and Nes, 1982; Elliott and Cameron, 1994). If it does, the implication is that there is imperfect information about that product, hence market failure, which then has to be addressed by voluntary or mandatory labeling (Lusk *et al.*, 2006). In a multi-product and multi-cue experiment, Wall et al. (1991) find that country of origin labeling surpasses price and brand information in influencing consumers' perception of product quality. But Lusk et al. also note that even in the absence of imperfect information, consumers' preference for country of origin labeling may stem from sheer ethnocentric tendencies.

The final rule of the U.S. COOL legislation was implemented on March 16, 2009. It was a provision in the Farm Security and Rural Investment Act of 2002 (2002 Farm Act) that required fruits and vegetables, peanuts, fish and shellfish, beef, pork, and lamb sold at the retail level to be labeled by their country of origin (Jones *et al.*, 2009). Amendments to the 2002 Farm Act, which led to the Food, Conservation, and Energy Act of 2008 (2008 Farm Act) have expanded the coverage of COOL to include poultry, goat meat, macadamia nuts, ginseng and pecans (U.S. Department of Agriculture, 2009a). The law, however, does not apply to these products if they are consumed in hotels, restaurants and institutions (HRI), or if they are ingredients in processed food items. Four meat labeling categories have been created under the law: meat is labeled Category A (Product of the U.S.) if it is from an animal that is born, raised and slaughtered in the U.S.; Category B (Product of U.S. and X) is meat derived from an animal born in country X, and raised and slaughtered in the U.S.; Category C (Product of X and U.S.) is meat derived from an animal born and raised in country X and slaughtered in the U.S., and Category D (Product of X) is meat imported into U.S. Also, the law provides for commingled meat. Meat from Category A that is commingled during a production day with meat from Category B may be labeled Category B (i.e., A + B = B). Meat from Category B that is commingled during a production day with meat from Category C may be labeled Category B (i.e., B + C = B).

Rude et al. (2006) predicted that COOL was more apt to be one of the most controversial issues from an international trade perspective. Indeed, on April 30, 2010, Canada and Mexico petitioned the World Trade Organization (WTO) to create a dispute resolution panel to determine whether the law was tantamount to a violation of international trade obligations by the U.S. Ideally, international trade regulations such as product labeling are mandatory requirements meant to correct market failure due to information asymmetry (Hobbs, 2007). The WTO Technical Barriers to Trade (TBT) Agreement acknowledges the right by member governments to adopt regulations that they deem necessary and appropriate to meet consumer interests. But at the same time, it has provisions that ensure that such regulations are not deliberately used for protectionist purposes thereby creating unnecessary obstacles to trade. In an interim ruling on May 20, 2011, the WTO panel ruled in favor of Canada and Mexico.

Several arguments have been made for and against COOL. Proponents - mainly U.S. cow-calf producers, and fruit and vegetable growers - argue that most U.S. consumers prefer domestic to imported products because of the superior quality of the former. Therefore labeling products by country of origin helps to allay consumers' food safety concerns while giving U.S. products a competitive advantage over imported ones (Krissoff *et al.,* 2004). Others argue that consumers simply have a right to know the country of origin of their food purchases (Schupp and Gillespie, 2001). From their benefit-cost analysis, VanSickle et al. (2003) conclude that not only are the benefits to the U.S. of COOL significant, they outweigh its costs.

Opponents of the law contend that it is a non-tariff barrier, or more precisely, a technical barrier to trade (Kerr, 2003; Vollrath and Hallahan, 2006; Grier and Martin, 2007), which imposes unnecessary and yet substantial transaction costs at all levels of the market chain (Rude *et al.*, 2006; Jones *et al.,* 2009; Carlberg *et al.,* 2009). A purely intuitive ground for this argument is that voluntary labeling by country of origin would have occurred if it were economically beneficial to do so (Lusk and Anderson, 2004; Plastina *et al.,* 2008).

Conceptually, assuming a perfectly competitive market, the costs of COOL will shift the supply function of a given product leftward. Brester et al. (2004) illustrate the resulting changes in supply and demand at each market level in a vertically linked beef cattle industry. If the added costs of COOL are to be incurred at all levels of the market chain, there would be a concurrent leftward shift in the respective supply functions, and hence a decline in the derived demand for cattle. The resulting changes in price will depend on the relative supply and demand elasticities at each level. But even if the final U.S. producer price were to be greater than the pre-COOL price, cattle producers would not necessarily be better-off due to a decline in farm output. If they are worse-off, then there will be a contraction in cattle imports.

A summary of the costs of COOL as estimated by different studies is provided by Rude et al. (2006). These costs have recently been updated by Informa Economics, Inc. (2010). U.S. importers of live animals, processors, and retailers are expected to incur costs associated with keeping records, segregating animals and meat by country of origin, verification, labeling, and certification.

At the heart of the COOL debate is the question as to whether U.S. consumers are willing to pay a premium for it; i.e., whether or not COOL will induce an increase in demand for the labeled products. The numerous studies that have examined this issue have yielded mixed results. For instance, Umberger et al. (2003) find that 73% of consumers are willing to pay up to 11% and 24% premium for COOL on steak and hamburger, respectively. Also, they are willing to pay 19% premium for steak labeled as “U.S.A. Guaranteed: Born and Raised in the U.S.” Loureiro and Umberger (2003) obtain even higher premiums of 38% and 58% for U.S. certified steak and hamburger, respectively. Considering that almost all the steak consumed in the U.S. is of U.S. origin, it is not reasonable to expect consumers to be willing to pay such a high premium just to have their steak "U.S. certified". It seems the high premiums obtained in these studies are due to hypothetical biases inherent in contingent valuation methods. In fact, in another study, Loureiro and Umberger (2005) find the premiums for certified U.S.-labeled chicken breasts, pork chops, and beef steaks to be 2.5%, 2.5%, and 2.9%, respectively, and that only 30% of consumers are willing to pay a premium of more than 5% for certified U.S. meat products. Loureiro and Umberger (2007) find that although COOL attracts a positive premium ($2.568 per pound of steak) among U.S. consumers of beef, this premium is very low relative to that of food safety certification by the U.S. Department of Agriculture ($8.068 per pound of steak).

Because of lack of consensus on consumer willingness to pay for COOL, studies on the impacts of the legislation have made varied assumptions. Brester et al. (2004) show that in the absence of an increase in consumer demand, COOL causes a decline in producer and consumer surplus in the U.S. beef and pork industries in both the short- and long-run. In the short-run, producer surplus declines by $647.8 million and $220.4 million in the beef and pork industries, respectively. When they assume an increase in consumer demand due to COOL, they find that one-time permanent increases of 4.05% and 4.45% in beef and pork demand, respectively, would be necessary to ensure zero losses in producer surplus in the cattle and hog industries.

Lusk and Anderson (2004) report on the impacts in the U.S. of COOL from various scenarios regarding the magnitude and incidence of the costs of compliance, and changes in consumer demand (willingness to pay). Consistent with Brester et al., they find that COOL leads to a reduction in beef consumer surplus in the absence of a demand increase. Results from their multi-market model indicate that a 2% increase in aggregate demand for beef and a similar increase in demand for pork would be sufficient to offset losses in beef consumer and pork producer surplus, respectively. Schmitz et al. (2005) find that a 0.035% increase in consumer demand would offset labeling costs of up to $0.05 per pound of beef in the U.S., and under this scenario, the total economic surplus accruing to U.S. producers, foreign producers, and U.S. consumers is the same as before implementation of COOL. COOL impacts for the Canadian and U.S. hog and pork industries have been analyzed by Rude et al. (2006). Their study reveals that COOL induces losses at all market levels in the U.S., while impacts in Canada depend on the level of trade in hogs and mixed supply chain pork. Specifically, U.S. consumers lose 5-6% of their consumer surplus if COOL does not stimulate demand. According to Loureiro and Umberger (2005), premiums for beef and pork are not high enough to raise the benefits of COOL above its costs. Furthermore, a study by Carter et al. (2006) dismisses the claim that COOL would be an effective branding strategy even if consumers were willing to pay a price premium for it.

Exchange Rate Appreciation

Exchange rate shocks, if sufficiently large, can have lasting impacts on trade flows, and hence lead to structural change (Baldwin and Krugman, 1989). Assuming one commodity being traded in two perfectly competitive markets without trade barriers and zero transportation costs, Coleman and Meilke (1988) show that a depreciation of the exporter's currency increases the commodity's price, which in turn leads to an increase in quantity supplied. Conversely, for any given price quoted in the importer's currency, an appreciation of the exporter's currency decreases the domestic currency-equivalent received by the exporter, hence a decline in quantity exported. However, excess demand and excess supply functions contain several other prices, which are also affected by changes in exchange rate. Thus assuming a small exporting country and perfect price transmission, exchange rate effects on prices will be larger but effects on equilibrium quantities traded will be smaller than in the one commodity model (Coleman and Meilke, 1988).

Between 2000 and 2008, the Canadian dollar appreciated by more than 50% against the U.S. dollar (Lamoureux, 2010), reaching close to parity between mid 2007 and mid 2008 as shown in figure 2. This was due to an increase in export demand for Canada's oil, natural gas and coal, and relatively higher interest rates that attracted substantial capital inflows (Klein *et al.*, 2006; Boyer and Irvine, 2007). From 2002 to 2007, there was a 31.5% appreciation of the Canadian dollar implying an equivalent loss in the value of cattle and beef exports that was independent of losses due to BSE (Klein and Le Roy, 2010). Schaufele et al. (2009) find that exchange rate fluctuations in the same time period caused far greater losses to the equity (net worth) of cattle producers than did the BSE crisis. Klein et al. (2006) too reveal that appreciation of the Canadian dollar adversely affected cow-calf producers, feedlot operations, and beef packers in the short-run, with the greatest impact being felt by cow-calf producers.

Figure 2: Monthly Exchange Rates

In the long-run, losses to cow-calf producers are expected to be reflected in lower values of their fixed assets. As feedlot operators pay a lower price for feeder cattle, beef packers will try to align their operating costs with those of their U.S. counterparts. In addition, the structural impact of the appreciation of the dollar will be seen in the decline in the cow herd inventory. Interestingly, however, Klein et al. argue that inasmuch as exchange rates directly impacted prices, they did not directly alter trade flows of cattle and beef. Therefore to comprehensively examine the impacts of exchange rate appreciation on the beef and cattle industry, this study simulates the impact on cattle and beef trade flows, and on feed prices.

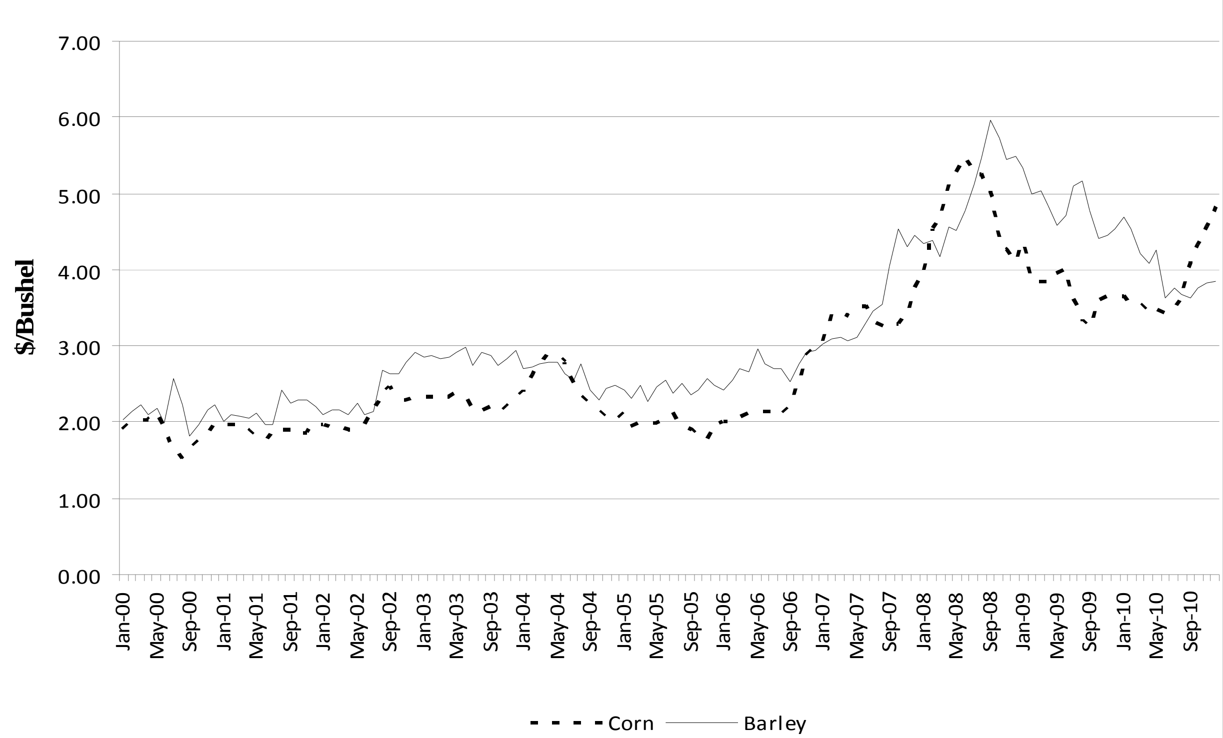
Rise in Feed Prices

Barley, corn, wheat, and oats are the common feed grains used in western Canada, barley being the main one, and barley and corn being the most internationally traded. In 2009, Canada supplied 99% of U.S. barley imports (Taylor *et al.*, 2010). Canadian corn production, however, is relatively small, and therefore imports from the U.S. are used to balance the feed grain market in western Canada (Boaitey, 2010).

High grain feed prices negatively impact cattle and beef production. In cattle feeding, feed grains account for as much as 70% of operating costs (Grier and Bouma, 2008), and for Canadian feedlots in particular, they account for more than 80% of the cost of gain, defined as the cost of raising the weight of an animal by one unit (Canadian Cattlemen's Association, 2007). Thus an escalation in grain feed prices reduces profit margins of feedlot operators, who in turn respond by offering lower feeder cattle prices to cow-calf operators.

Between 2006 and 2008, there was a large increase in global barley and corn prices to well above historical levels as illustrated by U.S producer nominal price trends in figure 3. Between mid 2007 and mid 2008, corn producer prices rose by about 156%. In Canada, barley prices stood at $113 per tonne in mid 2006, but by the first quarter of 2008, they had almost doubled to $216 per tonne (Grier and Bouma).

Figure 3: U.S. Corn and Barley Producer Prices



The rapid increase in feed grain prices has been attributed in part to the emergence of a bio-fuels industry in North America (Grier, *et al.,* 2012). The increasing demand for ethanol has driven up the price of corn – since at present almost all ethanol production in the region is from corn – and hence a dramatic increase in the price of other major feed grains that closely follow corn prices. Although grain prices have trended downwards since early 2009, they are likely to remain higher than pre-2006 levels (Lawrence, 2009) due to bio-fuel consumption mandates set by Canada and the U.S. In fact, projections for the period 2005 to 2015 by Fridfinnson and Rude (2009) show corn prices remaining above baseline levels over the entire period because of these mandates.

Thus far, empirical evidence suggests that the run-up in grain feed prices has significantly undercut the competitiveness of Canada's beef cattle industry relative to that of the U.S. (Grier and Bouma). Further, the Canadian Cattlemen's Association (2007) predicts that in the absence of a market-driven bio-fuels policy, high grain feed prices will over the long-run cause a structural shift in the industry as some feedlot operators switch to alternative feeds and/or move their operations closer to sources of cheaper feeds, while others exit the industry altogether leading to a decline in cattle inventories.

Global Economic Recession

Economic recessions are characterized by, among other things, a decline in GDP and household incomes. The most recent economic recession began in December 2007 and ended in June 2009. In 2008, Canada's real per capita GDP was $39,425, a decrease of $574 (1.4%) from the 2007 level of $39,999 (Human Resources and Skills Development Canada, 2011). In the U.S., real GDP declined 2.4% from the 2008 to the 2009 annual level (U.S. Department of Commerce, 2010). Although the recession is over, employment rates and incomes are yet to return to their pre-recession levels.

The contraction in beef demand observed recently may have been caused by the recession-induced decline in real incomes (U.S. Department of Agriculture, 2010b). From 2007 to 2010, there was a 3.5% reduction in beef and veal demand in the world's major beef markets including the U.S. (U.S. Department of Agriculture, 2009b) to which Canada exports over 70% of its beef exports. Consumption of beef in the Canadian market, which is about 50% of domestic production, declined by 4.7% between 2007 and 2008 (Thoren, 2009).

Such contraction in retail demand is likely to negatively impact cattle producers and other market chain intermediaries. Assuming perfectly competitive market conditions, a leftward shift in retail demand for beef would lower demand for slaughter cattle, which in turn would cause a leftward shift in the derived demand for feeder cattle. The resulting changes in farm price imply lower producer profits, which would cause producers to scale back production. In the U.S., declining consumer demand for beef in the 1980s and 1990s had profound negative impacts on slaughter and feeder cattle prices and production, and hence producer welfare (Marsh, 2003).

CattleFax (2009), however, dispute the existence of a direct correlation between recessions and retail beef prices. Through a correlation analysis, they show that during recessions, changes in beef prices tend to be associated more strongly with changes in supply. They argue that previous recessions have coincided with declining beef supplies, hence the observed increase in price. It could be that the impacts of previous recessions have led to rightward supply shifts. In this study, however, we conjecture that the reduction in consumer incomes that has occurred in the most recent recession has had a substantial impact on the Canadian beef cattle industry.

3. Modeling Framework

The economic model is a multi-market partial equilibrium model of the Canadian and U.S. beef cattle industry. A similar framework has been used by Moschini and Meilke (1992) and Rude, Wang and Unterschultz (2010) to analyze hog and pork markets, and Coleman and Meilke (1988) for cattle and beef markets. The model used in this study is based on three general assumptions. First, we assume a competitive market structure at all levels of the supply chain (Morrison-Paul, 2001; Marsh, 2003; Rude *et al.,* 2011). Second, cattle and beef markets are vertically linked through a fixed proportions technology; the quantity of beef produced is equal to the average cold carcass weight multiplied by the slaughter demand for cattle. Third, COOL leads to product differentiation in the U.S. market for beef. U.S. consumers are assumed to choose between two different types of beef; beef of U.S. origin (Category A), and beef of Canadian origin (Category D). Whereas markets for these two categories can be easily modeled, markets for mixed supply chain beef (Categories B and C) are nonexistent at this time.

The model consists of 28 structural equations solving for 28 endogenous variables. There are 18 behavioral equations and 10 identities, with the latter consisting of accounting identities and market clearing conditions. Accounting identities are used to model both U.S. and Canadian inventories of cows and bulls, and aggregate Canadian beef demand (from per capita consumption) and supply (from cattle slaughter given the conversion factors). Market clearing identities specify equilibrium conditions in each market. The behavioral equations model farm supply of and processor demand for cattle (including U.S. processor demands for Canadian cattle), inventories of breeding heifers, and wholesale level demand for beef.

Following Rude et al. (2007), for both countries, farm supply of cull cattle is derived from inventories of cows and bulls, while supply of steers and heifers is derived from inventories of breeding heifers. Inventory of cows and bulls ($I_{i,t}^{cow}$) is an identity in which the ending inventory is equal to the previous year's ending inventory plus the number of heifers that became beef cows in the same period less marketing of slaughter bulls and cows. The inventory of breeding heifers ($I_{i,t}^{heifer}$), however, is a behavioral equation in which the number of heifers in the current period is a function of the number of heifers in the previous period, and the first, second and third lags of the real price of feeder steers (Mbaga and Coyle, 2003). Farm supply of cull cattle ($S_{i,t}^{cull}$) is a function of the ratio of price of cows ($P_{i,t}^{cow}$) to price of steer calves ($P_{i,t}^{steer}$), a lagged dependent variable, which captures producers' adaptive expectations, and in the case of U.S., the ending inventory of bulls and beef cows as well.

$$S_t^{cull} = \beta_0 + \beta_1 (P_t^{cow} / P_t^{steer}) + \beta_2 S_{t-1}^{cull} + \beta_3 I_t^{cow} \text{ .... } (1)$$

Equation (1) is a dynamic equation in which β_2 is the coefficient of adjustment and is obtained from knowledge of the short- and long-run supply elasticities. The inventory variable captures the influence of the culling rate.

Supply of fed cattle is determined by the expected price of feeder steers and the expected price of fed steers each normalized by the price of feed, $P_{i,t}^{g}$, and a 70 percent share of the inventory of bulls and cows lagged two periods.

$$S_{i,t}^{fed} = \lambda_0 + \lambda_1 (0.4 P_{i,t}^{fed} / P_{i,t}^{g} + 0.6 P_{i,t-1}^{fed} / P_{i,t-1}^{g}) + \lambda_2 (0.4 P_{i,t}^{feeder} / P_{i,t}^{g} + 0.6 P_{i,t-1}^{feeder} / P_{i,t-1}^{g}) + \lambda_3 I_{i,t-2}^{cow} \text{ .. } (2)$$

By appearing in this supply function, the inventory of bulls and cows links the fed cattle market to the cull cattle market.

Feeder cattle markets in both countries are accounted for by linking the price of feeder steers to that of fed steers:

$$P_{i,t}^{feeder} = \tau_0 + \tau_1 P_{i,t}^{fed} \text{ .... } (3)$$

Derived slaughter demands for cattle are typically input demand equations that can be derived from a profit function. Demand for cull cattle ($D_{i,t}^{cull}$) is a function of the weighted average price of cows normalized by the average wage rate in meat processing, wholesale price of D1 carcass normalized by consumer price index, and a lagged dependent variable. Processor demand for fed cattle is a function of the national weighted average price of steers normalized by the average wage rate in meat processing, wholesale price of steer carcass normalized by consumer price index, and a lagged dependent variable. Normalization makes the demand functions homogeneous of degree zero in prices.

$$D_{i,t}^{cull} = \delta_{i0} + \delta_{i1} (P_{i,t}^{cow} / wage_{i,t}) + \delta_{i2} (P_{i,t}^{cowcarcass} / CPI_{i,t}) + \delta_{i3} D_{i,t-1}^{cull} \text{ .... } (4)$$

$$D_{i,t}^{fed} = \gamma_{i0} + \gamma_{i1}(P_{i,t}^{steer} / wage_{i,t}) + \gamma_{i2}(P_{i,t}^{steercarcass} / CPI_{i,t}) + \gamma_{i3} D_{i,t-1}^{fed} \text{ ………….. (5)}$$

Trade flows of live cattle are accounted for by two U.S. import demand equations for Canadian cattle; one for cull cattle, and another for both feeder and fed cattle. Import demand for cull cattle, $D_t^{cull,m}$, is specified as:

$$D_t^{cull,m} = \alpha_0 + \alpha_1 P_t^{cow,US} + \alpha_2 P_t^{beef,US} \text{ …………………………………………… (6)}$$

where $P_t^{cow,US}$ and $P_t^{beef,US}$ are U.S. cow and beef prices, respectively. Import demand for feeder and fed cattle[1] is:

$$D_t^{f,m} = \mu_0 + \mu_1 P_t^{steer,C} + \mu_2 P_t^{beef,US} \text{ …………………………………………… (7)}$$

where $P_t^{steer,C}$ is the Canadian price of steers. U.S. excess demand for cull cattle enters both U.S. and Canadian cull cattle market clearing conditions, which equate cull cattle supply to domestic demand plus exports less imports. Likewise, U.S. import demand for feeder and fed cattle enters fed cattle market clearing identities, which also explicitly account for trade flows of feeder cattle.

Beef supply in Canada and the U.S. ($S_{i,t}^{beef}$) is determined by a fixed proportions relationship that converts slaughter numbers to beef by a carcass weight equivalent conversion factor (CF_i).

$$S_{i,t}^{beef} = CF_i \cdot D_{i,t}^{cattle} \text{ ………………………….. (8)}$$

where $D_{i,t}^{cattle}$ is processor demand for slaughter cattle.

With respect to beef demand, the Canadian beef market is assumed to be homogeneous with demand (D_C^{beef}) being a function of the deflated wholesale price of beef[2] and per capita

[1] Feeder cattle make up less than twenty percent of the total volume of Canadian feeder and fed cattle exports to the U.S., and there are hardly any studies that have estimated the feeder export equation. Thus we aggregate exports of the two types of cattle and use elasticities in Brester et al. (2002) for this equation in our synthetic model.
[2] We model beef demand at the wholesale level using disappearance data.

income. Other variables thought to influence beef demand such as price of other meats are assumed constant, hence captured by the intercept. In the U.S., however, beef is assumed to be differentiated by country of origin because of mandatory country of origin labeling. We assume that demand for beef involves a two-step budgeting procedure in which expenditure is initially allocated to the broad product category, beef, and then disaggregated into source-specific beef, e.g., U.S. beef, Canadian beef, etc. This procedure, which implies that a change in the price level in any country (holding other prices constant) affects trade between any two countries, is predicated on three assumptions (Armington, 1969): (i) weak separability – the marginal rate of substitution between any two types of beef is independent of the quantities purchased of non beef commodities; (ii) elasticities of substitution among the different types of beef are constant; and (iii) the elasticity of substitution between any two types of beef competing in a market is the same as that between any other pair of beef types competing in the same market. In our model, the demand for each type of beef in the U.S. is a function of income, own price and the price of other types of beef. Other likely explanatory factors including cross-price effects are captured by the intercept. Thus,

$$D_{ij,t}^{beef} = \omega_{ij0} + y_t + \sum_m \omega_{mj} (P_{mj,t}^{beef} / CPI_{j,t}) \text{ .... (9)}$$

where i is Canadian, and U.S. beef. $D_{ij,t}^{beef}$ is demand for beef type *i* in market *j* (U.S.) at time *t*, y_t U.S. is per capita income, $P_{mj,t}^{beef}$ is price of beef type *m* in market *j*, and *CPI* is consumer price index in market *j*. With knowledge of beef market shares and elasticities of substitution between beef types, own- and cross-price elasticities for equation (9) can be computed as follows:

$$\eta_j^i = (1 - S_j^i)\sigma^i + S_j^i \eta^i$$

$$\eta_{jh}^i = S_j^i (\sigma^i - \eta^i), j \neq h$$

where η_j^i is the price elasticity of demand in country *i* for beef produced by country *j* with respect to a change in country *j*'s price. η_{jh}^i is the price elasticity in country *i* for country *j*'s beef with respect to a change in the price of country *h*'s beef. S_j^i is the value share of country *j*'s beef in country *i*. σ^i is the elasticity of substitution between different types of beef in country *i*, and η^i is the overall price elasticity of demand for beef from all sources in country *i*.

The U.S. beef market has two market clearing identities; one for U.S. and the other for Canadian beef. Market clearing for U.S. beef is an identity that equates U.S. demand for U.S. beef to U.S. supply of category A beef plus change in stocks less exports to Canada and the rest of the world.

$$D_{US,US}^{beef} = S_{US}^{beef} + \Delta stocks_{US}^{beef} - X_{US}^{beef} \quad \text{………………………….} \ (10)$$

Exports to the rest of the world and the change in beef stocks are treated as exogenous variables. Market clearing for Canadian beef in the U.S. market equates U.S. demand for Canadian (category D) beef to total Canadian beef supply plus imports plus change in stocks less domestic (Canadian) demand less exports to the rest of the world.

$$D_{US,C}^{beef} = S_{C}^{beef} + M_{C}^{beef} + \Delta stocks_{C}^{beef} - D_{C}^{beef} - X_{C}^{beef} \quad \text{…………..} \ (11)$$

Market clearing in the Canadian beef market is obtained by rewriting equation (11).

The model is calibrated to annual data for the period 1995 to 2008 and is solved using the simulation procedure in OxMetrics™. Calibration is done by computing linear slope coefficients from elasticities using the elasticity formula, and then calculating each year's intercept for all behavioral equations. Intercepts are obtained by subtracting, for each equation, the sum of the product of the slope coefficients and the respective independent variables from the dependent variable. Calculating intercepts for each year ensures that the model is perfectly calibrated, i.e., it exactly reproduces the baseline data. The analysis of shocks is implemented against a historical baseline, which is long enough to allow the model to fully adjust to the shocks.

Table 3.1: Definition of variables

Label	Definition	Unit	Mean and SD U.S.	Canada
$I_{i,t}^{heifer}$	Inventory of breeding heifers	000 head	982.6 (119.1)	835.2 (204.0)
$I_{i,t}^{cow}$	Inventory of cows & bulls	000 head	36307.1 (970.3)	4998.0 (346.3)
$S_{i,t}^{cull}$	Marketing of cows & bulls	000 head	4040.8 (559.3)	829.6 (160.8)
$S_{i,t}^{fed}$	Marketing of fed steers & heifers	000 head	27721.5 (824.5)	3340.9 (196.4)
$D_{i,t}^{cull}$	Inspected slaughter cows & bulls	000 head	3831.0 (450.0)	620.0 (128.8)
$D_{i,t}^{fed}$	Inspected slaughter steers & heifers	000 head	28526.5 (964.2)	2766.8 (318.7)
$D_{t}^{cull,m}$	U.S. imports of Canadian cull cattle	000 head	219.63 (158.73)	
$D_{t}^{f,m}$	U.S. imports of Canadian fed & feeder cattle	000 head	783.40 (409.87)	
$S_{i,t}^{beef}$	Beef production	000 tonnes	11756.8 (346.2)	1200.4 (156.3)
D_{C}^{beef}	Beef disappearance in Canada	000 tonnes		969.9 (29.0)
$D_{US,US}^{beef}$	Disappearance U.S. beef in U.S.	000 tonnes	10930.5 (275.5)	
$D_{US,C}^{beef}$	Disappearance Canadian beef in U.S.	000 tonnes	388.4 (87.7)	
$\Delta stocks_{i}^{beef}$	Change in beef stocks	000 tonnes	10.9 (53.7)	0.6 (7.1)
X_{i}^{beef}	Beef exports	000 tonnes	835.4 (313.8)	455.9 (117.2)
M_{i}^{beef}	Beef imports	000 tonnes	1390.8 (196.7)	225.5 (63.1)
$P_{i,t}^{cow}$	Wholesale price D1 cow carcass	$/cwt	44.8 (8.4)	46.4 (12.3)
$P_{i,t}^{feeder}$	Feeder steer (500-6001b) price	$/cwt lw	94.1 (18.5)	119.8 (21.2)
$P_{i,t}^{steer}$	Wholesale price steer carcass	$/cwt	75.7 (11.2)	88.6 (7.2)
$P_{i,t}^{beef}$	Retail price of beef	$/kg	7.59(1.31)	7.56(1.11)
$P_{i,t}^{g}$	Feed grain price	$/tonne	134.0 (21.6)	134.0 (21.5)
$CPI_{i,t}$	Consumer price index		180.1 (19.6)	118.1 (10.1)

Figures in parentheses are standard deviations
lw refers to live weight

Table 3.2: U.S. elasticities and their sources

Elasticity	Estimate	Source
Demand for U.S. cull cattle w.r.t. U.S. cow price	-1.66	Ziemer and White (1982)
Demand for U.S. cull cattle w.r.t. price of beef	0.064	Yang (2010)
Demand for Canadian cull cattle w.r.t. Canadian cow price	-0.40	U.S. Department of Agriculture (2007)
Demand for Canadian cull cattle w.r.t. U.S. beef price	1.52[3]	Brester et al. (2002)
Supply of cull cattle w.r.t. U.S. cow price	0.076	Cranfield and Goddard (1999)
Heifer investment w.r.t. feeder price	-1.06 (t-1) -0.88 (t-2)	Arnade and Jones (2003)
Demand for U.S. fed cattle w.r.t. price of steers	-0.70	Assumed[4]
Demand for U.S. fed cattle w.r.t. price of beef	0.45	Assumed
Demand for Canadian feeder and fed cattle w.r.t. Canadian steer price	-1.79	Brester et al. (2002)
Demand for Canadian feeder and fed cattle w.r.t. U.S. beef price	1.52	Brester et al. (2002)
Supply of fed cattle w.r.t. steer price	0.076	Cranfield and Goddard (1999)
Demand for beef w.r.t. price	-0.71	Marsh (1991)
Elasticity of substitution between U.S. and Canadian beef	1.3	Goddard (1987)

Baseline data on physical quantities were obtained from Statistics Canada, the U.S. Department of Agriculture (USDA) Red Meat Yearbook, and Livestock, Dairy and Poultry Situation and Outlook. Prices and exchange rates were obtained from Agriculture and Agri-Food Canada (AAFC) and the Economic Research Service of the USDA. Model variables are defined and described in table 3.1. Means and standard deviations are for the 1995 to 2008 period.

[3] The elasticity is for fed and nonfed cattle combined; cross price elasticities for the different types of cattle are not available.
[4] There is a wide variation among these elasticities in the literature, ranging (in absolute terms) from as low as 0.18 (Cranfield and Goddard, 1999) to as high as 1.45 (Marsh, 2003).

Elasticities used to calibrate Canadian equations are similar to those in Rude et al. (2007), while those for U.S. equations and their sources are presented in table 3.2.

4. Analysis of Shocks

In order to evaluate the economic impacts of the four exogenous shocks on the Canadian and U.S. beef cattle industries, we examine the individual impacts of each shock, the combined impacts for shocks that occurred in the same time period, and the combined impacts of all the shocks. As shown in section 2, the earliest shock was the appreciation of the Canadian dollar, which began in mid-2002 and peaked in mid-2007. This was followed by the sudden increase in feed price in early 2007 until mid-2008. The global economic recession began in late 2007 and ended in mid-2009, and the final rule of COOL came into effect in the first quarter of 2009 following an interim rule that had been introduced on September 30, 2008. Thus it seems reasonable to concomitantly simulate the impacts of exchange rate appreciation and feed price escalation, and of economic recession and COOL. In spite of the shocks having different durations, comparison is made possible by calculating each shock's average impact for the time period in which it occurred[5]. Also, Rude, Wang and Unterschultz (2010) note that although both exchange rate appreciation and feed price increase occurred before differentiation of the beef market, the use of a differentiated product model provides an empirically consistent approach for comparing all shocks.

To simulate the impact of shocks, we need an estimate of the magnitude of each shock in each time period. This requires creating a new time path for each exogenous variable related to a particular shock. An incremental approach is used whereby the percentage change in the

[5] For COOL, we assume that the different economic agents along the market chain began adjusting to it as early as 2005. As such, its average impacts are calculated over a four-year period.

exogenous variable from one year to the next in the shock period is added to a baseline value (value of exogenous variable prior to the shock).

The impact of the economic recession is modeled as a 4.3% and 3.3% reduction in U.S. and Canadian per capita income, respectively. In addition, income shocks from major importers of U.S. and Canadian beef, namely, Mexico, Japan, and Hong Kong, are accounted for; each importer's beef income elasticity is used to compute reductions in import demands for beef from U.S. and Canada. The impacts of a stronger Canadian dollar are captured through changes in the exchange rate variable. This also necessitates adjusting Canadian feed prices to remove the effect of exchange rates.

Simulating the impacts of mandatory COOL necessitates several assumptions. First, we assume U.S. feedlot operators and beef processors will continue to import Canadian live cattle, but because they now face additional costs of complying with COOL, they will factor these costs into their procurement price. Informa Economics Inc. (2010) estimates indicate that U.S. plants accepting only U.S. cattle will incur an additional $0.25 per head, while those accepting Canadian cattle will incur between $10 and $18 per head. Importers of feeder cattle, however, will incur a substantially smaller total dollar pay out in additional costs (Informa Economics, Inc). To use these costs in our simulation model, we convert them to their per hundredweight equivalent by dividing them by the average weight of a live animal, and incorporate them into U.S. demand functions for own fed and for Canadian feeder and fed cattle. Also, retailers of one or more beef labels will incur $0.15 – $0.17 per lb.

Second, we assume an autonomous decline in U.S. imports of Canadian beef, and feeder and fed cattle. Regarding beef imports, we assume a decline of 15%. CanFax (2009) reports on changes due to COOL in the procurement policies of various U.S. plants importing Canadian cattle. For instance, Cargill decided it would import only feeder and cull cattle, and would have at least 70% of its beef meeting the "Category A" labeling standard by January 2009. On the extreme end is National Beef, which has completely ceased accepting any Canadian live cattle at their two plants. Therefore it appears that in the long-run, some plants will completely stop importing Canadian cattle, while others will import only cull cattle and/or feeder and fed cattle, but with fed cattle to be slaughtered on specific days. We account for these changes in procurement policies by simulating three scenarios: 25%, 35%, and 45% autonomous reductions in cattle imports[6].

The third assumption concerns the expansion of Canada's slaughter capacity as it becomes increasingly hard to export cattle to the U.S. Determining the extent to which slaughter capacity has expanded in response to COOL is a challenge considering that since the outbreak of BSE in 2003 and the subsequent border closures, the government has been facilitating the industry to achieve the long-term goal of processing 100% of the country's livestock production (Agriculture and Agri-Food Canada, 2005). Two of the country's largest beef packers, XL Foods and Cargill Meat Solutions, have, with assistance from the provincial and federal governments, recently embarked on capacity expansion, with the former aiming to double the capacity of its Lakeside plant in Brooks, and the latter aiming to improve operational efficiency at its High River plant. Considering that federally inspected slaughter increased by 2.2% from 3.14 million head in 2009 to 3.21 million head in 2010 (Canadian Meat Council, 2010), we assume a modest 2 to 4% increase in domestic slaughter capacity.

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[6] USDA data on imports of Canadian cattle by destination are used to obtain an estimate of the reduction in imports into the states in which the beef packing plants in the CanFax (2009) report are located. Between January and June 2009, combined feeder and fed cattle imports declined by 45% compared to the same period in 2008. We take this to be the largest probable decline in cattle imports.

The fourth assumption is about the willingness of U.S. consumers to pay a price premium for beef labeled by country of origin. As seen in section 2, empirical literature on the issue is inconclusive. Consequently, we hypothesize that COOL does not lead to an increase in demand for both U.S. and Canadian beef and therefore consumers will not pay a premium for it.

5. Results

The average impacts of the four exogenous shocks on the beef cattle industries, which are calculated as absolute and percentage changes in the endogenous variables relative to their baseline values, are provided in tables 5.1 – 5.3. Generally, COOL and the hike in feed prices have had the largest negative impacts on the Canadian beef cattle industry. The impacts of a stronger Canadian dollar are quite significant too, whereas impacts of the economic recession are relatively minimal. For the most part, impacts on the U.S. beef cattle industry are negligible.

Table 5.1 shows that on average, exchange rate appreciation alone causes a decline in cull cattle and fed and feeder cattle exports to the U.S. by 25% and 4%, respectively, which in turn will drive down Canadian cull cow prices by 6%, fed steer prices by 6%, and feeder steer and beef prices each by 5%. Changes in the U.S. market due to a stronger Canadian dollar are insignificant.

Feed price escalation increases Canadian feeder and fed steer prices each by an average of 3%, and cull cow prices by 2%. Subsequently, Canadian beef prices will increase by 2%. This will lead to a 1% reduction in the demand for fed cattle, and an equal reduction in demand for beef. The largest impact, however, will be a 31% reduction in U.S. import demand for Canadian cull cattle because of the large sensitivity of cull cow imports to the Canadian cull cow price. In the U.S. market, higher feed prices cause fed and feeder steer prices to increase by 2% and 3%, respectively, which will then decrease the demand for slaughter cattle by 2%. The increase in the price of fed and feeder cattle will be passed on to consumers as a 2% increase in the price of U.S. beef, hence a reduction in demand for U.S. beef. Also, the increase in the price of Canadian beef means that there will be a drop in the demand for Canadian beef in the U.S. market.

Table 5.1: Average impacts of exchange rate appreciation, feed price escalation, and economic recession on the beef cattle industry

		Exchange Rate Appreciation		**Feed Price Escalation**		**Economic Recession**	
		Unit Δ	% Δ	Unit Δ	% Δ	Unit Δ	% Δ
Canada							
Cull cattle supply	000 head	-5	-1	-6	0	0	0
Cull cattle demand	000 head	-3	0	-2	0	-2	0
Cull cattle exports to U.S	000 head	-3	-25	-4	-31	3	1
Cow price	$/cwt	-2	-6	1	2	0	-1
Slaughter cattle supply	000 head	-2	0	-54	-2	-1	0
Slaughter cattle demand	000 head	22	1	-32	-1	-9	0
Feeder & fed cattle exports to U.S	000 head	-24	-4	-22	-2	8	1
Fed steer price	$/cwt	-5	-6	3	3	-1	-1
Feeder steer price	$/cwt	-6	-5	4	3	-1	-1
Beef supply	000 tonnes	7	1	-12	-1	-4	0
Beef demand	000 tonnes	23	2	-8	-1	-10	-1
Beef price	$/kg	0	-5	0	2	0	-1
U.S.							
Cull cattle supply	000 head	-1	0	-14	0	1	0
Cull cattle demand	000 head	-4	0	-18	0	4	0
Cow price	$/cwt	0	0	0	0	0	0
Slaughter cattle supply	000 head	2	0	-417	-2	-5	0
Slaughter cattle demand	000 head	2	0	-417	-2	-5	0
Fed steer price	$/cwt	0	0	2	2	0	0
Feeder steer price	$/cwt	0	0	3	3	-1	-1
Beef supply	000 tonnes	-1	0	-165	-1	-1	0
Demand for U.S. beef	000 tonnes	-1	0	-166	-1	56	0
Demand for Canadian beef	000 tonnes	-16	-4	-5	-1	7	2
Beef price	$/kg	0	0	0	2	0	-1

We now turn to the isolated impacts of mandatory country of origin labeling. The actual costs of implementing mandatory country of origin labeling at each market level coupled with changes in U.S. packer procurement policies causes a reduction in U.S. imports of Canadian live cattle. This creates an excess supply of slaughter cattle, which cannot be sufficiently offset by a 2 – 4% increase in domestic slaughter capacity, hence a reduction in cattle prices offered by processors. It can be discerned from table 5.2 that country of origin labeling has disproportionately large negative impacts on the Canadian beef cattle industry relative to the U.S. Moreover, for most of the endogenous variables, the difference in impacts across scenarios are not as great as the changes in cattle import reductions from one scenario to another, implying that the impacts of COOL are generally not so sensitive to the size of the autonomous reduction in U.S. imports of Canadian cattle.

In the first scenario, Canadian prices of cull cattle, fed steers, feeder steers, and beef drop by 25%, 27%, 31%, and 21%, respectively, following a 27% decline in feeder and fed cattle exports to the U.S. At lower prices, there will be an increase in domestic and U.S. demand for cull cattle by 1% and 27%, respectively, fed cattle by 10%, and beef by 11%. Losses in margins and profits will cause producers to increase their culling rates by 7% (hence an increase in beef supply), while cutting back on supply of slaughter cattle by 3%. The impacts of COOL on the industry are largest in this scenario.

In the same scenario, COOL produces relatively less movements in endogenous variables within the U.S. market. Following the influx of Canadian cull cattle, U.S. cull cattle prices will decline by a mere 1%. The substitution between Canadian and U.S. beef and the unwillingness by consumers to pay a price premium for the differentiated beef implies that the reduction in Canadian beef prices will exert a downward pressure on the latter’s price, equivalent to a 5%

reduction. Beef processors will pay a lower price on fed cattle, and in turn, feedlot operators will reduce their offer price for feeder cattle. However, there will be no significant impacts on equilibrium quantities of beef and cattle.

Table 5.2: Average impacts of mandatory COOL on the beef cattle industry

		45% reduction in U.S. cattle imports		35% reduction in U.S. cattle imports		25% reduction in U.S. cattle imports	
		Unit Δ	% Δ	Unit Δ	% Δ	Unit Δ	% Δ
Canada							
Cull cattle supply	000 head	76	7	58	5	40	4
Cull cattle demand	000 head	7	1	0	0	-7	-1
Cull cattle exports to U.S	000 head	69	27	58	23	47	18
Cow price	$/cwt	-11	-25	-9	-21	-8	-17
Slaughter cattle supply	000 head	-93	-3	-78	-2	-62	-2
Slaughter cattle demand	000 head	254	10	175	7	95	4
Feeder & fed cattle exports to U.S	000 head	-347	-27	-252	-20	-157	-12
Fed steer price	$/cwt	-24	-27	-21	-23	-17	-19
Feeder steer price	$/cwt	-32	-31	-27	-26	-22	-21
Beef supply	000 tonnes	95	8	63	5	32	3
Beef demand	000 tonnes	107	11	92	9	78	8
Beef price	$/kg	-2	-21	-2	-18	-1	-15
U.S.							
Cull cattle supply	000 head	43	1	42	1	41	1
Cull cattle demand	000 head	112	3	100	2	88	2
Cow price	$/cwt	-1	-1	-1	-1	-1	-1
Slaughter cattle supply	000 head	-80	0	-78	0	-76	0
Slaughter cattle demand	000 head	-80	0	-78	0	-76	0
Fed steer price	$/cwt	-3	-3	-3	-3	-2	-3
Feeder steer price	$/cwt	-4	-3	-4	-3	-4	-3
Beef supply	000 tonnes	12	0	9	0	5	0
Demand for U.S. beef	000 tonnes	12	0	9	0	5	0
Demand for Canadian beef	000 tonnes	-12	-3	-29	-8	-46	-12
Beef price	$/kg	0	-5	0	-4	0	-4

In scenarios 2 and 3, Canadian exports of feeder and fed cattle decline by 20% and 12%, respectively. The less the autonomous reduction in cattle imports, the smaller will be the change in all endogenous variables, or the less will be the negative impact of COOL. However, changes in endogenous variables in one scenario are not dramatically different from the changes observed in the preceding scenario in both markets[7]. This suggests that any COOL-induced changes in U.S. packer procurement policies combined with COOL-specific implementation costs will have a considerable negative impact on the competitiveness of the Canadian beef cattle industry.

The interactions between and among shocks are analyzed and the results summarized in table 5.3. When exchange rate appreciation is interacted with the surge in feed prices, impacts are tempered. For instance, Canadian prices will decrease by 2% for cull cattle, 2% for fed cattle, and by 1% for beef, and there will hardly be any changes in equilibrium quantities except for cull cattle exports to the U.S., which will decline by 7%. This may be due to the simultaneous reduction in U.S. import demand for Canadian beef and cattle, and the supply of fed cattle in both countries. The combined impacts of mandatory COOL and the economic recession are for the most part similar to the isolated impacts of COOL because of the minimal impact of the latter. The economic recession lasted less than two years, and the associated decline in consumer incomes would decrease Canadian demand for beef by 1%, and subsequently the price of beef, fed, feeder, and cull cattle each by 1% as shown in table 5.1.

Results from the simultaneous simulation of the impacts of all four shocks closely mimic scenario 1 impacts of mandatory country of origin labeling. This is a rough indication that COOL has been the most important exogenous shock to the Canadian beef cattle industry in recent times. To ascertain this, we evaluate the relative importance of each shock by calculating the

[7]An exception is the change in demand for Canadian beef in the U.S. market; bigger reductions are obtained with each successive scenario, which is a result of holding constant the assumed autonomous reduction in beef imports across scenarios.

change in producer gross margins as a summary measure of welfare change. This is done only for the Canadian industry since impacts on the U.S. industry are relatively small.

Table 5.3: Combined average impacts of shocks to the beef cattle industry

		Exchange rate appreciation & feed price increase		COOL[8] & economic recession		All shocks	
		Unit Δ	% Δ	Unit Δ	% Δ	Unit Δ	% Δ
Canada							
Cull cattle supply	000 head	-1	0	77	7	76	7
Cull cattle demand	000 head	0	0	5	1	6	1
Cull cattle exports to U.S	000 head	-1	-7	72	28	70	27
Cow price	$/cwt	-1	-2	-12	-30	-13	-28
Slaughter cattle supply	000 head	-1	0	-94	-3	-92	-3
Slaughter cattle demand	000 head	4	0	245	9	242	9
Feeder & fed cattle exports to U.S	000 head	-8	-1	-339	-26	-334	-26
Fed steer price	$/cwt	-1	-2	-25	-28	-27	-30
Feeder steer price	$/cwt	-2	-2	-33	-32	-35	-34
Beef supply	000 tonnes	2	0	91	7	90	7
Beef demand	000 tonnes	7	1	97	10	106	11
Beef price	$/kg	0	-1	-2	-23	-2	-24
U.S.							
Cull cattle supply	000 head	-3	0	44	1	24	1
Cull cattle demand	000 head	-4	0	116	3	94	2
Cow price	$/cwt	0	0	-1	-1	0	-1
Slaughter cattle supply	000 head	-124	0	-85	0	-703	-3
Slaughter cattle demand	000 head	-124	0	-85	0	-703	-3
Fed steer price	$/cwt	1	1	-3	-3	0	0
Feeder steer price	$/cwt	1	1	-4	-4	1	0
Beef supply	000 tonnes	-48	0	12	0	-232	-2
Demand for U.S. beef	000 tonnes	-48	0	68	1	-176	-2
Demand for Canadian beef	000 tonnes	-5	-1	-5	-1	-14	-4
Beef price	$/kg	0	1	-1	-5	0	-2

[8] For this and the next scenario (in which all shocks are combined), we assume a 45% COOL-induced reduction in U.S. demand for Canadian feeder and fed cattle.

Here, gross margin is taken to be the value of a slaughter animal less feed costs. Multiplying the gross margin per animal by total marketings gives total revenue less feed costs. We calculate the change in revenues for each individual shock and for all shocks combined, and then obtain the percentage contribution of each shock to the overall change in revenues.

We find that on average, 25% of the decline in Canadian producer revenues net of feed costs was caused by the appreciation of the Canadian dollar, 32% was due to feed price escalation, and 5% is associated with the economic recession. The remaining 38% is attributable to mandatory country of origin labeling. There are other studies that have also found the impacts of exchange rate appreciation to be considerable. For instance, in comparing the impact of exchange rates with that of the BSE crisis, Schaufele et al. (2009) find that Canadian cattle producers lost about 10.75% in net worth because of exchange rate appreciation compared to only 0.65% due to BSE. On the flipside, a much earlier study by Coleman and Meilke (1988) reveals that exchange rate depreciation has a significant positive impact on Canada's net beef exports. When undertaking an analysis similar to ours but for the Canadian hog and pork industry, Rude, Wang and Unterschultz (2010) find that, on average, 23% of the decline in producer revenue was due to exchange rate appreciation.

Increase in feed prices has the second largest impact on the welfare of Canadian cattle producers. Biofuel mandates remain in place in U.S. and Canada, and therefore feed prices are likely to remain high for the long haul. To cope with this shock, the industry needs to innovate; increasing feed efficiency and incorporation of distillers grains in feed rations may both be viable solutions in the short- and long-run.

The 38% reduction in producer welfare associated with mandatory country of origin labeling demonstrates the growing concern that the industry has about the law. Not only is this impact substantially large, it is likely to be felt for a longer time considering that the law is a lasting trade policy instrument. This is unlike the other three shocks, which are basically market shocks to which the industry has, to a certain extent, adjusted too already. Moreover, while exchange rate appreciation, feed price escalation, and the economic recession all seem to have peaked, mandatory country of origin labeling is a relatively new law, and U.S. packers could still alter their procurement policies for Canadian cattle and beef in ways that more adversely impact the Canadian beef cattle industry than they do now.

6. Conclusion

This study seeks to investigate the impacts that four shocks, namely, mandatory country of origin labeling, exchange rate appreciation, feed price escalation, and the economic recession have had on the competitiveness of the Canadian and U.S. beef cattle industries. Results indicate that the shocks have impacted both industries, but their impacts on the U.S. industry are relatively minimal. Whereas the impact of the economic recession is almost negligible, mandatory country of origin labeling, feed price escalation, and exchange rate appreciation have had substantially large impacts on the Canadian industry.

Although the impact of exchange rate appreciation appears to be large, it is likely that Canada's beef cattle industry will somehow adjust to the shock. Moreover, a stronger Canadian dollar implies cheaper imports of inputs. Adjustment to higher feed prices will necessitate new technological innovations that will lead to more cost-effective and efficient feed rations. Mandatory country of origin labeling, however, will have even far greater impacts in the foreseeable future. It is a relatively new law but permanent. In this study, simulation of its impacts has been based on what is currently thought to be the minimum implementation costs, changes in Canada's beef processing capacity, and changes in U.S. packer procurement policies.

More analysis of its impacts and potentially viable responses will be necessary as new and better information becomes available. Specifically, it will be insightful to determine the minimum increase in domestic slaughter capacity that would be sufficient to offset its impacts. Additionally, the impacts of COOL have demonstrated the risk associated with over-reliance on a single export market, however large it may be. In essence, COOL has provided the Canadian beef cattle industry with an opportunity to search for other off-shore markets.

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