Evaluating the Economic Benefits From the Canadian Beef Check-Off

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Executive Summary

Since 2002, the Canadian Beef Cattle Research, Market Development and Promotion Agency (NCO agency) has been responsible for the national check-off program for beef cattle in Canada. Where agreements exist between the NCO agency and provincial beef agencies, the mandatory national levy of $1 per head on domestic cattle sales is collected by the provincial agency and remitted to the NCO agency. The NCO agency distributes the funds to the respective divisions that manage beef cattle marketing and research activities, while the Canadian Cattlemen's Association is contracted for administration. Canada's national cattle check-off generates approximately $8.2 million annually. While the establishment of the NCO was seen as a significant step toward growing the market for Canadian beef and increasing the economic benefits flowing to Canadian cattle producers, concerns have arisen that the check-off does not provide adequate funding for beef and cattle marketing and research activities.

This document reports results from a research project that evaluated the impact of check-off-funded marketing and research activities on the economic well-being of Canadian beef cattle producers. The analysis focused on three core questions:

- What is the historic producer return to investment in marketing and research activities?
- How can the allocation of check-off funds be optimized across marketing and research activities?
- What impact does optimizing check-off fund investment in marketing and research activities have on the economic well-being of Canadian cattle producers?

An environmental scan of other beef and pork check-off programs revealed that check-off levies vary considerably. While countries with a high dependence on exports — such as New Zealand, Australia and Canada — have not applied levies to imports, U.S. check-off programs for beef and pork do apply their respective levies to meat imports. The focus of a country's check-off program also reflects the importance of either the domestic or export market to the growth and competitiveness of the industry. Countries with a high degree of export dependency (e.g., Canada, Australia and New Zealand) focus their check-off funds on export marketing activities, while U.S. beef and pork programs focus their efforts on the U.S. domestic market.

A review of previous studies that evaluated the benefits arising from investing check-off funds revealed that benefit-cost ratios (the ratio of producer benefits attributed to investment in marketing or research to the value of the investment) tend to be higher for investment in production research, followed by export marketing activities and, lastly, by domestic marketing activities. Differences in these BCRs reflect the long duration of benefits arising from investment in production research activities, the targeted nature of export marketing activities, and the diffuse nature of many domestic marketing activities. As well, results from previous studies suggest that it may be preferable to focus efforts on export market promotion and production research, rather than domestic promotion, especially when the domestic price is not appreciably influenced by the volume of trade.

The analysis in this study uses an econometric simulation model that mimics the beef and cattle markets in Canada and the U.S. This model explicitly accounts for the impact that Canadian cattle-producer investment in beef cattle marketing and research activities has on prices and quantities in these markets. The model enables one to calculate retail and farm-level prices for beef and live cattle,

respectively; final consumer demand for beef; production of beef; packer demand for cattle; supply of fed and non-fed cattle; and beef and cattle trade for a baseline situation and a variety of "what-if" scenarios. The baseline situation reflects what actually happened in these markets and is used as the basis of comparison for the "what-if" scenarios. The "what-if" scenarios allow one to determine the retail and farm-level prices and quantities that would result if investment in marketing and research activities was different from the actual level of investment. Once these prices and quantities are determined, they are used to calculate producer benefits associated with the respective "what-if" scenario and compared to the baseline producer benefits. Cattle producer benefits are defined as gross revenue from the sale of cattle minus variable cost of production, and are measured at a national market level.

Analysis with this model showed that Canadian cattle producers gain net economic benefits from investment in marketing and research activities. Specifically, between 2005 and 2008 the BCR associated with the investment of producer check-off dollars in marketing and research activities grew from 7:1 to 11:1, with an average BCR of 9:1 over this time period. **This means that on average from 2005 to 2008, every check-off dollar invested in marketing and research activities earned $9 for Canadian cattle producers**. As well, by 2008 the return to the average dollar invested slightly exceeded the return to the average dollar invested prior to the BSE-crisis.

Nevertheless, subsequent analysis showed **there has been under-investment of check-off dollars in marketing and research**. Results show that investing one additional dollar in marketing and research activities yields anywhere between $9 and $15 in additional producer benefits. Had investment been optimal, this marginal investment should have yielded one additional dollar in producer benefits. This means **there has been under-investment in marketing and research activities, and investment in these activities should increase in order to maximize producer benefits**. Moreover, the extent of this under-investment has been larger for research activities than for marketing activities.

A natural question to ask is whether the allocation of check-off funds to marketing and research activities can be optimized. Ignoring NCO administration costs, the historic ratio of investment in marketing to investment in research is 93:7 (i.e., 93 per cent to marketing, 7 per cent to research). Analysis was undertaken to measure the impact of varying this ratio from 90:10 to 50:50, all the while holding constant the total funds available for investment. Results show that a 90:10 split in marketing-to-research investment can generate an additional $17 million in producer benefits, while a 50:50 split can generate $76 million in additional producer benefits. **While both marketing and research suffer from under-investment, reallocating check-off funds from marketing to research would increase Canadian cattle producer benefits.**

Lastly, the impact of possible check-off refund requests by Alberta cattle producers was explored. Given the sizable amount of cattle sales in Alberta, it is important to recognize that refund requests by Alberta cattle producers would impact the national industry's ability to invest in marketing and research activities. Assuming the refund requests made by Alberta cattle producers are not channeled into other marketing and research activities, results showed that **every dollar refunded will cost Canadian cattle producers $11 in economic benefits**. Depending on the size of the refund, the reduction in Canadian cattle producer benefits could range anywhere between $13 million (with a 40 per cent refund rate) and $23 million (with a 70 per cent refund rate).

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1. Introduction

In 1992, the Canadian Parliament passed Bill C-54. This bill gave the National Farm Products Council the responsibility to oversee national promotion and research agencies created under the Farm Products Agencies Act. The Canadian Beef Cattle Research, Market Development and Promotion Agency — the national check-off (NCO) agency — was established in 2002. The NCO agency collects check-off levies applied to the domestic sale of live cattle. The resulting pool of funds provides financing for marketing and research activities intended to expand the market and increase sales of Canadian beef.

While the establishment of the NCO agency was heralded as a significant step forward in growing the market for Canadian beef, a number of external pressures and events have had a negative effect on Canada's beef sector. The discovery of BSE-infected bovine animals in Canada in 2003 resulted in the closure of borders to Canadian beef and, importantly, the closure of the U.S. border to exports of live Canadian cattle. More recently, rising commodity prices have squeezed cattle producer margins through rising feed prices. As well, recent fluctuation in the Canada-U.S. exchange rate had a negative effect on the competitiveness of Canadian beef and live cattle exports. These adversities underscore the importance of the beef cattle check-off and related activities.

Indeed, investment in marketing and research activities has the potential to increase the economic benefits flowing to Canadian cattle producers. However, concerns have arisen that the check-off does not provide adequate funding for beef and cattle marketing and research activities. The purpose of this research project is to evaluate the impact of historic NCO-funded expenditures on the economic well-being of Canadian beef cattle producers. The analysis focuses on three core questions:

- What is the historic producer return to investment in marketing and research activities?
- How can the allocation of check-off funds be optimized across marketing and research activities?
- What impact does optimizing check-off fund investment in marketing and research activities have on the economic well-being of Canadian cattle producers?

This report provides an environmental scan of producer check-off programs in Canada and competing jurisdictions. The environmental scan documents the context and institutional arrangements underlying producer-funded activities in these competing jurisdictions, with a primary focus on beef and pork. Next, the report provides a review of the published literature on the effectiveness of check-off program expenditures and insight into optimal levels of investment, particularly for domestic and export marketing activities and cost-of-production research. The purpose of the review is to summarize and assess the range of research and empirical findings. We do not offer detailed methodological discussions or comparisons but do provide some context on challenges and important considerations in this type of research.

Next, the report contains a brief description of the econometric simulation model used to undertake the analysis. Attention is focused on the scope and features of the model, a brief discussion of how the model works and a review of the important economic variables. More detailed information about the model can be found in Appendix 1. Discussion then moves to the analysis of the various policy scenarios considered here. Four different aspects are discussed: the economic benefits associated with historic check-off fund investment in marketing and research activities; the benefits associated with incremental

investment in marketing and research activities; optimizing investment in marketing and research activities; and lastly, the potential impact of refund requests by Alberta cattle producers. In all cases, attention is focused on the economic benefits accruing to Canadian beef cattle producers.

2. Environmental Scan: An Overview of Meat Producer Check-Off Approaches

This section provides an overview and comparison of check-off programs used to fund marketing and/or production research programs. The focus will be on meat producers in jurisdictions that compete with Canadian beef. The intention is to provide insight into the institutional structure of the levies used in these other programs, how these levy funds are allocated and any recent reviews of the respective programs.

2.1 Canada – Beef

Beef producers in Canada pay provincial and national levies. The provincial check-offs vary by province, with the provincial component of the check-off being allocated to support the respective provincial association's activities. Where agreements between the NCO agency and provincial beef agencies are in place, the mandatory national levy of C$1 per head on domestic sales is collected by the provincial agency and remitted to the NCO agency. The NCO agency allocates the funds while the Canadian Cattlemen's Association is contracted for administration. The NCO generates approximately $8.2 million annually.[2]

Note that the NCO does not apply to live animals exported from Canada, nor does the levy apply to imported cattle and beef products. In order for the levy to apply to imported products, the program must be national in scope, which means agreements must be in place to implement the levy in all regions of Canada. To date, agreements with the provinces of Quebec and Prince Edward Island are pending. It is estimated that the application of the levy to imported products would generate an additional $800,000 annually[3]. Nevertheless, the recent passing of legislation allowing refunds of the provincial and NCO levy in Alberta (effective April 1, 2010) may hamper efforts to evolve the NCO to a national program. Newfoundland and Labrador have production below the threshold required for national treatment. There also remain a number of details pending in the Atlantic provinces relative to collection of levies on inter-provincial sales and the resulting levy collection.

Table 2.1 provides a summary of check-off value by province. Note that Prince Edward Island is not included as it is still waiting for legislation and establishment of final levy levels. Also note that provinces can target their NCO remittance to marketing and research activities, as reflected in the right-hand column of Table 2.1. The allocation of the levy is presented in Figure 2.1. It is important to note that Beef Information Centre (BIC) investment in domestic marketing activities refers to activities in Canada and the U.S.

[2] Canadian Beef Cattle Research. (2008). 2007/08 Annual Report.

[3] The Canadian Beef Cattle Research, Market Development and Promotion Agency. (2008). "National Beef Check-Off Backgrounder."

Table 2.1: National and provincial levy rates for Canada

Province	Provincial levy per transaction	Remittance to NCO	Allocation
British Columbia	$2.00	$1.00	95% to marketing, 5% to research
Alberta	$3.00	$1.00	90% to marketing, 10% to research
Saskatchewan	$2.00	$1.00	90% to marketing, 10% to research
Manitoba	$3.00	$1.00	86% to marketing, 5% to research, 9% to Manitoba research
Ontario	$3.00	$1.00	95% to marketing, 5% to research – portion of funds rebated for veal
Quebec	$2.00 for beef and veal for sale plus $165 annually per enterprise $6.04 for culled cows $5.04 for bob calves		Not yet negotiated
New Brunswick	$3.00	$1.00	All allocated to marketing
Nova Scotia	$2.00	$1.00	All allocated to marketing

Source: Canadian Beef Research 2008 and Federation des producteurs de boivins du Quebec 2006

The BIC is responsible for marketing activities for Canadian beef in Canada and the U.S. The BIC works towards market objectives relative to product perception, quality and consistency, convenience and food safety. The BIC has also invested in the development of the commercial beef market and the protection of the Canadian beef sector's share of the overall market.

The Canada Beef Export Federation (CBEF) is responsible for the promotion of Canadian beef outside Canada and the U.S. It is important to note that the CBEF is able to lever its allocation of check-off funds with funds from existing federal government programs. In addition, the CBEF also receives funding from membership fees and other non-check-off funds. The focus of CBEF activities includes local market representation and promotion, Canadian beef branding and strategic market research.

The Beef Cattle Research Council (BCRC) co-ordinates investment in research funded by the NCO agency. BCRC funding is used to leverage additional research investment (at an estimated rate of 5.7:1[4]). In addition to research funding, the BCRC supports training and awareness through its on-farm food safety quality assurance programs.

[4] Canadian Beef Cattle Research. (2008). 2007/08 Annual Report.

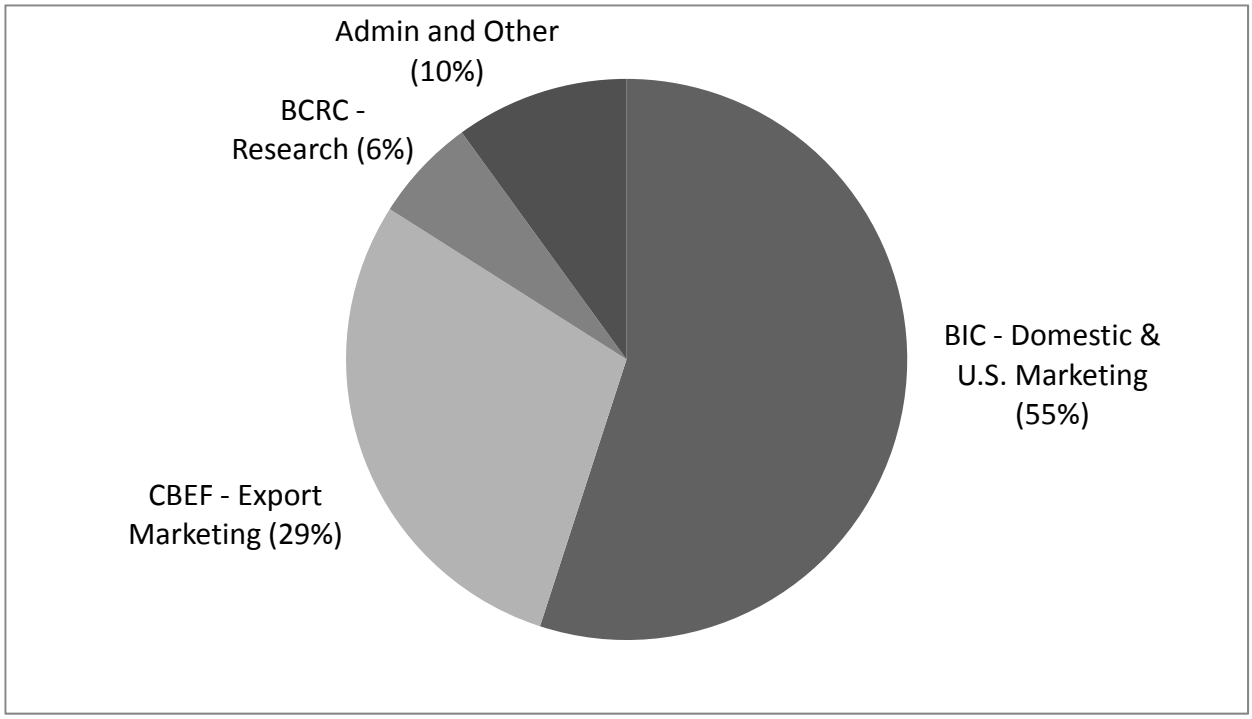

Figure 2.1: Allocation of the NCO levy

2.2 Australia - Beef

Beef producers in Australia pay the Australian Cattle Transaction Levy (ACTL). This levy has two components: a A$5 (Australian dollar) levy per head when grain-fed and grass-fed beef cattle are sold and a A$0.90 levy per bobby calf (a male dairy calf sold for veal). The ACTL is a mandatory levy with no option for refund. As well, the ATCL does not apply to imports. The levy is collected by the Australian Agriculture Department and disbursed to the relevant agencies.

Three agencies receive funds collected via the ACTL: Meat and Livestock Australia (MLA), Animal Health Australia (AHA) and the National Residue Survey (NRS). AHA oversees animal health, safety and quality issues in Australia, while NRS monitors for the presence of agricultural and veterinary chemicals. MLA manages check-off fund expenditures and administers programs for beef and other red meat producers. The majority of the ACTL goes to fund research and development (R&D) and marketing activities undertaken by MLA for Australian cattle producers. The current levy for beef is broken down in Table 2.2, while expenditures are shown in Figure 2.2. The current ACTL generates approximately A$64 million annually.

It is important to note that the allocation of the check-off levies vary by production system (i.e., grass-fed versus grain-fed cattle). As well, the current levies reflect a change to the check-off rates in 2006. Table 2.3 shows the pre-2006 check-off levies. While there was an overall increase of A$1.50 per head in 2006, the allocation to the various programs under the MLA's responsibility changed. In particular, the grain-fed cattle sector increased the amount of the total levy allocated to marketing but decreased the amount allocated to research and development. Nevertheless, there was a temporary increase in the allocation to research and development to replenish the fund for grain-fed research.

Table 2.2: Australian beef cattle levy allocation

	R&D (MLA)	Marketing (MLA)	Animal Health Australia	National Residue Survey	Total
Grass-Fed Cattle	$0.92	$3.66	$0.13	$0.29	$5.00
Grain-Fed Cattle	$1.17	$3.41	$0.13	$0.29	$5.00
Bobby Calves	$0.16	$0.48	---	$0.26	$0.90

Source: Beef Marketing Funding Committee 2009

Table 2.3: Australian beef cattle levy allocation: pre-increase

	R&D (MLA)	Marketing (MLA)	Animal Health Australia	National Residue Survey	Total
Grass-Fed Cattle	$0.92	$2.16	$0.30	$0.12	$3.50
Grain-Fed Cattle	$1.57	$1.51	$0.30	$0.12	$3.50
Bobby Calves	$0.16	$0.48	---	$0.26	$0.90

Source: Beef Marketing Funding Committee 2009

The following elements of the Australian program are worth noting:

- The research and development funds are matched dollar for dollar to leverage research projects.
- There is also some matching from industry organizations within the domestic marketing activities of the MLA.
- There is a partnership with exporter groups to support market development for live cattle to nearby southeast Asian countries.
- The marketing component is allocated to both domestic and export market development.

The Australian beef levy underwent a review, which was completed in 2009 (Beef Marketing Funding Committee 2009). The report recommended that the current A$5 per head value be continued. The independent review commissioned by the committee (Warrick Yates and Associates 2009) found that the A$1.50 increase in the levy generated an estimated average return of 5:1. The committee recommended a minimum return of 3:1 for any future reviews of the check-off levy. In the fall of 2009, Australian cattle producers voted to continue the A$5 ACTL.

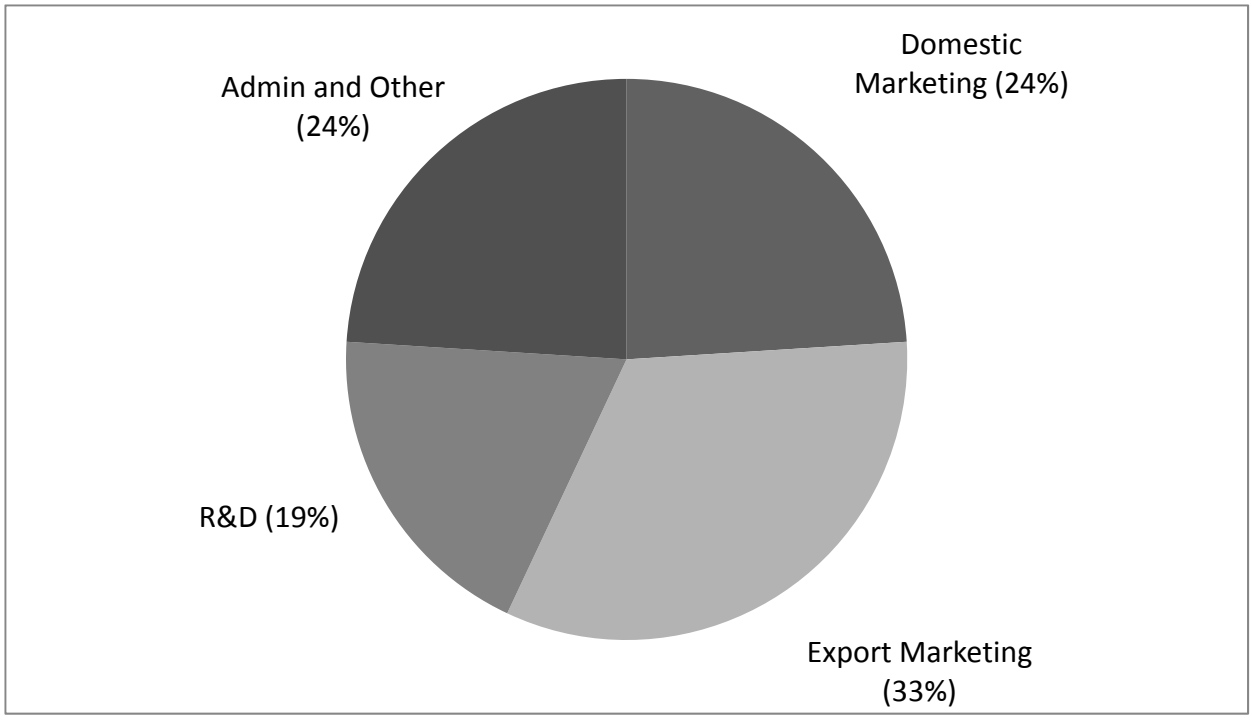

Figure 2.2: Allocation of Australian beef levy

2.3 New Zealand - Beef

New Zealand has a mandatory NZ$3.60 (New Zealand dollar) check-off levy that is charged on beef and dairy cattle sold for slaughter (excluding bobby calves). The levy is collected and managed by Meat and Wool New Zealand (MWNZ), which also administers programs for goats, sheep and wool. The beef component of MWNZ's activities totalled almost NZ$10 million in 2007/08 (Meat and Wool New Zealand 2008), with NZ$8.5 million coming directly from levies and NZ$1.4 million as a grant from the New Zealand Meat Board. The beef levy is primarily allocated to market services, farm productivity and adoption and market access activities. These allocations are presented in Figure 2.3.

MWNZ does not undertake traditional domestic market promotion. However, market services largely entail export promotion activities wherein MWNZ invests to build relationships with key target markets and engages in joint ventures with industry for promotion activities. There are also a number of research activities in this area, notably functional foods development and food processing efficiency. The farm productivity research and adoption program focuses on farm-level productivity research and technology adoption. Market access activities relate to participation and advisory services during the development of free trade agreements.

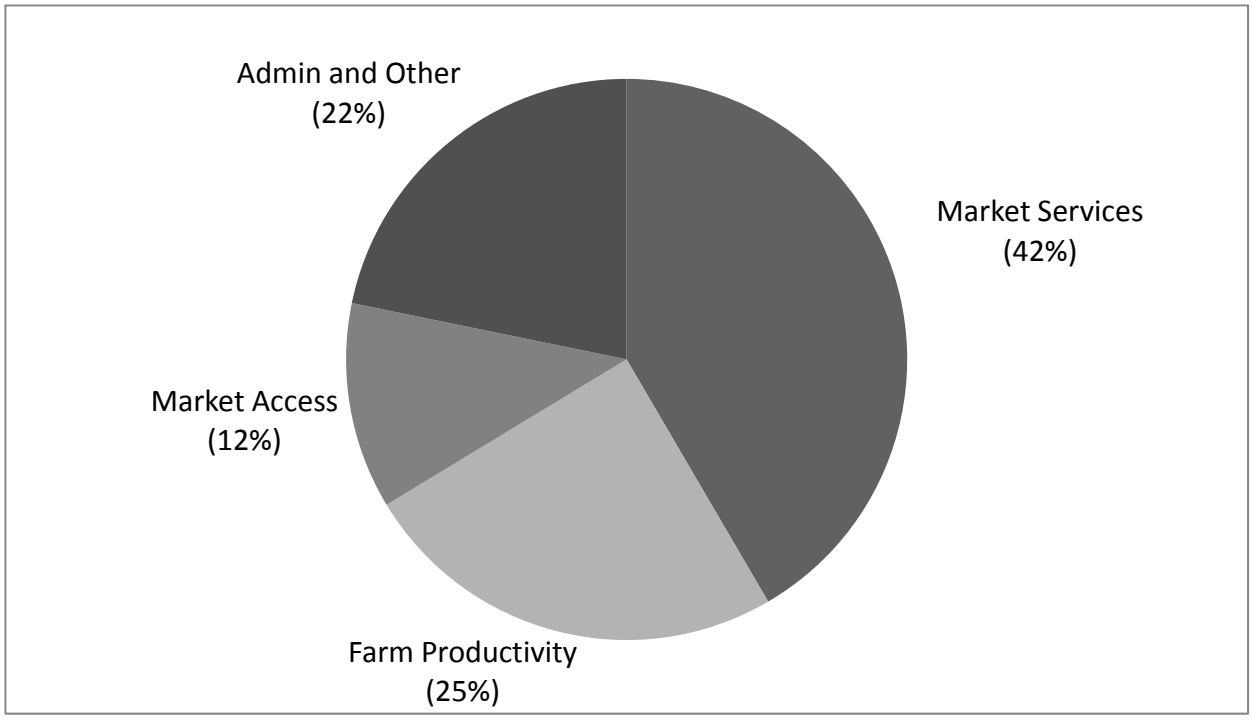

Figure 2.3: New Zealand beef-levy expenditures

While much of the MWNZ efforts are geared to the export market, there are a number of other important domestic initiatives (allocated under the "Admin and Other" section in Figure 2.3), such as skills and education programming and an environmental program. The environmental program primarily focuses on policy development and lobbying with an element of policy analysis as well. The skills and education program has two primary objectives: attracting and developing high-quality individuals to work in the beef sector and educating the non-farm population, primarily school children, about beef production and rural life.

The enabling legislation for the New Zealand check-off requires an annual consultation and input from the stakeholders paying the levy. MWNZ are currently undertaking a strategic review. Moreover, a recent producer referendum led to the passing of a resolution that would see a continuation of and an increase in the mandatory cattle-producer levy to NZ$3.80 per head in 2009/2010 and then to NZ$4.60 by 2014/2015. And while an increase in the mandatory New Zealand sheep-meat producer levy was also carried, motions seeking the continuation of the mandatory producer levies for goat meat and wool were not carried. The latter may have important budgetary consequences for the activities undertaken by MWNZ on behalf of their constituent producers. Specifically, elimination of the wool levy is estimated to remove NZ$6.4 million from MWNZ's annual budget of NZ$30 million.

2.4 United States – Beef

Beef producers in the U.S. are required to pay a mandatory levy of US$1 on every live animal transaction. Moreover, the levy applies to imported animals and at an equivalent rate on imported beef products. Levies are collected at the state level with the allocation between the state and the national programs differing by state. Approved state beef councils obtain remittances from producers and submit 50 per cent to the Cattlemen's Beef Board (CBB), which administers the national funds under the supervision of the USDA. Those states that do not have approved state beef councils submit the entire

amount to the national program. Fifty-six (56) per cent of the total check-off funds go to the national program. The total annual assessments average almost US$82 million annually, with import assessments equalling approximately US$7 million in 2008. The CBB not only administers the funds but also undertakes all of the activities related to the check-off programs. Figure 2.4 presents the allocation of the levy dollars for the 2007 fiscal year.

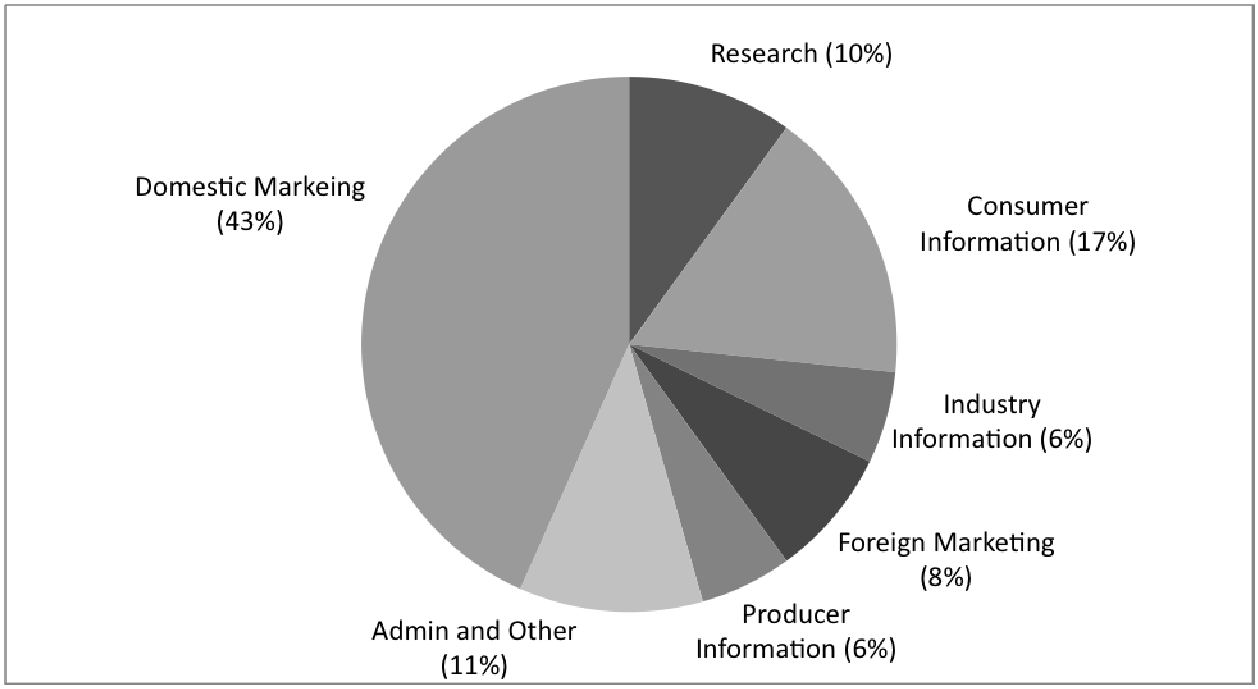

Figure 2.4: U.S. beef-levy expenditures

Domestic promotion activities in the U.S. beef program span a range of initiatives to improve the "image and desirability" of beef and beef products in order to increase demand. The CBB also undertakes programs such as direct consumer advertising (in a variety of media), product development and retail and food service marketing.

The research component of the U.S. beef check-off program is not farm-level production research. While there is a food safety component, the remainder of the research funding is targeted at consumer market research, new product development and human nutrition research. In reality, these activities largely support domestic and export promotion/marketing activities. This is true for the industry and consumer information components as well. The domestic promotion component comprises over 80 per cent of the activities of the CBB.

The U.S. beef check-off program is required to undergo a regular review. The most recent review (Ward 2009) focused on the domestic promotion of beef in the U.S. market and did not consider foreign marketing activities. The study found that the activities increased both the likelihood of purchasing beef (i.e., promotion activities brought new consumers into the market) and the number of times beef was consumed by existing consumers. To gauge whether cattle producers have benefited from the check-off, Ward calculated a marginal benefit-cost ratio (BCR). A marginal BCR shows the ratio of incremental producer benefits **at the market level** arising from one additional dollar of program spending. Producer benefits are maximized when this marginal BCR is 1:1. A marginal BCR that is greater than one indicates the last dollar of program expenditure generated more than one dollar in additional benefits and is a

sign of under-investment, and a marginal BCR that is less than one indicates the last dollar of program expenditure generated less than one dollar in additional benefits and is a sign of over-investment.

Ward (2009) reported a marginal BCR for the 2003-2008 period of 5.55:1. Previous reviews have reported BCRs of 5:1 (Ward and Lambert 1993), 5.67:1 (Ward 2001) and a range from 5.5:1 to 6.5:1 (Ward 2004). Such high BCRs suggest that the U.S. cattle check-off has benefited U.S. cattle producers. Despite this, there have been ongoing legal challenges regarding the constitutionality of the mandatory check-off, but the levy has been upheld to date. A 6-3 decision by the U.S. Supreme Court upheld the check-off in 2005.

2.5 United States - Pork

Swine producers in the U.S. are required to remit a levy of 0.4 per cent of the market value of all hogs sold. This levy applies to every transaction involving live animals. The rate of 0.4 per cent was established in 2004 when it was lowered from 0.45 per cent, a rate established in 1995. The seller is required to remit payment on all sales to the National Pork Board (NPB), which administers all of the funds. The pork levy also applies to imported hogs and pork products, with the importer required to submit reports and remittances to the NPB. The pork levy has historically collected approximately $72 million annually. In 2008, the number was lower, with levies yielding approximately $64 million; importers contributed about six per cent of the total. Each year about $11 million to $14 million is returned to the individual states for local programming.

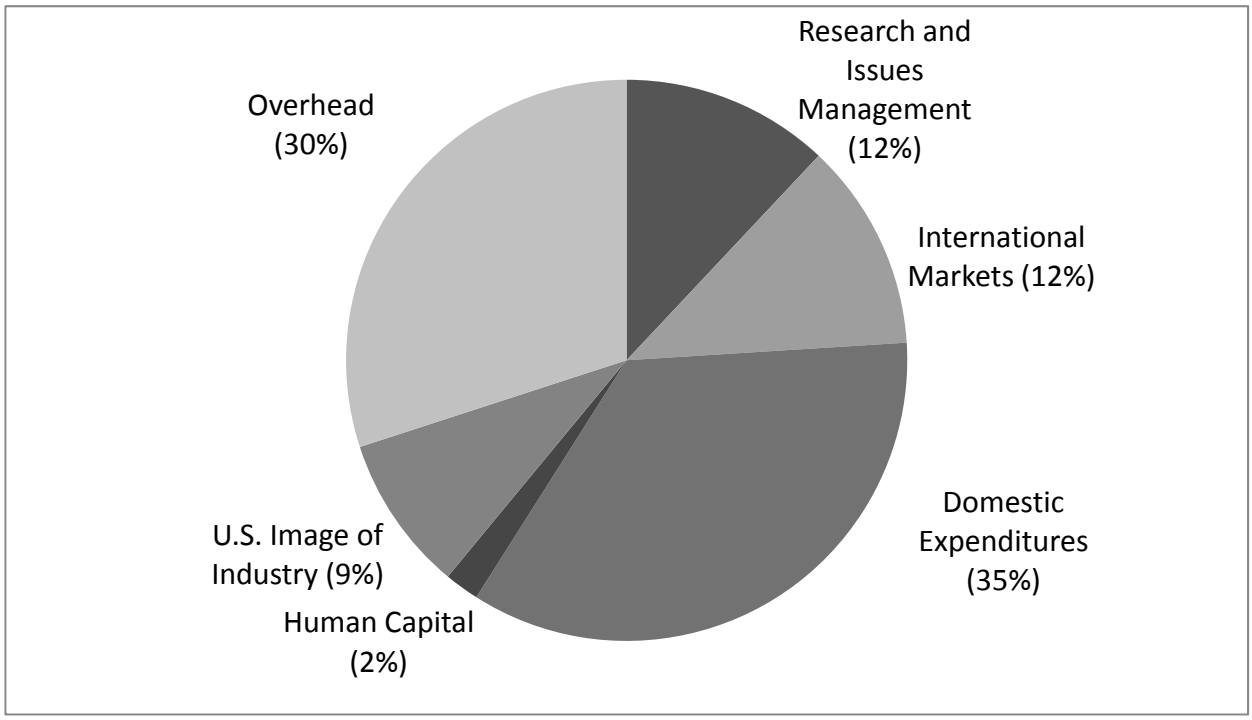

Figure 2.5: U.S. pork-levy expenditures

The NPB not only collects the money but administers the program as well. Figure 2.5 outlines the broad classifications of pork-levy fund investments. In reality, the allocation of the levy to various initiatives is relatively fluid as the NPB regularly identifies priority issues and then undertakes activities specific to those priorities. The critical issues are outlined in an annual strategic plan and include specific

measurable objectives. The 2009 Strategic Plan (National Pork Board 2009) focused on the competitive advantage for U.S. Pork with activities ranging from issues management and farm management insight to production and animal health research.

The NPB undergoes regular review with the most recent one undertaken in 2007 (Beach, Zhen et al. 2007). The review found a marginal BCR of 13.8:1 for all of the expenditures under the program. Specifically they found marginal BCRs of 20:1 on production research, 56:1 on post-farm research, 7:1 on domestic promotion and 28:1 for foreign market development.

2.6 Environmental Scan Summary

Table 2.4 provides a brief summary of the main features of the producer check-off levy programs reviewed in this environmental scan. It is important to note that all of the check-off levies are mandatory (at the time of writing). As indicated in the second column, the per-unit value of the check-off levy varies from country to country. However, countries with a high export dependency, such as New Zealand, Australia and (at least historically) Canada, have not applied the levies to imports. In contrast, the U.S. check-off programs for beef and pork do apply to imports under the notion that imported products should not be allowed a free ride on the investment of U.S. producers.

Table 2.4. Summary of the structure of reviewed producer check-off levies

Country	Check-off levy	Applies to imports?	Revenue (millions)	Main focus
Canada (beef)	C$1 per head sold	No	C$8.2	Domestic (i.e., Canada and the U.S.) marketing
Australia (beef)	A$5 per head sold	No	A$64	Export marketing
New Zealand (beef)	NZ$3.6 per head sold for slaughter	No	NZ$8.5	Export marketing
U.S. (beef)	US$1 per head sold	Yes	U$82	Domestic marketing
U.S. (pork)	0.4% of value sold	Yes	U$72	Domestic marketing

Differences in the revenue generated by the respective levies are also of note. The U.S. beef check-off is the leader in terms of revenue generation, followed by U.S. pork and Australia (beef). New Zealand and Canada have the smallest check-off revenues. While the size of these revenues generally reflects the size of the respective industries, Australia stands out for having check-off revenues closer to those of the sizeable U.S. market than to the more-comparable Canadian market.

The last column of Table 2.4 shows the main focus of check-off fund investment. The majority of NCO expenditure is on domestic marketing activities, and it is important to emphasize that the domestic market includes Canada and the United States. Australia and New Zealand, with a high degree of export dependency, focus the majority of their check-off funds on export marketing activities. In contrast, U.S. beef and pork programs focus their main efforts on the U.S. domestic market. Clearly, the focus of a country's check-off program expenditure reflects the importance of either the domestic or export market to the growth and competitiveness of the industry.

Several important questions arise in light of the environmental scan. Specifically: what return do these historical allocations generate for producers? Are these historical allocations optimal? What allocation of check-off funds would maximize producer benefits? While this section has provided some discussion

of the producer returns associated with these check-off levies, further insight can be gained by reviewing the literature that explores the impact of check-off investment.

3. Literature Review

There has been considerable research published that evaluates producer investment in marketing and production research activities. We synthesize this literature with an emphasis on empirical outcomes rather than analytical approaches. We first discuss studies specific to the beef industry. Following this, attention is focused on studies related to other commodities. The last section discusses an approach to structuring and collecting non-mandatory producer levies.

The reviewed studies typically address at least one of three areas: effectiveness, return to investment, and optimality. Studies that focus on measuring **effectiveness** typically use statistical methods to determine if investment in marketing activities has increased demand, or whether investment in production research has either lowered the cost of production or increased productivity. **Return to investment** studies assess whether the change in producer benefits (which are almost universally **measured at a market level**) resulting from investment of check-off funds exceeded the cost of the investment. In this respect, most studies report a BCR to gauge whether producers have benefited. Two types of BCRs are reported in the literature. A marginal BCR shows the change **in market-level** producer benefits arising from a small change (typically $1) in investment in producer-funded activities. Producer benefits are maximized when this marginal BCR is 1:1 (in which case the incremental dollar earns back just $1 in benefits). A marginal BCR greater than one (i.e., 2:1) indicates the last dollar of program expenditure generated more than $1 in additional benefits and is a sign of under-investment. A marginal BCR less than one (i.e., 0.5:1) indicates the last dollar of program expenditure generated less than $1 in additional benefits and is a sign of over-investment. The second type of BCR is an average BCR; this measures the change **in market-level** producer benefits arising from historical investment in producer-funded activities (i.e., it is the dollar return for each dollar actually invested). Lastly, **optimality** studies attempt to derive formulae that enable calculation of the check-off levy and/or allocation of funds across activities that lead to maximum producer benefits.

3.1 Initiatives Funded by Beef Producers

3.1.1 Domestic Marketing Activities

There has been considerable research related to measuring effectiveness and returns on beef-producer investment in domestic marketing activities in the U.S. (Ward and Lambert 1993; Brester and Schroeder 1995; Kinnucan et al. 1997; Ward 2001, 2004, 2009; Boetel and Liu 2003) and to a limited degree in Canada (Cranfield and Goddard 1999), Australia (Piggott et al. 1996) and Europe (Verbeke and Ward 2001; Dong et al. 2007).

It is important to note, that while some authors consider marketing activities generally, others specifically focus on generic advertising or promotion. Where relevant, this distinction is preserved, but it should be recognized that conclusions drawn regarding advertising or promotion can be equally relevant for the broader set of marketing activities considered in this study.

Canada

Cranfield and Goddard (1999) evaluated cattle producer investment in generic beef advertising in Canada up to 1991. Their results suggest that both generic and branded beef advertising had a statistically significant effect on the demand for beef in Canada and the U.S. Moreover, they measured an average BCR for generic beef advertising in Canada of approximately 17:1, indicating a positive return to historic producer investment in generic beef advertising in Canada up to 1991. However, when they simulated a hypothetical 20 per cent increase in investment in generic beef advertising in Canada, the marginal BCR was less than zero, which means additional producer investment in generic beef advertising in Canada during the 1980s and early 1990s would not have paid for itself. Nevertheless, Cranfield and Goddard (1999) reported positive marginal BCRs associated with producer investment in branded beef advertising in the U.S. and Canada, and generic advertising in the U.S.

Cranfield and Goddard's (1999) focus on generic advertising reflects the fact that, at the time, producer investment in domestic marketing activities was targeted largely on generic advertising. The relevance of these returns to this study is limited, as generic advertising plays virtually no role in the portfolio of domestic marketing activities undertaken by BIC. Moreover, Cranfield and Goddard's (1999) study evaluated returns only up to 1991. Given the changes that have occurred in the cattle industry worldwide, and in Canada since the early 1990s, such returns do not reflect the current state of the market. Nevertheless, this is the only peer-reviewed study to evaluate producer returns on investment for domestic marketing activities in Canada.

Cranfield (2002a) developed optimal investment rules for beef marketing activities when the raw agricultural commodity (e.g., live cattle) and related food good (e.g., beef) were traded. He showed that optimal marketing investment intensities (the ratio of investment to farm-gate sales) depend on the price responsiveness of export demand. The more price-responsive export demand is, the lower the optimal marketing investment intensity. Using data for the Canadian beef industry between 1995 and 1998, simulation results indicate that optimal producer investment in beef promotion in Canada ranged from $2.8 million to $7.4 million.

Later, Cranfield (2002b) developed optimal marketing activity investment rules for a good sold in an open market (e.g., beef) when a competing good is governed by supply management (e.g., chicken) and considered what might happen if supply management for the competing good was eliminated. One key result to emerge from this study is that the elimination of supply management for a related good would lead to an increase in optimal marketing activity investment. The notion here is that the elimination of supply management would lower the price of chicken and place beef at a relative price disadvantage in terms of meat protein. To overcome this effect, additional investment would be needed to grow demand for beef. Simulation results using the same data as Cranfield (2002a) suggest that optimal beef marketing activity investment ranged between $5 million and $23 million.

Australia

A framework for evaluating the impacts of generic advertising in the domestic market was established by Piggott et al. (1995). They explicitly addressed the cross-commodity impacts of substitute products. They simulated changes in the Australian market arising from changes in domestic meat promotion, and found that farm-level profit impacts are positive for beef but negative for pork and lamb. These results

were later supported in subsequent work by Piggott et al. (1996), who reported marginal benefits associated with generic beef advertising in Australia of 24:1.

United States

While some evidence suggests that check-off-funded domestic marketing activities increased demand for beef in the U.S. (Ward and Lambert 1993; Ward 2001, 2004, 2009), other results suggest that generic advertising did not have a statistically significant impact on U.S. beef demand when the role of branded meat advertising (Brester and Schroeder 1995) and information related to the link between health and red meat consumption (Kinnucan et al. 1997; Boetel and Liu 2003) were taken into account. Moreover, Boetel and Liu (2003) reported that health concerns related to cholesterol and fat were associated with a six per cent reduction in per capita U.S. beef consumption during the 1990s, while Kinnucan et al. (1997) found that health information had a larger relative (and negative) impact on beef demand than did the retail price of beef. Similarly, Marsh et al. (2004) found that product recalls can have negative impact on the demand for the recalled meat product and that these impacts can spill over to other meats.

Nevertheless, as mentioned previously, Ward measured marginal BCRs for U.S. producer investment in domestic marketing activities of about 5:1 to 6:1 since the early 1990s. As well, results from Kinnucan (1997) point to marginal BCRs for investment in domestic marketing activities in the U.S. beef market ranging from 9:1 to 1.3:1. However, Kinnucan's (1997) results underscore two important issues: marginal BCRs were sensitive to the assumed value of key parameters of his model, and ignoring the role of marketing intermediaries resulted in overstated producer benefits compared to a scenario where these intermediaries are reflected in the structure of the model. The sensitivity of BCRs underscores the importance of developing a model that resolves uncertainties related to key parameters, while the issue of overstated benefits when ignoring marketing agents underscores the need to account for the structure of the marketing channel when measuring producer benefits (as is done in this study).

Alston et al. (2001) argued that producer benefits arising from domestic marketing activities are often at the expense of the producers of a closely related substitute product. They evaluated a scenario in which producer groups co-operated to maximize benefits to beef and pork producers rather than making investments independently. Using U.S. data, and focusing on generic advertising expenditures, they found that when producer groups (i.e., beef producers or pork producers) acted independently, the optimal advertising expenditure was three times higher than when producer groups chose expenditures co-operatively. There are, however, allocation issues in that co-operative advertising investment by beef and pork producers benefits beef producers largely at the expense of pork producers. Nevertheless, their results further highlight the role of market inter-relationships in advertising effects.

Europe

While only limited study has been undertaken to assess the impact of producer investment in marketing activities in Europe, Dong et al. (2007) found a positive and statistically significant impact of generic meat advertising on demand for various meats (including beef) in Norwegian households. While not addressing the impact of producer investment in marketing activities per se, Verbeke and Ward (2001) explored demand for fresh meat in Belgium in a post-BSE environment. Not surprisingly, they found that negative press coverage had a significant and negative effect on beef demand. Their findings also suggest that the impact of negative press was greater than the impact of positive messages communicated via advertising. Such a result highlights the difficulty commodity agencies may face

when undertaking advertising/promotion, or other communications designed to balance negative information presented to consumers.

3.1.2 Export Promotion

Compared to domestic marketing activities for beef, there has been considerably less research on producer-funded export marketing programs. This may be due, in part, to the lower proportion of funding allocated to export marketing activities in a number of countries and the fact that export marketing is often undertaken by governments. There are also issues with respect to the range of activities that can be called export promotion (including price and non-price initiatives) that make measurement more difficult.

Nevertheless, export market promotion of U.S beef and meat has received some attention. Comeau et al. (1997) reported that export marketing activities (in particular advertising and promotion) had a positive and significant effect on demand for U.S. beef in Japan. In addition, the marginal BCR for these export-marketing activities was reported to range between 16:1 and 18:1. Le et al. (1998) evaluated U.S. meat export marketing activities in four industrialized Pacific Rim economies – Hong Kong, South Korea, Singapore and Taiwan – and reported positive and significant effects only for South Korea. While the average BCR for the investment in the entire region was estimated to be approximately 15:1, Le et al. (1998) note that producer benefits would have been higher if more money had been allocated to South Korea.

One challenge in the analysis of export marketing activities is separating broad generic effects (general beef promotion in an export market) from specific branded effects (promoting a specific country's product in an export market). Kinnucan and Myrland (2008) evaluated the relative merits of generic or branded advertising in export markets. They acknowledged that country-of-origin branded advertising can invite retaliation by third party countries. In the extreme, depending on the demand and supply responses for both the country in question and competing exporters, and if retaliation occurs, own-price can actually decrease due to branded advertising in export markets. Generic advertising (i.e., non-country-specific advertising or promotion) helps everyone, but can have a reduced impact because of free riding by other countries in the export market. Kinnucan and Kyrland (2008) reported that losses experienced by Australian producers, arising from U.S.-branded advertising, exceeded the gains for American producers; this suggests a significant incentive for retaliation by Australian producers in the form of escalated investment in the export market. On the other hand, gains for Australian producers exceeded those for American producers as a result of the U.S.'s generic export promotion in Japan.

3.1.3 Production Research

The published research related to producer-funded research on beef cattle production is rather limited; instead, much of this literature recognizes the potential "public good" aspect of production-related research and focuses on the impact of both public and private investment in these activities. Alston et al. (1995) provides a comprehensive overview of the approach to this analysis and they highlight the approaches and challenges faced by researchers attempting to determine the returns on cost-of-production research. Nevertheless, some empirical work has been undertaken for Canada and we highlight these studies below.

Widmer et al. (1988) provides an early evaluation of the returns on federally funded beef research in Canada. They found this federally funded research led to statistically significant reductions in the marginal cost of cattle production in Canada in the 1970s and early 1980s. Moreover, the marginal BCR was reported to range between 26:1 and 57:1 (the variation in the BCR reflects assumptions about the real discount rate used in the analysis). These marginal returns imply an under-investment in research and were consistent with the 35:1 to 40:1 marginal BCRs later reported by Klein et al. (1994). An important point to be emphasized from this research is the need to account for the long-lasting effect of research innovations through model specifications that reflect past expenditure on production research.

Zhao et al. (2003) evaluated the benefit of research to beef producers in Australia. They considered not only returns to research but also compared the relative returns on different investment strategies for levies collected from producers and the additional funds provided by the Australian government. They found: a positive return to production research investment; that returns to on-farm research investment were higher than those for off-farm research; that returns to on-farm research were higher than those for domestic marketing; and that returns to investment in export marketing activities were higher than those for domestic promotion.

3.1.4 Integration of Multiple Initiatives

There has been very little work undertaken in evaluating instances where producers' check-off dollars fund multiple activities simultaneously (Wohlgenant 1993, and Ding and Kinnucan 1996 are two somewhat dated exceptions). Given the findings relative to health information (Kinnucan, Xiao et al. 1997; Boetel and Liu 2003) and adverse publicity (Verbeke and Ward 2001; Marsh, Schroeder et al. 2004), it would seem that such integrated research might be essential to providing a complete and accurate evaluation of the impact of different producer initiatives. Cranfield (2003) is a first attempt to evaluate alternate choices for producer levies by evaluating the optimal levels of investment for domestic and export marketing activities, and cost-of-production research.

Cranfield (2003) was one of the first to evaluate optimal investment intensities both with a fixed budget and when total investment was unconstrained. A key finding of his work is that producer benefits are maximized when the marginal returns to investment in domestic marketing, export marketing and producer research are equal. Moreover, empirical findings suggest that the optimal, unconstrained level of beef producer investment in Canada was higher than historical levels – pointing to a need to increase levy rates. Cranfield (2003) also suggested that the actual mix of activities was suboptimal; while the results were relatively clear for domestic marketing activities (under-investment) and export activities (over-investment), the simulation results were not definitive for cost-of-production research, reinforcing the difficulty in evaluating returns to research and the need for further research.

3.1.5 Summary

A number of key points have emerged from the review of the impact of investment in domestic marketing, export marketing and production research activities for beef:

- BCRs tend to be higher for investment in production research, followed by export marketing activities and, lastly, by domestic marketing activities.

- BCRs in a number of studies show wide variation and reflect uncertainty regarding key model parameters (the present study will resolve this uncertainty by estimating these parameters using contemporary data).
- The impact of negative media attention regarding health concerns linked to red meat appears to negate the impact of some domestic marketing activities (notably generic advertising).
- Broad-based export marketing activities can lead to lower producer benefits through free riding, while very well targeted and branded (e.g., Canadian Beef) export marketing activities can limit or even reduce free riding (depending on the degree to which the products can be substituted).
- The impact of production research investment tends to have a long duration, generating benefits over long periods of time.
- Studies for Canada are all rather dated and do not reflect a post-World Trade Organization nor a post-BSE world, and do not reflect the current set of activities funded by the Canadian cattle check-off.

3.2 Returns to Producer-Funded Initiatives in Other Markets

In many respects, this section mirrors the previous one in that it reviews the literature related to marketing and production research, but it does so for other markets and commodities. Attention is largely placed on discussion of the effectiveness of these investments, and BCRs, with some discussion of conceptual issues relevant to this study.

3.2.1 Domestic Marketing

Crespi (2003) provides a review of the literature that assessed the efficacy of generic advertising in the U.S. In response to the question of whether generic advertising even works, he concluded that there is considerable, although not universal, evidence that investment in such a domestic marketing activity increases demand for the product, and that producers are generally better off as a result of the advertising investment.

Perhaps of more relevance for this study are the producer returns reported in previous evaluations of domestic marketing activities for other commodities. As summarized in Table 3.1, these returns (measured via BCRs) are typically positive, indicating that producers benefit from their investment in these activities, and, while exceptions occur, BCRs tend to range between 2:1 and 6:1 or 7:1.

As evident in Table 3.1, domestic marketing activities for fluid milk in Canada and the U.S. have received considerable attention. In fact, a number of relevant points emerged from some studies that undertook evaluation of the impact of fluid-milk marketing activities. Kaiser and Schmidt (2003) found that U.S. milk processors benefited from producer investment in generic milk advertising and they pointed out the need to develop check-off mechanisms that maximize producer benefits but do not allow processors to free ride on producer investment (such as co-investment by producers and processors). Goddard and McCutcheon (1993) found that optimal producer investment in generic milk advertising in Ontario and Quebec was sensitive to the specification of the demand function; they also highlighted the need to be careful in drawing definitive conclusions and the need to explore the robustness of results to alternative model specifications. Adding to this issue, Kinnucan and Venkateswaran (1994) reported evidence of a dynamic response in the Ontario fluid-milk market and noted that this response may decrease over time, reflecting a “wear out” effect. They suggested that modellers need to either consider a range of

parameters or to allow parameters to change over time, a point further emphasized by Reberte et al. (1996).

Freebairn and Alston (2001) provide analytical results that characterize optimal generic advertising investment rules under a variety of circumstances, including how the advertising is funded and the effect of different market structures. They found that a per unit levy and an *ad valorem* (percentage of sales) levy were roughly equivalent at the profit-maximizing level of advertising, whereas the lump-sum funding option meant that all the costs were borne by producers. Notably, they also discussed the value of generic advertising campaigns for traded commodities produced in small open economies. Small open economies are those countries or markets with little or no border measures and a small volume of trade in relation to overall world trade. In such circumstances, the producers of a commodity typically take the world price as given and any change in trade of that commodity will not affect price. Freebairn and Alston's (2001) point is that investment in domestic marketing activities for a traded good produced in a small open economy may increase domestic demand (typically at the expense of exports), but will not increase price, and so such investment is likely to be unprofitable for producers. One conclusion to draw is that producers of traded goods in small open economies may find it more profitable to target any check-off investment in export marketing activities or production research.

Table 3.1. Summary of the returns to investment in domestic marketing activities

Author	Region	Commodity	Benefit-cost ratio
Cranfield (2000)	Manitoba	Fluid milk	2.7:1 to 2.8:1
Cranfield (2001a)	Alberta	Fluid milk	6.6:1
Cranfield (2001b)	B.C.	Fluid milk	7.6:1 to 9.3:1
Kaiser et al. (2005)	Eastern Canada	Fluid milk	Ontario 3.4:1
			Quebec 7.4:1
			Maritimes 2.2:1
Kaiser et al. (2007)	Canada	Butter	1.8:1
		Cheese	8.3:1
Zidach et al. (1992)	U.S.	Catfish	13:1
Kaiser et al. (1997)	U.S.	Dairy	3.4:1
Schmit et al. (1997)	California	Eggs	6.9:1
Kinnucan and Miao (2000)	U.S.	Fluid milk	6.2:1 to 11:1
Kaiser and Dong (2006)	U.S.	Dairy	3.7:1 and 5:1
Carman (2006)	California	Avocadoes	4.2:1 t 6.3:1
Beach et al. (2007)	U.S.	Pork	7:1
Nicholson and Kaiser (2008)	U.S.	Dairy	2.5:1 to 4.5:1

There have also been a number of studies that have evaluated the variability of returns on generic advertising over time (Chung and Kaiser 2000; Schmit and Kaiser 2002; Vande Kamp and Kaiser 2000; Schmit and Kaiser 2004), by geography (Lenz et al. 1998) and by media outlet (Pritchett, Liu et al. 1997; Kinnucan and Thomas 1997). While these approaches can shed light on specific details of the initiative, they do not provide significant additional insight into the value of the investment, the marginal benefits or market-level optimal investment. Moreover, such issues are of a secondary concern that could be addressed after the primary objectives of this study are satisfied.

3.2.2 Export Marketing

Table 3.2 provides a summary of studies that have reported BCRs for export market activities. As can be seen, BCRs for export marketing activities tend to be somewhat higher than those for domestic marketing activities, but also show greater variation. One reason for higher BCRs from export marketing activities compared to domestic market activities is that the former tend to take much more focused efforts, such as targeting specific buyers and marketing channels and developing relationships with key buyers, while the latter tends to entail marketing activities aimed at a broad audience (e.g., mass media promotion, provision of consumer information and recipes). The diffuse nature of these domestic marketing activities means their impact can be muted when compared to export marketing activities.

While Richards et al. (1997) and Richards and Patterson (1998) found investment in export marketing activities to have a positive and significant effect on export demand for U.S. apples, fruit and vegetables, they did flag two important issues. In Richards et al. (1997), the effectiveness of producer investment in export marketing activities for apples was muted because of free riding by other apple-producing countries. Richards and Patterson (1998) also noted that the impact of export marketing investment may not happen in the same time period in which the investment occurs; there may be a need to consider multi-period effects through dynamic analysis. Differences in the size of short run and long run BCRs for U.S. poultry export-market promotion (see Jan et al. 2003) underscore the importance of these dynamic effects. As well, the mode by which export marketing activities occur can also matter. For example, Shahid and Gempesaw (2002) found that price subsidies were more effective in increasing export market demand for U.S. poultry than non-price promotion activities.

Table 3.2. Summary of the returns to investment in export marketing activities

Author	Region	Commodity	Benefit-cost ratio
Kinnucan and Christian (1997)	U.S.	Almonds	6.3:1 to 20:1
Onunkwo (2000)	U.S.	Pecans	6.5:1 to 6.7:1
Onunkwo and Epperson (2000)	U.S.	Walnuts	6.1:1
Kaiser et al. (2003)	California	Raisins	5:1 to 15:1
Jan et al. (2003)	U.S.	Poultry	5:1 to 16:1 in the short run 30:1 to 60:1 in the long run
Adhidkari et al. (2003)	U.S.	Wheat	0.4:1 to 2:1
Beach et al. (2007)	U.S.	Pork	28:1
Boonsaeng and Fletcher (2008)	U.S.	Peanuts	240:1
Pimbucha Rusmevichientong (2009)	U.S.	Rice	6.2:1 to 15:1

3.2.3 Production Research

Table 3.3 provides a summary of previously reported BCRs for investment in production research. As should be evident from a comparison of Tables 3.1, 3.2 and 3.3, the BCRs for production research are typically higher than those for domestic and export marketing activities. It should be pointed out that the literature related to production research and productivity enhancement is immense and difficult to synthesize in a compact manner. Nonetheless, in a comprehensive review of 286 studies of returns to agricultural research (not all of which were related to producer-funded research), Alston et al. (2000) found an average rate of return to research of 65 per cent.

Alston et al. (2000) also highlighted differences in approaches to accounting for the dynamic nature of research effects, and that the impact of production research tends to be lasting. It is the long life of production research innovations that led to such large BCRs for production research activities. What is more, Lim et al. (2000) illustrated the importance of accurately capturing the dynamic nature of production research impacts when attempting to measure the return to investment of check-off funds in research.

Table 3.3. Summary of the returns to investment in production research activities

Author	Region	Commodity	Benefit-cost ratio
Horbasz et al. (1988)	Canada	Sheep	2:1 to 3:1
Haque et al. (1989)	Canada	Laying hens	25:1 to 35:1
Fox et al. (1992)	Canada	Dairy	50:1
Freebairn (1992)	Australia	Dairy	44:1
Lim et al. (2000)	U.S.	Soybean	29:1 for cost of production research
Beach et al. (2007)	U.S.	Pork	20:1 for on-farm production research 56:1 for off-farm production research

3.2.4 Summary

A number of key points have emerged from this review of the literature evaluating returns for other commodities and markets:

- Returns to investment in domestic marketing activities tend to be smaller than returns to export market promotion, while the latter tend to be smaller than returns to production research.
- Differences in the return to domestic marketing activities and export marketing activities relate to the diffuse nature of many domestic marketing activities, and the targeted nature of export marketing activities.
- Differences in returns to marketing and research activities reflect the long-lived nature of research innovations and the wear-out effects associated with marketing efforts, especially when the good in question is highly substitutable and faces stiff market competition.
- Free riding issues arise not only with respect to export markets but also in the domestic market where processors can realize benefits from producer investment in domestic marketing activities. This underscores the importance of properly accounting for the processing sector when undertaking any evaluation exercise.
- The role of trade, market size and market structure is very important when evaluating returns to producer investment. Where the good in question is traded and produced in a small open economy, it may be preferable to focus efforts on export market promotion and production research, rather than domestic promotion, but especially so when the domestic price is not appreciably influenced by volume of trade.

3.3 Structuring Voluntary Levy Programs

The free-riding issue and the constitutional challenges to some U.S. check-off programs have begun to receive more attention in the literature. For instance, Norman et al. (2008) provides theoretical results that show there is always a lower bound on the level of generic advertising investment an organization

should undertake and that this gives some justification for mandatory participation in advertising programs. Recognizing the "public good" aspect of collective investment, and the potential for free riding, Krishnamurthy (2001) advocated the use of a voluntary provision point contribution mechanism (VPPCM). VPPCM involves setting a contribution level (i.e., a check-off) and a minimum producer participation rate. If the number of producers contributing to the program does not meet the threshold participation rate, then the program will not be undertaken (and any funds collected will be refunded to producers). Krishnamurthy (2001) demonstrated that the VPPCM outperforms voluntary contribution in an experimental setting.

The provision-point mechanism was further evaluated in an agricultural producer check-off context by Messer et al. (2005). They found that a producer referendum increased the probability of participation and that producer benefits were optimized at a provision-point threshold of 82 per cent. Messer et al. (2008) extended their earlier results to explore alternate approaches to funding advertising initiatives should mandatory check-offs disappear, and found that the provision-point mechanism provided higher funding levels than a voluntary contribution mechanism. Noting that a single threshold may not be advantageous to program implementation, Messer et al. (2007) advocated two provision points; the first is the same as that proposed by Krishnamurthy (2001), with an additional, lower participation rate used to ensure that administrative capacity of the implementation agency is maintained in case the higher threshold is not met.

4. Overview of the Economic Model

To address the objectives of this study, one needs to be able to measure the change in producer benefits associated with investment of check-off funds in marketing and research activities. One option would be to compare producer benefits before and after the national check-off levy was implemented. However, such an approach would be sensitive to the pre-check-off time period that is used and to changes in the market environment arising from external shocks such as BSE. Alternatively, one could measure producer benefits associated with the actual investment of check-off funds and then ask, "How big would these producer benefits have been, had the check-off funds not been invested?" The difference between actual producer benefits and those estimated to have occurred in the absence of check-off fund investment in marketing and research provides an estimate of the impact of the check-off. This is the approach used here.

A natural question to then ask is "How does one measure producer benefits, especially those that would have occurred in the absence of the check-off?" The answer to this question is that one needs an economic model that accounts for the impact of investment in marketing and research activities on the prices producers receive and the quantity of live cattle supplied to the market (e.g., cattle sales), and allows one to predict these prices and quantities in the absence of the check-off. Recognize, however, that the literature review points to the importance of trade and marketing middlemen when considering the impact of marketing activities on the price that producers receive and the quantity of live cattle supplied to the market. To this end, the analysis in this study uses a model (called an econometric simulation model) that mimics the workings of beef and cattle markets in Canada and the U.S. It explicitly accounts for the impact of Canadian cattle producer investment in beef cattle marketing and research activities on prices and quantities in these markets.

4.1. Broad Overview of the Model & Analysis

The model enables one to calculate retail and farm-level prices for beef and live cattle, respectively; final consumer demand for beef; production of beef; packer demand for cattle; supply of fed and non-fed cattle; and beef and cattle trade for a baseline situation and a variety of "what-if" scenarios. The baseline situation reflects what actually happened in these markets and is used to calculate producer benefits given the actual level of investment in marketing and research activities. The baseline scenario is also used as the basis of comparison for the different "what-if" scenarios.

The "what-if" scenarios allow one to determine the retail and farm-level prices and quantities (i.e., demand for beef, beef production, slaughter, cattle supply and trade volumes) that would result if investment in beef cattle marketing and research activities was different from the actual level of investment. Once the prices and quantities in any particular "what-if" scenario are determined, they are used to calculate producer benefits for that respective "what-if" scenario and they are compared to the baseline level of producer benefits. The "what-if" scenarios are described in more detail in Section 6.

Important to this study is the fact that explicit account is taken of BIC, CBEF and BCRC investment in marketing and research activities. To be clear, BIC investment in marketing activities in Canada is included in a retail demand equation that allows one to calculate the level of beef demand in Canada as this investment is varied. The idea here is that an increase (or decrease) in marketing investment in Canada should increase (or decrease) the demand for beef in Canada. Moreover, given the structure of the model, any change in demand will stimulate changes throughout the entire beef cattle sector, ultimately affecting farm-level prices and the supply of live cattle. The model is designed to capture these effects and trace them back to the farm level, and then use these farm-level effects to calculate producer benefits given the change in investment at the retail level.

BIC investment in marketing activities in the U.S. market is also accounted for, but in a Canada-U.S. net beef export equation. The idea here is that an increase (or decrease) in BIC investment in U.S. marketing activities should increase (or decrease) exports of beef from Canada to the U.S. As with changes in demand for beef in Canada, any change in beef exports arising from a change in marketing investment will affect farm-level prices and the supply of live cattle, and hence producer benefits.

It is important to recognize that the BIC receives funds from both the check-off levy and other sources (e.g., Legacy funds, BIDF, etc.). The variables in the model that account for BIC investment in marketing activities (either in Canada or the U.S.) include funds from ALL sources. However, the analysis only considers changes to check-off funds; investment of funds from non-check-off sources is not varied. While some of these non-check-off funds arise from leveraging check-off funds, it is assumed that any leveraged funds would still be invested regardless of the level of check-off fund investment. While limiting, such an assumption is needed, as the extent to which investment of leveraged funds would change in light of changing check-off investment is not clear throughout the time period under study. Moreover, changing both the check-off and non-check-off component comingles the two effects, making it impossible to measure the benefits directly associated with the check-off by itself.

CBEF investment in marketing activities in the international market (i.e., countries other than Canada and the U.S.) is included in a Canada-Rest of World net-beef-export equation, where an increase (decrease) in CBEF investment in international marketplace activities is expected to increase (decrease) exports of Canadian beef to the rest of the world. As before, any change in beef exports arising from a change in marketing investment will affect farm-level prices and the supply of live cattle, and hence

producer benefits. Note that the CBEF receives revenues from the check-off and other sources; hence, the variable in the model that accounts for CBEF investment in marketing activities in the international marketplace includes both check-off and non-check-off funds. However, only the check-off funds are varied in this analysis; any leveraged funds or funds from other sources are not changed.

BCRC investment in beef cattle research is included in supply equations for fed and non-fed cattle, as well as an equation for carcass weights of slaughter-weight animals in Canada. The idea here is that investment in beef cattle research should lead to an increase in production efficiencies that lead to increased beef production (through higher carcass weights or increased supply of live cattle, or both). Recognize that any change in the supply of live cattle, or carcass weights, arising from a change in investment in research will directly affect producer benefits. Note too that any BCRC-funded research projects require leveraged/matching funds. However, unlike BIC or CBEF, these leveraged/matching funds do not flow to BCRC. Rather, these leveraged funds flow directly to the cattle researcher engaged in the approved project. The research investment variable in the model includes both investment of check-off funds in approved research projects and leveraged/matching funds associated with approved projects. However, as with marketing, only the check-off funds are varied in this analysis; any leveraged/matching funds are not changed. Further detail regarding the structure of the model is provided below, while the model is discussed in greater detail in Appendix 1.

4.2. Description of the Econometric Simulation Model

The model includes retail, processing and farm-level modules for both the Canadian and U.S. markets. Each country's retail module consists of an equation that relates per capita beef disappearance to the retail price of beef, the price of substitute meats, and per capita disposable income in the respective country. Moreover, the Canadian retail beef disappearance equation includes a variable that captures investment in beef marketing activities in Canada (as discussed above). To reiterate an important point, the notion here is that investment in marketing activities should grow demand for beef in Canada and, if successful, increase producer benefits.

Each country's processing module consists of two equations: one equation relates packer demand for fed-cattle to the retail price of beef and the price of fed cattle (i.e., slaughter-weight steers and heifers), the other equation relates packer demand for non-fed cattle (i.e., culled cows and bulls) to the retail price of beef and the price of non-fed cattle. Multiplying fed and non-fed cattle slaughter by carcass weights then yields beef production. Note that carcass weights are explicitly modelled in the Canadian market, with carcass weights depending on the ratio of the price of fed cattle to the price of feed and a variable capturing investment in beef cattle research (as discussed above).

The link between the retail and processor components is achieved with a market-clearing condition that equates disappearance of beef in Canada (i.e., per capita beef disappearance multiplied by population) to beef production less net exports of beef from Canada to the U.S. and the rest of world, plus the change in beef stocks. A similar market-clearing condition is included for the U.S. In each country, the link between the retail and processor sectors is reinforced with a margin equation that relates the price of fed cattle and the retail price of beef.

Beef trade from Canada to the U.S. and from Canada to the rest of the world is captured using two export demand equations that relate the volume of net beef exports to the retail price of beef in Canada and the price of beef in the respective export market. As mentioned above, the equation for net beef

exports from Canada to the U.S. includes a variable that captures investment in U.S. market development (as discussed above). Likewise, the equation for net beef exports from Canada to the rest of the world includes a variable that captures investment in marketing activities outside Canada and the U.S. (also discussed above).[5] The notion here is that investment in international marketing activities should increase demand for Canadian beef exports and benefit producers.

Each country's farm-level module consists of a set of equations that specify a dynamic supply response model for cattle. In each country, the supply of fed cattle is related to past values of the beef cow herd inventory, reflecting the notion that a decision to expand (or contract) the breeding herd in anticipation of higher (or lower) prices in the future will result in a change in the supply of slaughter-weight fed cattle in the future. Including lagged beef cow inventories in the supply of fed cattle is what generates the dynamic supply response embodied in this model. The supply of non-fed cattle in each country is related to the inventory of beef and dairy cows in the current period. Moreover, the fed and non-fed cattle supply equations in Canada include a variable that captures investment in beef cattle research in Canada (as discussed above). The link between supply and demand of fed cattle occurs through a market-clearing requirement that the supply of fed cattle equals the demand for fed cattle in Canada and net exports of fed cattle from Canada to the U.S. A similar market-clearing condition holds for non-fed cattle.

Each country's farm-level module also has a beef cow breeding herd inventory equation that relates the beef cow breeding herd inventory to the price of feeder cattle. In turn, price transmission equations in each country relate the price of feeder cattle to the respective price of fed cattle and the price of feed; as the price of fed cattle increases, the price of feeders will increase, while an increase in the price of feed will lead to a reduction in the price of feeders. As well, price transmission equations are used to link the price of non-fed cattle to the price of fed cattle in each country. The model links the Canadian and U.S. farm-level markets together using a fed-cattle price transmission equation; this equation relates the price of fed cattle in Canada to the price of fed cattle in the U.S.

A more detailed description of the model, as well as econometric estimation results, is provided in Appendix 1. The equations in the model are estimated using quarterly data from 1990 to 2008. Quarterly data allows one to capture important aspects of the beef market, such as seasonality. Once all equations are estimated, the simulation model is constructed and validated. This entails solving the estimated equations and market-clearing identities for the relevant economic variables. The simulation treats some economic variables as fixed (including investment in marketing and research activities), but solves for 30 relevant economic variables. These variables include:

- per capita beef disappearance in both Canada and the U.S. (in kilograms per person)
- aggregate beef disappearance in both Canada and the U.S. (in metric tons)
- retail price of beef in both Canada and the U.S. (in $/lbs)
- net beef exports from Canada to the U.S. (in metric tons)
- net beef exports from Canada to the rest of world (in metric tons)

[5] Attempts were made to model beef exports separately from beef imports. However, data limitations and resource constraints prevented this undertaking. While focusing on net beef exports is a limiting assumption, it also points to the need to undertake estimation of import-demand systems for beef in Canada's export markets under the assumption of country-of-origin differentiation.

- net beef exports from the U.S. to the rest of world (in metric tons)
- total beef production in both Canada and the U.S. (in metric tons)
- carcass weights in Canada (in kilograms)
- demand for fed cattle (i.e., steers and heifers) for slaughter in both Canada and the U.S. (in '000 of head)
- demand for non-fed cattle (i.e., culled cows and bulls) for slaughter in both Canada and the U.S. (in '000 of head)
- net exports of fed cattle from Canada to the U.S. (in '000 of head)
- net exports of non-fed cattle from Canada to the U.S. (in '000 of head)
- supply of fed cattle in both Canada and the U.S. (in '000 of head)
- supply of non-fed cattle in both Canada and the U.S. (in '000 of head)
- beef cow breeding herd inventory in both Canada and the U.S. (in '000 of head)
- price of steers for slaughter in both Canada and the U.S. (in $/lbs)
- price of cows for slaughter in both Canada and the U.S. (in $/lbs)
- price of feeder cattle in both Canada and the U.S (in $/lbs)

Since many of the quantities are reported in kilograms or metric tons, they are retained in metric units. As many of the prices are reported on an imperial basis of measurement (i.e., $/lbs), they are not converted to metric units during estimation or simulation. However, where relevant (such as when calculating producer benefits), prices are converted to metric units. All prices and monetary values have been deflated to account for inflation (see Appendix 1 for details). Note too that beef is measured in carcass-weight equivalents. Data sources are found in Appendix 3.

Once developed, the simulation model is used to establish a baseline scenario. This baseline scenario is a representation of the Canadian and U.S. beef markets over the period of analysis. Because statistical methods are used to estimate many of the equations in the model, and estimated equations can never perfectly predict what actually occurs, the simulated prices and quantities in the baseline will deviate to some degree from actual prices and quantities. Nevertheless, the model was developed to minimize any differences between actual prices and quantities and those from the baseline simulation. Results from this baseline scenario are then used to calculate producer benefits given the actual expenditure on marketing and research activities.

The simulation model is then used to show what would have occurred under a variety of "what-if" scenarios related to investment in marketing and research activities. The idea underlying these "what-if" scenarios is to change the level of investment in marketing or research activities, solve the model for the relevant prices and quantities, and use these "shocked" prices and quantities to calculate the producer benefits that would have occurred given a particular change in the level of marketing or research investment. For each "what-if" scenario, the producer benefits with the shock are compared to the baseline producer benefits.

5. Check-Off Revenue and Investment in Marketing and Research

To place investment in marketing and research activities in a proper context, Figure 5.1 plots the flow of check-off funds (in nominal dollars) from the NCO agency to the respective division (i.e., BIC, CBEF and BCRC) for the fiscal years 2002/2003 to 2008/2009. While all divisions received fewer check-off funds in 2003/2004 (a reflection of reduced sales arising from the BSE crisis), Figure 5.1 shows relatively consistent funding from the check-off program, with BIC receiving the lion's share of check-off dollars, followed by CBEF and then BCRC.

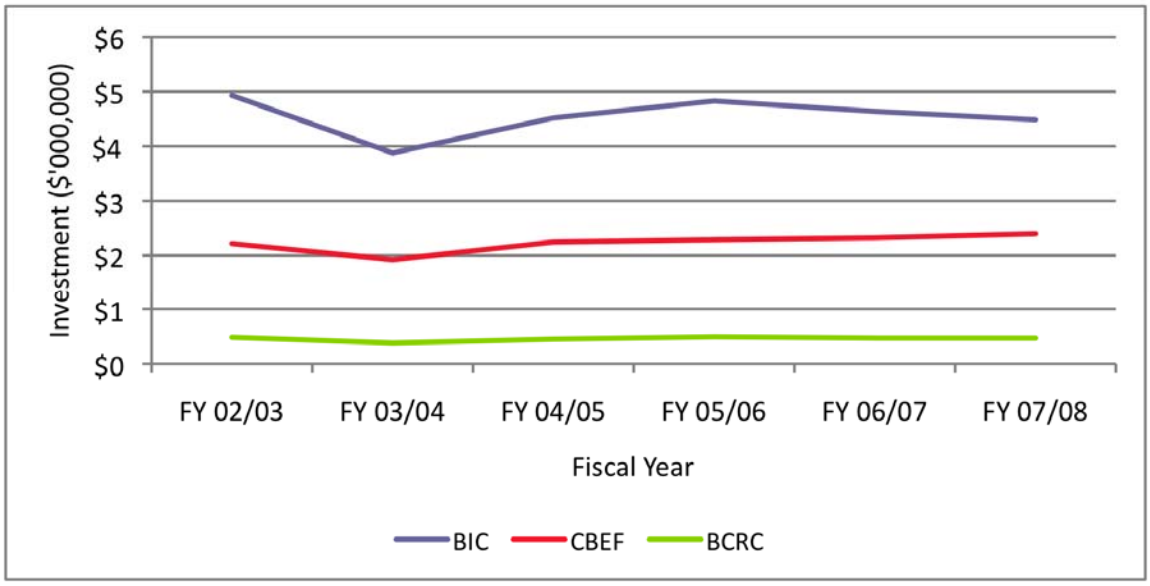

Figure 5.1. BIC, CBEF and BCRC check-off fund revenue

Figure 5.2 shows investment in marketing and research activities for the fiscal years 2002/2003 to 2007/2008. To be clear, domestic marketing activities includes BIC investment in the following activities for the Canadian marketplace:

- customer service centre
- commercial beef
- BSE recovery/marketing contingency
- processing development
- food service marketing
- consumer communications
- trade communications
- nutrition and food safety
- food safety program

- retail marketing
- consumer culinary service

Domestic marketing activities also include BIC investment in U.S. market development.

Note that investment in these activities includes direct program management and administration/operating costs for each activity, but **does not** include expenditure on:

- producer communications
- BIC corporate planning
- expenditures related to various regional offices
- funding and evaluation
- BIC committee
- brand management and research
- issues management

It is important to note that expenditures on the **BSE Containment and Recovery Strategy** were included in the **BIC corporate planning** expense line (i.e., cost centre 50) of the budget summaries in the quarterly progress reports (from which some of the marketing investment data were drawn). Because these BSE containment-and-recovery expenditures play an important role in shaping demand during and after the BSE crisis, they were separated from the BIC corporate planning expense and included in the marketing variable in the model.

These domestic marketing investment data were drawn from the BIC's quarterly stakeholder reports from 2002/2003 to 2008/2009, and from audited financial statements from 1990 to 2001/2002. The quarterly stakeholder reports enabled identification of quarterly investment in domestic marketing activities. However, reliance on the audited financial statements between 1990 and 2001/2002 is more limiting as these data are only available on an annual basis. As such, quarterly investment in marketing activities in each year between 1990 and 2001/2002 is equal to annual investment in the respective year divided by four. While limiting, such an approach is the most feasible tactic given the absence of a consistent and reliable source of quarterly marketing activity investment from 1990 to 2001/2002.

Investment in international marketing activities is accounted for by market development activities only; it does not include operating costs. Investment in international marketing activities is drawn from audited financial statements for the CBEF. As these are provided in annual terms for each fiscal year, the same approach used for BIC investment from 1990 to 2001/2002 is used for the CBEF: quarterly CBEF investment in each year equals annual investment divided by four. It is important to note that since the CBEF reports on a fiscal year that does not align with a calendar year, caution was taken to ensure that investment was allocated to the correct quarter. Moreover, since the CBEF changed its fiscal year-end on two occasions between 1990 and 2008/2009, equal care was taken to ensure that the investment was allocated to the proper quarter.

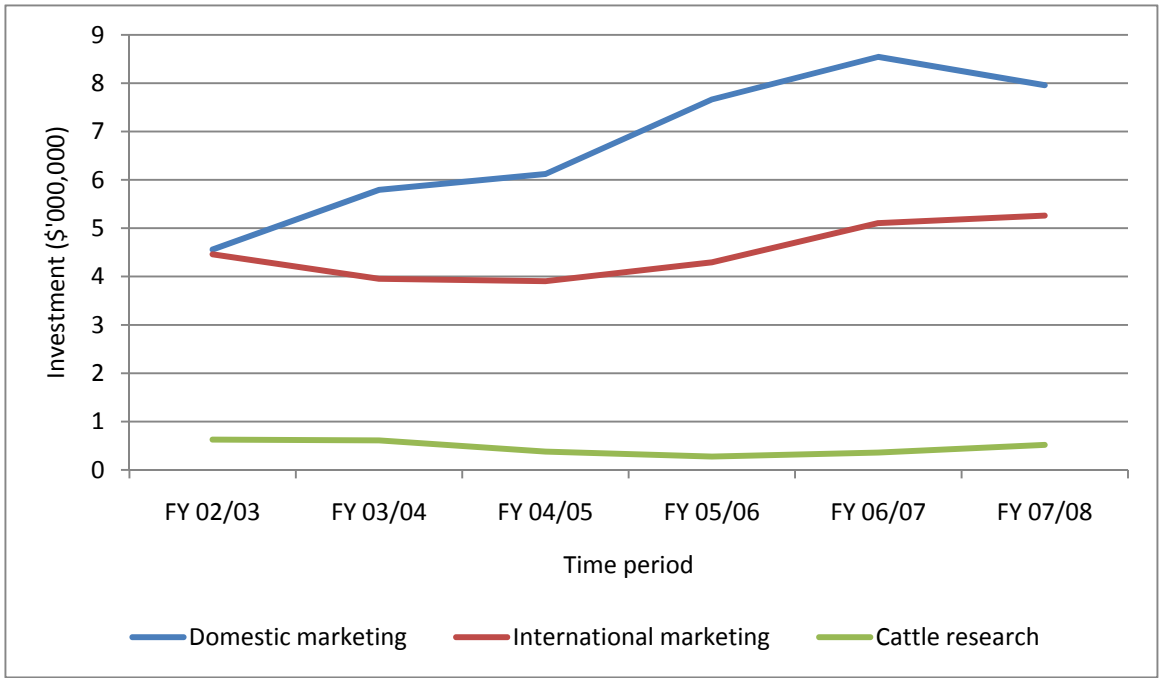

Figure 5.2. Investment in marketing and research activities.

Investment in beef cattle research only includes investment in actual beef cattle research projects; it does not include the cost of divisional services, investment in the Quality Starts Here (QSH) program, nor investment in the On-Farm Food Safety program and its implementation. BCRC staff provided detailed information on the timing of their investment in beef cattle research projects; as such it is possible to identify the quarter in which funds flowed to the cattle researcher. Recognize, however, that investment in a beef cattle project is lumpy in the sense that funds are transferred to the beef cattle researcher at periodic intervals. However, the beef cattle researcher uses these funds to finance research activities over the life of the project. As such, quarterly investment in beef cattle research is spread over the interval between periodic payments from the BCRC to the researcher.[6]

6. Analysis of the Economic Benefits From the Check-Off

This section reports the main results from the analysis. Measurement of producer benefits is discussed first. Attention then focuses on the discussion of the benefits accruing to Canadian cattle producers from investment in marketing and research activities. Next, the impact of a small increase in investment in marketing and research at one point in time is discussed, and used as a way to gauge whether investment has been optimal. The issue of optimizing the pattern of investment in marketing and research activities, and the implications for producer benefits, are then addressed. Lastly, this section contains discussion of analysis that seeks to measure the effect that check-off refund requests by Alberta cattle producers would have on Canadian cattle producer benefits.

[6] Note that the econometric results were not very sensitive to whether the smoothed or lumpy research investment was used.

6.1 How Are Producer Benefits Measured?

Cattle producer benefits are defined as revenue from the sale of cattle minus the variable cost of production, and are measured at a national market level. Specifically, fed-cattle producer benefits at a market level are calculated as follows:

$$CW * (P_{Fed} - Levy - COP_{Fed}) * Supply_{Fed}$$

where CW is carcass weight (in pounds), P_{Fed} is the price of fed cattle for slaughter (specifically the price of slaughter steers in dollars per pound), Levy is the check-off levy (in dollars per pound), COP is the cost of production (in dollars per pound) and $Supply_{Fed}$ is the number of fed cattle for slaughter (i.e., slaughter-weight steers and heifers). Note that a variety of cost-of-production estimates have been published and that these vary based on the region to which they apply and the size of the enterprise. The published COP estimates typically range from $0.54 per pound to $0.84 per pound. As a middle-ground approach, the COP used in calculating the benefits to fed-cattle producers is set at $0.70 per pound (which is deflated during calculation of producer benefits).

Producer benefits for non-fed cattle are also measured at a national market level, but as the revenue from the sale of culled cows and bulls:

$$CW * \left(P_{Non-fed} - Levy\right) * Supply_{Non-fed}$$

where $P_{Non\text{-}fed}$ is the price of non-fed cattle (specifically the price of slaughter cows in dollars per pound) and $Supply_{Non\text{-}fed}$ is the supply of culled cows and bulls for slaughter. Note that a cost-of-production deduction is not applied as culled cows and bulls are viewed as depleted assets and so the revenue from the sale of culled animals is viewed as a salvage value.

Cow-calf producer benefits are measures as follows:

$$550 * (P_{Feeder} - Levy - COP_{Feeder}) * CCrop$$

where this calculation assumes feeder cattle sell at 550 pounds, P_{Feeder} is the price of 550-pound feeder cattle (in dollars per pound), COP_{Feeder} is the cost of production for feeder cattle (in dollars per pound; based on an Ontario Ministry of Agriculture, Food and Rural Affairs study, this value is assumed to equal $1.02 per pound, which is also deflated when calculating cow-calf producer benefits), CCrop is the calf crop in the previous quarter. The calf crop is calculated as the inventory of beef cows in the breeding herd multiplied by 0.25. Multiplication of the inventory by 0.25 reflects the fact that, over the period considered, cattle supply is typically one-quarter of the beef cow breeding herd. The Farm Product Price Index is used to deflate all monetary values in the benefit calculations.

6.2 What Impact Has Historic Investment of Check-off Funds Had on Economic Benefits for Canadian Cattle Producers?

To determine whether beef cattle producers have benefited from investment of check-off dollars in marketing and research activities, the simulation model is used to create a “what-if” scenario (called a counterfactual scenario) that mimics the beef and cattle sector in the absence of the investment of these check-off dollars. The difference between producer benefits in this counterfactual scenario and

the baseline scenario measures the economic impact associated with the investment. If the change in producer benefits exceeds the value of the removed check-off funds, then producers have gained economic benefits. To capture this, an average benefit-cost ratio (BCR) is calculated as the difference between **market-level** producer benefits in the baseline and counterfactual scenarios, divided by the value of the check-off funds removed in the counterfactual scenario. An average BCR is calculated and reported for three scenarios:

1. Removal of check-off funds from marketing activities only.
2. Removal of check-off funds from research activities only.
3. Removal of check-off funds from marketing and research activities.

Splitting the analysis into these three steps enables one to isolate the impact of investment of check-off funds in marketing and research activities separately, and then for both activities as a whole.

To further isolate these effects, the counterfactual simulations are only undertaken for the time period from the third quarter (Q3) in 2005 to the fourth quarter (Q4) in 2008. Isolating the period of analysis to this time frame removes the immediate impact of the BSE crisis and also corresponds to the time period where the Canada-U.S. border was open to trade of live cattle under 30 months of age. To include time periods where barriers to all live cattle trade were in place significantly complicates the analysis as it introduces a distortion to trade that is not currently in place, and which arose in extraordinary circumstances. Nevertheless, to help put the more recent returns to check-off fund investment in a historic context, the average BCRs are also calculated for the period from quarter three (Q3) in 2002 to quarter one (Q1) in 2003. These three quarters correspond to a period where the NCO had a functioning presence, but before the BSE crisis began.

6.2.1 How Are Reductions in Marketing and Research Investment Calculated?

Given how funds flow from producers to the NCO agency, and then to the divisions that ultimately invest in marketing and research activities, it is not possible to link marketing and research activities in any particular quarter to the check-off funds in that or any other previous quarter. (The reason this is not possible relates to the fact that the flow of check-off funds is reported on an annual basis.) Consequently, it is not clear how much of a particular quarter's investment is from check-off funds and how much is from other sources.

To overcome this, it is assumed that a simulated reduction in check-off funds impacts general revenue for the respective division, and that this reduction in general revenue results in a reduction in the respective marketing and research investment undertaken. The most direct way to implement this approach is to assume that the percentage reduction in the division's revenue, arising from the simulated removal of check-off funds, is the same percentage reduction in that division's investment in their respective marketing or research activities. One complication is that check-off revenue and total divisional revenues show year-to-year fluctuation that makes it difficult to isolate removal of check-off funds from changes in other sources of revenue. To address this issue, each division's check-off revenue is calculated as a percentage of the division's total revenue. For each division, the highest and lowest value of this percentage is dropped and a trimmed average of this percentage is calculated. Using a trimmed average moderates the impact of large changes in check-off revenue as a percentage of total revenue.

Table 6.1 shows each division's check-off revenue as a percentage of its total revenue, from fiscal year

2002/2003 to 2008/2009, as well as the average, the minimum value, the maximum value and the trimmed average over this time period. The trimmed average shows that check-off funds account for: 48.7 per cent of BIC revenue; 37.5 per cent of CBEF revenue; and 58 per cent of BCRC revenue. The analysis that follows thus assumes that:

- Removal of check-off funds lowers investment in domestic (i.e., Canada and the U.S.) marketing activities by 48.7 per cent and investment in international marketing activities by 37.5 per cent.

- Removal of check-off funds lowers investment in beef cattle research activities by 58 per cent.

Table 6.1. Check-off revenue as a percentage of total revenue, by division

Fiscal year:	BIC	CBEF	BCRC
02-03	98.00%	40.86%	60.30%
03-04	41.50%	34.61%	90.90%
04-05	57.70%	40.97%	76.70%
05-06	47.50%	39.57%	84.00%
06-07	47.50%	36.55%	46.00%
07-08	48.00%	36.10%	23.00%
08-09	42.70%	31.75%	23.00%
Average	54.70%	37.20%	57.70%
Minimum	41.50%	31.75%	23.00%
Maximum	98.00%	40.97%	90.90%
Trimmed average:	48.68%	37.54%	58.00%

6.3.1. Average BCR From Investment of Check-off Funds in Marketing Activities

Table 6.2 shows the value of the reduction in marketing investment and corresponding reduction in total producer benefits (i.e., cow-calf, non-fed cattle and fed-cattle producers) in a pre-BSE period, and for fiscal years 2005/2006 through to the end of calendar year 2008. (Appendix 2 provides an illustrative example of the calculations undertaken to arrive at the values in Table 6.2.) To re-iterate an earlier point, the analysis has taken account of inflation by deflating prices and monetary values, and as such the reduction in investment and producer benefits are in real terms. Compared to the baseline scenario, the assumed reduction in marketing investment resulted in a reduction in producer benefits. Moreover, in all periods considered, the reduction in benefits exceeded the reduction in investment. **This tells us that, in the absence of check-off fund investment in marketing activities, market-level producer benefits would have been lower.**

Recall that the average BCR is the ratio of the reduction in producer benefits to the reduction in investment. For this particular what-if scenario, the average BCR for investment in marketing activities is greater than one. **This tells us that the market-level producer benefits associated with check-off fund investment in marketing activities exceeded the value of the invested funds – producers gained net economic benefits from investing their check-off dollars in marketing activities**. And, as shown in Table 6.2, the average BCR in the post-BSE time periods increased from 5.86 to 9.4. Moreover, these increases were such that by the end of 2008, the average BCR for investment in marketing activities was

on par with the average BCR prior to the BSE crisis.

Table 6.2. Impact of reduction in check-off fund investment in marketing activities

	Reduction in investment ('000 of dollars)	Reduction in benefits ('000 of dollars)	Average BCR
Pre-BSE	$2,577.67	$24,929.51	9.67
FY05/06	$4,925.79	$28,877.20	5.86
FY06/07	$5,502.26	$41,538.03	7.55
FY07/08	$5,185.43	$43,636.65	8.42
July 1 2008 to Dec 31 2008	$2,418.80	$22,736.54	9.4
NPV over the fiscal years 05/06 TO 08/09 YTD	$16,894.96	$127,623.07	7.55

To aggregate across the post-BSE time periods, the net present value (NPV) of the reduction in investment and reduction in producer benefits is calculated assuming a three per cent discount rate and discounted back to the start of FY 2005/2006. In this case, the reduction in investment equals $16.9 million, while the reduction in producer benefits is $127.6 million, implying an average BCR from FY 05/06 through to Dec. 31, 2008 of 7.55:1. **Stated another way, between FY 2005/2006 and the end of 2008, every check-off dollar invested in marketing activities gave back $7.55 in producer benefits.**

6.3.2. Average BCR From Investment of Check-off Funds in Research Activities

Recall that it is assumed that removal of check-off funds would only impact investment in beef cattle research; the QSH and On-Farm Food Safety programs are not affected by this reduction. Moreover, it is assumed that any matching funds associated with BCRC-funded projects would still be invested. While limiting, such an assumption is needed as it is not possible to assess the extent to which other groups' investment in beef cattle research would change in light of reduced check-off funds flowing to beef cattle research. Table 6.3 shows the reduction in research investment and the corresponding impact on producer benefits for this scenario.

Table 6.3. Impact of reduction in check-off fund investment in beef cattle research activities

	Reduction in investment ('000 of dollars)	Reduction in benefits ('000 of dollars)	Average BCR
Pre-BSE	$266.54	$11,818.41	44.34
FY05/06	$147.69	$5,830.92	39.48
FY06/07	$187.93	$10,754.98	57.23
FY07/08	$266.21	$11,978.12	44.99
FY08/09 to Dec 31 2008	$134.98	$5,267.90	39.03
NPV over the fiscal years 05/06 TO 08/09 YTD	$685.86	$31,509.99	45.94

Compared to the baseline scenario, the simulated reduction in beef cattle research investment resulted in a reduction in producer benefits. Moreover, the average BCR for investment in research activities is greater than one. **This tells us that the market-level producer benefits associated with investment in beef cattle research activities exceeded the value of the invested check-off funds – producers gained**

net economic benefits from investing their check-off dollars in beef cattle research. The implied average BCR for this scenario ranges from 39:1 to 57:1 in the post-BSE time periods. Moreover, the NPV of the reduction in investment equals $0.7 million, while the NPV of the reduction in producer benefits is $31.5 million, implying an average BCR of 46:1 from FY 05/06 through to Dec. 31, 2008. **Stated another way, between FY 2005/2006 and the end of 2008 every check-off dollar invested in research activities gave back $46 in producer benefits.**

6.3.3. Average BCR from Investment of Check-off Funds in Marketing and Research Activities

This scenario assumes that the individual reductions in marketing and research that were considered above now occur simultaneously. Table 6.4 shows the reduction in investment in marketing and research activities, and the change in producer benefits associated with these shocks. **Compared to the baseline scenario, the simulated reduction in investment in marketing and research activities results in lower producer benefits.** Moreover, in all periods considered, the reduction in benefits exceeded the reduction in investment. **This tells us that the market-level producer benefits associated with check-off fund investment in marketing and research activities exceeded the value of the invested funds – producers gained net economic benefits from investing their check-off dollars in marketing and research activities.**

The implied average BCR for investment in marketing and research activities in the post-BSE time period ranges from 6.8:1 to 11:1. Moreover, the NPV of the reduction in investment equals $17.6 million, while the NPV of the reduction in producer benefits is $158 million, implying an average BCR 9:1 from FY 05/06 through to Dec. 31, 2008. **Stated another way, between FY 2005/2006 and the end of 2008 every check-off dollar invested in marketing and research activities gave back $9 in producer benefits.**

Table 6.4. Impact of reduction in check-off fund investment in marketing and research activities

	Reduction in investment ('000 of dollars)	Reduction in benefits ('000 of dollars)	Average BCR
Pre-BSE	$2,844.21	$30,437.09	10.70
FY05/06	$5,073.48	$34,593.67	6.82
FY06/07	$5,690.19	$52,026.02	9.14
FY07/08	$5,451.65	$55,310.77	10.15
FY08/09 to Dec 31 2008	$2,553.78	$27,851.48	10.91
NPV over the fiscal years 05/06 TO 08/09 YTD	$17,580.81	$158,354.17	9.01

6.3.4 Comparing the Benefits of the Canadian Beef Check-off to Other Commodities and Regions

A natural question to ask is: How does the historic **average** BCR for the Canadian beef check-off compare to other check-off programs? Table 6.5 provides a summary of some of the average BCRs discussed in the environmental scan and literature review, with attention focused on examples for beef and other sources of animal protein. Note that few studies have attempted to measure the average BCR for producer investment in marketing and research activities together. More often than not, previous studies have considered only one aspect of check-off-funded activity, or have focused on the BCR associated with marginal investment. Many studies concentrate on the latter as their concern is focused

squarely on whether investment has been optimal.

Nevertheless, an important point of comparison is Australia's check-off program. Australia is important as it has both marketing and research activities and, like Canada, has a beef industry that relies heavily on the export market. As mentioned earlier, an evaluation of the economic benefits arising from an increase in the Australian cattle check-off levy showed a BCR of 5:1. More generally, recent studies for the U.S. have shown average BCRs for domestic and international marketing activities of 5.5:1 and 15:1, respectively. Unfortunately, there are no available studies reporting average BCRs for beef cattle research or research on other animal-protein commodities. **Nevertheless, the average BCR for the Canadian beef check-off program falls squarely within the range of values reported in these previous studies.**

Table 6.5. Summary of selected average benefit-cost ratios from other check-off programs

Commodity	Region	Activity	Average BCR
Beef	Australia	Marketing and research	5:1
Beef	United States	Domestic marketing	5.5:1
Beef	United States	Export promotion	15:1
Cheese	Canada	Domestic marketing	8.3:1
Fluid milk	Canada	Domestic marketing	Between 2.2:1 and 7.4:1
Dairy	United States	Domestic marketing	Between 3.7:1 and 6.3:1

While the average BCR indicates beef cattle producers have benefited from check-off investment in marketing and research activities, the next question to ask is whether the historic pattern of investment is optimal in the sense that it maximizes producer benefits. To answer this question, the next section discusses the impact on producer benefits arising from a small increase in marketing and research investment. The notion here is that if investment is at or near optimal, then a small increase in investment should yield incremental benefits that just equal the value of the incremental investment.

6.4 Has Investment of Check-off Funds Been Optimal?

To assess whether check-off investment has maximized producer benefits, attention is focused on a one-time increase in investment. The reason for using a one-time increase in investment relates to the fact that the econometric simulation model embodies a dynamic supply response. This means that a one-time shock will result in changes in market conditions in the period in which the shock occurs, as well as subsequent periods. This dynamic effect arises as the one-time investment shock generates price signals that initiate production decisions (i.e., changes in the breeding herd) that take place over subsequent periods of time. If we were to shock all time periods with a small shock, we would create waves of responses that would comingle and make it impossible to isolate the effect of a single shock, and hence impossible to determine if actual investment has been optimal.

Moreover, a one-time shock stimulates changes in producer benefits in subsequent periods. Because of this dynamic benefit response, the change in producer benefits arising from the one-time shock is discounted back to the period in which the incremental investment occurs. The marginal BCR is then calculated using the NPV of the change in producer benefits to the value of the one-time shock. As above, a three per cent (per annum) discount rate is used.

To focus attention on a more recent, and arguably more relevant, time period, this one-time shock is assumed to occur in the first quarter of 2007. Ideally a $1 shock is used. However, when a $1 increase in investment was attempted, the effect was so small that the econometric simulation model showed no change compared to the baseline simulation. As such, a $10 increase in the nominal level of investment is assumed. To account for inflation, this $10 shock is deflated by the all-item CPI during simulation. The year 2007 was used for this analysis to reflect a recent period of time, but also to allow the supply response to work its way through the beef cattle production system.

A natural question to ask is: How should the incremental $10 investment be allocated across marketing and research activities? To address this issue, three counterfactual scenarios are developed. In the first, the incremental investment is allocated entirely to marketing activities, with the split between investment in marketing activities in Canada, the U.S. and the rest of the world implemented proportionally to the historic level of investment in each. In the second scenario, the incremental investment is allocated entirely to beef cattle research. Lastly, the incremental investment is allocated to marketing and research activities, proportionally to the historic level of investment in these activities.

Table 6.6 shows the deflated value of the incremental investment and the NPV of the deflated stream of the producer benefits that arise when the assumed incremental investment occurs. (Since the NPV of the stream of benefits arising from a one-time shock is considered, the marginal BCRs reported here are for the long run.) What is clear is that an additional $10 in nominal investment (or $9.1 in deflated terms) generates positive incremental producer benefits. Moreover, the NPV of these benefits exceeds the cost of the incremental investment, indicating that producers gain economic benefits from these investments.

The marginal BCR for the scenario where all incremental investment is channelled to marketing equals the marginal BCR for the scenario when incremental investment is allocated to marketing and research. It is important to note that this is entirely coincidental. Indeed as will be shown, the size of the marginal BCRs vary when the incremental investment occurs in different time periods. The reasons for equality of the marginal BCRs in the first and third scenario shown in Table 6.6 relates to how the incremental funds are allocated across the different activities. Because the third scenario allocates some of the fixed amount of incremental funding to research activities, less is allocated to marketing activities. Consequently, the contribution of investment in marketing activities to producer benefits would be dampened compared to when all of the incremental investment is allocated to marketing. However, investing the remaining incremental investment in research activities generates a sufficiently large impact to overcome this dampening effect. The net effect is that the increase in producer benefits in scenarios 1 and 3 in Table 6.6 are the same, and so too are the marginal BCRs.

The marginal BCRs in Table 6.6 provide important economic information. If investment is at (or very near) an optimal level, the incremental benefits should equal the incremental investment. In microeconomics this is known as the equi-marginal principle: at the optimum, marginal benefits (i.e., the NPV of deflated producer benefits) should equal the marginal cost (i.e., the incremental investment). If the marginal benefits exceed costs, under-investment has occurred. If marginal benefits are less than marginal costs, then over-investment has occurred. Given that the change in the discounted stream of producer benefits arising from incremental investment exceeds value of this incremental investment, the **results indicate under-investment in marketing and research activities**. Moreover, the **extent of under-investment is larger for research activities than for marketing activities**.

Table 6.6. Impact of incremental investment of $10 in Q1 2007 in marketing and research activities

Allocated to:	Deflated incremental investment ('000 of dollars)	NPV of deflated stream of marginal benefits ('000 of dollars)	Marginal BCR*
Marketing	$0.0091	$0.142	15.70
Beef cattle research	$0.0091	$0.532	58.67
Proportional allocation across all activities	$0.0091	$0.142	15.70

* Calculated using incremental investment and NPV of deflated benefit stream measured to five decimals. As such, the ratio of the third column to second column will give rounding errors compared to the marginal BCR calculated in the analysis.

Results in Table 6.6 also inform an assessment of the pattern of investment across marketing and research activities. Cranfield (2003) shows that for a commodity agency investing producer funds in market and research activities, the optimal allocation equates the marginal benefits across these activities. This implies that the optimal pattern of allocating incremental funds will equate the marginal BCRs. If marginal BCRs are not equated, and both are greater than one, the equi-marginal principle tells us the activity with the higher marginal BCR should receive proportionally more incremental funding than the activity with a lower marginal BCR. In the context of Table 6.6, this means that **any changes to the pattern of investment in marketing and research activities should flow more funds to beef cattle research and then to marketing activities**.

Recognize that the pattern of investment of funds may vary over the year. To account for this, the three scenarios in Table 6.6 were repeated assuming the incremental investment occurred in either the second, third or fourth quarter of 2007. Table 6.7 shows the marginal BCRs associated with these shocks. Compared across quarters, we see that marginal BCRs show some variability, but are greater than one, again indicating under-investment in marketing and research activities.

Table 6.7. Impact of incremental investment of $10 in marketing and research activities in different quarters of 2007

Allocated to:	Shock in Q1	Shock in Q2	Shock in Q3	Shock in Q4
Marketing	15.70	8.19	8.65	4.76
Beef cattle research	58.67	40.32	32.86	32.03
Proportional allocation across all activities	15.70	8.63	8.66	11.59

How do these marginal BCRs compare? Recall from the environmental scan and literature review that a number of previous studies have calculated marginal BCRs for beef and other commodities. Table 6.8 provides a summary of these marginal BCRs. What should be clear is that the marginal BCRs reported here are all within the range of those reported in other studies. This points to the fact that while there may be under-investment in marketing and research activities funded by Canadian cattle producers through the check-off, the same is true for other commodities and regions.

The main conclusion to draw from this analysis is that there has been under-investment in marketing and research activities. Moreover, the extent of under-investment has been largest for beef cattle research, followed by marketing activities. A natural question to ask is: Can we optimize the allocation of check-off investments in marketing and research activities with the goal of increasing producer benefits?

Table 6.8. Summary of selected marginal benefit-cost ratios from other check-off programs			
Commodity	Region	Activity	Average BCR
Beef	United States	Domestic marketing	1.3:1 to 9:1
Beef	United States	Export marketing	16:1 to 18:1
Beef	Australia	Generic advertising	24:1
Beef	Canada	Research	26:1 to 57:1
Pork	United States	Marketing and Research	14:1
Pork	United States	Domestic marketing	7:1
Pork	United States	Domestic marketing	28:1
Pork	United States	Research	20:1 to 56:1

6.5 Optimizing Allocation of Check-off Investment in Marketing and Research Activities

Results from the previous section point to under-investment in marketing and research activities. Moreover, results also suggest that the extent of under-investment is larger for research than for marketing. Given these conclusions, one question to ask is whether it is possible to optimize producer benefits by changing the marketing-research allocation of check-off funds. Important in this regard is that provinces with remittance agreements with the NCO agency can allocate varying proportions of their national check-off remittance to marketing and research activities. Indeed, these allocations range from 100 per cent to marketing and no funds to research (e.g., New Brunswick and Nova Scotia), to 90 per cent to marketing and 10 per cent to research (e.g., Saskatchewan), to 86 per cent to marketing and 14 per cent to research (i.e., Manitoba). The question then becomes: Can producer benefits be increased by varying the allocation of check-off funds to marketing and research?

To address this issue, first recall that the marginal BCRs in Table 6.7 show the increase in benefits from an incremental increase in investment. They can also be interpreted as the decrease in producer benefits arising from an incremental ***reduction*** in investment. For example, if, in quarter one of 2007, the $10 of nominal investment ($9.10 in deflated terms) was reallocated from marketing to research activities, producer benefits would increase by $429. This increase in producer benefits comes about as the incremental reduction in marketing investment lowers producer benefits by $157 (the marginal benefits lost by reducing investment in marketing), while the incremental investment in research increases producer benefits by $586 (the marginal benefit gained by increasing investment in research activities), with the net effect being an increase in producer benefits of $429.

However, it is important to recognize that the marginal BCRs reflect the impact of small changes in investment. If larger changes were considered, or if investment in one activity were to increase while investment in another were to decrease, the net impact on producer benefits would not necessarily reflect the marginal BCRs reported in the previous section. To overcome this limitation, this section reports on the impact on producer benefits arising from five different marketing-research allocation scenarios. Data in Figure 2.1 tells us that, ignoring administration charges, the historic ratio of check-off investment in marketing and research is 93.3:6.7 (i.e., 93.3 per cent goes to marketing, 6.7 per cent to research). To see how changes from this historic norm might affect producer benefits, the scenarios considered in this section vary this ratio from 90:10 (i.e., 90 per cent to marketing, 10 per cent to research) to 50:50 (i.e., 50 per cent to marketing, 50 per cent to research), in 10 percentage point increments.

To be clear, these different allocations apply ONLY TO CHECK-OFF FUNDS; funds from other sources are not varied. Moreover, it is assumed that the administration charge for NCO does not change and that the total amount of check-off funds available for investment does not change. As well, allocation of the check-off to marketing activities in Canada, the U.S. and rest of world are implemented proportionally to the historic pattern of marketing investment in these markets. Lastly, note that the different allocation scenarios do not go beyond a 50:50 allocation. The rationale for ending at a 50:50 split relates to the notion that lower allocations to marketing activities may undermine the ability of the respective divisions to mount and administer successful marketing efforts.

Table 6.9 shows the impact of alternative check-off allocations to marketing and research activities on Canadian cattle producer benefits in fiscal year 2007/2008. Compared to the status quo allocation, moving to a 90:10 split results in a $280,000 shift in investment from marketing to research and a $17 million increase in Canadian cattle producer benefits. This change in producer benefits reflects the net effect of a reduction in producer benefits due to reduced marketing investment, but a larger increase in producer benefits due to increased research investment. These changes reflect two key notions; first, we have assumed diminishing marginal returns to investment in marketing and research; second, more check-off funds have been invested in marketing than in research. Taken together, these two points mean the reduction in producer benefits arising from removing a dollar of investment in marketing is smaller than the increase in producer benefits arising from spending that dollar on research.

Table 6.9. Impact of alternative allocations of check-off funds to marketing and research activities on Canadian cattle producer benefits in fiscal year 2007/2008.

Ratio of marketing to research check-off fund allocation	Funds reallocated from marketing to research ('000 of dollars)	Change in producer benefits compared to the status quo allocation ('000 of dollars)
90:10	$279.92	$17,018.56
80:20	$826.03	$35,430.61
70:30	$1,372.15	$50,848.45
60:40	$1,918.27	$64,130.09
50:50	$2,464.38	$75,751.46

As the allocation shifts from a 90:10 to 50:50 marketing-research split, the funds reallocated from marketing to research naturally grow (since the total amount of check-off funds are fixed, an increase in investment in one activity leads to a reduction in investment in the other activity). More importantly, the change in producer benefits remains positive and actually becomes larger. Note, however, that the increase in producer benefits becomes smaller as the ratio of investment in marketing and research moves from 90:10 to 50:50. That producer benefits are increasing at a decreasing rate reflects diminishing returns to marketing and research activities. Nevertheless, **while both marketing and research suffer from under-investment, reallocating check-off funds from marketing to research would increase Canadian cattle producer benefits.**

One issue that merits discussion relates to leveraging check-off funds. If we take the ratio of BCRC investment in research projects plus the associated value of the matching funds (made available through BCRC staff) to the value of the check-off funds allocated to research, we have a number that tells us how much each check-off dollar is leveraged. Between the fiscal years 2002/2003 and 2007/2008, this leverage ratio averaged 5.2:1; every check-off dollar allocated to research resulted in a total of $5.20 invested in research (by the BCRC and project partners).

Note too that the CBEF and the BIC have access to leveraged funds. Since its inception, the CBEF has had access to various government programs at a 1:1 government-to-industry ratio. Moreover, both the CBEF and the BIC had access to the Beef Industry Development Fund from 1995 to 2000, followed by the National Beef Industry Development Fund. More recently, Legacy funds are available at a 3:1 government-to-industry matching ratio. Recognize, of course, that not all marketing investment is eligible for matching; investment in marketing activities in the Canadian market, for instance, has not historically been eligible for matching from government sources.

Nevertheless, if we take the ratio of investment in marketing activities to the value of the check-off funds allocated to marketing, we have a similar leverage ratio as calculated for research. Between the fiscal years 2002/2003 and 2007/2008, the leverage ratio for marketing activities averaged 1.7:1. This means every check-off dollar allocated to marketing resulted in a total of $1.7 invested in marketing.

Assuming these leverage ratios do not change, this means that transferring $1 of check-off investment from marketing to research reduces total investment in marketing by $1.70, but increases total investment in research by $5.20. Consequently, the decrease in producer benefits that arise from reduced investment in marketing would be larger than those embodied in the above scenarios. But at the same time, the increase in producer benefits that arise from increased investment in research would be larger than those embodied in the above scenarios. Given the large differences in the leverage ratios, and under most foreseeable circumstances, the net effect of these changes would be such that the change in producer benefits when account is taken of this leverage effect would be larger than those reported in Table 6.9. As such, the estimated increases in producer benefits shown in Table 6.9 are lower bounds and should be viewed as conservative estimates.

6.6 Impact of Possible Refund Requests by Alberta Cattle Producers

A very serious concern relates to recently passed legislation in Alberta that would allow Alberta cattle producers to request a refund of their check-off dollars. While such refund requests apply to the provincial check-off (of $3 per head), they also affect the national check-off (of $1 per head) that the Alberta Beef Producers dedicate from the provincial check-off. Given the size of Alberta's cattle sector, refund requests for national check-off dollars could affect investment in marketing and research activities. As such, it is important to understand the consequences to the entire Canadian cattle industry arising from refunds of check-off dollars to Alberta cattle producers.

To understand the economic impacts arising from such a refund request, this section discusses four scenarios designed to measure the impact on producer benefits of a range of refund requests. Based on consultation with members of the NCO executive and staff, the scenarios include requests for refunds equal to 40-, 50-, 60- and 70-per cent of Alberta cattle producers' contribution to the national check-off program. To focus the impact of any refund request, this analysis is conducted for the last full fiscal year in the model, namely fiscal year 2007/2008. It is assumed that a refund request reduces investment in marketing and research activities, and that the reduction in marketing activities reduces demand for beef, while the reduction in research activities reduces supply of live cattle and beef. Calculation of the reduction in these activities is complicated by two issues: first, the econometric simulation model is a quarterly model, while the flow of check-off funds is only available on an annual basis; second, it is not possible to directly observe Alberta's check-off contribution to beef cattle research.

To overcome these issues, note that in FY 2007/2008, 95 per cent of Alberta's national check-off contribution was allocated to marketing, while the reminder (five per cent) was allocated to research. Audited financial statements show the flow of Alberta's check-off funds to the BIC and the CBEF (see Table 6.10). Using Alberta's contribution to the BIC and the CBEF, and Alberta's 95:5 marketing-to-research rule, Alberta's investment in the BCRC in 2007/2008 is calculated at $195,878. Hence, the second limiting issue noted above has been addressed.

To address the first issue (which relates to the frequency of observation of each province's check-off funds), note that the last column in Table 6.10 shows Alberta's share of investment in the respective division's activities. We use this share to help calculate the reduction in marketing and research activities arising from the simulated refund scenario. Specifically, the proportional reduction in marketing and research activities (arising from refund requests from Alberta producers) equals the share in the last column of Table 6.10 multiplied by the assumed refund rate. Structuring the analysis in this manner overcomes the inability to capture the flow of check-off funds on a quarterly basis, but it does assume that the proportional reduction is the same in all quarters of fiscal year 2007/2008.

Table 6.10. Breakdown of Alberta's check-off investment across BIC, CBEF and BCRC (all values are in nominal dollars)

	Alberta's check-off investment	Total investment in marketing or research activity	Alberta's check-off investment as a percentage of total marketing or research investment
BIC[a]	$2,519,142	$7,958,150	31.7%
CBEF[b]	$1,202,548	$5,013,446	23.9%
BCRC	$195,878	$536,923	36.5%

a. Alberta's check-off investment and BIC budget are based on fiscal year ending June 30
b. CBEF is based on a fiscal year ending March 31.

Table 6.11 shows the value of the refund and corresponding lost producer benefits (in thousands of deflated dollars) for refund rates ranging from 40 per cent to 70 per cent for fiscal year 2007/2008. Regardless of the assumed refund rate, the loss to Canadian cattle producers is large in comparison to the value of the refund flowing back to Alberta producers. The size of the lost producer benefits ranges from $13 million (from a $1.2-million refund) to $23 million (from a $2-million refund). To provide better context, the ratio of the lost benefits to the value of the refund is calculated (and shown in the last column of Table 6.11). This ratio shows that **for fiscal year 2007/2008, every refunded dollar reduces Canadian cattle producer benefits by $11**.

Table 6.11. Impacts of refund requests by Alberta beef producers on the economic benefits of Canadian cattle producers.

Assumed refund rate (%)	Value of refund ('000 of deflated dollars)	Value of lost producer benefits ('000 of deflated dollars)	Ratio of lost producer benefits to value of the refund
40	$1,167.49	$13,056.09	11.2
50	$1,459.36	$16,417.20	11.3
60	$1,751.23	$19,820.45	11.3
70	$2,043.10	$23,268.12	11.4

7. Summary and Conclusions

This research project evaluated the economic impact of investing Canadian cattle producer check-off dollars in marketing and research activities. The analysis focused on three core questions:

- What is the historic producer return to investment in marketing and research activities?
- How can the allocation of check-off funds be optimized across marketing and research activities?
- What impact does optimizing check-off fund investment in marketing and research activities have on the economic well-being of Canadian cattle producers?

To provide answers to these questions, an econometric simulation model was developed. This model mimics the workings of beef and cattle markets in Canada and the U.S. It explicitly accounts for the effect that investment by Canadian cattle producers in beef cattle marketing and research activities has on prices and quantities in these markets. Moreover, the model allows for calculation of Canadian cattle producer benefits in a baseline situation and under a variety of "what-if" scenarios. Differences between the producer benefits in the baseline and the various "what if" scenarios were used to help answer the three core questions posed above.

Analysis with this model shows that Canadian cattle producers gain net economic benefits from investment in marketing and research activities. Specifically, between 2005 and 2008 the benefit-cost ratio (BCR) associated with investment of producer check-off dollars in marketing and research activities grew from 7:1 to 11:1, with an average of 9:1 over this time period. **This means that on average from 2005 to 2008, every check-off dollar invested in marketing and research activities earned $9 for Canadian cattle producers**. As well, by 2008 the return to the average dollar invested slightly exceeded the return to the average dollar invested prior to the BSE-crisis.

Nevertheless, subsequent analysis showed **there has been under-investment of check-off dollars in marketing and research**. Results show that investing one additional dollar in marketing and research activities returns between $9 and $15 in additional producer benefits. Had investment been optimal, the return to this marginal investment should have yielded one additional dollar in producer benefits. This means **there has been under-investment in marketing and research activities, and investment in these activities should increase in order to maximize producer benefits**. Moreover, the extent of this under-investment has been larger for research activities than for marketing activities.

A natural question to ask is whether the allocation of check-off funds to marketing and research activities is optimal. Ignoring NCO administration costs, the historic ratio of investment in marketing to research is 93:7 (i.e., 93 per cent to marketing, 7 per cent to research). Analysis was undertaken to measure the impact of varying this ratio from 90:10 to 50:50, all the while holding constant the total funds available for investment. Results show that a 90:10 split in marketing-to-research investment can generate an additional $17 million in producer benefits, while a 50:50 split can generate $76 million in additional producer benefits. **While both marketing and research suffer from under-investment, reallocating check-off funds from marketing to research would increase Canadian cattle producer benefits.**

Lastly, the impact of possible check-off refund requests by Alberta cattle producers was explored. Specific attention was focused on how check-off refunds would affect Canadian cattle producer benefits.

Recognize that, given the sizable number of cattle sales in Alberta, refunding a portion of the national check-off fund could affect producers' ability to invest in marketing and research activities. Assuming these refund requests are not channelled into other marketing and research activities, results shows that **every dollar refunded will cost Canadian cattle producers $11 in benefits**. Depending on the size of the refund, the reduction in Canadian cattle producer benefits could range anywhere between $13 million (with a 40 per cent refund rate) and $23 million (with 70 per cent refund rate).

8. References

Alston, J. M., G. W. Norton, et al. (1995). Science Under Scarcity: Principles and Practice for Agricultural Research Evaluation and Priority Setting. Ithaca, Cornell University Press.

Alston, J., M. Marra, et al. (2000). "Research returns redux: A meta-analysis of the returns to agricutural R&D." Australian Journal of Agricultural and Resource Economics **44**(2): 185-215.

Alston, J. M., J. W. Freebairn, et al. (2001). "Beggar-thy-neighbor advertising: Theory and application to generic commodity promotion programs." American Journal of Agricultural Economics **83**(4): 888-902.

Alston, J. M., J. W. Freebairn, et al. (2004). "Levy-funded research choices by producers and society." Australian Journal of Agricultural and Resource Economics **48**(1): 33-64.

Beach, R. H., C. Zhen, et al. (2007). An Economic Analysis of the Effectiveness of the Pork Checkoff Program, RTI International.

Beef Marketing Funding Committee, T. (2009). Beef Levy Review 2009: Final Report.

Boetel, B. L. and D. J. Liu (2003). "Evaluating the Effect of Generic Advertising and Food Health Information within a Meat Demand System." Agribusiness **19**(3): 345-354.

Boonsaeng, T. and S. M. Fletcher (2008). "Import Demand for Shelled Peanuts in the European Union: Impacts of the U.S. Export Promotion Program**.**"

Brester, G. W. and T. C. Schroeder (1995). "The Impacts of Brand and Generic Advertising on Meat Demand." American Journal of Agricultural Economics **77**(4): 969-979.

Canadian Beef Cattle Checkoff Agency. (2008). "National Beef Check-Off Backgrounder."

Canadian Beef Cattle Research. (2008). 2007/08 Annual Report.

Canadian Beef Research. (2008). "National Beef Check-Off Backgrounder."

Carman, H. F. (2006). "Offsetting price impacts from imports with generic advertising and promotion programs: The Hass avocado promotion and research order." Review of Agricultural Economics **28**(4): 463-481.

Chung, C. and H. M. Kaiser (2000). "Determinants of temporal variations in generic advertising effectiveness." Agribusiness **16**(2): 197-214.

Comeau, A., Mittelhammer, R. C., and Wahl, T. I. (1997). "Assessing the Effectiveness of MPP and TEA Advertising and Promotion Efforts in the Japanese Market for Meats." Journal of Food Distribution Research (July 1997).

Cranfield, J. A. L. and E. W. Goddard (1999). "Open economy and processor oligopoly power effects of beef advertising in Canada." Canadian Journal of Agricultural Economics **47**(1): 1-19.

Cranfield, J. (2000). "Econometric Review of Manitoba Milk Producers Market Expansion Activities." Report prepared for the Manitoba Milk Producers.

Cranfield, J. (2001). "An Econometric Review of British Columbia Milk Producers Investment in Fluid Milk Advertising." Report prepared for the British Columbia Dairy Foundation.

Cranfield, J. (2001). "An Econometric Review of Alberta Milk Producers Investment in Fluid Milk Advertising." Report prepared for the Alberta Milk Producers.

Cranfield, J. A. L. (2002a). "Optimal advertising with traded raw and final goods: The case of variable proportions technology." Journal of Agricultural and Resource Economics **27**(1): 204-221.

Cranfield, J. A. L. (2002b). "Optimal generic advertising with a rationed related good: The case of Canadian beef and chicken markets." Canadian Journal of Agricultural Economics **50**(2): 117-133.

Cranfield, J. A. L. (2003). "Optimal collective investment in generic advertising, export market promotion and cost-of-production-reducing research." Canadian Journal of Agricultural Economics **51**(3): 299-321.

Crespi, J. M. (2003). "The generic advertising controversy: How did we get here and where are we going?" Review of Agricultural Economics **25**(2): 294-315.
Ding, L., and H. Kinnucan. (1996). "Market allocation rules for nonprice promotion with farm programs: U.S. cotton." Journal of Agricultural and Resource Economics **21**(2) 351-367.
Dong, D. S., H. M. Kaiser, et al. (2007). "Quantity and quality effects of advertising: a demand system approach." Agricultural Economics **36**(3): 313-324.
Federation des producteurs de boivins du Quebec (2006). "Rapport de l'administration du Plan conjoint des producteurs de bovins du Québec."
Fox, G., B. Roberts, et al. (1992). "Canadian Dairy Policy and the Returns to Federal Dairy-Cattle Research." Agricultural Economics **6**(3): 267-285.
Freebairn, J. (1992). "Evaluating the Level and Distribution of Benefits from Dairy Industry Research." Australian Journal of Agricultural Economics **36**(2): 141-165.
Freebairn, J. W. and J. M. Alston (2001). "Generic advertising without supply control: implications of funding mechanisms for advertising intensities in competitive industries." Australian Journal of Agricultural and Resource Economics **45**(1): 117-145.
Goddard, E. W. and M. L. Mccutcheon (1993). "Optimal Producer Investment in Generic Advertising - the Case of Fluid Milk in Ontario and Quebec." Canadian Journal of Agricultural Economics **41**(3): 329-347.
Haque, A. K. E., G. Fox, et al. (1989). "Product Market Distortions and the Returns to Federal Laying-Hen Research in Canada." Canadian Journal of Agricultural Economics **37**(1): 29-46.
Horbasz, C. N., G. Fox, et al. (1988). "A Comparison of Ex Post and Ex Ante Measures of Producers Surplus in Estimating the Returns to Canadian Federal Sheep Research." Canadian Journal of Agricultural Economics **36**(3): 489-500.
Jan, M.-S., C. L. Huang, et al. (2003). "Estimating the Effects of Non-Price Promotion on Export Demands for U.S. Poultry Meat." Journal of International Food & Agribusiness Marketing **13**(1): 61 - 82.
Kaiser, H. M. (1997). "Impact of National Generic Dairy Advertising on Dairy Markets, 1984–95." Journal of Agricultural and Applied Economics **29**(2): 303-313.
Kaiser, H. M., D. J. Liu, et al. (2003). "An Economic Analysis of California Raisin Export Promotion." Agribusiness **19**(2): 189-201.
Kaiser, H. M. and T. M. Schmidt (2003). "Distributional Effects of Generic Dairy Advertising Throughout the Marketing Channel." Agribusiness **19**(3): 289-300.
Kaiser, H. J. Cranfield and Maurice Doyon. (2005). “An Economic Analysis of Generic Fluid Milk Advertising in Ontario, Quebec, and the Maritime Provinces.” Report prepared for the Dairy Farmers of Canada.
Kaiser, H. M. and D. Dong (2006). "Measuring the Impacts of Generic Fluid Milk and Dairy Marketing." NICPRE **July 2006**.
Kaiser, H. J. Cranfield and Maurice Doyon. (2007). “An Economic Analysis of Generic Cheese and Butter Advertising and Promotion Activities by the Dairy Farmers of Canada.” Report prepared for the Dairy Farmers of Canada.
Kinnucan, H. W. and M. Venkateswaran (1994). "Generic Advertising and the Structural Heterogeneity Hypothesis." Canadian Journal of Agricultural Economics **42**(3): 381-396.
Kinnucan, H. W. and M. Thomas (1997). "Optimal media allocation decisions for generic advertisers." Journal of Agricultural Economics **48**(3): 425-441.
Kinnucan, H. W., H. Xiao, et al. (1997). "Effects of health information and generic advertising on U.S. meat demand." American Journal of Agricultural Economics **79**(1): 13-23.
Kinnucan, H. W. (1997). "Middlemen behaviour and generic advertising rents in competitive interrelated industries." Australian Journal of Agricultural and Resource Economics **41**(2): 191-207.

Kinnucan, H. W. and J. E. Christian (1997). "A method for measuring returns to nonprice export promotion with application to almonds." Journal of Agricultural and Resource Economics **22**(1): 120-132.
Kinnucan, H. W. and Y. L. Miao (2000). "Distributional impacts of generic advertising on related commodity markets." American Journal of Agricultural Economics **82**(3): 672-678.
Kinnucan, H. W. and Ã. y. Myrland (2008). "On generic vs. brand promotion of farm products in foreign markets." Applied Economics **40**(6): 673 - 684.
Klein, K. K., B. Freeze, et al. (1994). "Returns to Beef Research in Canada - a Comparison of Time-Series and Mathematical-Programming Approaches." Agricultural Systems **46**(4): 443-459.
Krishnamurthy, S. (2001). "The effect of provision points on generic advertising funding." Marketing Letters **12**(4): 315-325.
Le, Cong, Harry Kaiser, , William Tomek, (1998). "Export promotion and import demand for U.S. red meat in selected Pacific Rim countries." Agribusiness **14**(2): 95-105.
Lenz, J., H. M. Kaiser, et al. (1998). "Economic analysis of generic milk advertising impacts on markets in New York State." Agribusiness **14**(1): 73-83.
Lim, H., C. R. Shumway, et al. (2000). "Research contributions from the soybean checkoff program." Journal of Agricultural and Resource Economics **25**(1): 128-146.
Marsh, T. L., T. C. Schroeder, et al. (2004). "Impacts of meat product recalls on consumer demand in the USA." Applied Economics **36**(9): 897-909.
Meat and Wool New Zealand (2008). 2007/2008 Financial Statements and Notes.
Messer, K. D., T. M. Schmit, et al. (2005). "Optimal institutional mechanisms for funding generic advertising: An experimental analysis." American Journal of Agricultural Economics **87**(4): 1046-1060.
Messer, K. D., H. M. Kaiser, et al. (2007). "Voluntary funding for generic advertising using a provision point mechanism: An experimental analysis of option assurance." Review of Agricultural Economics **29**(3): 612-631.
Messer, K. D., H. M. Kaiser, et al. (2008). "The problem of free riding in voluntary generic advertising: Parallelism and possible solutions from the lab." American Journal of Agricultural Economics **90**(2): 540-552.
National Pork Board (2009). 2009 Strategic Plan and Budget.
Nicholson, C. F. and H. M. Kaiser (2008). "Dynamic market impacts of generic dairy advertising." Journal of Business Research **61**(11): 1125-1135.
Norman, G., L. Pepall, et al. (2008). "Generic product advertising, spillovers, and market concentration." American Journal of Agricultural Economics **90**(3): 719-732.
Onunkwo, I. M. and J. E. Epperson (2000). "Export Demand for U.S. Pecans: Impacts of U.S. Export Promotion Programs." Agribusiness **16**(2): 253-265.
Onunkwo, I. M. E., J.E. (2000). "Export Demand for U.S. Walnuts: Impacts of U.S. Export Promotion Programs." Journal of Food Distribution Research **31**(3): 21-27.
Piggott, N. E., J. A. Chalfant, et al. (1996). "Demand Response to Advertising in the Australian Meat Industry." American Journal of Agricultural Economics **78**(2): 268-279.
Piggott, R. R., N. E. Piggott, et al. (1995). "APPROXIMATING FARM-LEVEL RETURNS TO INCREMENTAL ADVERTISING EXPENDITURE - METHODS AND AN APPLICATION TO THE AUSTRALIAN MEAT INDUSTRY." American Journal of Agricultural Economics **77**(3): 497-511.
Pimbucha Rusmevichientong, H. M. K. (2009). "Measuring the effectiveness of U.S. rice export promotion programs." Agribusiness **25**(2): 215-230.
Pritchett, J. G., D. J. Liu, et al. (1997). "Generic milk advertising: Optimal allocation among types of media." Journal of Agricultural and Resource Economics **22**(2): 398-398.

Reberte, C., H. M. Kaiser, et al. (1996). "Generic advertising wearout: The case of the New York City fluid milk campaign." Journal of Agricultural and Resource Economics **21**(2): 199-209.
Richards, T. J., P. V. Ispelen, et al. (1997). "A Two-Stage Analysis of the Effectiveness of Promotion Programs for U.S. Apples." American Journal of Agricultural Economics **79**(3): 825-837.
Richards, T. J. and P. M. Patterson (1998). "Dynamic complementarity in export promotion: The market access program in fruits and vegetables." Journal of Agricultural and Resource Economics **23**(2): 319-337.
Schmit, T. M. and H. M. Kaiser (2002). "Measuring the Impacts of Generic Fluid Milk and Cheese Advertising: A Time-Varying Parameter Application." NICPRE **May 2002**.
Schmit, T. M. and H. M. Kaiser (2004). "Decomposing the variation in generic advertising response over time." American Journal of Agricultural Economics **86**(1): 139-153.
Schmit, T. M., J. C. Reberte, et al. (1997). "An economic analysis of generic egg advertising in California, 1985-1995." Agribusiness **13**(4): 365-373.
Shahid, A. and C. M. Gempesaw II (2002). "The Role of Promotion Programs for U.S. Poultry Exports." Agricultural and Resource Economics Review **31**(1): 59-70.
Vande Kamp, P. R. and H. M. Kaiser (2000). "Optimal temporal policies in fluid milk advertising." American Journal of Agricultural Economics **82**(2): 274-286.
Verbeke, W., R. W. Ward, et al. (2000). "Probit analysis of fresh meat consumption in Belgium: exploring BSE and television communication impact." Agribusiness. **16(2) p. 215-234.**
Verbeke, W. and R. W. Ward (2001). "A fresh meat almost ideal demand system incorporating negative TV press and advertising impact." Agricultural economics. **25(2/3) p. 359-374.**
Ward, R. W. and C. Lambert (1993). "Generic Promotion of Beef - Measuring the Impact of the United-States Beef Checkoff." Journal of Agricultural Economics **44**(3): 456-465.
Ward, R. (2001). "Beef Demand and its Response to the Beef Checkoff." Evaluation Report to the Cattlemen's Beef Promotion and Research Board. Centennial, CO.
Ward, R. (2004). "Beef Demand and the Rate-Of-Return to the U.S. Beef Checkoff: Two Independent Evaluation Approaches." Evaluation Report to the Cattlemen's Beef Promotion and Research Board. Centennial, CO.
Ward, R. W. (2009). The Beef Checkoff Programs and Their Impact on U.S. Beef Demand, University of Florida.
Warrick Yates and Associates (2009). Independent Review of the Effectiveness of the Additional $1.50 Beef Marketing Levy.
Widmer, L., G. Fox, et al. (1988). "The Rate of Return to Agricultural-Research in a Small Country - The Case of Beef-Cattle Research in Canada." Canadian Journal of Agricultural Economics **36**(1): 23-35.
Wohlgenant, M. (1993). "Distribution of gains from research and promotion in multi-stage production systems: The case of the U.S. beef and pork industries. American Journal of Agricultural Economics **75**(3): 642-651.
Zhao, X., John Mullen, Garry Griffith, Roley Piggott, William Griffiths, (2003). "The incidence of gains and taxes associated with R&D and promotion in the Australian beef industry." Agribusiness **19**(3): 333-344.
Zidack, W., H. Kinnucan, et al. (1992). "Wholesale-Level and Farm-Level Impacts of Generic Advertising - The Case of Catfish." Applied Economics **24**(9): 959-968.

Appendix 1: Econometric Simulation & Baseline Validation

RETAIL DEMAND

Retail demand in Canada is modelled on a per capita basis as follows:

$$PCBFD3 = a_0 + a_1 Q_1 + a_2 Q_2 + a_3 Q_4 + a_4 t + a_5 RPBF3 + a_6 RPPK3 + a_7 RPCK3 + a_8 PDI3 + a_{10} SCNDMRK \quad (1a)$$

where PCBFD3 is quarterly per capita disappearance of beef (and veal) in Canada (in kilograms per person per quarter), Q_i are quarterly dummy variables included to account for seasonality in beef disappearance, t is a time trend, RPBF3 is the deflated retail price of beef (in CND dollars per pound), RPPK3 is the deflated retail price of pork (in CND dollars per pound), RPCK3 is the retail price of chicken (in CND dollars per pound), PDI3 is deflated per capita disposable expenditure (in CND dollars per person per capita), SCNDMRK is the square root of deflated per capita marketing investment in beef marketing activities in Canada, and the a_j terms are parameters to be estimated. Note that the all-item CPI for Canada (2002=100) is used as the deflator for prices and expenditure terms in the Canadian equation.

The variable SCNDMRK includes investment in marketing initiatives aimed at increasing demand for beef in Canada and includes BIC expenditure on: the customer service centre, commercial beef, BSE recovery/marketing contingency, processing development, food service marketing, consumer communications, trade communications, nutrition and food safety, food safety program, retail marketing and consumer culinary service. It was not possible to separate (on a consistent basis) the program management and administration/operating costs from expenditure on each activities, so SCNDMRK contains the program management and administration/operating costs associated with each of these items.

Nevertheless, SCNDMRK does not include the following elements of the BIC Division: U.S. market development; producer communications; BIC corporate planning, expenditures related to various regional offices; funding and evaluation; the BIC committee; brand management and research and issues management. It is important to note that expenditure on the BSE Containment and Recovery Strategy was included in BIC corporate planning expense line (i.e., cost centre 50) of the budget summaries in the quarterly progress reports from which marketing investment data were drawn. Because these BSE containment and recovery expenditures play an important role in shaping demand during and after the BSE crisis, they were separated from BIC corporate planning expenses and included in the SCNDMRK variable. Lastly, note that including the square root of the relevant deflated per capita marketing activity expenditures imposes diminishing marginal returns on these activities (see Cranfield 1995 and Cranfield and Goddard 1999).

Per capita beef demand in the U.S. is modelled as:

$$PCBFD4 = b_0 + b_1 Q_1 + b_2 Q_2 + b_3 Q_4 + b_4 t + b_5 RPBF4 + b_6 RPPK4 + b_7 RPPY4 + b_8 PDI4 \quad (1b)$$

where PCBFD4 is quarterly per capita disappearance of beef (and veal) in the U.S. (in kilograms per person per quarter), RPBF4 is the deflated retail price of beef (in U.S. dollars per pound), RPPK4 is the deflated retail price of pork (in U.S. dollars per pound), RPPY4 is the retail price of poultry (in U.S. dollars per pound), PDI4 is deflated per capita disposable expenditure (in U.S. dollars per person per capita),

and the b_j terms are parameters to be estimated. Note that the all-item CPI for the U.S. (1982-1984=100) is used as the deflator for prices and monetary terms in the U.S. equation. Table A.1 shows summary statistics of the variables used for estimation, while Table A.2 shows OLS estimates and elasticities for the Canadian and U.S. retail demand function.

Table A.1. Summary statistics of the data used during estimation[a]

Variable	Units	Mean	Std. dev.
PCBFD3	Kg per person	8.277	0.607
DSH3	'000 head	765.812	161.595
DBW3	'000 head	150.617	34.280
SSH3	'000 head	898.078	160.685
SBW3	'000 head	195.668	41.518
IBW3	'000 head	4449.637	519.078
INV3	'000 head	5603.378	414.959
CW3	Kg	295.614	10.937
NT3BF4	'000 kg	50085.880	31852.677
NT3BF9[b]	'000 kg	25068.594	7751.665
RPBF3	Deflated $ per pound	3.434	0.232
RPPK3	Deflated $ per pound	3.742	0.265
RPCK3	Deflated $ per pound	2.417	0.117
PDI3	Deflated $10,000 per person	2.206	0.167
SCNDMRK	Square root of deflated $ invested per person	0.202	0.027
SUSMRK	Square root of deflated $ invested	161.721	277.057
SINTMRK	Square root of deflated $ invested	1031.193	69.028
SSRND	Square root of deflated $ invested	292.771	356.950
PSS3	Deflated $ per pound	0.953	0.121
PFC1	Deflated $ per pound	0.987	0.086
PBW3	Deflated $ per pound	0.545	0.171
PBARLEY	Deflated $ per bushel	1.309	0.249
BFEXPP	Deflated $ per pound	2.555	0.344
PCBFD4	Kg per person	10.826	0.378
DSH4	'000 head	7013.756	452.918
DBW4	'000 head	1627.378	170.371
SSH4	'000 head	6881.488	447.074
SBW4	'000 head	1582.328	163.323
IBW4	'000 head	34097.526	931.753
RPBF4	Deflated $ per pound	2.211	0.164
RPPK4	Deflated $ per pound	1.643	0.072
RPPY4	Deflated $ per pound	1.035	0.029
PDI4	Deflated $ per person	13541.145	1426.632
PSS4	Deflated $ per pound	0.449	0.064
PFC4	Deflated $ per pound	0.837	0.084
PBW4	Deflated $ per pound	0.267	0.057
FPCO4	Deflated $ per bushel	0.014	0.004

a. Unless otherwise noted, all summary statistics are calculated using quarterly data from 1991 quarter 1 to 2008 quarter 4.
b. Calculated using data from 2003 quarter 4 to 2008 quarter 4.

The adjusted-R2 and F-statistic values indicate that the estimates of both the Canadian and U.S retail beef demand equations track actual per capita disappearance and carry statistical significance. While the Durbin-Watson (DW) statistic for the Canadian retail beef demand equation indicates the model does not suffer from autocorrelation, the DW statistic for the U.S. model is in the indeterminate range. Efforts to correct for autocorrelation in the U.S. equation (using either a lagged dependent variable or AR1 estimator) did not change the signs of the significant variables, nor did the estimated magnitudes vary considerably. As such, no effort was undertaken to correct for autocorrelation in the U.S. beef demand equations.

Table A.2. OLS estimates of the per capita retail disappearance equations for Canada and the United States

	Canada		U.S.	
Variable	Estimate & t-statistics	Elasticity evaluated at the means	Estimate & t-statistics	Elasticity evaluated at the means
Intercept	9.176***		7.786***	
	(4.756)		(5.882	
Q1	-0.277**		-0.594***	
	(-2.113)		(-9.838)	
Q2	0.264*		-0.065	
	(1.954)		(-1.082	
Q4	-0.575***		-0.597***	
	(-4.469)		(-10.208)	
Time trend	-0.015**		-0.035***	
	(-2.415)		(-5.597)	
Beef price	-0.699***	-0.289	-0.960***	-0.196
	(-2.916)		(-6.564)	
Pork price	-0.083	-0.003	0.015	0.002
	(-0.278)		(0.032)	
Chicken/poultry price	0.897	0.262	-0.098	-0.009
	(1.300)		(-0.093)	
Per capita expenditure	-0.001	0.0002	0.001***	0.637
	(-0.001)		(5.268)	
SCNDMRK	1.912	0.023		
	(1.032)			
Sample	1990:1 to 2008:4		1990:1 to 2008:4	
N	76		76	
Adj-R^2	0.589		0.777	
DW	1.974		1.520	
F-statistic	12.988***		33.754***	

*** Denotes significance at the one per cent significance level
** Denotes significance at the five per cent significance level
* Denotes significance at the 10 per cent significance level

The intercept, and coefficients on the Q1, Q2 and Q4 seasonal dummy variables, time trend, and retail beef price are significant at the 10 per cent level or better on the Canadian demand equation. The intercept, and coefficients on the Q1 and Q4 dummy variables, retail price and per capita disposable

variables income are significant at the one per cent level in the U.S. demand equation. For both countries, the own-price effect is negative, as expected. While the coefficient on the SCNDMRK variable is not significant at the 10 per cent level, this does not mean there is no effect; rather it means the coefficient on investment in beef marketing activities in Canada is not estimated with the same degree of precision as, say, the retail price effect. Nevertheless, the elasticities (evaluated at the means of the data) suggest that beef demand in Canada and the U.S. is inelastic with respect to own-price. More importantly, the elasticity of retail beef demand in Canada with respect to SCNDMRK is positive and indicates that a one per cent increase in investment in beef marketing activities in Canada brings about a 0.023 per cent increase in demand for beef in Canada. While the magnitude of this effect may seem small, it is about 2,000 times previously reported values of this elasticity for Canada (see, e.g., Cranfield and Goddard 1999).

DEMAND FOR SLAUGHTER STEERS AND HEIFERS

Steer and heifer (i.e., fed cattle) slaughter in Canada is modelled as a derived demand:

$$DSH3 = c_0 + c_1 Q_1 + c_2 Q_2 + c_3 Q_4 + c_4 D1996 + c_5 D03Q2 + c_6 RPBF3 + c_7 PSS3 + c_8 DSH3(-1) \quad (2a)$$

where DSH3 is commercial (i.e., federally and provincially inspected slaughter) of steers and heifers in Canada, D1996 is a dummy variable equal to one from 1990 to 1996 and zero thereafter, D03Q2 is a dummy variable equal to one in Q2 of 2003, PSS3 is the deflated price of slaughter steers in Canada, DSH3(-1) is a lagged dependent variable and the c_j terms are parameters to be estimated. The all-item Farm Product Price Index is used as the price deflator for PSS3. D1996 is included to account for structural change in the derived demand for slaughter steers and heifers in Canada, while D03Q2 is included to account for the large change in steer and heifer slaughter in the quarter in which a BSE-infected bovine animal was discovered in Canada. The lagged dependent variable is included to remedy the presence of first-order autocorrelation detected in the model.

Steer and heifer slaughter in the U.S. is modelled as an unconditional demand equation:

$$DSH4 = d_0 + d_1 Q_1 + d_2 Q_2 + d_3 Q_4 + d_4 PSS4 + d_5 DSH4(-1) \quad (2b)$$

where DSH4 is commercial steer and heifer slaughter, PSS4 is the deflated price of slaughter steers, DSH4(-1) is a lagged dependent variable and the d_j terms are estimated parameters. The price of slaughter steers in the U.S is deflated by the U.S. slaughter livestock price index, while the lagged dependent variable corrects for autocorrelation. A derived demand function for U.S. steer and heifer slaughter was originally specified; however, the sign of the retail price term in that equation was negative and insignificant. Moreover, removal of the retail beef price variable in the U.S. equation did not affect the size and significance of the other variables, suggesting it is an irrelevant variable. As such, retail beef price in the U.S. is omitted from the final version of the model. As with the Canadian equation, the lagged dependent variable is included to correct of significant first-order autocorrelation. Table A.3 shows the OLS parameter estimates and elasticities for the U.S. steer and heifer slaughter equation.

Table A.3. OLS estimates of the steer and heifer slaughter equations for Canada and the United States

	CANADA		U.S.	
Variable	Estimate & t-statistics	Elasticity	Estimate & t-statistics	Elasticity
Intercept	268.628**		5639.520***	
	(2.578)		(7.825)	
Q1	31.676*		-316.694***	
	(1.777)		(-4.678)	
Q2	52.173***		334.236***	
	(3.083)		(4.777)	
Q4	6.902		-565.038***	
	(0.407)		(-10.631)	
D1996	-92.901***			
	(-2.995)			
D03Q2	-215.079***			
	(-4.084)			
Time trend	-1.143		-3.401***	
	(-1.476)		(-3.257)	
Retail prices	30.773	Short run: 0.137		
	(0.954)	Long run: 0.683		
Steer price	-166.381**	Short run: -0.207	-3252.900***	Short run: -0.209
	(-2.343)	Long run: -1.025	(-6.979)	Long run: -0.374
Lagged slaughter	0.798***		0.442***	
	(10.956)		(5.737)	
Sample	1990:2 to 2008:4		1990:2 to 2008:4	
N	75		75	
Adj-R2	0.90		0.87	
Durbin's h	0.052		-0.251	
F-stat	77.131		83.5565***	

*** Denotes significance at the one per cent significance level
** Denotes significance at the five per cent significance level
* Denotes significance at the 10 per cent significance level

Regression diagnostics (adjusted-R2 and F-statistic) for the Canadian and U.S. steer and heifer slaughter equations show the estimated models track the data rather well. Moreover, the Durbin-h statistics (used to test for autocorrelation in the presence of a lagged dependent variable) suggest the estimated models do not suffer from autocorrelation. The intercept and coefficients on the seasonal dummy variables indicate significant quarterly variation in steer and heifer slaughter, as expected, while coefficients on D1996 and D03Q2 in the Canadian equation and time trend in the U.S. are also significant. While the retail price coefficient in the derived demand equation for Canada was not significant, however, removal of this price variable changed the magnitude of the other coefficients, suggesting its removal would result in an omitted variable bias. Coefficients on the price of slaughter steers are significant and negative, as expected, in both equations. Lastly, the lagged dependent variable in each country's steer and heifer slaughter equation is significant.

For Canada, the elasticity of steer and heifer slaughter with respect to retail beef price is inelastic in both the short- and long run. The short run elasticity with respect to the price of slaughter steers (evaluated at the means of the data) suggests that demand for slaughter steers and heifers in Canada and the U.S. is inelastic. However, the long run, own-price elasticity for steer and heifer slaughter is elastic in Canada, but inelastic in the U.S.

DEMAND FOR SLAUGHTER COWS AND BULLS

Cow and bull slaughter in Canada is also modelled as a derived demand:

$$DBW3 = e_0 + e_1 Q_1 + e_2 Q_2 + e_3 Q_4 + e_4 D03Q24 + e_5 RPBF3 + e_6 PBW3 + e_7 DBW3(-1) \quad (3a)$$

where DBW3 is commercial slaughter of cows and bulls, D03Q24 is a dummy variable equal to one in quarters two, three and four of 2003, zero otherwise, PBW3 is the deflated price of cows for slaughter in Canada, DBW3(-1) is a lagged dependent variable and the e_i terms are estimated parameters. The all-item Farm Product Price Index is used as the price deflator for PBW3. D03Q24 is included to account for the large impact of the 2003 BSE event on cow and bull slaughter in that year. The lagged dependent variable is included to remedy the presence of first-order autocorrelation.

Cow and bull slaughter in the U.S. is modelled as an unconditional demand equation:

$$DBW4 = f_0 + f_1 Q_1 + f_2 Q_2 + f_3 Q_4 + f_4 t + f_5 PBW4 + f_6 DBW4(-1) \quad (3b)$$

where DBW4 is commercial cow and bull slaughter, PBW4 is the deflated price of slaughter cows, DBW4(-1) is a lagged dependent variable and the f_i terms are estimated parameters. The price of slaughter steers in the U.S. is deflated by the U.S. slaughter livestock price index, while the lagged dependent variable corrects for autocorrelation. Table A.4 shows the OLS parameter estimates and elasticities for the U.S. cow and bull slaughter equation.

The estimated cow and bull slaughter equations for Canada and the U.S. fit the data well (i.e., high adjusted-R2 and significant F-statistics). The low value of Durbin's h-statistic indicates that the null hypothesis of no first-order autocorrelation cannot be rejected. The intercept and coefficients on the seasonal dummy variables indicate significant variation in cow and bull slaughter in both countries. As expected, the coefficient on D03Q24 in the Canadian equation is negative and significant (reflecting the marked reduction in cow and bull slaughter immediately after the 2003 BSE event). While the retail price coefficient in the derived demand equation for Canada is not significant, removal of this variable results in omitted variable bias and so RPBF3 is retained. Coefficients on the price of cows for slaughter are significant and negative, as expected, in both equations. Lastly, the lagged dependent variables are also significant in each country's equation.

While the coefficient on retail price in the Canadian cow and bull slaughter equation is not significant, the elasticity with respect to this price is inelastic in both the short- and long run. The short- and long run elasticities of cow and bull slaughter with respect to the price of slaughter cows is inelastic in both equations, but are more inelastic in the U.S. than for Canada.

Table A.4. OLS estimates of the cow and bull slaughter equations for Canada and the United States

	Canada		U.S.	
Variable	Estimate & t-statistic	Elasticities	Estimate & t-statistic	Elasticities
Intercept	33.840		616.531***	
	(1.148)		(3.515)	
Q1	13.688***		-120.978***	
	(3.018)		(-4.102)	
Q2	-5.459		-82.057***	
	(-1.197)		(-3.201)	
Q4	42.273***		161.930***	
	(9.439)		(6.374)	
D03Q24	-40.651***			
	(-4.404)			
Time trend			-1.189**	
			(-2.069)	
Retail price	4.615	Short run: 0.105		
	(0.667)	Long run: 0.429		
Cow price	-42.337***	Short run: -0.153	-537.319**	Short run: -0.088
	(-3.948)	Long run: -0.629	(-2.384)	Long run: -0.345
Lagged slaughter	0.755***		0.744***	
	(12.134)		(9.811)	
Sample	1990:2 to 2008:4		1990:2 to 2008:4	
N	75		75	
Adj-R2	0.85		0.80	
Durbin's h	-0.643		1.265	
F-stat	61.299***		50.391***	

*** Denotes significance at the one per cent significance level
** Denotes significance at the five per cent significance level

SLAUGHTER STEER AND HEIFER SUPPLY

Slaughter steer and heifer supply in Canada is modelled as follows:

$$SSH3 = g_0 + g_1 Q_1 + g_2 Q_2 + g_3 Q_4 + g_4 D2004 + g_5 D03Q2 + g_6 t + g_7 PBARLEY(-1) + g_8 IBW3(-8) + g_9 SSRND + g_{10} SSH3(-1) \quad (4a)$$

where SSH3 is supply of slaughter steers and heifers, D2004 is a dummy variable equal to one from 2004 onwards, zero otherwise, PBARLEY(-1) is the lagged deflated price of feed barley, IBW3(-8) is the inventory of beef cows in Canada lagged eight quarters back, SSRND is the square root of deflated investment in beef cattle research in Canada, SSH3(-1) is a lagged dependent variable and g_j are parameters to be estimated. D2004 is included to account for the long-term effect of the BSE crisis on the supply of slaughter-weight cattle in Canada. PBARLEY(-1) is included to account for the potential effect of feed costs on marketing decisions. IBW3(-8) is included to account for the potential size of the calf crop in previous periods (and hence the size of the potential supply of slaughter cattle). The lagged dependent variable is included to correct for first-order autocorrelation.

Beef cattle research investment equals BCRC project expenditures plus any partner funding of approved BCRC projects (i.e., leveraged funds associated with approved BCRC projects). Both sources of cattle research investment are included to reflect the fact that BCRC is not the only source of funding for cattle research in Canada. A description of these data is included in the data sources. Lastly, note that including the square root of the relevant deflated beef cattle research expenditures imposes diminishing marginal returns to investment in these activities (see Alston, Norton and Pardey 1995).

Steer and heifer supply in the U.S. is modelled as follows:

$$SSH4 = h_0 + h_1 Q_1 + h_2 Q_2 + h_3 Q_4 + h_4 t + h_5 FPCO4 + h_6 IBW4(-8) + h_7 SSH4(-1) \qquad (4b)$$

where SSH4 is the supply of slaughter steers and heifers, FPCO4 is the deflated price of feed corn, IBC4(-8) is the inventory of beef cows lagged eight quarters back, and SSH4(-1) is a lagged dependent variable and h_i are parameters to be estimated. As with other equations, the lagged dependent variable is included to correct for first-order autocorrelation. The all-item CPI is used to deflate FPCO4. Table A.5 shows the OLS parameter estimates and elasticities for the Canadian and U.S. steer and heifer supply equation.

The estimated steer and heifer supply equation for the U.S. fit the data well (i.e., they have high adjusted-R2 and significant F-statistics). Moreover, results of Durbin's h-test indicate lack of evidence of first-order autocorrelation. The only significant coefficients (at the 10 per cent level or better) in the Canadian equation are on D2004, D03Q2 and the lagged dependent variable. The negative and significant signs on D2004 and D03Q2 speak to the sizable impact of the BSE crisis on fed-cattle sales in Canada. While lack of significance is generally viewed negatively, it is important to note that the estimated model for steer and heifer supply in Canada greatly improved the fit of the baseline simulation model used for policy analysis and so it was retained. The elasticities for the Canadian equation show steer and heifer supply to be: inelastic with respect to the price of feed in both the short- and long run; inelastic with respect to beef cow inventories in the short run, but elastic in the long run; and inelastic to beef cattle research investment (in the short- and long run). Note too, that the supply of slaughter steers and heifers is more responsive to changes in the beef cow herd than to the price of feed.

In the U.S. version of the steer and heifer supply model, coefficients on all seasonal dummy variables, the price of feed corn, the lagged inventory of beef cows, and the lagged dependent variable are significant at the five per cent level or better. Furthermore, the feed-price effect is negative, while the beef cow inventory effect is positive, as expected. The short run, own-price elasticity (evaluated at the means of the data) suggests that the supply of slaughter steers and heifers in the U.S. is inelastic with respect to the price of feed and the beef cow herd, while the long run, own-price elasticity is less inelastic (as expected). Note too, that the supply of slaughter steer and heifers in the U.S. is more responsive to changes in the beef cow herd than the price of feed.

Table A.5. OLS estimates of the steer and heifer supply equations for Canada and the United States

	Canada		U.S.	
Variable	Estimate & t-statistics	Elasticity	Estimate & t-statistics	Elasticity
Intercept	11.740		38.756	
	(0.037)		(0.036)	
Q1	-14.315		-308.763***	
	(-0.674)		(-3.146)	
Q2	27.746		365.852***	
	(1.299)		(3.705)	
Q4	0.027		-617.076***	
	(0.001)		(-8.508)	
D2004	-57.151***			
	(-1.792)			
D03Q2	-274.944***			
	(-4.184)			
Time trend	0.322		0.305	
	(0.095)		(0.217)	
Feed price	-69.029	Short run: -0.101	-17246.500**	Short run: -0.035
	(-1.522)	Long run: -0.350	(-2.399)	Long run: -0.070
Lagged beef cow inventory	0.078	Short run: 0.386	0.111***	Short run: 0.550
	(0.762)	Long run: 1.346	(2.946)	Long run: 1.100
Beef cattle research	0.049	Short run: 0.008		
	(0.905)	Long run: 0.028		
Lagged slaughter	0.713***		0.500***	
	(8.036)		(4.760)	
Sample	1992:1 to 2008:4		1992:1 to 2008:4	
N	68		68	
Adj-R2	0.83		0.77	
Durbin's h	-0.825		-1.729	
F-stat	33.091***		37.464***	

*** Denotes significance at the one per cent significance level
** Denotes significance at the five per cent significance level
* Denotes significance at the 10 per cent significance level

COW AND BULL SUPPLY

Slaughter cow and bull supply in Canada is modelled as follows:

$$SBW3 = k_0 + k_1 Q_1 + k_2 Q_2 + k_3 Q_4 + k_4 D02Q24 \\ k_5 INV3(-5) + k_6 SSRND + k_7 SBW3(-1) \quad (5a)$$

where SBW3 is the supply of cows and bulls for slaughter in Canada, INV3(-5) is the inventory of beef and dairy cows lagged five periods (included to account for herd dynamics and the lag between expansion of the breeding/milking herd and subsequent slaughter of culled members of the breeding herd), SBW3(-1) is a lagged dependent variable, and k_j are parameters to be estimated.

The supply equation for slaughter cows and bulls in the U.S. is modelled as follows:

$$SBW4 = l_0 + l_1 Q_1 + l_2 Q_2 + l_3 Q_4 + l_4 t + l_5 PFC4 + l_6 INV4(-5) + l_7 SBW4(-1) \quad (5b)$$

where SBW4 is the supply of cows and bulls for slaughter, PFC4 is the deflated price of feeder calves, INV4(-5) is the size of the beef and dairy cow herd lagged five periods, and SBW4(-1) is a lagged dependent variable and the l_i terms are estimated parameters. The U.S. slaughter livestock price index is used to deflate PFC4. Table A.6 shows the OLS parameter estimates and elasticities for the supply equation for Canadian and U.S. slaughter cows and bulls.

Table A.6. OLS estimates of the cow and bull supply equations for Canada and the United States

	Canada		U.S.	
Variable	Estimate & t-statistic	Elasticity	Estimate & t-statistic	Elasticity
Intercept	11.752		502.438	
	(0.299)		(0.887)	
Q1	20.666***		-108.293***	
	(3.231)		(-4.213)	
Q2	-5.476		-109.559***	
	(-0.860)		(-4.853)	
Q4	59.027***		174.404***	
	(9.531)		(8.011)	
D03Q24	-73.776***			
	(-5.982)			
Time trend			1.600***	
			(3.156)	
Feeder-calf price			-847.075***	SRE: -0.448
			(-4.829)	LRE: -0.891
Beef & dairy cow inventory	0.003	SRE: 0.090	0.021*	SRE: 0.576
	(0.443)	LRE: 0.373	(1.942)	LRE: 1.146
Beef cattle research	0.011	SRE: 0.008		
	(1.264)	LRE: 0.034		
Lagged supply	0.758***		0.497***	
	(11.809)		(6.151)	
Sample	1991:2 2008:4		1990:2 to 2008:4	
N	71		75	
Adj-R2	0.814		0.84	
Durbin's h	-0.922		1.044	
F-stat	44.805***		55.461***	

*** Denotes significance at the one per cent significance level
** Denotes significance at the five per cent significance level
* Denotes significance at the 10 per cent significance level

The estimated slaughter cow and bull supply equations fit the data well (i.e., they have high adjusted-R2 and significant F-statistics). Moreover, results of Durbin's h-test indicate lack of evidence of first-order autocorrelation. The only significant coefficients (at the 10 per cent level or better) in the Canadian slaughter cow and bull equation are for the D03Q24, Q1 and Q2, and the lagged dependent variables.

The negative and significant sign D03Q24 speaks to the sizable impact of the BSE crisis on non-fed cattle sales in Canada. As with the supply of slaughter steers and heifers, while lack of significance is generally viewed negatively, it is important to note that the estimated model for slaughter cow and bull supply in Canada greatly improved the fit of the baseline simulation model used for policy analysis and so is retained. The elasticities for the Canadian equation show non-fed cattle supply to be: inelastic with respect to the cow-herd inventory (in both the short- and long run); and inelastic with respect to beef cattle research investment (in both the short- and long run).

For the U.S. model, the coefficients on all seasonal dummy variables, time trend, the price of feeder calves, inventory of beef and dairy cows, and the lagged dependent variable are significant at the 10 per cent level or better. Furthermore, the feeder-calf price effect is negative, while the beef cow inventory effect is positive, as expected. The short run elasticities (evaluated at the means of the data) suggest that the supply of slaughter cows and bulls in the U.S. is inelastic with respect to the price of feeder calves and the beef and dairy cow herd, while the long run feeder-calf price elasticity is less inelastic (as expected), and the long run elasticity with respect to the cow inventory is elastic. Note too, that supply of slaughter cows and bulls is more responsive to changes in the beef cow herd than to the price of feeders.

BEEF COW INVENTORY

The size of the beef cow herd, an indicator of the potential size of the calf crop and hence steer and heifer slaughter in future periods, is modelled as follows for Canada:

$$IBW3 = m_0 + m_1 Q_1 + m_2 Q_2 + m_3 Q_4 + m_4 D03 + m_5 D04 + m_6 D05 + m_7 D06 + m_8 D07 + m_9 D08 + m_{10}(PFC1 - LEVY) + m_{11} IBW3(-1) \quad (6a)$$

where D03, D04, D05, D06, D07 and D08 are dummy variables assuming the value of one in 2003, 2004, 2005, 2006, 2007, and 2008, respectively, zero otherwise, PFC1 is the deflated price of feeder calves, LEVY is the per pound value of the $1 per head NCO levy, IBW3(-1) is a lagged dependent variable and m_j are parameters to be estimated. The dummy variables for each year from 2003 through 2008 are included as they significantly improve the fit of this equation in the simulation model. The beef cow herd in the U.S. is modelled as:

$$IBW4 = n_0 + n_1 Q_1 + n_2 Q_2 + n_3 Q_4 + n_4 t + n_5 PFC4 + m_6 IBW4(-1) \quad (6b)$$

where IBC4 is the inventory of beef cows, PFC4 is the deflated price of feeder calves, and IBW4(-1) is a lagged dependent variable and the n_i terms are estimated parameters. Table A.7 shows the OLS parameter estimates and elasticities for inventory equations for the Canadian and U.S. beef cow herds.

The estimated beef cow inventory equations fit the data well (i.e., they have high adjusted-R2 and significant F-statistics). Moreover, results of Durbin's h-test indicate lack of evidence of first-order autocorrelation. The coefficient on the Q1, D04 and D05 dummy variables in the Canadian beef cow inventory model are significant, as is the lagged dependent variable. And while not significant, the elasticity of the beef cow herd with respect to the price of feeder calves is very inelastic in the short run, but less inelastic in the long run.

In the U.S. beef cow inventory equation, only the intercept, time trend and lagged dependent variable are significant at the 10 per cent level or better. Furthermore, the feeder-calf price effect is positive as

expected. The short- and long run elasticity of beef cow herd size with respect to the price of feeder calves (evaluated at the means of the data) is very inelastic. This, coupled with the large coefficient on the lagged dependent variables, suggest that herd dynamics are more important than the price of the output from the herd.

Table A.7. OLS estimates of the beef cow herd inventory equations for Canada and the United States

	Canada		U.S.	
Variable	Estimate & t-statistics	Elasticity	Estimate & t-statistics	Elasticity
Intercept	159.250		2955.490*	
	(1.342)		(1.811)	
Q1	81.349***		19.963	
	(4.322)		(0.215)	
Q2	0.177		-1.868	
	(0.010)		(-0.020)	
Q4	-0.206		3.513	
	(-0.011)		(0.039)	
D03	29.471			
	(0.908)			
D04	81.115**			
	(2.356)			
D05	100.946**			
	(2.518)			
D06	26.016			
	(0.654)			
D07	-39.170			
	(-1.084)			
D08	-4.559			
	(-0.116)			
Time trend			-3.848**	
			(-2.106)	
Feeder calf price	65.843	SRE: 0.015	37.715	SRE: 0.001
	(0.601)	LRE: 0.276	(0.069)	LRE: 0.011
Lagged inventory	0.947***		0.917***	
	(40.463)		(22.554)	
Sample	1990:2 to 2008:4		1990:2 to 2008:4	
N	75		75	
Adj-R2	0.987		0.91	
Durbin's h	-0.995		-0.172	
F-stat	530.346***		131.053***	

*** Denotes significance at the one per cent significance level
** Denotes significance at the five per cent significance level
* Denotes significance at the 10 per cent significance level

CARCASS WEIGHT EQUATION

The equation for carcass weights of slaughter cattle in Canada is as follows:

$$CW3 = s_0 + s_1 Q_1 + s_2 Q_2 + s_3 Q_4 + s_4 t + s_5 \left(\frac{PSS3(-1) - LEVY(-1)}{PBARLEY(-1)}\right) + s_6 SSRND + s_7 CW3(-1) \quad (7)$$

where CW3 is the carcass weight of slaughtered cattle (in kilograms), LEVY(-1) is the per pound value of the $1 per head NCO levy, CW3(-1) is a lagged dependent variable, and s_j are parameters to be estimated. Table A.8 shows the OLS estimates for this equation.

Table A.8. OLS estimates of the carcass weight equation for Canada

Variable	Estimate & t-statistics	Elasticity
Intercept	180.349***	
	(5.194)	
Q1	-13.512***	
	(-6.057)	
Q2	-1.194	
	(-0.497)	
Q4	-14.132***	
	(-6.593)	
Time trend	0.184***	
	(2.816)	
Lagged steer price to lagged barley price	4.669	SRE: 0.012
	(0.908)	LRE: 0.019
Beef cattle research investment	0.001	SRE: 0.001
	(0.367)	LRE: 0.002
Lagged carcass weight	0.378***	
	(3.260)	
Sample	1990:2-2008:4	
N	75	
Adj-R2	0.656	
Durbin's h	0.922	
F-stat	21.199***	

*** Denotes significance at the one per cent significance level

The estimated carcass-weight equation for Canada fits the data reasonably well (i.e., they have high adjusted-R2 and significant F-statistics). Moreover, results of Durbin's h-test indicate lack of evidence of first-order autocorrelation. The intercept, and coefficient on the Q1 and Q4 dummy variables, the time trend and the lagged dependent variable are significant. While not significant, the elasticity of carcass weights with respect to the ratio of slaughter-steer price (adjusted for the NCO levy) to barley price is inelastic (in both the short- and long run), as is the elasticity of carcass weights with respect to beef cattle research investment.

CANADA-U.S. PRICE LINKAGE

To capture the economic relationship between the Canadian and U.S. beef cattle sectors, they are linked through a price linkage equation at the farm level, specifically using the price of slaughter steers (i.e., fed cattle). Recognize that a farm-level price linkage relationship will not hold when the Canada-U.S. border is closed to live cattle trade. To account for this situation, the Canada-U.S. price linkage equation is estimated only using data from when the Canada-U.S. border was open to live cattle under 30 months of age. Specifically, the following Canada-U.S. retail price linkage equation is estimated:

$$PSS3 = \alpha_0 + \alpha_1 Q_1 + \alpha_2 Q_2 + \alpha_3 Q_4 + \alpha_4 t + \alpha_5 PSS4 * ER34 + \alpha_6 PSS3(-1) \quad (8)$$

where ER34 is the Canada-U.S. exchange rate (C$/U$). Table A.9 shows OLS estimation results and price transmission elasticity estimates for this equation:

Table A.9. OLS estimates of the Canada-U.S. price linkage equation

Variable	Estimate & t-statistics	Elasticity
Intercept	-0.204***	
	(-2.739)	
Q1	0.013	
	(0.925)	
Q2	-0.012	
	(-0.876)	
Q4	0.016	
	(1.141)	
Time trend	0.001***	
	(3.285)	
Price of slaughter steers in the U.S.	0.875***	SRE: 0.413
	(5.961)	LRE: 1.067
Lagged beef price in Canada	0.631***	
	(9.582)	
Sample	1990:2-2003:1, 2005:1-2008:4	
N	68	
Adj-R2	0.883	
Durbin's h	1.411	
F-stat	85.336***	

*** Denotes significance at the one per cent significance level

The estimated equation fits the data well and is jointly significant, while Durbin's h-statistics indicates autocorrelation is not present. Importantly, there is a positive and significant relationship between the price of slaughter steers in Canada and the price of slaughter steers in the U.S. Moreover, the short run, retail price transmission elasticity between Canada and the U.S. is inelastic, while the long run elasticity is elastic.

FARM-RETAIL LINKAGE EQUATION

While the previous equation provides an explicit link between the Canadian and U.S. fed-cattle markets, it is also important to account for the relationship between retail and farm-level prices within each country. To do so, a farm-retail price linkage equation (i.e., a margin equation) is estimated and included in the simulation model to account for the relationship between the price of slaughter steers and the retail price of beef. These equations appear as follows for Canada and the U.S. respectively:

$$PSS3 = \beta_0 + \beta_1 Q_1 + \beta_2 Q_2 + \beta_3 Q_4 + \beta_4 t + \beta_5 RPBF3 + \beta_6 PSS3(-1) \quad (9a)$$

$$PSS4 = \gamma_0 + \gamma_1 Q_1 + \gamma_2 Q_2 + \gamma_3 Q_4 + \gamma_4 t + \gamma_5 RPBF4 + \gamma_6 PSS4(-1) \quad (9b)$$

where all variables have been defined previously, and β_j and γ_j are parameters to be estimated. Table A.10 shows the coefficient estimates and model diagnostic statistics for the above margin equations.

Table A.10. OLS estimates of the retail-farm margin equations for Canada and the United States

	Canada		U.S.	
Variable	Estimate & t-statistic	Elasticity	Estimate & t-statistic	Elasticity
Intercept	0.512*		-0.094**	
	(1.943)		(-2.135)	
Q1	0.098***		0.015*	
	(2.931)		(1.893)	
Q2	0.042		0.008	
	(1.252)		(1.103)	
Q4	0.105***		0.015*	
	(3.025)		(1.844)	
Time trend	-0.004**		-0.002***	
	(-2.379)		(-4.405)	
Retail price	0.019	SRE: 0.072	0.217***	SRE: 1.069
	(0.282)	LRE: 0.163	(4.426)	LRE: 1.457
Lagged steer price	0.560***		0.267*	
	(3.977		(1.893)	
Sample	1999:1-2008:4		1990:2-2008:4	
N	40		75	
Adj-R2	0.70		0.855	
Durbin's h	0.250		3.675	
F-stat	16.178		74.074	

*** Denotes significance at the one per cent significance level
** Denotes significance at the five per cent significance level
* Denotes significance at the 10 per cent significance level

Regression diagnostics suggest that the estimated margin models fit the data well (i.e., high adjusted-R2 and significant f-statistics). While Durbin's h-statistics indicates the Canadian model has been purged of all first-order autocorrelation, the U.S. model appears to suffer from apparent first-order autocorrelation. Nevertheless, attempts to remedy this using more complicated auto-regressive structures did not result in appreciably different estimates and the model in Table A.10 is retained.

In the Canadian margin equation, the intercept, coefficients on Q1 and Q4 dummy variables, the time trend and lagged dependent variable are significant. While the coefficient on the retail price variable is not significant, it is positive, as one would expect. Also note that the farm-retail price transmission elasticity in Canada is inelastic in both the short- and long run. In the margin equation for the U.S., the intercept and coefficients on Q1, Q4, the time trend, retail price and the lagged dependent variable are all significant. As well, the coefficient on retail price in the U.S. equation is positive and the corresponding elasticity is elastic in both the short- and long run.

FARM PRICE LINKAGE EQUATIONS

The relationship between the price of slaughter steers and slaughter cows is captured via the following equations for Canada and the U.S., respectively:

$$PBW3 = \delta_0 + \delta_1 Q_1 + \delta_2 Q_2 + \delta_3 Q_4 + \delta_4 t + \delta_5 (PSS3 - LEVY) + \delta_6 PBW3(-1) \quad (10a)$$

$$PBW4 = \phi_0 + \phi_1 Q_1 + \phi_2 Q_2 + \phi_3 Q_4 + \phi_4 t + \phi_5 PSS4 + \phi_6 PBW4(-1) \quad (10a)$$

Where δ_j and ϕ_j are parameters to be estimated and all other variables have been defined above. The lagged dependent variable in the above equations is included to correct first-order autocorrelation. Table A.11 shows the coefficient estimates and model diagnostic statistics for the above price linkage equations.

Regression diagnostics suggest that both equations fit the data well (i.e., high adjusted-R2 and significant f-statistics). While Durbin's h-statistic indicates the U.S. model has been purged of all first-order autocorrelation, the Canadian model appears to suffer from first-order autocorrelation. Nevertheless, efforts to correct for autocorrelation in the Canadian equation did not change the econometric results appreciably and the Canadian equation reported in Table A.11 is retained.

In the slaughter cow price linkage equation for Canada, the intercept, coefficient on the Q4 dummy variable, and coefficients on the time trend, steer price and lagged dependent variable are significant at the five per cent level or better. Moreover, the elasticity of slaughter cow price with respect to the price of slaughter steers is inelastic in the short run, but elastic in the long run. In the U.S. version of the slaughter cow price linkage equation, the intercept, coefficients on the Q2 and Q4 dummy variables, and coefficients on the time trend, steer price and lagged dependent variable are significant at the 10 per cent level or better. As with the Canadian results, the elasticity of slaughter cow price with respect to the price of slaughter steers in the U.S. is inelastic in the short run, but elastic in the long run.

Table A.11. OLS estimates of the slaughter cow price linkage equations for Canada and the United States

	Canada		U.S.	
Variable	Estimate & t-statistics	Elasticity	Estimate & t-statistics	Elasticity
Intercept	-0.136***		-0.041***	
	(-2.913)		(-2.975)	
Q1	-0.002		0.005	
	(-0.141)		(1.143)	
Q2	0.012		0.008**	
	(0.983)		(2.035)	
Q4	-0.059***		-0.028***	
	(-4.777)		(-7.170)	
Time trend	-0.001**		0.0001*	
	(-2.513)		(1.658)	
Steer price	0.378***	SRE: 0.657	0.268***	SRE: 0.452
	(6.507)	LRE: 1.939	(5.855)	LRE: 1.463
LDV	0.661***		0.691***	
	(11.930)		(14.080)	
Sample	1990:2 to 2008:4		1990:2 to 2008:4	
N	75		75	
Adj-R2	0.95		0.95	
Durbin's h	3.091		1.172	
F-stat	238.664***		262.436***	

*** Denotes significance at the one per cent significance level
** Denotes significance at the five per cent significance level
* Denotes significance at the 10 per cent significance level

The relationship between the price of slaughter steers and the price of feeder calves is captured via the following equations for Canada and the U.S., respectively:

$$PFC1 = \theta_0 + \theta_1 Q_1 + \theta_2 Q_2 + \theta_3 Q_4 + \theta_4 (PSS3 - LEVY) + \theta_5 PBARLEY + \theta_6 PFC1(-1) \quad (11a)$$

$$PFC4 = \lambda_0 + \lambda_1 Q_1 + \lambda_2 Q_2 + \lambda_3 Q_4 + \lambda_4 t + \lambda_5 PSS4 + \lambda_6 FPCO4 + \lambda_7 PFC4(-1) \quad (11b)$$

where θ_j and λ_j are parameters to be estimated and all other terms have been defined. Table A.12 shows the coefficient estimates and model diagnostic statistics for the above price-linkage equations. Note that the feeder-calf price linkage equation for Canada was estimated using two-stage least squares and a time trend as the instrumental variable.

Regression diagnostics suggest that both equations fit the data well (i.e., high adjusted-R2 and significant f-statistics), while Durbin's h-statistic indicates the U.S. model has been purged of all first-order autocorrelation, the Canadian model appears to suffer from first-order autocorrelation. Nevertheless, efforts to correct for this did not change the econometric results appreciably and the Canadian equation reported in Table A.11 is retained.

Table A.12. Estimates of the feeder-calf price linkage equations for Canada and the United States

	Canada		U.S.	
Variable	Estimate & t-statistic	Elasticity	Estimate & t-statistic	Elasticity
Intercept	0.040		0.435***	
	(0.139)		(5.193)	
Q1	-0.001		-0.083***	
	(-0.297)		(-6.207)	
Q2	-0.013		-0.049***	
	(-0.880)		(-4.068)	
Q4	-0.005		-0.027**	
	(-0.300)		(-2.136)	
Time trend			0.001*	
			(1.712)	
Steer price	0.073	SRE: 0.070	0.024	SRE: 0.013
	(0.471)	LRE: 0.289	(0.278)	LRE: 0.032
Feed price	0.105***	SRE: 0.139	-5.927***	SRE: -0.104
	(3.343)	LRE: 0.570	(-3.925)	LRE: -0.404
LDV	0.756***		0.596***	
	(5.074)		(6.644)	
Sample	1990:2 to 2008:4		1990:2 to 2008:4	
N	75		75	
Adj-R2	0.79		0.80	
Durbin's h	Not calculated		0.804	
F-stat	44.004***		44.002***	

*** Denotes significance at the one per cent significance level
** Denotes significance at the five per cent significance level

In the Canadian version of the feeder-calf price linkage equation, the coefficient on the price of feed and the lagged dependent variable were significant at the one per cent level. As well, the elasticity of feeder-calf price with respect to the price of slaughter steers was inelastic in both the short- and long run, as was the elasticity of feeder-calf price with respect to the price of feed. Except for the coefficient on the price of slaughter steers, all estimated coefficients in the U.S. version of the feeder-calf price linkage equation were significant at the 10 per cent level or better. As with the Canadian version of the model, the elasticity of feeder-calf prices with respect to steer price was inelastic in the short- and long run, as was the elasticity of feeder-calf prices with respect to the price of feed.

NET BEEF EXPORT EQUATIONS

In order to capture the relationship between beef trade and export marketing activities, two equations are estimated for Canadian net beef export. The first equation reflects net beef exports between Canada and the U.S., while the second reflects net beef trade between Canada and the rest of the world. These net-trade equations with respect to the U.S. and rest of the world are specified, respectively, as follows:

$$NT3BF4 = \upsilon_0 + \upsilon_1 Q_1 + \upsilon_2 Q_2 + \upsilon_3 4 + \upsilon_4 t + \upsilon_5 D03Q24 + \upsilon_6 AUSBEEF + \upsilon_7 AUSCAT30 + \upsilon_8 AFEEDBAN + \upsilon_9 AUSCAT31 + \upsilon_{10} RPBF3 + \upsilon_{11} RPBF4 * ER34 + \upsilon_{12} SUSMRK + \upsilon_{13} NT3BF4(-1) \quad (12a)$$

$$NT3BF9 = \omega_0 + \omega_1 Q_1 + \omega_2 Q_2 + \omega_3 4 + \omega_4 t + \omega_5 AMACAU + \omega_6 AHK + \omega_7 AJAPAN + \omega_8 FEEDBAN + \omega_9 RPBF3 + \omega_{10} BFEXPP + \omega_{11} SINTMRK + \omega_{12} NT3BF9(-1) \quad (12b)$$

In equation 12a, NT3BF4 is net exports of beef from Canada to the U.S., AUSBEEF is a dummy variable that denotes the post-BSE time periods when Canadian beef was allowed U.S. market access, AUCAT30 is a dummy variable denoting the post-BSE time periods when live cattle under 30 months of age from Canada were allowed U.S. market access, AFEEDBAN is a dummy variable indicating the post-BSE time periods when enhanced feed-ban restrictions were in place in Canada, AUSCAT31 is a dummy variable denoting the post-BSE time periods where live cattle over 30 months of age were allowed U.S. market access, SUSMRK is the square root of the BIC's U.S. market-development program (deflated by the all-item CPI), and υ_j are parameters to be estimated. To be clear, the market access dummy variables equal one in the period in which access was announced and in all subsequent periods, but zero otherwise.

In equation 12b, NT3BF9 is net exports of beef from Canada to all countries other than the U.S., AMACU, AHK and AJAPAN are dummy variables indicating periods where Canadian beef was allowed market access to Macau, Hong Kong and Japan, respectively, BFEXPP is the deflated unit value of Canadian beef exports, SINTMRK is the square root of CBEF's market development expenditures in the rest of the world (also deflated by the all-item CPI), and ω_j are parameters to be estimated. Note that SINTMRK does not include administration and operating costs (see Appendix 3 for details). Note that efforts to include dummy variable denoting market access for Russia, Mexico and Taiwan resulted in a linear dependency and the model would not estimate. As well, since Country of Origin Labelling (COOL) was only announced in the fourth quarter of 2008 (the last time period used for estimation), including a dummy variable for this effect would not have an appreciable impact on the overall results, and so a COOL dummy variable was not included.

Recognize that Canada moved from being a net beef importer from the rest of the world to a net beef exporter to the rest of the world. Because of this, equation 12b is estimated from quarter 4 of 2003 to quarter 4 of 2008. While limiting, trimming the estimation window for equation 12b enables analysis of a time period when Canada was consistently a net exporter to the rest of the world. Table A.13 shows regression results for the two net-beef-export equations.

Regression diagnostics suggest that the equation for net beef exports to the U.S. fits the data well (i.e., high adjusted-R2 and significant f-statistics) and does not have significant autocorrelation (at the five per cent level). The equation for net beef exports to the rest of the world, however, is estimated with less precision (i.e., low adjusted-R2 and low F-statistic). Nevertheless, in both cases, the signs on the coefficients on price indicate that as price rises in Canada, net beef exports would fall (the notion here is that a higher beef price puts Canadian beef in a less advantageous position), while an increase in the price in the export market would result in higher net beef exports from Canada.

Table A.13. OLS estimates of the net beef export equations for Canada

	Net exports to the U.S.		Net exports to the rest of world	
Variable	Estimate & t-statistic	Elasticity	Estimate & t-statistic	Elasticity
Intercept	-7289.96		-323230.0	
	(-0.225)		(-1.218)	
Q1	1039.45		-113.140	
	(0.217)		(-0.019)	
Q2	952.56		-4510.63	
	(0.196)		(-1.017)	
Q4	-342.626		310.480	
	(-0.074)		(0.062)	
D03Q24	-45181.5***			
	(-3.834)			
Time trend	1046.00***		2583.71	
	(3.252)		(1.253)	
AUSBEEF	5380.36			
	(0.451)			
AUSCAT30	-25484.5**			
	(-2.413)			
AFEEDBAN	-15878.9		-802.903	
	(-1.002)		(-0.089)	
AUSCAT31	-7494.99			
	(-0.484)			
AMACAU			46958.1**	
			(2.317)	
AHK			-5710.67	
			(-0.706)	
AJAPAN			-12495.1	
			(-1.207)	
Price in Canada	-29597.1***	SRE: -2.028	-34773.3	SRE: -4.979
	(-3.011)	LRE: -2.373	(-1.189)	LRE: -3.373
Price in ROW/U.S.	39419.6**	SRE: 2.275	63319.4	SRE: 6.441
	(2.582)	LRE: 2.660	(1.620)	LRE: 4.264
SUSMRK	21.444	SRE: 0.035		
	(1.005)	LRE: 0.040		
SINTMRK			116.849*	SRE: 2.403
			(1.873)	LRE: 1.628
LDV	0.145		-0.476*	
	(1.258)		(-1.800)	
Sample	1990:2 to 2008:4		2003:4 to 2008:4	
N	75		21	
Adj-R2	0.82		0.30	
Durbin's h	-2.638		-1.448	
F-stat	26.608***		1.706	

*** Denotes significance at the one per cent significance level
** Denotes significance at the five per cent significance level
* Denotes significance at the 10 per cent significance level

Moreover, the coefficients on the SUSMRK and SINTMRK variables have the expected sign, while the coefficient on SINMRK in the NT3BF9 equation is also significant. These results indicate that net beef exports to the U.S. and the rest of the world increase with investment in Canadian beef marketing activities in these regions. The elasticity of net beef exports to the U.S. with respect to SUSMRK is inelastic in the short- and long run, while the elasticity of net beef exports to the rest of the world is elastic in both the short- and long run.

MARKET CLEARING IDENTITIES

While the equations estimated above form the main component of the simulation model (and reflect the underlying behaviour of producers, processors and consumers), the following identities are used to provide model closure:

Aggregate beef disappearance in Canada:

$$DBF3 \equiv PCBFD3 * POP3/1000 \quad (13)$$

Beef production in Canada:

$$QBF3 \equiv (DSH3 + DBW3) * CW3 \quad (14)$$

Retail market clearing in Canada:

$$DBF3 \equiv QBF3 + QVL3 + UBEEF3 - NT3BF4 - NT3BF9 + DSTOCKS3 \quad (15)$$

Slaughter steer and heifer market clearing in Canada:

$$SSH3 \equiv DSH3 - NT3SCT4 \quad (16)$$

Slaughter cow and bull market clearing in Canada:

$$SBW3 \equiv DBW3 - NT3BW4 \quad (17)$$

where POP3 is the Canadian population, QVL3 is veal production in Canada, UBEEF3 is uninspected beef production in Canada, DSTOCKS3 is change in Canadian beef stocks. Note that QVL3, UBEEF3 and DSTOCKS3 are held fixed and constant in this analysis.

Aggregate beef disappearance in the U.S.:

$$DBF4 \equiv PCBFD4 * POP4/1000 \quad (18)$$

Beef production in the U.S.:

$$QBF4 \equiv (DSH4 + DBW4) * CW4 \quad (19)$$

Retail market clearing in the U.S.:

$$DBF4 \equiv QBF4 + QVL4 + UBEEF4 + NT3BF4 - NT4BF9 + DSTOCKS4 \quad (20)$$

where POP4 is the U.S. population (in millions), QVL4 is veal production in the U.S., UBEEF4 is uninspected beef production in the U.S., NT4BF9 is net U.S. beef exports to the rest of the world, and DSTOCKS4 is the change in U.S. beef stocks. Note that QVL4, UBEEF4 and DSTOCKS4 are held fixed and constant in this analysis.

BASELINE SIMULATION

The baseline simulation solves equations 1a through 20 for all endogenous variables. These endogenous variables are: PCBFD3, DBF3, QBF3, DSH3, DBW3, SSH3, SBW3, IBW3, CW3, NT3BF4, NT3BF9, NT3SCT4, NT3BW4, RPBF3, PSS3, PFC1, PBW3, PCBFD4, DBF4, QBF4, DSH4, DBW4, SSH4, SBW4, IBW4, NT4BF9, RPBF4, PSS4, PFC4, PBW4. Before using the estimated model for policy analysis, it is important to evaluate model performance. Five validation statistics are used to compare actual and simulated values over the baseline period. Root Mean Squared Percent Error (RMSPE) shows the deviation of the predicted values from actual, stated as a percentage of the actual value. The lower the RMSPE, the closer the prediction to the actual value.

Theil's U, another means to assess model performance, is bounded between zero and infinity. If U=0, then the predictions fit the actual values perfectly; if U=1, the predictions are no better than the naive no-change extrapolation from the past period. As U goes to infinity, the worse the predictions fit the actual values.

Theil's U can be broken down into three components that measure the amount of systematic and non-systematic error. The bias component measures how much of the mean squared error is accounted for by systematic error in the simulation. If bias equals zero, there is no systematic bias. The variance component measures how much of the mean squared error is accounted for by differences in the predicted variance and actual variance. If variance equals zero, then the simulation perfectly predicts the variance of the actual data. Covariance measures how much of the mean square error is due to unsystematic error, and reflects errors not accounted for by bias or variance. Ideally, the measures of bias and variance approach zero, while covariance approaches one. Note too that a bias measure greater than 0.2 is considered large.

To evaluate the baseline simulation, Table A.13 shows summary statistics of the baseline simulation over the period from the fourth quarter of 2003 to the fourth quarter of 2008. The rationale for evaluating the model over this time period is that it is the time period spanned by the equation estimated for net beef exports from Canada to the rest of the world, and is the longest period of time used to estimate ALL equations.

Except for NT3BW4 (non-fed cattle trade between Canada and the U.S.), NT3BF9 (net beef exports from Canada to the rest of world) and NT4BF9 (net beef exports from the U.S. to all other non-Canadian countries), all RMSPE values are low and considered acceptable. Theil's U-statistic shows that the model fits the data well. In general, the measures of bias and variance suggest the model performs well (in the sense of not having large bias and variance for all variables), and, for the most part, the prediction errors between the actual and simulated values appear to be due to un-systematic error that cannot be purged from the model. It is important to note that the econometric estimates provided above were not developed one at a time, but in the context of trying to improve the fit of the simulated data to the actual data. In this respect, the values on Table A.13 reflect efforts to eliminate as much systematic error as possible.

Table A.13. Baseline simulation summary statistics

Variable	PRMSE	Theil's U	Bias	Variance	Covariance
PCBFD3	0.064	0.068	0.002	0.077	0.919
DBF3	0.064	0.068	0.002	0.016	0.982
QBF3	0.097	0.101	0.011	0.011	0.978
DSH3	0.124	0.066	0.007	0.287	0.707
DBW3	0.155	0.061	0.015	0.238	0.746
SSH3	0.074	0.036	0.010	0.156	0.834
SBW3	0.197	0.071	0.231	0.122	0.647
IBW3	0.015	0.007	0.003	0.092	0.905
CW3	0.021	0.010	0.003	0.357	0.640
NT3BF4	0.480	0.162	0.054	0.177	0.769
NT3BF9	0.964	0.281	0.033	0.173	0.794
NT3SCT4	0.285	0.313	0.036	0.387	0.578
NT3BW3	0.909	0.344	0.258	0.367	0.374
RPBF3	0.094	0.047	0.011	0.703	0.286
PSS3	0.138	0.057	0.022	0.028	0.950
PFC1	0.058	0.031	0.001	0.219	0.780
PBW3	0.519	0.174	0.161	0.015	0.823
PCBFD4	0.026	0.013	0.038	0.023	0.938
DBF4	0.026	0.013	0.038	0.034	0.928
QBF4	0.051	0.024	0.260	0.098	0.641
DSH4	0.042	0.020	0.207	0.031	0.762
DBW4	0.112	0.052	0.048	0.083	0.868
SSH4	0.037	0.019	0.002	0.212	0.787
SBW4	0.068	0.033	0.018	0.061	0.920
IBW4	0.011	0.005	0.007	0.277	0.716
NT4BF9	1.469	0.688	0.557	0.198	0.244
RPBF4	0.079	0.041	0.157	0.176	0.667
PSS4	0.110	0.058	0.239	0.053	0.708
PFC4	0.049	0.024	0.009	0.108	0.882
PBW4	0.114	0.064	0.311	0.037	0.652

SUMMARY OF THE CHANGES IN SELECTED PRICES AND QUANTITIES

The simulations undertaken in this analysis have an effect on the 30 endogenous variables in the model. To help illustrate these effects, Table A.14 shows the quarterly average (from the third quarter of 2005 to the fourth quarter of 2008) of five key Canadian prices and quantities in the baseline scenario, as well as the scenarios used to: assess the historic return to marketing and research investment; optimize investment across marketing and research activities; and examine the Alberta refund situation. Changes in prices and quantities arising from the incremental investment scenarios have not been included; they were not included because the changes to the individual prices and quantities were very small and not informative. For each simulation, the table also shows the percentage difference between the respective price, or quantity, in the baseline scenario and the "what-if" scenario (these percentage differences are shown in parenthesis).

For the scenarios used to assess historic return to investment in marketing and research, note that the direction in which prices and quantities move reflects changes in the position of the demand curve for beef in Canada, or the demand curve for Canadian beef in export markets, or the supply curve for cattle for slaughter (depending on the scenario). When attention is focused on the scenario where check-off fund investment is removed from both marketing and research, we see that both retail and farm prices fall in Canada. And while beef demand does grow (a reflection of the lower price of beef), beef production falls. Moreover, the supply of fed and non-fed cattle for slaughter also falls. The reduction in the farm price, coupled with the reduction in the supply of fed and non-fed cattle for slaughter is what leads to a reduction in producer benefits when investment in marketing and research activities is reduced.

For the scenarios used to assess the impact of optimizing the allocation of check-off funds across marketing and research, we see some subtle differences depending on the allocation ratio. With a 90:10 allocation ratio, retail and farm prices actually rise compared to the baseline; while beef disappearance falls, beef production rises, as does supply of fed and non-fed cattle for slaughter. When an 80:20 split is simulated, retail and farm prices fall, as does beef disappearance and production, but supply of fed and non-fed cattle for slaughter rises. When allocations of 70:30 through to 50:50 are simulated, retail and farm prices again fall, but beef disappearance rises, beef production increases, as does supply of fed and non-fed cattle. The different direction of changes in these prices and quantities reflects the fact that these simulations change investment in both marketing and research activities, and that investment in marketing and research has different effects on prices and quantities. Because investment in both activities is changing, demand (in Canada and its export markets) and supply shift at the same time, with the size of the shift varying with the particular marketing-research split. Whenever demand and supply shift at the same time, and by differing amounts and in differing directions, it can become difficult to predict the direction and size of change in prices and quantities, especially when there is trade. Nevertheless, we do see that the supply of live cattle increases in all cases. This supply response arises from an outward shift in supply of fed and non-fed cattle when investment in research increases. This research-induced shift in supply is so large that it offsets the reduction in farm price and leads to an increase in producer benefits (as discussed in the text) when check-off funds are reallocated from marketing to research.

The simulations dealing with refund requests by Alberta cattle producers all resulted in lower retail and farm-level prices. And while beef disappearance increased, beef production fell, as did the number of fed and non-fed cattle supplied to the market for slaughter. Moreover, the magnitude of change in

these prices and quantities increased with the refund rate. This means the larger the number of producers requesting a refund, the more amplified the impact will be on the cattle market.

Table A.14. Summary statistics for select prices and quantities in the baseline and other "what-if" scenarios

	Retail price of beef ($/lbs)	Total beef disappearance (tonnes)	Beef production (tonnes)	Farm price of slaughter-weight fed cattle ($/lbs)	Supply of fed cattle for slaughter ('000 head)	Supply of non-fed cattle for slaughter ('000 head)
			Baseline scenario			
	$3.20	265143	342080	$0.792	1060.624	217.687
Reduction in:			**Scenarios used to calculate historic returns**			
Marketing	$2.96	267054	334871	$0.782	1061	218
	(-7.49%)	(0.72%)	(-2.11%)	(-1.21%)	(-0.001%)	(-0.001%)
Research	$3.20	265121	342003	$0.792	1053.707	215.917
	(0.03%)	(-0.01%)	(-0.02%)	(0.01%)	(-0.65%)	(-0.81%)
Marketing and research	$2.96	267032	334796	$0.782	1053.693	215.915
	(-7.46%)	(0.71%)	(-2.13%)	(-1.20%)	(-0.65%)	(-0.81%)
Ratio of investment of check-off funds in marketing and research			**Scenarios used to calculate impact of optimizing marketing and research investment**			
90:10	$3.20	264577	342383	$0.792	1071.799	220.574
	(0.14%)	(-0.21%)	(0.09%)	(0.02%)	(1.05%)	(1.33%)
80:20	$3.18	264876	341804	$0.791	1086.142	224.258
	(-0.68%)	(-0.10%)	(-0.08%)	(-0.11%)	(2.41%)	(3.02%)
70:30	$3.15	265174	341186	$0.790	1098.523	227.434
	(-1.52%)	(0.01%)	(-0.26%)	(-0.24%)	(3.57%)	(4.48%)
60:40	$3.12	265474	340535	$0.789	1109.610	230.276
	(-2.37%)	(0.12%)	(-0.45%)	(-0.38%)	(4.62%)	(5.78%)
50:50	$3.09	265777	339853	$0.788	1119.754	232.876
	(-3.23%)	(0.24%)	(-0.65%)	(-0.52%)	(5.58%)	(6.98%)
Refund rate:			**Alberta refund scenarios**			
40%	$3.14	265589	340382	$0.790	1058.948	217.258
	(-1.74%)	(0.17%)	(-0.50%)	(-0.28%)	(-0.16%)	(-0.20%)
50%	$3.13	265703	339943	$0.789	1058.523	217.150
	(-2.19%)	(0.21%)	(-0.62%)	(-0.35%)	(-0.20%)	(-0.25%)
60%	$3.11	265818	339496	$0.789	1058.094	217.040
	(-2.64%)	(0.25%)	(-0.76%)	(-0.43%)	(-0.24%)	(-0.30%)
70%	$3.10	265934	339043	$0.788	1057.663	216.930
	(-3.11%)	(0.30%)	(-0.89%)	(-0.50%)	(-0.28%)	(-0.35%)

Appendix 2: An Example of How Benefit-Cost Ratios Are Calculated

This appendix includes a more detailed example of how BCR calculations are undertaken. For illustrative purposes, the example is for the simulation used to calculate the average BCR for investment of check-off funds in marketing activities. To begin, the model described in Appendix 1 is simulated without any changes to the exogenous variables. The solution to this simulation provides the predicted baseline values of the endogenous prices and quantities in each quarter of each year considered. These baseline prices and quantities are then used to calculate the baseline level of producer benefits in each quarter of each year.

Specifically, the simulated valued value of CW3, PSS3 and SSH3 are substituted for the carcass-weight, price-of-fed-cattle and supply-of-fed-cattle terms in the fed-cattle producer benefit equation. Likewise, the simulated value of CW3, PBW3 and SBW3 are substituted for the carcass-weight, price-of-non-fed-cattle and supply-of-non-fed-cattle terms in the non-fed cattle producer benefit equation, while the simulated value of the price of feeder calves and beef cow herd inventory are substituted into the relevant terms of the cow-calf producer benefit equation. These values are then added together to obtain the baseline level of Canadian cattle producer benefits in each quarter.

To implement the simulated reduction in investment of check-off funds in marketing activities, recognize that these marketing activities occur in Canada, the U.S. and the rest of the world. As discussed above, the beef-demand equation in Canada includes a term that reflects BIC investment in beef marketing in Canada. As well, the equation for net beef exports from Canada to the U.S. includes a variable equal to BIC investment in U.S. market development. Lastly, the equation for net beef exports from Canada to the rest of the world includes a variable equal to CBEF investment in export market development outside of the U.S.

The value of the check-off funds invested in marketing activities in the respective market is subtracted from the respective marketing investment variable in Canada, the U.S. and the rest of the world, and the simulation model is run. By removing these check-off funds, we reduced demand for beef in Canada, as well as net exports of beef from Canada to the U.S. and net exports of beef from Canada to the rest of the world. The solution to this particular simulation provides the predicted values of the endogenous prices and quantities for the "what-if" scenario where check-off investment in marketing activities is removed (because there is an exogenous shock to the market, these are called shocked prices and quantities). The relevant shocked prices and quantities are then used to calculate fed, non-fed and cow-calf cattle producer benefits without the investment of check-off funds in marketing activities. These three producer groups' benefits are then added together to obtain a measure of the value of Canadian cattle producer benefits with the shock.

The difference between the shocked and baseline level of producer benefits is then calculated and aggregated to fiscal-year basis. The reason for aggregating from a quarterly basis to a fiscal-year basis relates to simplicity of reporting. The quarterly benefits measures show variation from one quarter to the next, and the sheer number of quarters can overwhelm the reader. Next, the quarterly reduction in investment in marketing activities is then aggregated to a fiscal-year basis. The ratio of the reduction in producer benefits to the reduction in marketing activities is the average BCR.

To further illustrate, the baseline and shocked level of Canadian cattle producer benefits, and their difference, are shown below for fiscal year 2006/2007. Column A shows the baseline level of Canadian cattle producer benefits (in thousands of deflated dollars) in each quarter of FY 2006/2007. Column B shows the shocked level of Canadian cattle producer benefits (again, in thousands of deflated dollars) for each quarter of FY 2006/2007. The values in Column B are estimates of Canadian cattle producer benefits had the check-off funds NOT been invested in marketing activities. The difference between the baseline and shocked producer benefits (i.e., Column A minus Column B) shows the reduction in producer benefits after removing investment of check-off funds in marketing activities. The sum of these quarterly changes, shown at the bottom of Column C, equals $41.5 million.

The value of the reduction in check-off fund investment in marketing activities (for each quarter of 2006/2007) is shown in Column D. In each quarter, the reduction in marketing investment equals the reduction in beef marketing investment in Canada, the U.S. and the rest of world. The value of these reductions is $5.5 million. The ratio of the sum of Column C to the sum of Column D equals the average BCR for this particular simulation in fiscal year 2006/2007, which is the average BCR for 2006/2007 shown in Table 6.2. This process is repeated for each year in each particular scenario.

	Column A Baseline producer benefits ('000 dollars)	**Column B** Shocked producer benefits ('000 dollars)	**Column C** Reduction in producer benefits ('000 dollars)	**Column D** Reduction in marketing investment ('000 dollars)	**Column E** Average BCR for FY 2006/2007
2006 Q3	$216,20535	$206,319.17	$9,886.18	$1,008.43	
2006 Q4	$281,439.86	$271,195.02	$10,244.85	$1,252.19	
2007 Q1	$370,939.39	$360,585.58	$10,353.80	$1,282.26	
2007 Q2	$400,672.56	$389,619.36	$11,053.20	$1,959.38	
		SUM:	$41,538.03	$5,502.26	7.55

Appendix 3: Data Sources

Data definitions, manipulations and sources are presented in the same order as the different aspects of the model are presented in Appendix 1.

Canadian Data

PCBFD3 is quarterly per capita disappearance of beef (and veal) in Canada (in kilograms per person per quarter, on a carcass-weight basis). Calculated as beef disappearance divided by the Canadian population. Source: author's calculation.

DBF3 is beef disappearance. Calculated as commercial beef production (i.e., federally and provincially inspected slaughter multiplied by carcass weights) plus commercial veal production (i.e., federally and provincially inspected slaughter multiplied by carcass weights) plus uninspected beef production (i.e., uninspected slaughter multiplied by average warm carcass weight) minus beef exports plus beef imports plus the change in beef stocks. Source: author's calculation using the following data:

> Commercial beef production (QBF3) equals federally and provincially inspected cattle slaughter multiplied by average warm carcass weights. Source: Livestock Meat Report and Livestock and Meat Trade Report, Agricultural and Agri-food Canada; CANFAX
>
> Commercial veal production (QVL3) equals federally and provincially inspected cattle slaughter multiplied by average warm carcass weights. Source: Livestock Meat Report and Livestock and Meat Trade Report, Agricultural and Agri-food Canada; CANFAX
>
> Uninspected beef and veal production (UBEEF3) equals uninspected cattle and calf slaughter multiplied by respective average warm carcass weights. Source: Statistics Canada; Agriculture Division (purchased data)
>
> Beef exports in tonnes of carcass-weight equivalent. Source: Statistics Canada (purchased data); Livestock Meat Report, Agricultural and Agri-food Canada
>
> Beef imports in tonnes of carcass-weight equivalent. Source: Statistics Canada (purchased data); Livestock Meat Report, Agricultural and Agri-food Canada
>
> DTSOCKS3, change in beef stocks, in tonnes of carcass-weight equivalent. Source: Statistics Canada (CANSIM); Statistics Canada (purchased data)

RPBF3 is the deflated retail price of beef (in CND dollars per pound), weighted average of the price of six retail cuts (sirloin steak, round steak, prime rib roast, blade roast stewing beef and ground beef) from fed and non-fed cattle deflated with the all-item CPI (2002=100). Weights based on beef production from slaughtered steers, heifers, cows and bulls. Source: Agriculture and Agri-food Canada; Statistics Canada (CANSIM)

RPPK3 is the deflated retail price of pork (in CND dollars per pound), calculated as the CPI for pork multiplied by the base year price deflated with the all-item CPI (2002=100). Source: Statistics Canada (CANSIM)

RPCK3 is the retail price of chicken (in CND dollars per pound), calculated as the CPI for pork multiplied by the base year price deflated with the all-item CPI (2002=100). Source: Statistics Canada (CANSIM)

PDI3 is deflated per capita disposable expenditure (in CND dollars per person per capita), calculated as personal disposable income divided by population deflated with the all-item CPI (2002=100). Source: Statistics Canada (CANSIM)

SCNDMRK is the square root of deflated per capita marketing investment in beef marketing activities in Canada, calculated as BIC investment in marketing activities in Canada divided by the population of Canada and deflated with the all-item CPI (2002=100). Source: BIC quarterly progress reports, quarterly stakeholder reports and annual reports

DSH3 is commercial (i.e., federally and provincially inspected slaughter) of steers and heifers in Canada. Source: Livestock Meat Report and Livestock and Meat Trade Report, Agricultural and Agri-food Canada; AAFC website; CANFAX

PSS3 is the deflated price of slaughter steers in Canada, calculated as the weighted average of the provincial/regional price of slaughter steers in Canada, with provincial/regional share of slaughter used as the weight, and deflated by the Farm Product Price Index (1997=100). Source: Livestock Meat Report and Livestock and Meat Trade Report, Agricultural and Agri-food Canada; AAFC website; Statistics Canada (CANSIM)

DBW3 is commercial (i.e., federally and provincially inspected) slaughter of cows and bulls. Source: Livestock Meat Report and Livestock and Meat Trade Report, Agricultural and Agri-food Canada; AAFC website; CANFAX

PBW3 is the deflated price of cows for slaughter in Canada, calculated as the weighted average of the provincial/regional price of slaughter cows in Canada, with provincial/regional share of slaughter used as the weight, and deflated by the Farm Product Price Index (1997=100). Source: Livestock Meat Report and Livestock and Meat Trade Report, Agricultural and Agri-food Canada; AAFC website; Statistics Canada (CANSIM)

SSH3 is supply of slaughter steers and heifers, equal to commercial slaughter of steers and heifers plus exports of slaughter steers and heifers minus imports of slaughter steers and heifers. Source: author's calculation

PBARLEY is the deflated price of feed barley ($/t), deflated by the Farm Product Price Index (1997=100). Source: CANFAX

IBW3 is the inventory of beef cows in Canada on July 1. Source: Statistics Canada (CANSIM)

SSRND is the square root of deflated investment in beef cattle research in Canada, deflated with the all-item CPI (2002=100). Source: BCRC staff

SBW3 is supply of cows and bulls for slaughter in Canada, equal to commercial slaughter of cows and bull plus exports of slaughter cows and bulls minus imports of slaughter cows and bulls. Source: author's calculation

INV3 is the inventory of beef and dairy cows on July 1. Source: Statistics Canada (CANSIM)

PFC1 is the deflated price of 500-pound feeder calves in Alberta. Source: CANFAX

CW3 is the carcass weight of slaughtered cattle (in kilograms), calculated as beef production divided by total commercial (i.e., federally and provincially inspected slaughter). Source: author's calculations

ER34 is the Canada-U.S. exchange rate (C$/U$). Source: Statistics Canada (CANSIM)

NT3BF4 is net exports of beef from Canada to the U.S., calculated as beef exports from Canada to the U.S. less imports of beef into Canada from the U.S. Source: author's calculation based on data from Livestock Meat Report and Livestock and Meat Trade Report, Agricultural and Agri-food Canada; AAFC website; CANFAX; Statistics Canada (purchased data); USDA FAS; USDA ERS

SUSMRK is the square root of the deflated BIC investment in the U.S. market development program, deflated with the all-item CPI (2002=100). Source: BIC quarterly progress reports, quarterly stakeholder reports and annual reports

NT3BF9 is net exports of beef from Canada to the rest of the world, calculated as beef exports from Canada to the rest of the world less imports of beef into Canada from the rest of the world. Source: author's calculation based on data from Livestock Meat Report and Livestock and Meat Trade Report, Agricultural and Agri-food Canada; AAFC website; CANFAX; Statistics Canada (purchased data); USDA FAS; USDA ERS

BFEXPP is the deflated unit value of Canadian beef exports, equal to the value of beef exports divided by the quantity of beef export. Source: Statistics Canada

SINTMRK is the square root of deflated CBEF investment in marketing activities, deflated with the all-item CPI (2002=100). Source: CBEF annual reports

POP3 is the population of Canada. Source: Statistics Canada (CANSIM)

NT3SCT4 is net exports of slaughter-weight steers and heifers from Canada to the U.S. Source: author's calculation based on data from Livestock Meat Report and Livestock and Meat Trade Report, Agricultural and Agri-food Canada; AAFC website; CANFAX

NT3BW4 is net exports of slaughter-weight cows and bulls from Canada to the U.S. Source: author's calculation based on data from Livestock Meat Report and Livestock and Meat Trade Report, Agricultural and Agri-food Canada; AAFC website; CANFAX

U.S. Data

PCBFD4 is quarterly per capita disappearance of beef (and veal) in the U.S. (in kilograms per person per quarter). Source: USDA Economic Research Service Livestock Outlook

RPBF4 is the deflated retail price of beef (in U.S. dollars per pound), calculated as the deflated CPI for beef multiplied by the base year price, deflated with the all-item CPI in the U.S. Source: U.S. Bureau of Labor

RPPK4 is the deflated retail price of pork (in U.S. dollars per pound), calculated as the deflated CPI for pork multiplied by the base year price, deflated with the all-item CPI in the U.S. Source: U.S. Bureau of Labor

RPPY4 is the deflated retail price of poultry (in U.S. dollars per pound), calculated as the deflated CPI for poultry multiplied by the base year price, deflated with the all-item CPI in the U.S. Source: U.S. Bureau of Labor

PDI4 is deflated per capita disposable expenditure (in U.S. dollars per person per capita), deflated with the all-item CPI in the U.S. Source: U.S. Bureau of Labor

DSH4 is commercial steer and heifer slaughter. Source: USDA Economic Research Service Livestock Outlook

PSS4 is the deflated price of slaughter steers (Choice Number 2-4 Nebraska Direct), deflated with the U.S. slaughter livestock price index. Source: USDA Economic Research Service Livestock Outlook; U.S. Bureau of Labor

DBW4 is commercial cow and bull slaughter. Source: USDA Economic Research Service Livestock Outlook

PBW4 is the deflated price of slaughter cows (specifically, the price of boning utility cows in the Sioux Falls market), deflated with the U.S. slaughter livestock price index. Source: USDA Economic Research Service Livestock Outlook; U.S. Bureau of Labor

SSH4 is supply of slaughter steers and heifers, calculated as commercial steer and heifer slaughter plus net exports of slaughter steers and heifers from Canada to the U.S. Source: author's calculation

FPCO4 is the deflated price of feed corn, deflated with the all-item CPI in the U.S. Source: USDA Feedgrain Database

IBC4 is the inventory of beef cows on July 1. Source: USDA Economic Research Service Livestock Outlook

SBW4 is supply of cows and bulls for slaughter, calculated as commercial cow and bull slaughter plus net exports of slaughter cows and bulls from Canada to the U.S. Source: author's calculation

PFC4 is the deflated price of feeder calves, deflated with the U.S. slaughter livestock price index. Source: USDA Economic Research Service Livestock Outlook; U.S. Bureau of Labor

INV4 is the size of the beef and dairy cow herd on July 1. Source: USDA Economic Research Service Livestock Outlook

POP4 is the U.S. population (in millions). Source: U.S. Bureau of Labor

QVL4 is veal production in the U.S. Source: USDA Economic Research Service Livestock Outlook

UBEEF4 is uninspected beef production in the U.S. Source: USDA Economic Research Service Livestock Outlook

NT4BF9 is net U.S. beef exports to the rest of the world. Source: USDA Economic Research Service Livestock Outlook

DSTOCKS4 is the change in U.S. beef stocks. Source: USDA Economic Research Service Livestock Outlook