RURAL ECONOMY

Formal beef alliances and alignment challenges: Issues in contracting, pricing and quality

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Project Report: # 07-02

Project Report

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Acknowledgements

This project was funded by the National Beef Industry Development Fund. The assistance of cattle producer organizations in Alberta, Saskatchewan, Manitoba and British Columbia with the survey is gratefully acknowledged. Kevin Lan, Rural Economy graduate student did much of the analysis of the cow-calf survey as part of his M.Sc. thesis. Gabriel John, Rural Economy graduate student did much of the research on price spreads and competition issues as part of his M.Sc. thesis. Emmanuel Laate, Rural Economy research assistant, undertook several parts of the risk analysis. Peter Boxall was very helpful during the development of the survey. A number of undergraduate and college students were instrumental in completing the on-site surveys. We are particularly grateful to several cow-calf producers from Alberta who assisted us with the survey development.

Formal beef alliances and alignment challenges: Issues in contracting, pricing and quality

Executive Summary

Vertical coordination throughout Canada's beef supply chain is imperfect on several accounts. We observe failures in the established pricing system, the established grading system, a lack of appropriate incentives for investments to promote adding value, and misalignments due to the increasing industry concentration at the processor level. Since all of these issues are inherently linked, the proposed project has aimed to address them in an integrated manner. At the heart of this study is a firm-level analysis of alignment and risk-management problems at the cow-calf sector.

A survey of cow-calf producers in Western Canada evaluated their willingness to participate in beef alliances. The initial part of the survey suggested that cow-calf producers view auction markets as price competitive but perhaps these markets are less successful at rewarding cattle quality. Very few of the surveyed participants had used contracts such as forward contracts or futures contracts in their cow-calf business.

Slightly over 22 percent of the participants indicated they would not participate in any beef alliance. The remaining survey group that did indicate a willingness to participate in a beef alliance showed a clear preference for the following:

- Alliance purchase calves from producer and producer have the opportunity to participate in profit sharing.
- Producers prefer to receive information on individual live animal performance versus individual carcass performance.
- Producers prefer minimal restrictions on production protocols and numbers of animals that must be committed to participate in the alliance.
- A small per head alliance fee paid by the producer was not a major issue in determining willingness to participate in the alliance.

These survey results above suggest the key issues that need to be addressed in alliance contracts. However it may be difficult to appropriately include price risk in these contracts if the alliance is also trying to share risk along the value chain. Analysis of secondary price data and other researcher conclusions indicate that contracts for Alberta cow-calf producers that include pricing based upon fed cattle or meat cut out values will expose producers to more variability in cow-calf returns. This risk cannot be effectively managed with existing market based risk tools. The choice of cow-calf producer alliance participants would be a pricing scheme that eliminated most if not all of the downside risk associated with fed cattle or meat cut out values. Cow-calf producers risk perception versus actual level of risk may not always be aligned. This may create increased difficulties in designing alliance contracts that appropriately share risk along the value-chain.

Successful alliance schemes that include cow-calf producers require more work on the compensation scheme. Specific risk-based compensations schemes need to be explored in more depth and in the broader context of the key value chain members to develop more appropriate alliance contracts. The divergence between perceived and actual risks deserves particular attention.

Results from our analysis on price spreads and competition at the packer, wholesale and retail level suggest that the industry has become somewhat more competitive since May 2003. While there were no noticeable differences between western and eastern regions of Canada, large disparities in price spreads were found between Canada and the US. Competition issues were not too dissimilar in the two countries with some evidence of imperfect competition pre-BSE (1980- May, 2003) in Canada and US, but much less evidence after May 2003 in both countries.

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I Introduction and project objectives

The study set out to address alignment problems in the Canadian beef industry through both a firm-level and an industry-level analysis. Several deficiencies and issues in vertical coordination throughout Canada's beef supply chain were initially identified, and several analyses were identified to address them.

1. The pricing system: From the US as well as from Europe, we have mounting evidence that the established pricing system, in which base price is tied to a cash market, has major flaws (Purcell, 2000; MacDonald *et al*., 2004). Deficiencies in the established pricing system appear to be even more prevalent in Canada (Schroeder, 2003).[1] However, it is also well documented that contracts can provide appropriate incentives for long-term investment to supply chain members, as well as improve alignment of cattle qualities supplied with final consumer demands (Purcell, 2000; Bailey, 2003; MacDonald *et al*., 2004). As for Canada, there is evidence that formal alliances have not been embraced on a large scale by industry members (Wood, Pratt and Grosenick, 2003, p.31). This suggests that there is economic potential to be exploited from such improved alignment through innovative pricing schemes in contracting schemes in the Canadian market.

2. The grading system: Considering that Canada uses the copyrighted grading standards employed in the US (a high degree of association, approximately 85%, exists between the marbling standards of the Canadian and American high quality beef grades: CBEF, 2005), it is tempting to conclude that inadequate grades and the related quality variation problems that have been identified for the US (Purcell, 2000), can be partly made responsible for the lack of alignment in Canada. Brocklebank and Hobbs (2004) support this assertion for Canadian beef by emphasizing that: "…, *it is widely recognized that the existing Canadian and U.S. grading systems do not identify adequate proxy variables for*

[1] "One place Canada lags behind the U.S. is with regards to the number of fed cattle that are being sold on a value-based grid." Schroeder (2003), p.12.

measurements of eating quality such as tenderness." (p.7).[2] Further, based on the beef quality audit that was conducted in Canada in 1998-99, Van Donkersgoed et al. (2001) conclude that "*Based on August 1998 to July 1999 prices, it was estimated that the Canadian beef industry lost $82.62 per head processed, or $274 million annually, from quality nonconformities, which was an increase from 1995*."

3. Lack of appropriate incentives for investment to promote adding value: The implications from inadequate grading and ineffective market reporting have been felt in the US in terms of lack of investment and innovation of value-added beef products (Purcell, 2004). Similar observations with regards to the lack of innovation in value chains can be made for Canada, although this can be partly explained by the past strong export dependence on low value-added beef products. Nevertheless, given the current desire to find new target markets and to recapture those that were previously held by Canada, appropriate investment and innovation incentives deserve top priority.

4. Industry consolidation: Recent changes in the Canadian beef industry structure are reflected in a small number of mid-sized processors. The related emergence of thinner spot markets for slaughter cattle has cast doubt on the competitiveness and fairness of pricing mechanisms used. Wood et al. (2003) have therefore emphasized that industry consolidation and related pricing issues pose a major concern to the Canadian beef industry (p.15).[3]

Given the above challenges to the Canadian beef industry, the research project tried to address the following issues:

(1.) How can contract incentives and formal beef alliances help to overcome undesirable quality variation? A recent survey of cow-calf producers in western Canada revealed that cow-calf producers have, on average, a *preference* for a combination of live weight *and* carcass quality pricing, even though using this pricing

[2] "In an Alberta survey, over 30 percent of steaks and 35 percent of roasts purchased in a six month period were ranked as unacceptable for tenderness by a trained lab panel (Brewin and Ulrich, 1999)." Brocklebank and Hobbs (2004), p.7.

[3] Similar concerns have been raised for the US market: Schroeter and Azzam (1990); Schroeter, Azzam and Zhang (2000); Azzam (2003).

method means that they incur some of the risk associated with variability in cattle quality (Brocklebank and Hobbs, 2004). This important result suggests that an analysis of incentives as part of contracts and beef alliances is critical for achieving desired quality changes. Further, Brocklebank and Hobbs (2004) found that, "*Overall, the risk of opportunistic behaviour as a result of investment in specific assets is minimal and has not had a great impact on the degree of supply chain coordination*." (p.58). This finding emphasizes that an analysis of alignment issues in the beef sector should focus on other issues than production and health protocols, as these can be considered as relation-specific investments. Instead, the question is what role monetary incentives and other attributes of beef alliances (and incentive contracts therein) can have. Further the question of this study was to what extent our results would confirm the findings of Brocklebank and Hobbs (2004), since this study was conducted in December of 2003.

(1.a.) What pricing mechanisms provide appropriate incentives for quality consistency and improved alignment? The general conclusion of Brocklebank and Hobbs (2004) is that a pricing system based solely on carcass quality remains unpopular with many cow-calf producers. More specifically, the study results suggest that cow-calf producers are willing to bear some price risk by being compensated through a combination of live weight and carcass quality pricing. Therefore, our study aimed to capitalize on this finding by analyzing producers' willingness to manage risks (a) through participation in alliances, where producers would pay certain price premiums (or requirements to be compensated) for specific contract and alliance characteristics, and (b) through other means outside of the direct alliance relationship.

More support to proceed in this way comes from a study funded by the NBDIF (Wood et al. 2003), which has also identified that several key players in the Canadian beef supply chain support the incorporation of retail prices into the compensation formula for beef producers (p.25, 29). Also, the fact that Canada uses a mandatory individual animal identification program lends support to an investigation of pricing schemes that tie producer compensation closely to retail prices.

(1.b.) Managing risks within contracts and encouraging successful participation in formal alliances: Since cow-calf producers were found to have an affinity to contracts that do not expose them to additional risk by linking compensation to processed beef and retail prices, the Brocklebank and Hobbs (2004) study proposes two ways to encourage producer participation in such alliances. First, the authors propose to focus on cow-calf producers' education with regards to benefits of a grid-based pricing system. Second, the authors propose to use methods so as to help individuals to manage their exposure to risk. This project also tried to evaluate possible benefits to producers of managing risk exposure more extensively.

(2.) Analysis of price spreads and competition pre- and post-BSE: A coherent firm-level analysis of improved pricing mechanisms and risk-management tools needs to be placed into the overall industry context. Acknowledging the limitations in terms of access to firm level data for the highly concentrated meat packer industry (Brocklebank and Hobbs 2004, p.5), our study set out to analyze competition issues in the US and Canada at the aggregate level (producers, packers, wholesalers, retailers).

Our analysis in this report consists of three parts. Part one (section II) includes a descriptive analysis of cow-calf survey participants and an experimental study of beef alliance participation. Part two (section III) analyzes risk attitudes and risk management issues facing cow-calf producers. Part three (section IV) explores market power issues in the US and Canadian beef industry.

II Analysis of cow-calf survey and beef alliances

II.1. Cow-calf producer survey

This study covers four Western provinces, namely, British Columbia, Alberta, Saskatchewan and Manitoba. Based on a membership list that was made accessible by one of the beef producers associations (Alberta), and as a result of the other associations' active efforts to approach cow-calf producers for participation in this survey, 951 cattle producers were contacted by telephone. The scope of the survey was severely limited due to the constraints that most beef producer associations faced in terms of making membership lists accessible for our research purpose. Initially, the 2001 Agricultural consensus was used to identify how many cow-calf producers should be contacted from each province and from each region within a given province, such as to guarantee a representative sampling. However, due to the inability to contact producers directly outside of Alberta, this sampling information could not be used outside of Alberta. As a result, it was expected that our survey would result in an over sampling from Alberta.

During the telephone screening, the producers were first asked whether they would in principal be willing to participate in an online-survey. The respondents were then told that the same survey could also be completed during an on-site interview, where trained students would use an electronic version of the survey on a laptop. No financial incentives were given for participation. The survey varied in length, since it was constructed in a tree-structure, to circumvent questions most effectively that would not apply to a particular type of cow-calf producer. On average, it took 15 to 20 minutes to complete a survey. Of the 151 cow-calf producers that participated in the survey, 100 were surveyed on-site, and the remaining 51 completed the same survey on-line. It should be noted that until spring of 2006, we had only 110 completed surveys, which were obtained through the above sampling procedure. During the summer, a privately organized group of beef producers from north of Westlock (Alberta) raised their interest in participating in the survey, as a result of which we obtained another 41 completed surveys.

Especially due to the over sampling of Alberta producers, the question is how representative the survey population is relative to the entire Canadian producer population. Compared to the 2001 Census of Agriculture and compared to the survey population of Brocklebank and Hobbs (2004), the producers in our sample have a larger beef cowherd size (Table 1, p.7). The sample has also a higher education level compared to the 2001 census data. The sample is also younger than the census population, but slightly older than that of Brocklebank and Hobbs (2004).

As shown in Figure 1 (p.8), the majority of respondents (50%) belong to the category of mainly cow-calf operations. The distribution of age classes across on-line or and on-site surveys was of interest, since it was hypothesized that younger respondents would be more likely to choose an on-line survey rather than an on-site interview. However, the distribution was not as clear cut. As shown in Figure 2 (p.8), more than 71% of respondents from the age group 31-41 completed the survey on-site, and more than 79% that were age 61 and older completed the survey on-site.

Table 1. Comparison of the sample population

	Percentage in Category		
	Census of Agriculture (2001)	**Brocklebank and Hobbs (2004)**	**This study**
Gross Revenues ($'000' s)			
0-10	21.00%	6.00%	
10-49	29.00%	11.00%	
50-99	14.00%	16.00%	No Comparable Data
100-249	20.00%	30.00%	Available
250-499	10.00%	23.00%	
500+	6.00%	14.00%	
Farm Income from Beef			
Less than 25%	No Comparable Data	No Comparable Data	35.45%
Between 25% and 50%	Available	Available	11.82%
More than 50%			52.73%
Alliance Participation			
Yes	No Comparable Data	15.00%	76.36%
No	Available	85.00%	23.64%
Herd Size			
0-50		20.00%	38.18%
50-100	Avg. Canadian Herd Size:	18.00%	36.36%
100-150	53 Head; Avg. Western	20.00%	
150-200	Canadian Herd Size: 67	21.00%	19.09%
200-300	Head	10.00%	
300+		11.00%	6.36%
Education[4]			
High School	62.00%	29.00%	53.64%
College	27.00%	27.00%	28.18%
University	11.00%	11.00%	18.18%
Age[5]			
Less than 35	11.50%	35.00%	21.82%
35-60	53.60%	62.00%	62.72%
60+	34.90%	3.00%	15.45%

Source: Statistics Canada & Brocklebank and Hobbs (2004)

[4] The Census of Agriculture (2001) uses categories of “less than grade 9”; “grade 9-12”; ‘post secondary (non-university”; and “post secondary (university)”.

[5] The survey used in this study categories age of respondents as “ under 30”; “31-40”; “41-50”; “51-60” and “60+”.

Figure 1: Type of cattle operation

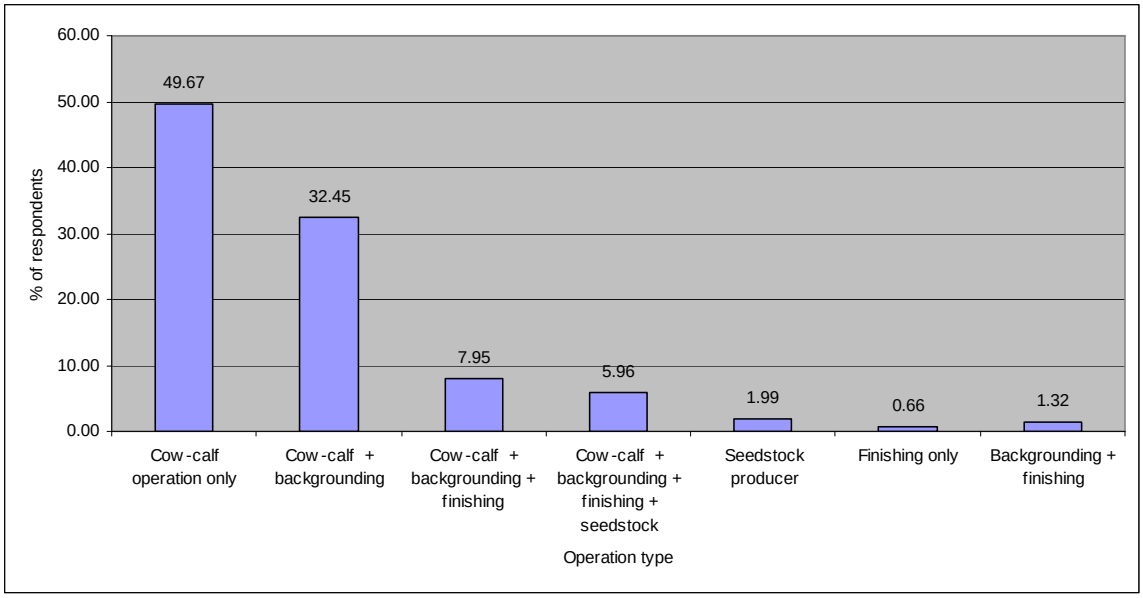
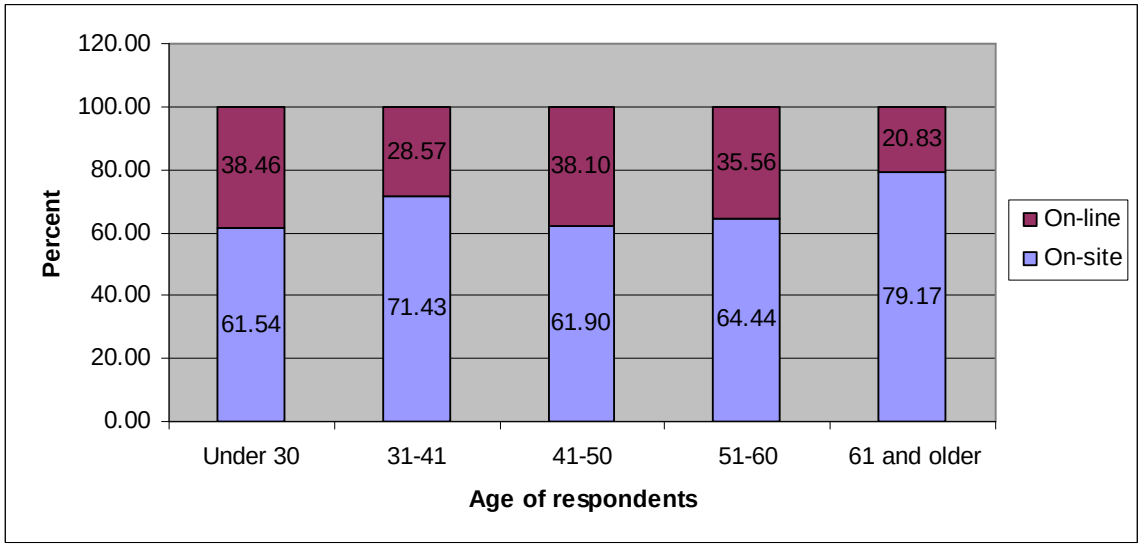
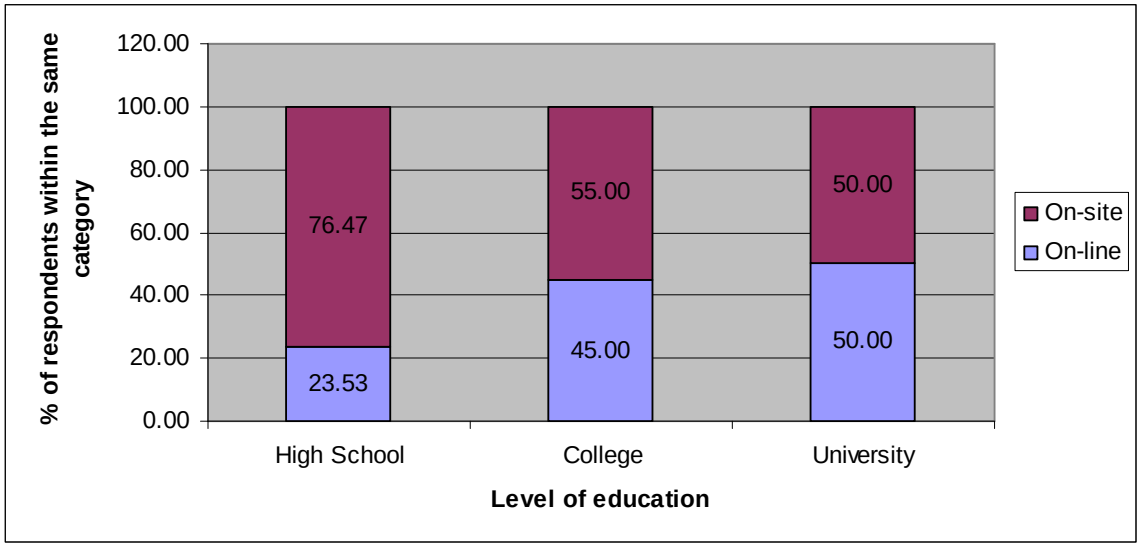


Figure 2: Distribution of participants across age groups



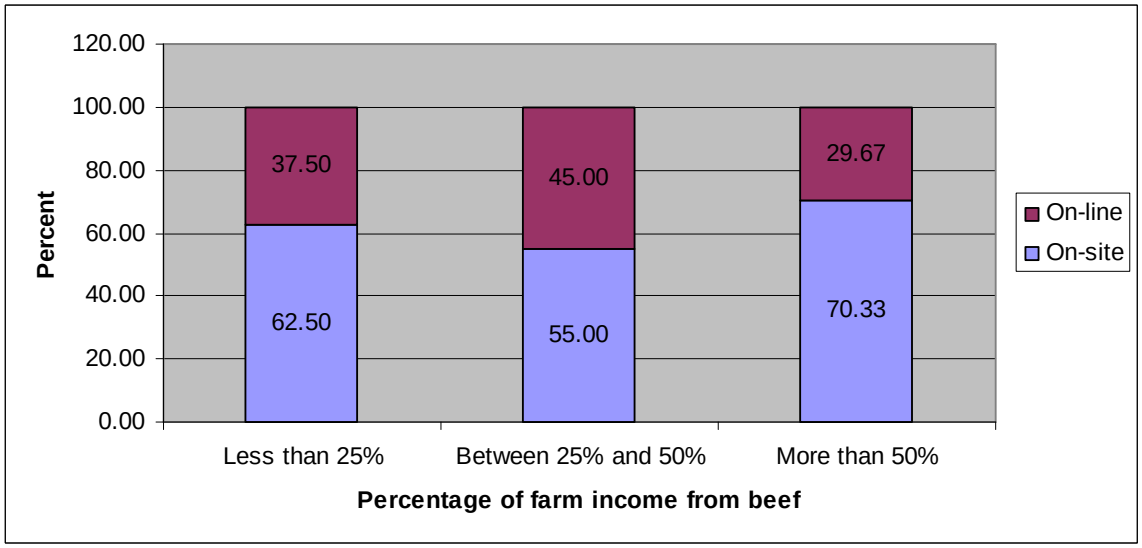
Respondents' educational levels are categorized as three ways, 1) high school; 2) college; and 3) university. As expected, Figure 3 shows that respondents with higher levels of education completed the survey on-line.

Figure 3: Survey participation and levels of education



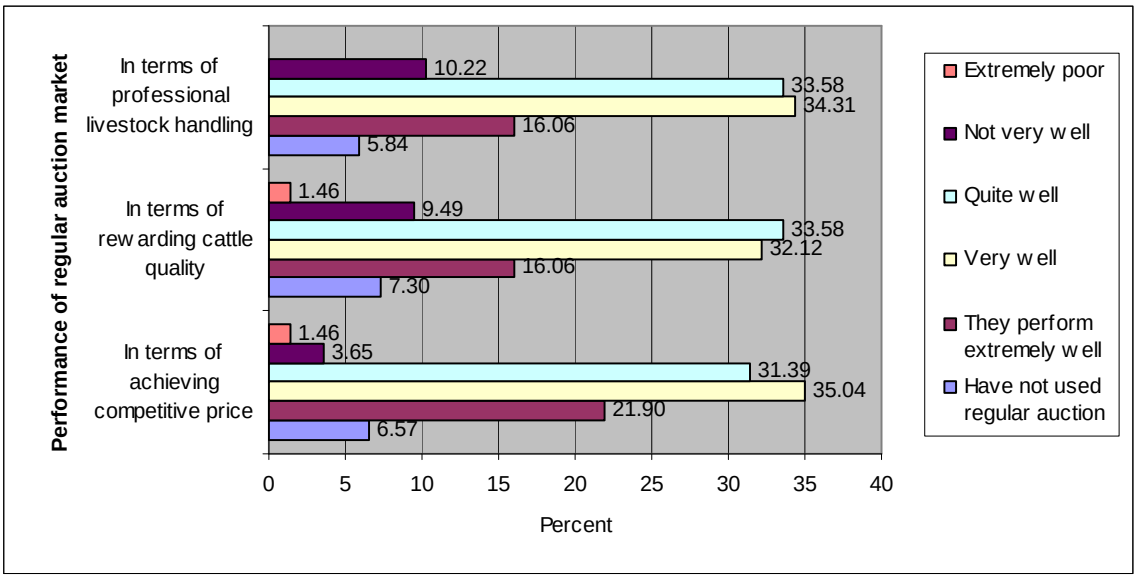
As Figure 4 shows, producers who were willing to complete the survey on-site where more income-dependent on beef production compared to producers who completed the survey on-line. More than 70% of the on-site respondents earned more than 50% of their farm income from beef production.

Figure 4: Farm income from beef production



As Figure 5 shows, producers were also asked to indicate their level of satisfaction with regular auction markets in terms of (i) rewarding the qualities of cattle, (ii) in terms of professional livestock handling and (iii) in terms of achieving a competitive price (on a scale of 1-5 where 1 is "they performed extremely well", 2 is "very well", 3 is " quite well", 4 is " not very well", and 5 is " extremely poor"). Perhaps most surprisingly was the finding that the greatest level of satisfaction was expressed for the auction's perceived ability to achieve a competitive price (22% of the respondents stated that the auction performed extremely well in this regard). However, as expected, the auction's ability to reward cattle qualities was judged most poorly, compared to both the price function and the ability to professionally handle livestock (1.5% of the producers stated that auction markets perform extremely poor, and 9.5% stated that they perform not very well in terms of rewarding cattle quality).

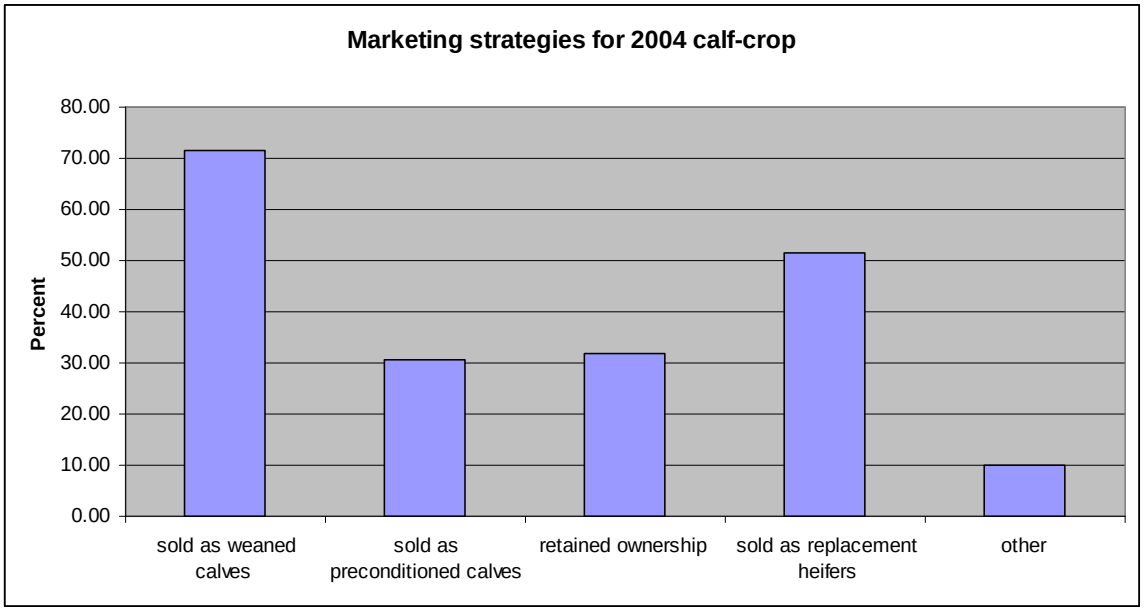
Figure 5: Performance of regular auction markets



Cow-calf producers were also asked about their marketing strategies for their 2004 calf crop. As shown in Figure 6, more than 70 percent of respondents indicated that they sold their calf crops in 2004 as weaned calves. About 30 percent of beef producers indicated that they retained ownership and about 50 percent of respondents indicated that they handled their calf crops as replacement heifers. The remaining calves were "sold as

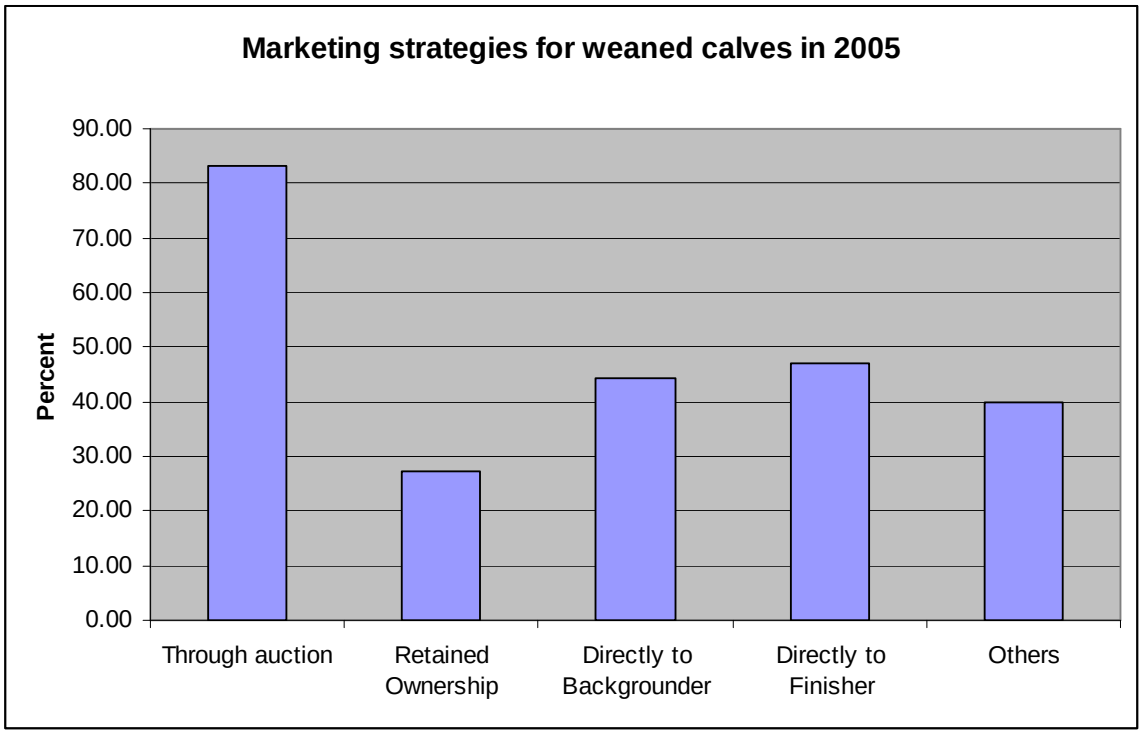
preconditioned calves" (30%) or put to others use (10%). The latter included "backgrounding the light calves", "slaughtered for personal use", etc..

Figure 6: Marketing strategies for 2004 calf crop



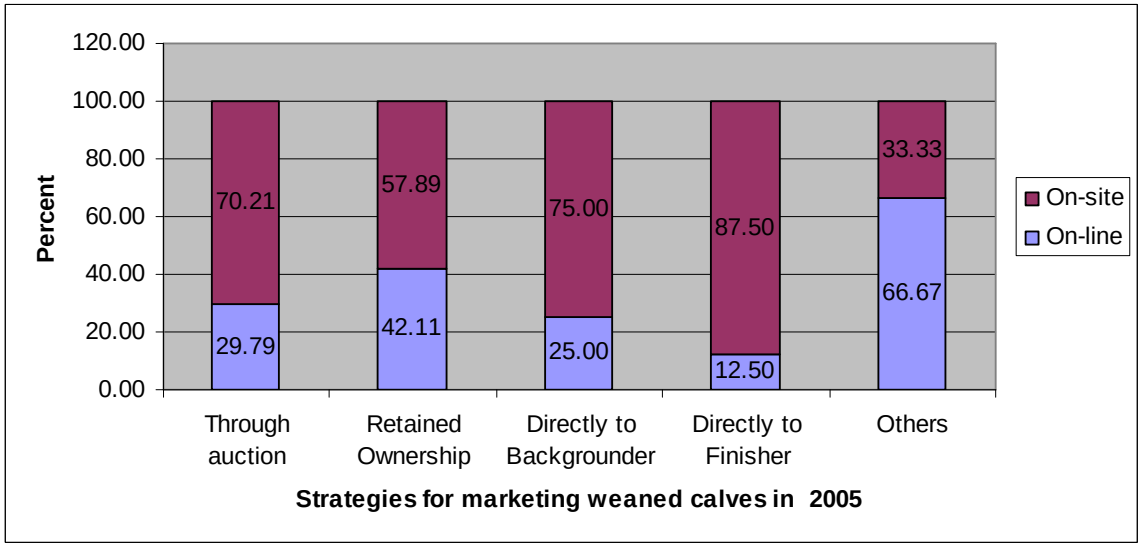
Using a ranking technique, respondents were asked to indicate their most preferred marketing strategy through which they handle their weaned calves in 2005. As Figure 7 shows, auction markets are the most frequently used marketing strategies (more than 80%). The next most frequently used marketing channel was selling the animals directly to finishers (more than 45%).

Figure 7: Marketing strategies for weaned calves in 2005



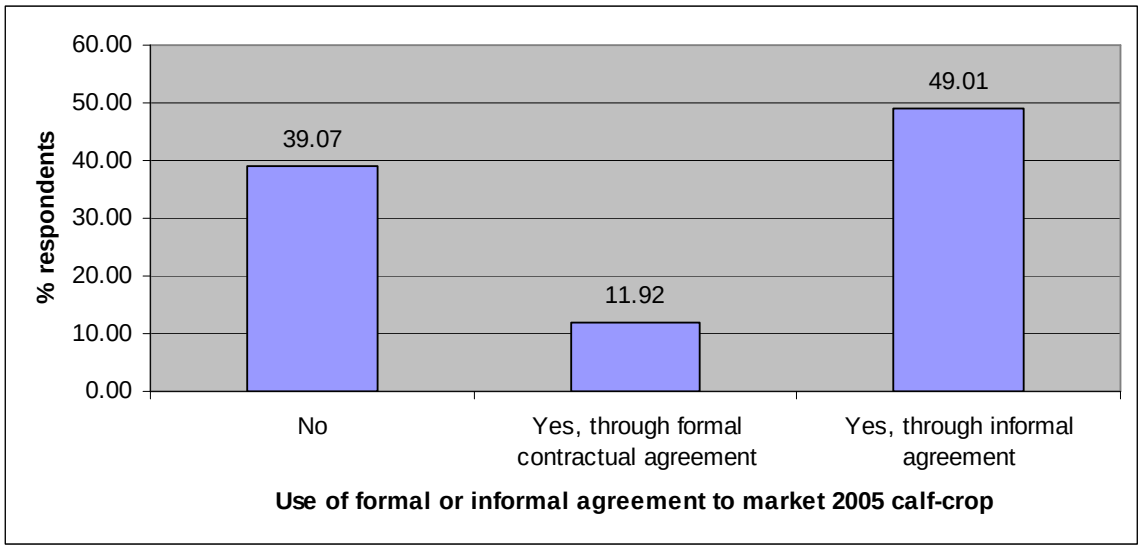
As Figure 8 shows, the use of the above marketing channels for weaned calves differed substantially across on-site and on-line respondents. In particular, nearly 90% of all animals in the sample that were sold directly to finishers were sold by participants that completed the survey on-site.

Figure 8: Marketing strategies for weaned calves according to type of survey



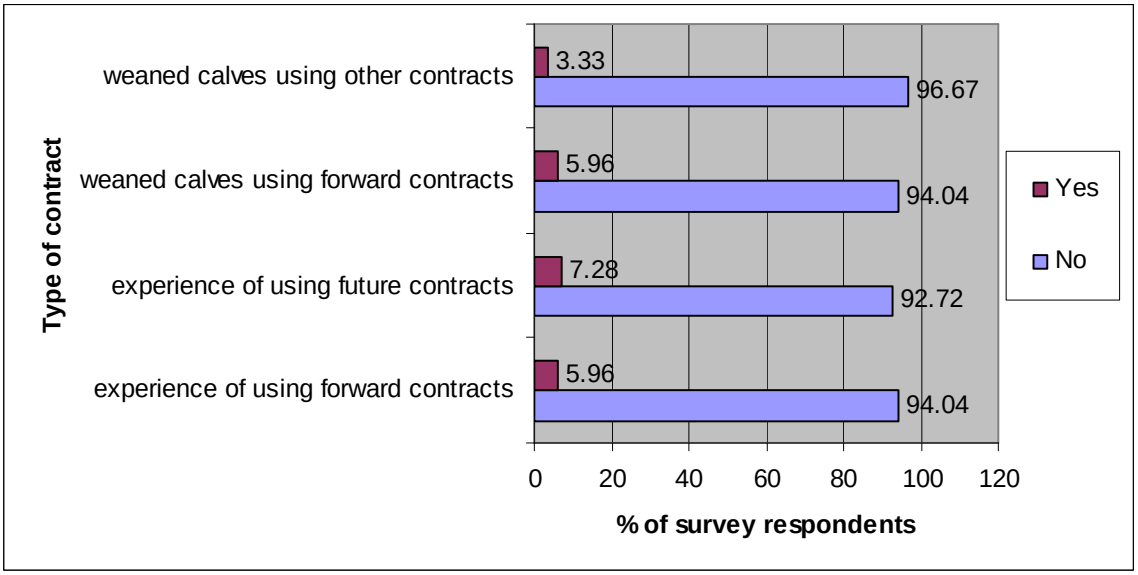
Producers were also asked about their experience of using contractual arrangements in 2005. As Figure 9 indicates, 49 percent of respondents use informal agreements, and only 12 percent of producers use formal contractual agreements. About 39% of the respondents indicated that they had never used formal contracts before to market their calf crop.

Figure 9: Use of formal contracts and informal agreements



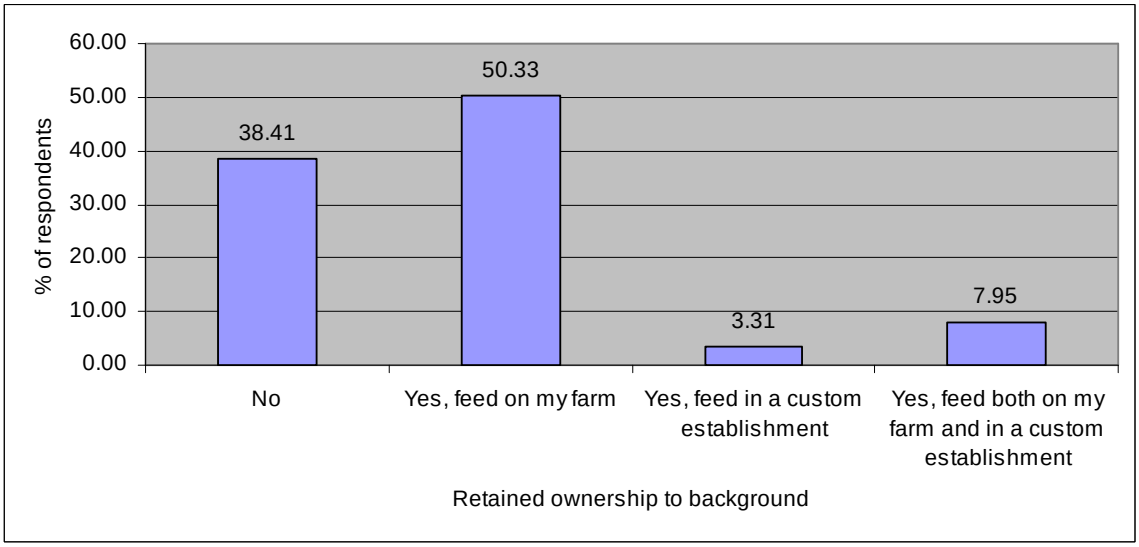
In order to explore the types of contracts and risk-management options that producers used further, we inquired about producers' experience of using pre-specified pricing contracts (i.e., future and forward contracts), and custom feeding contracts in cattle marketing. As shown in Figure 10, fewer than 15 percent of producers have experience with either futures or forward contracts.

Figure 10: Use of contracting



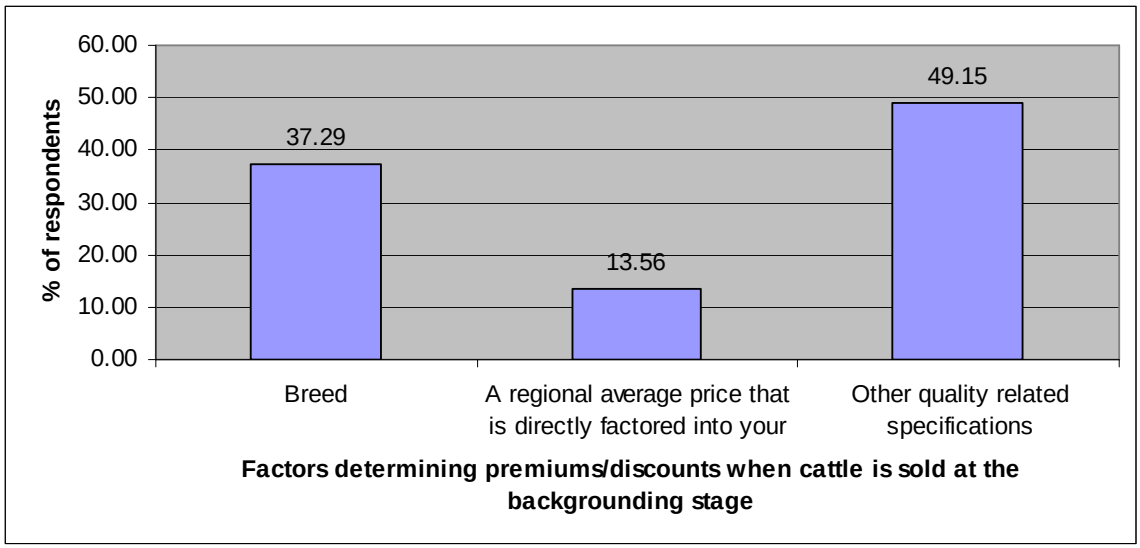
We also asked respondents about their different strategies in retaining ownership to background. The majority (50%) feed on their own farm, whereas less than 11% retain ownership through a feedlot operation (Figure 11).

Figure 11: Retaining ownership to background



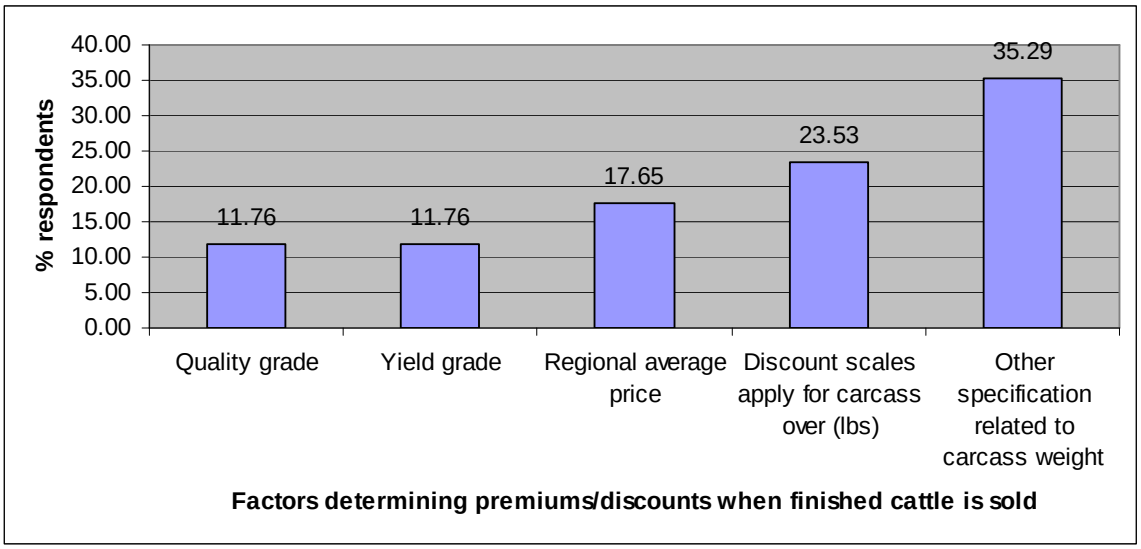
For those producers who sold at the backgrounding stage, we were interested in how price premiums and discounts were determined. As Figure 12 shows, about 14% of the producers indicated that a regional average price was used in selling cattle at the backgrounding stage. More important was the actual breed (37% of respondents), followed by other quality-related specifications (49% of respondents) in determining premiums and discounts.

Figure 12: Factors determining premiums/discounts at backgrounding stage



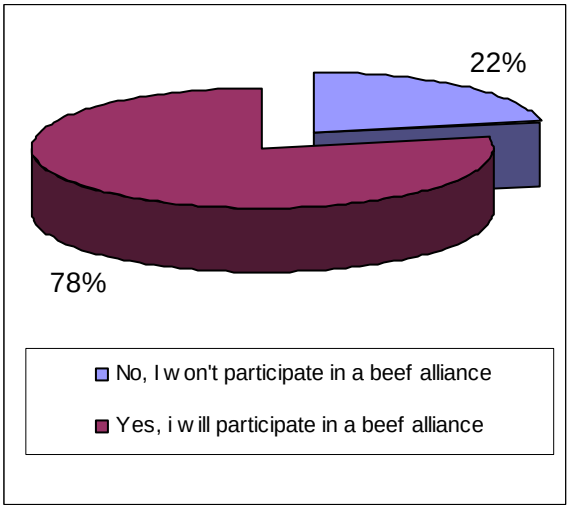
For sales of finished cattle, only 12 percent of the premiums/discounts were associated with quality grades or yield grades (Figure 13). Discount scales for carcasses above a particular weight class were used more frequently (24%). More than 35% of the producers had experiences with premiums/discounts that were associated with other specifications related to carcass weight.

Figure 13: Factors associated with premiums/discounts for sales of finished cattle



Further, we asked respondents whether they would be willing, in principle, to consider participation in a formal agreement between cow-calf producers and other members in a value chain, and more specifically where this would entail participation in a beef alliance that is developing niche markets. About 22% of all survey participants declined this question (Figure 14).

Figure 14: Beef alliance participation



The remaining participants (78%) were told to assume that their animals were close or ready to qualify for participating in an alliance, such that they could then consider several scenarios, i.e. several types of beef alliances to choose from. The analysis of the choice questions are in the next section.

II.2. Analysis of beef alliance participation

II.2.1. Specification of beef alliances

The different types of alliances between which cow-calf producers could choose were described in terms of sales type, production protocols, information sharing scheme and membership fee. These attributes and attributes levels are shown in Table 2.

Table 2: Attributes and Attributes Levels of Choice Experiment

Beef Alliance Attributes	Level 1	Level 2	Level 3	Level 4
Sale Type	Sell to alliance, NO profit sharing	Sell to alliance, bonuses based on animal performance	Retain ownership, NO profit sharing	Retain ownership, profit sharing
Information Sharing Scheme	live performance, pen	live performance, individual data	Carcass, group data	carcass, individual yield & grade data
Production Protocols	NO restrictions on vaccination and use of antibiotics & NO min. number of animals required	NO restrictions on vaccination and use of antibiotics & min. number of animals required	Restrictions on vaccination and use of antibiotics & NO min. number of animals required	Restrictions on vaccination and use of antibiotics & min. number of animals required
Membership Fee	$0	$5	$10	$20

1. Sales Type (marketing methods)

The attribute of sales type includes different combinations of marketing strategies adopted by cow-calf operations, including details on the compensation scheme. The

marketing strategies are direct sale to the alliance and retained ownership. The compensation scheme is a profit sharing scheme based on animal performance.

2. Information Sharing Scheme (data sharing)

The attributes of information sharing schemes include live performance per pen or individual live performance data, and carcass data of a group of animals or individual carcass data. Live performance data per pen represents the status quo of information exchange adopted by current cattle auction markets.

3. Production Protocols and quantity commitment

Production commitments were considered as very important because they determine the quality control practices adopted by beef producers. In this study, the production commitments include production protocols and quantity commitments. Production protocols refer to the use of antibiotics and specific restriction of vaccination. Quantity commitment was represented by number of minimum cattle required by the beef alliance.

4. Membership Fee

In order to gain insight into the effect that different membership fees have on a respondent's willingness to participate in a program, four levels of membership fees were included.

II.2.2. Empirical Results

Our empirical results are based on two models. The first model ("beef alliance participation model") explored what types of cow-calf producers were willing (or not) to participate in a beef alliance in principle. The second model ("beef alliance choice model") analyzed what type of cow-calf producers were willing to opt for which types of beef alliances. The following discussion provides only the key results and statistical tables (in the appendix). Those readers who wish to explore more details of the statistical approach should consult Lan (2006).

II.2.2.1. Beef alliance participation model

The estimation results that were used to analyze the beef alliance participation is presented in Table A1.1.

1. Survey Type

The estimates suggest that participants in on-site interviews were less likely to participate in a beef alliance.

2. Producer Type

The results suggest that if a beef enterprise is limited to a cow-calf operation, the producer is unlikely to participate in a beef alliance. On the contrary, producers who have mixed production characteristics are more likely to participate in a beef alliance.

3. Age

Our expectations of the effect of producer age on beef alliance participation choice are indeterminate. On the one hand, older and more experienced cattle producers might recognize the advantages of alternative marketing arrangements such as beef alliances and, thus are willing to adopt them. On the other hand, older producers may be slower to adopt newer marketing alternatives. The estimates favour the latter explanation, as younger producers were found to be more likely to participate in a beef alliance.

4. Education

It is expected that more educated producers are more likely to adopt alternative marketing practices. Indeed, the results suggest that producers with high school and lower levels of education are less likely to participate in a beef alliance.

5. Beef Cowherd Size

Our findings indicate the smaller cow-calf operations are less likely to participate in a beef alliance.

6. Use of Information

The variable representing producers' attitudes toward using information sources (e.g., marketing data, contract data, data on cost of production, production and processing data) is not significant in the model. However, the positive sign is expected, since it implies that producers who are using information sources actively for management purposes are more willing to participate in a beef alliance.

7. Experience of Using Retained Ownership and Contracts

It was expected that producers who have experienced retaining ownership and contracts would be more likely to participate in a beef alliance (because either of these two strategies implies a closer vertically coordinated marketing relationship throughout the value chain). This expectation was only met in the case of prior experience with contracting. The estimate for the experience with retained ownership is significant at the 10% level with a negative sign, which suggests a negative attitude toward participating in a beef alliance. In contrast, the positive sign on the estimate for experience of using contracts suggests that prior contracting experience has a positive impact on beef alliance participation.

II.2.2.2. Beef alliance choice model

The stated preference results are shown in Table A1.2**.** (model 2 is the final model).

Most strikingly, our estimation results suggest that none of the attributes that represent "production protocols" have a significant influence on the choices between different alliance types. The remaining results are as following, using the descriptions as in Table 3.

Table 3: Variable description used in the choice experiment

Variable	Descriptions
S1	Sell to alliance, NO profit sharing
S2	Sell to alliance, bonuses based on animal performance
S3	Retain ownership, NO profit sharing
S4	Retain ownership, profit sharing
D1	live performance, pen
D2	live performance, individual data
D3	Carcass, group data
D4	carcass, individual yield & grade data
P1	NO restrictions on vaccination and use of antibiotics & NO min. number of animals required
P2	NO restrictions on vaccination and use of antibiotics & min. number of animals required
P3	Restrictions on vaccination and use of antibiotics & NO min. number of animals required
P4	Restrictions on vaccination and use of antibiotics & min. number of animals required
FEE	$0,$5,$10,$20
SRT	Survey Method(1=on-site interview; otherwise 0)
AGE	Producer Age(1= less than 50;otherwise 0)
EDU	Producer's Education (1=less than high school(included);otherwise 0)
INCOME	Farm Income from Beef (1 =less than 50%; otherwise 0)
HERD	Beef Cowherd Size (1=Less than 150 heads; otherwise 0)

1. Sales Type (marketing methods)

Option S4 (retain ownership, profit sharing) has no statistically significant impact on producers' choices. The estimates for S1 (Sell to alliance, NO profit sharing) indicate that producers reject this marketing strategy, whereas the results for S4 (Retain ownership, profit sharing) indicate a positive attitude toward this marketing strategy. The following order of producers' preferences for the attribute of sales type (from high to low) can be derived: "sell to the alliance, bonuses based on animal performance", "retain ownership, profit sharing", "retain ownership, No profits sharing" and "sell to alliance, No profit sharing", respectively. The difference between "sell to alliance" and "retain ownership" suggests that cow-calf producers opt away from scenarios with potential profits resulting from retaining ownership, toward scenarios where profits can be realized in a fast way. In this situation, a marketing strategy similar to auction markets (i.e., sell to alliance directly) is perceived to be superior to a closer vertically coordinated relationship (i.e. retain ownership).

2. Information Sharing Scheme (data sharing)

The estimation results suggest that this category of attributes strongly influences individual choice behavior. The only attribute in this category that does not have a significant impact on choice behaviour is D4 (carcass, individual yield & grade data). The preference order appears to be that producers choose from D2 (live performance, individual data), D4 (carcass, individual yield & grade data), D1 (live performance, per pen), and then D3 (carcass, group data). Similarly to the attributes of sales type, cow-calf producers' preference for the information sharing schemes is limited to a low intensity level of coordination scheme. Respondents appear to opt away from the spot cash market (live performance, per pen), towards a closer level of coordination (live performance, individual data). Hence, the results also suggest that producers' prefer using individual data rather group data (D1: pen, D2: group).

3. Production Protocols

The results suggest that all attribute levels of "production protocols" are insignificant in affecting producers' choice behavior. Producers' preferences are in the following order: P2 (NO restrictions on vaccination and use of antibiotics & minimum number of animals required), P3 (restrictions on vaccination and use of antibiotics & No minimum number of animals required), P4 (restrictions on vaccination and use of antibiotics & minimum number of animals required), and P1 (No restrictions on vaccination and use of antibiotics & No minimum number of animals required). Thus, producers appear to perceive the restriction in terms of the minimum number of animals as least restrictive. Further, the producers' positive attitude toward accepting "restrictions on vaccination and use of antibiotics" could be interpreted as producers anticipating more quality control and restrictions to be forthcoming in the future.

4. Membership Fee

The results suggest that, as expected, higher fees are less likely to induce producers to participate in the alliances offered. However, although the results suggest that membership fees play a significant role in a producer's choice behavior in participating in alternative beef alliance, its effect is small.

II.2.2.2.a. The impact of demographics

We examined the effect that demographic characteristics have on an individual's choice of a beef alliance. The results suggest that smaller beef producers prefer an information sharing scheme using individual live performance data. In the case of D4 (carcass, individual yield & grade data), the results suggest a positive attitude toward information sharing scheme that uses carcass, individual yield and grade data. However, the estimates also suggest that the smaller beef producers do not prefer a beef alliance with an information sharing scheme of D4. Further, the results suggest that low income beef producers are not willing to choose a beef alliance with a sales type of S4 (retain ownership, profit sharing).

II.2.2.2.b. Willingness to Pay

The willingness-to-pay estimates are instructive for comparing the ranking of attributes and attribute levels. For both the entire sample of respondents (the unconditional population, i.e. including producers that refused to participate in alliances) and respondents that participated in the choice experiment (conditional population), the most important attribute for a beef alliance is the information sharing scheme. Producers associated higher marginal willingness-to-pay with "live performance, individual data" compared to "carcass, individual yield & grade data". of the option "Carcass, group data" was valued least by producers in this sample. The second most important attribute is sales type. Producers are willing to pay between $15.26/ head and $6.43/head for the attribute of "sale to alliance, bonus on the animal performance" and "retain ownership, profit sharing", respectively. The least important attribute is related to the production protocols; producers are willing to pay only $5.06/head for the attribute of "No restrictions on vaccination and use of antibiotics & minimum number of animals required" while they are not willing to pay for the attributes "restrictions on vaccination and use of antibiotics & No minimum number of animals required" and "restrictions on vaccination and use of antibiotics & minimum number of animals required". As expected, producers were also not willing to pay for "sale to alliance, No profit sharing".

II.3. Alternative Beef Alliance Scenarios

The insights from those scenarios can be used to explore producers' motivations for choosing new and different types of beef alliances in the future.

1. Alternative Beef Alliance Scenario (S2 vs. S4)

The first scenario assumes that there are two alternatives, Alliance A and B. Both of these alternatives have the same attributes except that the sales type in alternative A is "sell to alliance, bonuses based on animal performance" while the one in alternative B is "retain ownership, profit sharing". A cost reduction of 58% of the membership fee in Alliance B is required to equalize the probability of choosing between these two sales types**.**

2. Alternative Beef Alliance Scenario (D2 vs.D4)

The second scenario assumes that both of thes alternatives have the same attributes except that the information sharing scheme in alternative A is "live performance, individual data" while the one in alternative B is "carcass, individual yield & grade data". In this case, a cost reduction of 66% of the membership fee in Alliance B is required to equalize the probability of choosing between these two alternatives.

3. Alternative Beef Alliance Scenario 3 (P2 vs. P4)

Alternative A has the same attributes as B except that the production protocols in alternative A is "No restriction and min. number of animals required" and the one in alternative B is "Restriction and minimum number of animals required". In this case, a cost reduction of 55% of the membership fee for Alliance B is required to equalize the probability of choosing between these two productions protocols.

The scenarios reported above were designed by shifting from the most preferred attributes toward the attribute level with the highest degree of vertical coordination in the choice experiment. These results suggest a significant cost reduction associated with the shifts in a single category of attributes. Considering the small magnitude for the price factor (i.e., membership fee) in this sample, it appears that the incentive problem toward

the higher degree of vertical coordination cannot be solved only by reducing the financial commitment of participating in a beef alliance. This suggests that the trade-off between a significant cost reduction (in terms of the level of participation fee) and an improvement in vertical coordination requires a different, more refined type of compensation scheme that accounts for risk more explicitly.

II.4. Summary and policy implications

In sum, our results suggest that cow-calf producers see benefits in participating in those beef alliances that were presented to them. They appear to see the underlying benefits from increasing formal contracting and the resulting improved coordination between actors in the beef supply chain.

The following variables significantly affected the beef alliance participation: survey method, producer type, age, education, beef cowherd size, and experience of using retained ownership. Somewhat unexpectedly, cow-calf producers that were interviewed through on-site surveys were found to be unlikely to participate in the beef alliances presented. Considering the entire sample (responses from both the on-line and on-site interviews), farms that were limited to cow-calf operations were found to be unlikely to participate in a beef alliance. On the contrary, producers who have mixed production characteristics are more likely to participate in a beef alliance. Further, younger producers are more likely to participate in a beef alliance than the older producers. Producers with relative lower educational level (i.e., high school and less) are less likely to participate in a beef alliance than those more educated producers. The smaller cow-calf producers are less likely to participate in a beef alliance than the large producers. Producers who have experience using retained ownership are less likely to participate in a beef alliance than those producers who did not retain ownership before. The demographic and socioeconomic characteristics that do not significantly influence or do not have a strong influence on respondents' choice behavior include respondent's income, attitude toward use of information and the experience of using marketing or production contracts. Most

of these empirical results from the beef alliance participation model were consistent with prior hypotheses (i.e., expected sign) that younger, more educated and larger beef producers may be expected to more likely use of alternative marketing arrangements in cattle business such as strategic beef alliance. Brocklebank and Hobbs (2004) found that the beef cowherd size, age, education impact on the transaction characteristics of cow-calf producers, and influence their choice behavior in adopting alternative marketing and production practice.

It is worth emphasizing that producers' use of production and management-related information does not have a significant impact on alliance participation, although a positive relationship between them was as expected. It was expected that the need for information sharing is one of the major incentives for beef producers to closer vertically integrate. Because the participants and non-participants were distinguished through the hieratical structure of survey questionnaire, a further exploration of the attitude toward information sharing was examined through a second model.

The results from the second model suggest that the attributes of "sales type", "information sharing scheme" and "membership fee" significantly affect the respondent's choice behavior. Producers appear to opt away from the status quo of non-integration, toward a closer coordinated beef marketing and production system. Production protocols did not have a significant impact on the respondent's choice behavior.

The results obtained from the second model further suggest that the following order of producers' preferences for the attribute of sales type (from high to low) can be derived: "sell to the alliance, bonuses based on animal performance", "retain ownership, profit sharing", "retain ownership, No profit sharing" and "sell to alliance, No profit sharing", respectively.

Considering respondents' attitudes towards information sharing schemes, there appears to be a clear preference to opt away from spot cash markets (live performance, per pen), towards a closer level of coordination (live performance, individual data). Following

“live performance, per pen”, the respondents’ next preferred choice is to use information sharing scheme of “carcass, individual yield & grade data”, followed by “carcass, group data”. The results also suggest that producers prefer using individual data rather group data.

With regard to the attribute of “production protocols”, each level of this attribute insignificantly affects the respondent’s choice behavior. But the magnitude and sign of coefficient estimates suggest that producers’ preferences for production protocols are in the following order: “No restrictions on vaccination and use of antibiotics & minimum number of animals required”, “restrictions on vaccination and use of antibiotics & No minimum number of animals required”, “No restrictions on vaccination and use of antibiotics & No minimum number of animals required” and “restrictions on vaccination and use of antibiotics & minimum number of animals required”.

The attribute of ‘membership fee’ examined the respondent’s preference for different level of financial commitments to beef alliances. As expected, an increasing participation fee lowers the respondents’ utility and willingness to participate in an alliance. However, the small magnitude of the estimated coefficient also suggests that this effect is slight.

The interactions terms with demographic variables indicate that only income and beef cowherd size have a significant impact on the respondent’s choice behavior. The interaction terms also suggest that compared to larger beef producers, smaller ones prefer an information sharing scheme that relies on individual live performance data. The cumulative effects also suggest that the smaller beef producers do not prefer a beef alliance with an information sharing scheme of “carcass, individual yield & grade data”.

With regards to different farm income levels, the cumulative income effects suggest that lower income beef producers are less likely to choose a beef alliance with a sales type of ‘retain ownership, profit sharing’ compared to high income beef producers. However, the farm income level does not have significant impact on the preference for different levels of membership fees.

Overall, the most important attributes for a beef alliance is the information sharing scheme. Producers have greater preferences for “live performance, individual data” rather than “carcass, individual yield & grade data”. The results further suggest that the second most important attribute is sales type. Producers are willing to pay between $15.26/ head and $6.43/head for the sales type options that were available (“sell to alliance, bonus on the animal performance” and “retain ownership, profit sharing”, respectively). However, and as expected, producers are not willing to pay for the attribute of “sell to alliance, No profit sharing”. The least important attribute is related to the production protocols; producers are willing to pay only $5.06/head for the attribute of “No restrictions on vaccination and use of antibiotics & minimum number of animals required” while they are not willing to pay for the attributes “restrictions on vaccination and use of antibiotics & No minimum number of animals required” and “restrictions on vaccination and use of antibiotics & minimum number of animals required”.

The results of this analysis enable us to highlight some issues regarding formal contractual arrangements and the design of strategic alliances in the Canadian beef industry. Given the assumptions and the limited sample size of this study, the following implications can be derived:

(1) Although the use of conventional auction market is still a dominant marketing strategy in the current beef supply chain, cow-calf producers recognize the limitation of spot cash transaction where consumers’ needs for specific qualities can only be matched imperfectly. This is reflected in the fact that cow-calf producers show a positive attitude toward alternative marketing arrangements such as strategic alliances.

(2) Cow-calf producers are willing to move from the status quo of no coordination toward a higher level of vertically coordination. However, they are not willing to choose the highest level of vertical coordination. The highest levels of vertical coordination such as “carcass, individual yield and grade data”, and “restrictions on vaccination and use of

antibiotics & minimum number of animals required" imply a required increase in relation specific investment. The transaction cost literature suggests that producers' utility will decrease with an increasing investment in asset specificity as the potential for hold-up increases (Williamson 1985). The results therefore suggest that cow-calf producers appear to recognize the increasing danger of being held-up. But the results also suggest that producers consider the benefits from being able to access individual yield and grade data to be smaller than the costs associated with hold-up and relationship-building in a value chain (beef alliance).

(3) Previous research on the Canadian beef industry based on the transaction cost framework of Williamson (1985) suggests that the risk of opportunistic behavior as a result of required investment in specific assets is minimal, and has not had a great impact on the degree of supply chain coordination around 2003 (Brocklebank and Hobbs 2004). Our insignificant coefficient estimates for "production protocols" suggest that producers perceive that such relation-specific investments are not key inhibitors for improving alignment in beef alliances, and are thus in line with Brocklebank and Hobbs's (2004) findings. However, considering our conclusions from **(2)** with regards to producers' perceptions towards other relation-specific investments, our overall findings are not as conclusive as Brocklebank and Hobbs (2004). This mixed evidence can be attributed to the fact that our analysis has allowed for more facets of relation-specific investments. Nevertheless, if we consider producers' responses from the choice experiment with other responses in the survey, there appears to be definitive evidence that producers are very aware of hold-up, trust and relationship-building issues in beef value chains.

(4) To address the incentive problems that cow-calf producers face, our results suggest that a well-designed compensation scheme needs to be part of a beef alliance design. Our simulation results suggest that cow-calf producers recognize the trade-off between significant cost reductions and an improvement of vertical coordination. However, an adjustment of financial commitments, such as reducing the level of alliance membership fees, is unlikely to be a sufficient way to solve the incentive problem that cow-calf

producers face. The challenge remains to build alliances in which compensation schemes are complementary to other key management decisions (Steiner 2007).

(4) Beef producer's individual specific characteristics (demographic and socio-economic characteristics) were found to determine their decision-making when using alternative marketing arrangements (i.e. contractual arrangements and strategic beef alliances). In this study, beef cowherd size, the level of education and age significantly influenced producers' participation decision in beef alliances. Further, when faced with a variety of beef alliances, smaller producers were more reluctant to make use of individual carcass data. As a result, policy makers interested in supporting the emergence of beef alliances need to recognize the diversity, such that support for alternative marketing arrangements needs to be targeted to different groups of producers.

(5) Based on our survey results, cow-calf producers' preferences for attributes of alternative beef alliances are in the following order (from high to low): information sharing scheme, sales type, production protocols, and membership fee. These results suggest that the design of an effective information sharing scheme as part of an overall compensation scheme is key for overcoming cow-calf producers' reluctance for greater coordination in an environment of information asymmetry and unequal bargaining power between industry participants. These results also suggest that even if cattle feeders and packers appear to be better off by applying a value-based or grid pricing system (i.e., carcass, individual yield & grade data), a grid pricing scheme is likely to fail in improving vertical coordination in beef alliances when cow-calf producers are not truly integrated through effective information sharing schemes.

II.5. Limitations and Further Research

The inability to access a significant number of cow-calf producers outside of Alberta resulted in an over-sampling of Alberta producers. This was largely due to the fact that the regional beef associations were bound by their bylaws not to provide us access to their membership lists. A regionally diverse sample would have been highly desirable

since we would expect that different regional conditions result in different attitudes toward alternative marketing arrangements.

A further limitation to this study relates to the possible existence of hypothetical biases which is common to stated preference methods (Bishop and Heberlein 1979). Hypothetical biases arise when a situation lacks realism or when respondents find the survey instrument too complex or lengthy. Although were able to use feedback from cow-calf producers during the development of the survey, we observed that the survey method (on-line vs. on-site) had a significant impact on the estimate results. Although the surveys were identical in design and presentation (the same on-line version of the survey was presented, either sent via email or else visible on a laptop), the fact that trained students helped cow-calf producers to complete the surveys on-site could have led to a systematic bias. Nevertheless, we believe that the systematic difference in responses between both producer groups is more likely a reflection of their openness for new technologies and alternative risk-management strategies (the majority of respondents who completed the survey on-line choose to participate in beef alliances).

III Risk and Risk Management

III.1. Risk Background and Secondary Risk Measures

Cattle production is risky due to the variability of returns from production risk and cattle marketing risk (Viney 1995). Production risk consists of un-predicted interest costs, feed conversions, feed costs, morbidity and mortality. Marketing risk on the other hand is represented by the variability of returns due to changes in cash market prices, futures market prices and basis levels (Viney 1995).[6]

Beef producers are managing risk through retained ownership, on-farm diversification, minimizing debt, government programs, or commodity specific derivative instruments. Alberta Agriculture, Food and Rural Development conducted a Cattle Herd Analysis in 1999. This survey among other things explored the use of hedging techniques namely forward contracts, futures contracts and options contracts by beef cattle farmers to pre-price weaned calves, feeder/grass cattle and slaughter cattle. Overall the results from the analysis conducted showed that hedging techniques are not popular among farmers (Unterschultz 2000). Less than 5% of cow-calf producers in Alberta used futures or options. This low participation rate is again confirmed with the results found in this survey (Figure 10).

CanFax has been conducting an annual survey of the three largest packing plants in Alberta since 1998 to determine changes in trends in procuring fed steers and heifers. The procurement methods used by these packing plants include cash, grid or formula, forward contract and packer owned. The results are presented in Table 4. It is worth noting that the 2003 survey results showed some changes in patterns compared to 2002 (Grier 2005; CanFax 2004a; CanFax 2006; CanFax 2004b). Those changes likely reflect the changes in market conditions after the BSE crisis in May 2003. There were more cattle forward contracted or purchased on spot in 2003 as compared with 2002 (Table 4). After 2003,

[6] Basis is the difference between the futures market price and the cash price on a specific day at a specific location.

cattle bought on spot have been decreasing. Forward contracted cattle made up a much smaller percentage in 2005 at 4.1% compared to 8.4% in 2004 and 6.4% in 2003. Packer owned cattle and those bought using grid pricing in Alberta has been increasing except for 2003 when it fell in percentage points. Packer owned cattle accounted for 11.3% of the total in 2005 but this is lower as compared with the pre-BSE levels. Grid and/or formula cattle accounted for 20.8% in 2005.

Table 4 Alberta Fed Cattle Marketing Methods: Years 1998-2005

Marketing Method	1998 (	1999	2000	2001	2002	2003	2004	2005
Cash	68%	68%	68%	60%	59.7%	66.3%	65.4%	63.8%
Grid or Formula	10%	11%	13%	16%	19.5%	13.9%	15.5%	20.8%
Forward Contracted	8%	6%	2%	5%	3%	6.4%	8.4%	4.1%
Packer Owned	14%	15%	17%	19%	17.7%	13.4%	10.7%	11.3%

Source: Grier (2005, pp. 85); CanFax (2006).
Data compiled by CanFax and is from the three largest packers in Alberta.
Comparable data for the US for 2002 are 40% cash, 51% grid, 4% forward contracted and 5% packer owned (Schroeder 2003, pp. 12).

The dominant reasons identified by U.S. cattle producers for using contract and marketing agreements are to secure quality premiums, sell cattle for higher prices and reduce price risk (Lawrence, Schroeder, and Hayenga 2001). The packers' identified quality concerns as the dominant reasons for using marketing contracts or self production. The level of importance packers attach to managing price risk is lower as compared with cattle producers.

Prior research conducted to investigate slaughter price risk management in finishing heavy steers in a custom feedlot in Alberta showed that hedging 100% of expected production using CME live cattle futures can reduce slaughter price risk but also reduces average returns (Unterschultz 1991). This conclusion conflicts with previous studies which argue that hedging live cattle in the futures markets often reduce returns while increasing price risk for cattle (Carter and Loyns 1985). Viney (1995) used alternative marketing and pricing strategies to evaluate the risk and returns to cattle feeding in Alberta over the period 1980 to 1993. Production contracting strategies which eliminate

basis risk were found to provide the best returns in a market-based risk-return comparison. Viney found that the use of put options did not add value to cattle feeding investments.

Munro (1993) used historical simulation approaches to investigate the risk and return of retained ownership of steer calves past weaning in Alberta over the period 1979 to 1991. The results showed that using the futures market can reduce the risk and in some instances increase the revenues received. Selective hedging strategies, based on a target return increased returns and decreased the level of risk exposure but these selective hedging strategies can be costly. Routine hedging on the other hand does not appear to be desirable as a risk management tool if the production horizon is greater than 8 months.

Noussinov and Leuthold (1999) concluded that following a regimented hedging plan substantially reduces cattle feeding price margin risks in the US. Lawrence and Smith (2001) evaluated alternatives by which US cattle feeders could manage price risk. Their findings showed that the cash market offered the greatest average return of any of the strategies used. The next highest average return strategy was hedging about 50% of expected production 50. Claus (2003) investigated the implications of combining feeding and packing margins into one alliance. Claus found that long hedging feeder cattle and short hedging live cattle improved the level of revenue and thus the profit to an alliance. Claus commented that the risk management strategies developed for the alliance as a whole could also be used by individual cattle owners and packers not involved in an alliance since the results for the feeding margin and packing margin are separable.

Benefits of selling fed cattle on pricing grids include potential for higher prices (or fewer discounts) if cattle meet the quality specifications that bring premiums under the particular grid. With grid pricing, producers bear the risk for all carcass characteristics. That is the risk of animal quality (yield and quality grades) is transferred from the packer to the seller (Ward, Schroeder, and Feuz 2002; Unterschultz et al. 2000). Prices paid to producers are based on the quality of animals slaughtered. Better quality cattle receive premiums and poorer quality cattle are discounted.

Feuz, Fausti, and Wagner (1995) comparing grid pricing to average pricing showed that marketing fed cattle at an average price typically results in lower revenues. Marketing fed cattle at an average price also reduces per head and per hundredweight (cwt) revenue variability relative to marketing fed cattle through a value-based pricing system such as grid pricing (Feuz, Fausti, and Wagner 1995; Feuz, Fausti, and Wagner 1993; Fausti, Feuz, and Wagner 1998). Thus less risk-averse cattle producers will more likely sell fed cattle under a grid pricing mechanism while more risk-averse producers may prefer selling fed cattle at an average price.

Anderson and Zeuli (2001) quantified the revenue variability differential between grid and live weight pricing of fed cattle using a simulated set of US cattle data. Their results indicate that marketing cattle on a grid would result in only a marginal increase (if any) in returns however grid pricing exposes the seller (cattle producer) to increased risk. Fausti and Qasmi (2002) used weekly grid price reports over the period January 1997 to December 2000 combined with carcass data on a set of 2,590 South Dakota slaughter steers to investigate barriers to the adoption of grid pricing by fed cattle producers. They concluded that grid pricing is a riskier marketing option for fed cattle producers relative to average pricing.

The beef industry in Canada and US is characterized by automated processing facilities. Boxed beef is beef fabricated into primals, sub-primals or individual meat cuts, vacuum packaged and sold to retailers and wholesalers in boxes. Mattos et al. (2003) argued that retailers and wholesalers negotiate prices on a boxed beef cutout value rather than a carcass sale. Mattos et al. (2003) also pointed out that as cutout values can change independently of the live cattle futures prices, many of the participants in beef industry have been left without an adequate price risk management mechanism. Schroeder and Yang (2001) further demonstrated that the live cattle futures contract has not been an adequate risk management tool related to meat cuts. In general, low correlation between live cattle futures and meat cut prices, and related high basis risk has made effective risk transfer highly problematic. The findings of Mattos et al. (2003) is consistent with an earlier research by Schroeder and Yang (2001) which concluded that live cattle futures

markets do not give much opportunity for effective wholesale beef cuts price risk management. In general low correlation between futures and meat cut prices, and related high basis risk has made effective risk transfer highly problematic. These conclusions would also suggest a low correlation between fed cattle cash prices and meat cut prices.

Previous research suggests that risk management using futures and options may not be useful at the cow calf level, especially in Canada. An analysis of more recent data suggests that this conclusion has not changed for Canada. Hedge ratios[7] show that Canadian producers of fed cattle, feeder cattle and calves may have difficulty effectively using the United States based futures markets for live cattle and feeder cattle. The hedge ratios are often low and the hedge effectiveness is low, especially if Canada-US currency risk is ignored (Table 5). The usefulness of these futures markets, as measured by the hedge effectiveness, during the period of June 2002 to June 2004 when the largest direct impacts of the BSE crisis were impacting Canada, was further reduced (Table 5). Based on the results in Table 5 and prior research reported for the U.S., hedging Canadian cutout values using the CME live cattle futures or feeder futures would be ineffective. Price risk in cow-calf or backgrounder alliance contracts with prices or payments based in part on cutout values may not be effectively managed with the current set of market based risk tools available.

[7] Hedge ratios are related to correlation between two markets. A hedge ratio of 1 in fed cattle would suggest 1 futures contract to hedge 40,000 pounds of live fed cattle. A hedge effectiveness close to zero suggest that little if any risk is removed by hedging. A hedge effectiveness number near 1 suggests that most of the price risk is removed by hedging. The feeder cattle futures contract is for 50,000 pounds.

Table 5: Minimum Variance Hedge Ratios for Canadian Cattle Using the Chicago Mercantile Exchange Nearby Live Cattle or Feeder Futures Contract.

Canadian Cattle Type	Canadian Slaughter cattle and CME Live Cattle Futures	Canadian feeders and CME feeder cattle futures	Canadian calves and CME feeder cattle futures
1992-June 2004 – Hedge Ratio. No Currency Adjustment	0.19 (0.01)	0.90 (0.30)	1.81 (0.39)
1992- June 2004 –Hedge Ratio Currency Adjusted	0.51 (0.22)	0.66 (0.49)	1.30 (0.61)
June 2002 to June 2004. Currency Adjusted	0.31 (0.025)	-0.14 (0.01)	-0.35 (0.03)

-Data Source: Canadian Cattle Prices: Cansim II (Statistics Canada). US Futures Live Cattle Prices and Currency Prices from CRB database on futures prices. All prices are monthly.
-Hedge effectiveness in brackets. Estimates developed using regression models of nearby futures with spot prices. More sophisticated models and improved data may provide different results.

III.2. Perceived Cow Herd Value Risk From Cow-Calf Survey

The cow herd is a major asset in the cow-calf business. Data from the 2006 web-based and on-site survey of beef producers in western Canada were analyzed to provide an indirect measure of perceived risks at the cow-calf level. The specific objectives in this group of survey questions were to evaluate cow-calf producer perceptions' of risk related to the asset value of their cow herd. Asset values of the cow herd are directly related to the value of calf sales and the cost of production.

III.2.1 Survey Risk Questions Analyzed

The respondents were asked to indicate how many years it takes for bred cow prices to return to the long run average price when cow prices are very low. Also the respondents were asked whether it would be extremely unlikely that the value of their cows wintered in 2007 would be a certain percentage above or below the average value of cows

wintered. Answers to these questions were used to develop a subjective risk measure comparable to the standard volatility measure used in market based risk markets. The base results from survey questions are presented in Table 6.

III.2.2 Risk Discussion

An estimation of the volatility of returns indicates that overall the bred cow prices are somewhat volatile. Historical monthly Western Canada bred cow prices from Canfax over the period January 2000 to May 2003 suggest the risk (estimated volatility) is 25.8% annually. This measure of risk from secondary data can be compared to the perceived risk results from the survey.

Following Copeland and Antikarov, (2003) cow prices are assumed to follow a mean reverting stochastic process. First, the average bred cow price around which the uncertainty fluctuates was determined and used as a proxy for the value of cow wintered. Copeland and Antikarov, (2003 pp. 259-264) illustrated how the volatility estimate is computed given the expected value of prices around which the uncertainty fluctuates, the speed with which the uncertainty returns to the average after every long term price deviation as well as the upper and lower bound prices. On average producers estimate that it takes approximately 2.8 years for the price of bred cows to return to the long run average when there is a major price shock to cow prices. (Table 6)

The results calculated from the producer responses and presented in Table 7 indicate producers perceive that the risk they face in the asset value of their cow herd is about 75% lower (i.e. 4.2% to 6.8% as compared to empirical estimates (25.8%) on risk in cow values). Total overall perceived price risk (i.e. total volatility) does not increase quickly (i.e. 5 years) given perceptions about longer run trends in cow price directions. However these results need to be interpreted with caution since over 50% of the survey respondents did not answer these particular questions.

Table 6: Descriptive Statistics on the Producer Responses to the Risk Questions and Other Data

	N	Minimum	Maximum	Mean	Std. Deviation
Expprice (years)*	150	0	10	2.84	1.572
Mvexpea (%)*	151	0	100	12.65	19.363
Mvexpeb (%)*	151	0	95	11.54	17.544
WCBCprices ($)**	41	768.75	1237.59	1067.97	100.63

Expprice – number of years it takes for market prices for bred cows to return to the average.

Mvexpea - % above the value of cow herd wintered (used as an upper bound value).

Mvexpeb - % below the value of cow herd wintered (used as a lower bound value).

WCBCprices – Western Canada bred cow prices

* - Source: Survey Data

** - Source: CANFAX – Monthly data (January 2000 – May 2003)

Table 7: Perceived Risk of Cow Herd Values by Cow-Calf Producers

	Annual Risk (Volatility)		**Risk (Volatility) Over a 5 Year Time Horizon With Reversion**	
	Upper bound*	Lower bound	Upper bound	Lower bound
Average market price risk (volatility) per producer	4.2%	6.8%	5.5% (9.5%)**	8.8% (15.2%)

*Upper bound is shock to cow values that increases the price of cows substantially. Lower bound is a shock to cow prices that decreases the value of cows substantially.
** This assumes that in slightly less than three years, cow prices return to long-run averages if there is a price shock. Numbers in brackets are estimates of this risk over five years when producers are not sure that prices will ever return to an average price in the future.

III.3 Risk Conclusions

The risk analysis, while preliminary, suggests the following regarding managing risk in alliance contracts. Grid or cutout pricing schemes will increase price risk to the cow calf producer if incorporated into contract compensation schemes. Managing these grid or cutout prices with current risk tools such as futures contracts will not be overly successful at a backgrounder or cow calf level. A different set of risk management tools or risk-based compensation schemes may be required to manage these risks if cow-calf producers share the risk of fed cattle prices, grid prices or meat cut out prices in the

alliances contracts. However, it is likely that even a different set of such tools and compensation schemes is not sufficient in isolation. We have evidence that risk-based compensation schemes may need to be considered as part of a larger set of complementary factors, such that the latter need to be aligned in the search for competitive beef alliances (value chains) that offer fair returns to all participants (Steiner 2007). The challenge remains thus to provide a set of risk-management tools that is useful for the entire industry, while supporting individual beef alliances (value chains) to differentiate themselves through an idiosyncratic mix of such complementary resources and capabilities.

On a related issue, cow-calf producers may view the risk associated with the value of their cow herd as being much lower than the actual market risk. It may be useful to explore producer perceptions of risk versus actual risk in other aspects of the supply chain to align risk. If perceived risks and actual risks are misaligned it may be difficult to design contracts that share risks among alliance members in an "equitable" fashion. A more objective assessment of actual risks may be imperative to help overcome the deep-rooted distrust that seems to prevail at the producer level with regards to feedlot operators, packers and retailers.

IV. Price Spread and Imperfect competition in the Canadian Beef-Cattle Industry

IV.1. Introduction

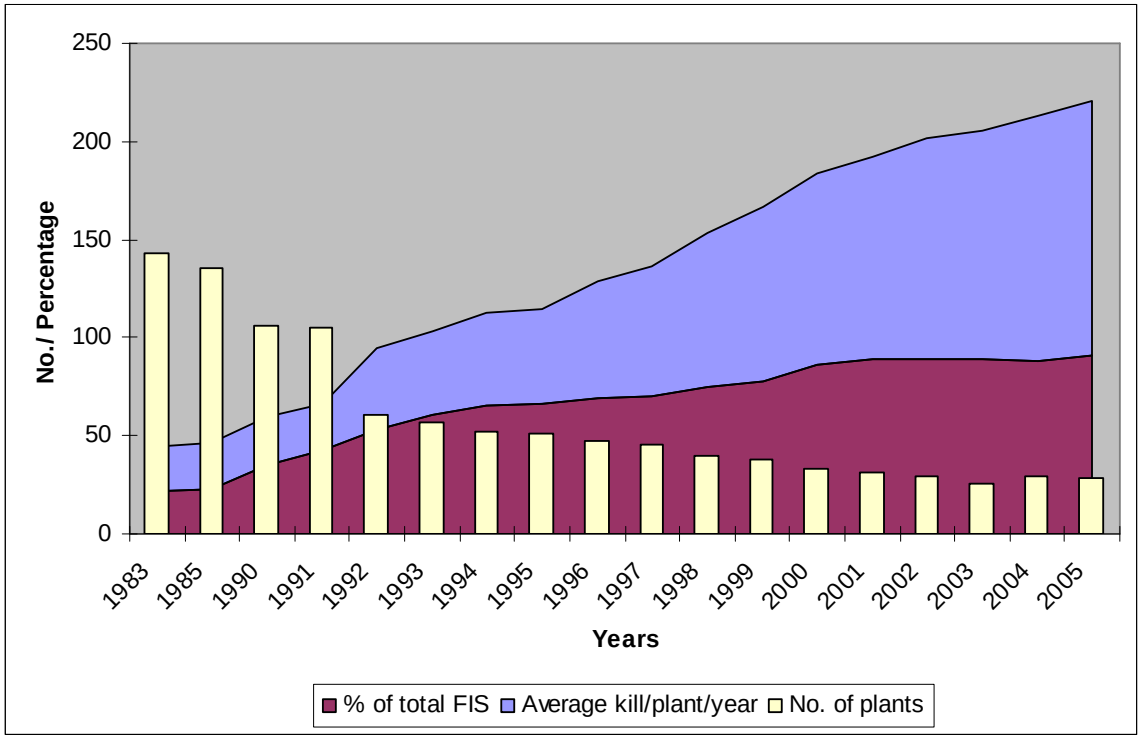
Concerns about the lack of competition in the Canadian beef processing industry have precipitated a series of hearings and reports from both the legislative and executive arms of government[8]. Most of these reports however refute the claims and allegations of market power by the packing plants and blame the impasse in the market on border closure following the simple theory of demand and supply. It is possible that the Canadian packing industry has seen extraordinary profits since the BSE crisis as one

[8]The Canadian International Trade Tribunal, The Federal Standing Senate Committee of Agriculture and Forestry and The Canadian Competition Bureau

report observed that the three major packers in Alberta saw a 281% increase in profit margin after May 2003 (Report of the Auditor General on the Alberta government's BSE-related assistance programs, July 27, 2004).

In September 2003, the packers were able to resume exports of boxed beef into the lucrative U.S. market; even though live cattle exports were prohibited. Hence, cattle prices remained low while export and retail beef prices resumed normal trajectories. Figure 15 below summarizes the situation in the beef industry as regards beef packers' consolidation in Canada.

Figure.15 Distribution of cattle slaughtering activity and the top 4 plants market Share in Canada (1983-2005)



Source: Agriculture and Agri-Food Canada, Cattle Slaughter Statistics for Federal Abattoirs
FIS = Federally Inspected slaughter

IV.2. Objectives

This part of the report aims to provide an analysis on price spreads, by animal, age and sex for Canada and the U.S. To achieve our objective it is necessary is to develop a consistent carcass weight equivalent data set for cattle by age and sex and estimate price

spreads between the different market levels- farm, packer/processor and retail, and determine the impact of different economic factors on price spreads. The hypothesis of a structural change in these relationships in May 2003 will also be tested for Canada. Previous studies that have analyzed competition issues and price-cost margin differentials include Scott (1983), Beck and Mozejko (1992), Liu (1991), Cranfield (1995), Cranfield and Goddard (1999), Druhan (1992), Zhou (1991), Unterschultz et. al. (1997), and Quagrainie et al. (2003).

IV.3. Theory

A complete theory of price spread (or market margin relationships) assumes simultaneous equilibrium at two or more market levels in an industry. The forces of demand and supply at the retail level determine retail prices, and demand at the producer (farm gate) level, and primary supply determine producer prices. The price spread behaviour is determined by the difference between the two prices. Wholesale prices are determined from equilibrium in demand and supply at intermediate market levels if the analysis is to cover more than two market levels. Firm level behaviour at farm (primary supply), processor/retailer (farm level demand, retail level supply) and consumer behaviour at retail drive the economics of price spreads. For a more detailed discussion of the underlying theory, see Appendix 2, section A2.1..

IV.4. Data and Method

The importance of accurate and consistent data in any empirical investigation of price spread behavior cannot be over emphasized (Scott 1983). Scott (1983) was able to build spatial/ continental price spread behavioral models for red meat in Eastern and Western Canada, and the U.S. Specifically, price spread data was developed between the farm and packer level, and the packer and retail level for steers, heifers, cows and beef. The results

of her price spread behavioural analysis over the 1970's revealed *levelling*[9] of the farm to packer price spread and *averaging* of the packer to retail price spread. Processing costs, by-product values and dynamic adjustments were found to explain these spread behaviours.

In an attempt to capture variability and differences in production patterns we follow Cranfield and Goddard (1999) and Martin and Haack (1977) in categorizing the cattle and beef market into regions as follows: Western Canada, Eastern Canada and the U.S.. Monthly data is used for this analysis so as to reflect the dynamics of modeling and thus improve empirical estimations. Since one of the purposes of this investigation is to capture the effect of BSE in relation to its effect on the Canadian cattle beef industry, the estimations and tests are done in two different periods: pre and post BSE, that is from January, 1980-May, 2005 when North America had the first BSE case, and from June, 2003 to December, 2005 respectively.

For the sake of valid comparisons across the different market levels, coupled with the fact that beef carcasses go through processing before the final product is sold at retail stores, an acceptable standard unit of measurement becomes necessary. Following Scott's (1983) estimation and method, the chilled and trimmed fresh carcass by weight, prior to any further processing is used as a standard unit of product for constructing cattle/beef price spreads. All prices of cattle/beef at all levels will be expressed as Canadian cents per pound of chilled carcass, by weight. Following previous analyses ((Cramon-Taubadel (1998), Holloway (1991), Gardner (1975)), nominal prices are used throughout because our focus is on price behavior across market levels in an industry.

[9]Price levelling is defined by Watson and Parish (1982) as being the practice whereby retailers vary margins to smooth retail prices over time in the face of fluctuating sale yard and wholesale prices, while price averaging is the practice of averaging margins through spreading costs across all classes of meat in order to minimize the extent of an individual price change.

Data used are monthly observations for the period 1980-2005 of retail, wholesale and farm prices of steers, heifers and cows, and their respective quantities. Canada is split into West and East because of regional differences in the structure and trade relationships in the two regions. The same data is collected for the US cattle/beef sector since both countries trade in the North American cattle/beef industry.

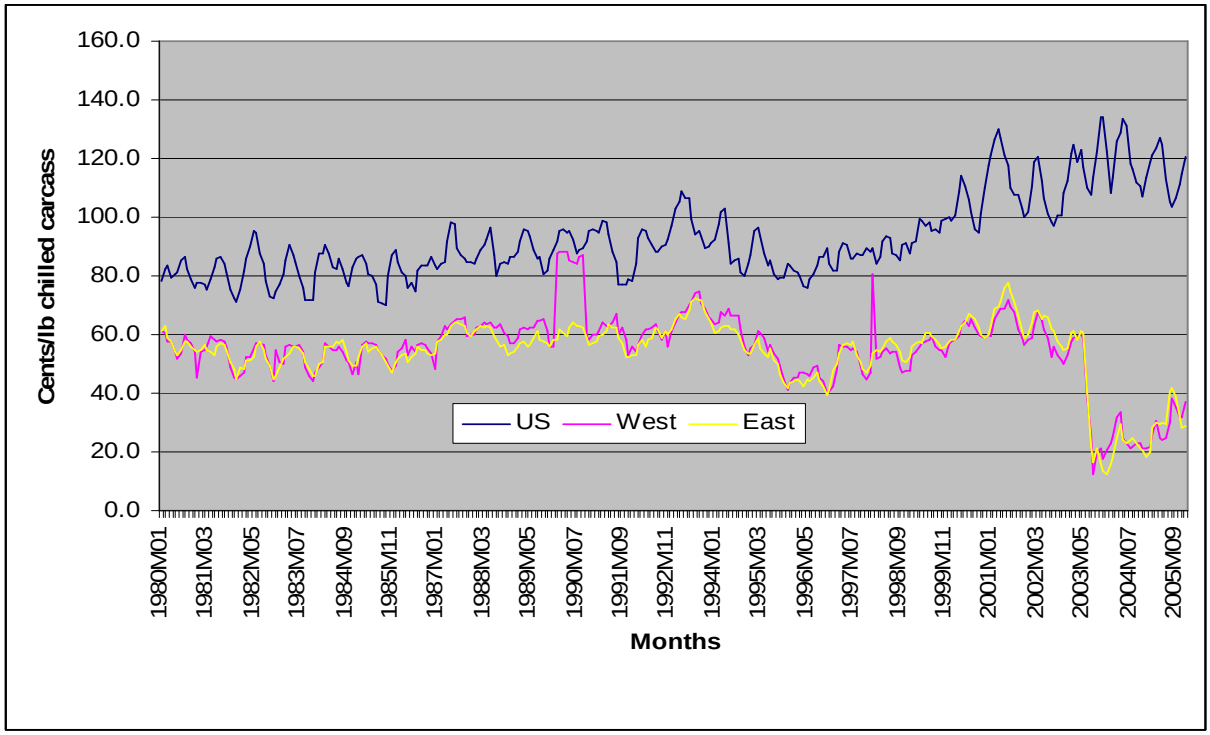
Other data includes prices of by-products for the three cattle sexes and types, pork CPI as one proxy for a close substitute to beef, the industrial products price index for intermediate slaughtering and processing in the packing industry as a proxy for processing costs; and a raw material price index as a proxy for retail costs of marketing. Exchange rates between the US. and Canada were collected as well as carcass weights for the different class and sex of cattle. Data were all sourced from the CANSIM database of Statistics Canada, Agricultural and Agri-food Canada (AAFC) Canada Livestock and Meat Trade Reports, George Morris Centre, Canfax Statistical data. Other data sources include the Economic Research Service (ERS) agency of the USDA data bases. A brief description of data and sources is presented in Appendix II.2.. A detailed description of the underlying model is provided in Appendix II.3..

IV.5. Estimation results

Figure 16 shows the evolution of cow prices in Canada and the US.

The estimated price spreads for all steers, heifers and cows for Eastern and Western Canada, and the U.S. are presented graphically in Figures 17 to 22. The figures show that all price spreads generally trend upward, where the Canadian spread is moving upward faster than that of the U.S.. Price spreads in the U.S. are lower than in Canada and the spread between the farm-wholesale is generally lower as compared to that between wholesale and retail. The opposite is the case in Canada where spreads between farm-wholesale are sometimes double the farm price but the spreads between wholesale to retail are smaller.

Fig 16. Farm Price of Cows in Western and Eastern Canada and the U.S. (1980-2005)



In May 2003, there appears to be a structural break in each animal category, which saw plummeting prices in all market levels. Canadian producer, wholesale and retail prices of steers and heifers fell by about 37 percent, 17 percent and 4 percent respectively. The prices of cows fell by more than 60 percent after May 2003 due to the long term ban on trading live animals which particularly affected cows above thirty months of age. These percentages were also maintained for the first three months of the total ban on Canadian cattle and beef, after which the conditions for the wholesalers and retailers improved without any corresponding increase in farm prices. This is because the Canada-US border was opened to beef and beef products three months after the imposition of the ban and the ban on live cattle remained until July 2005. The figures also show the magnitude of the losses incurred by participants at the different market levels in Canada and the gains made by the same types of participants in the United States. Capacity utilization also picked up in both countries; an indication of the increase in supply of cattle and the

enhancement in processing technology. Capacity utilization rates also suggest that there were larger cost- savings in Canada compared to the US during the post- BSE period.

Fig. 17. Farm Prices of Steers in Western and Eastern Canada and the U.S. (1980-2005)

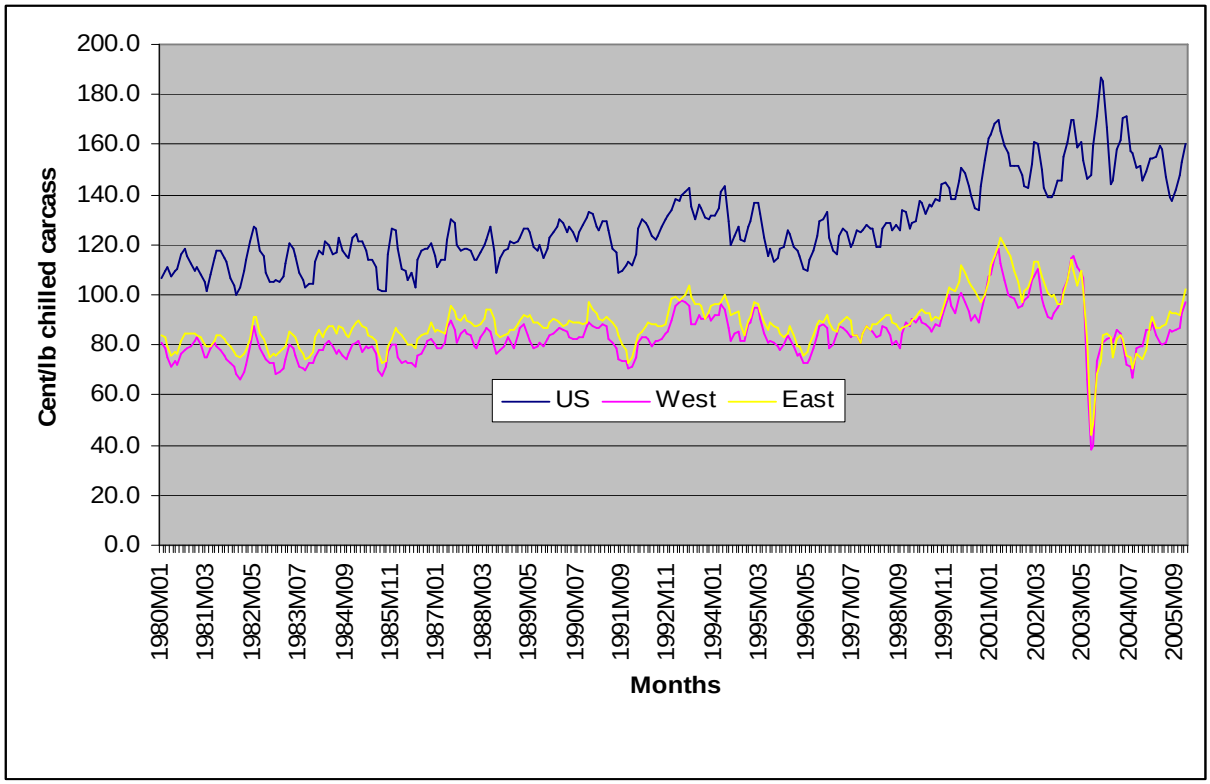


Fig. 18. Farm to Wholesale Price Spreads for Canadian and U.S. Steers (1980-2005)

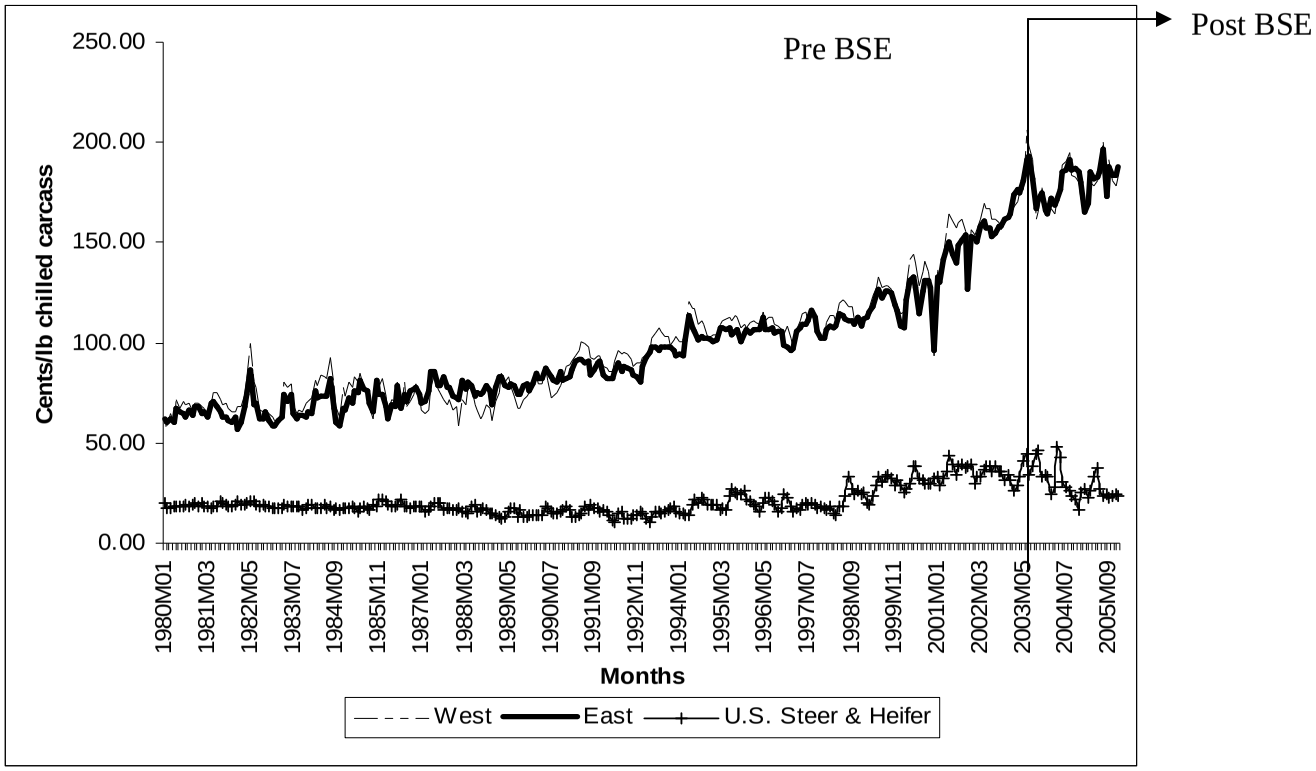


Fig. 19. Wholesale to Retail Price Spreads for Canada and U.S. Steers (1980-2005)

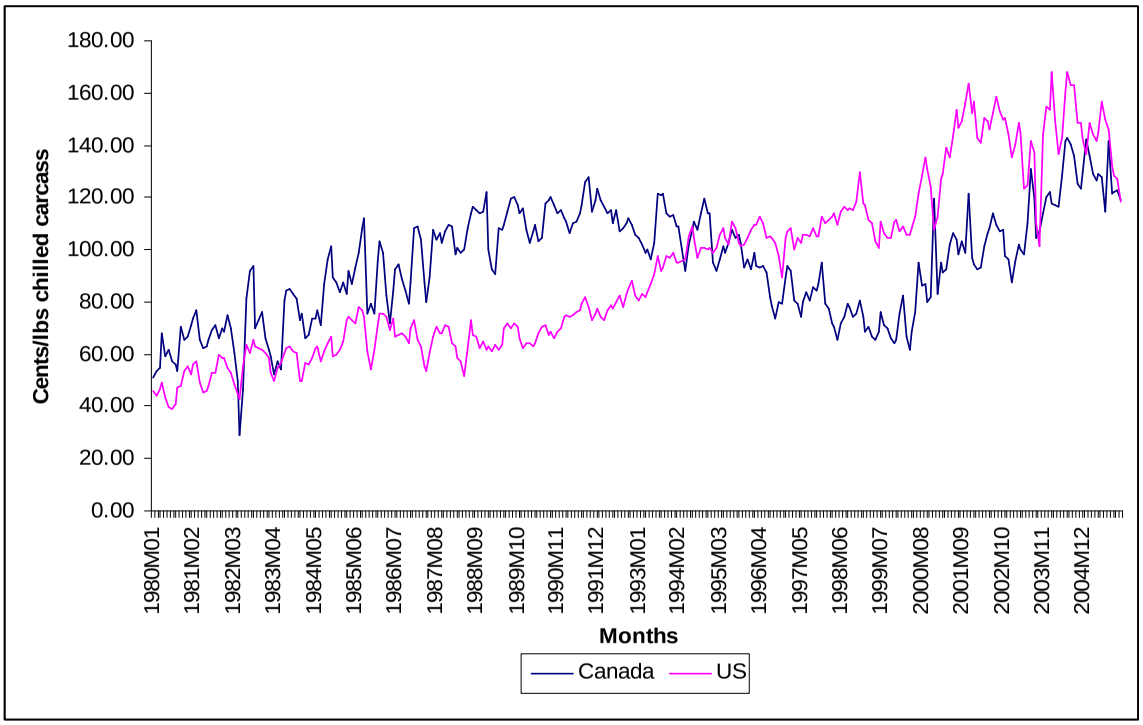


Fig. 20. Prices and Spreads for Western Canada Steers (1980-2005)

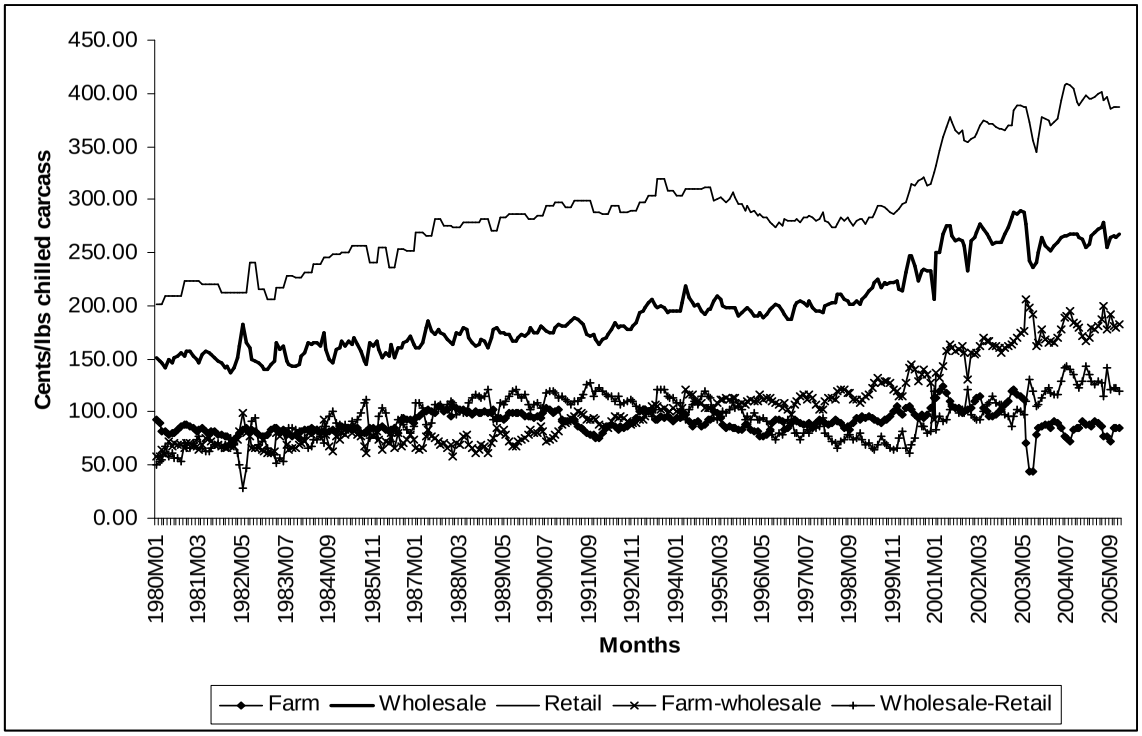


Fig.21. Prices and Spreads for Western Canada Cows (1980-2005)

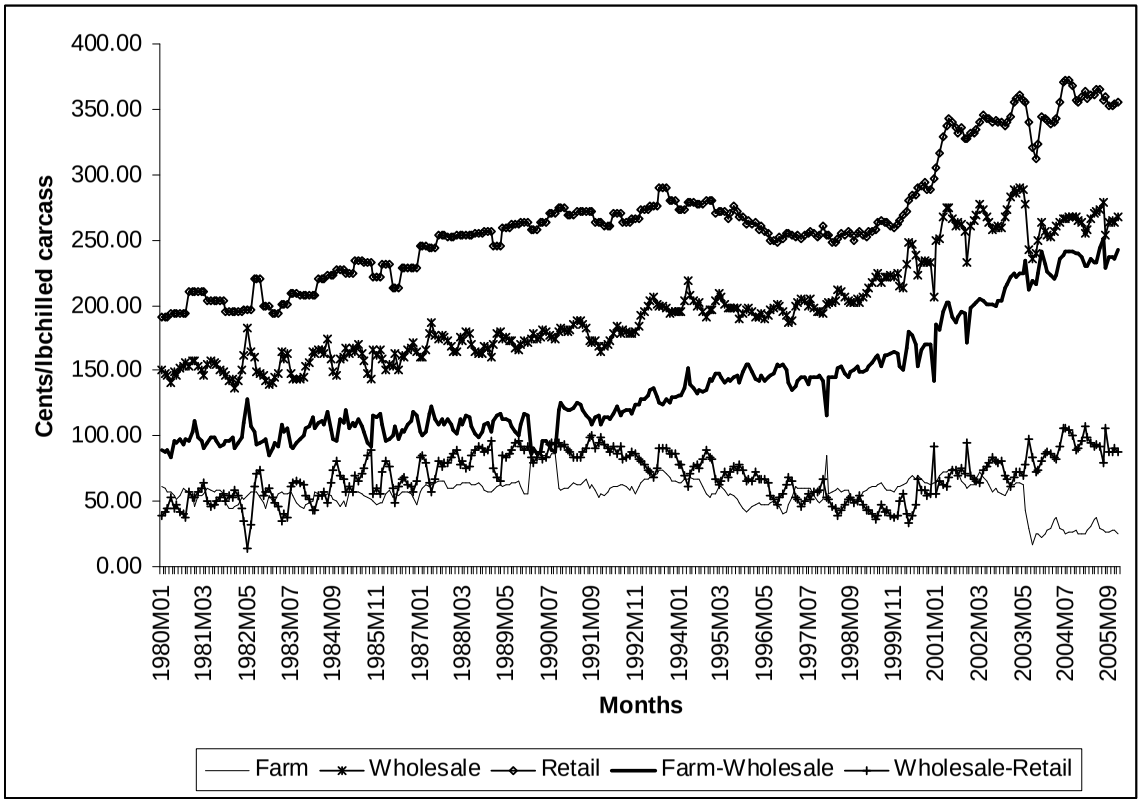
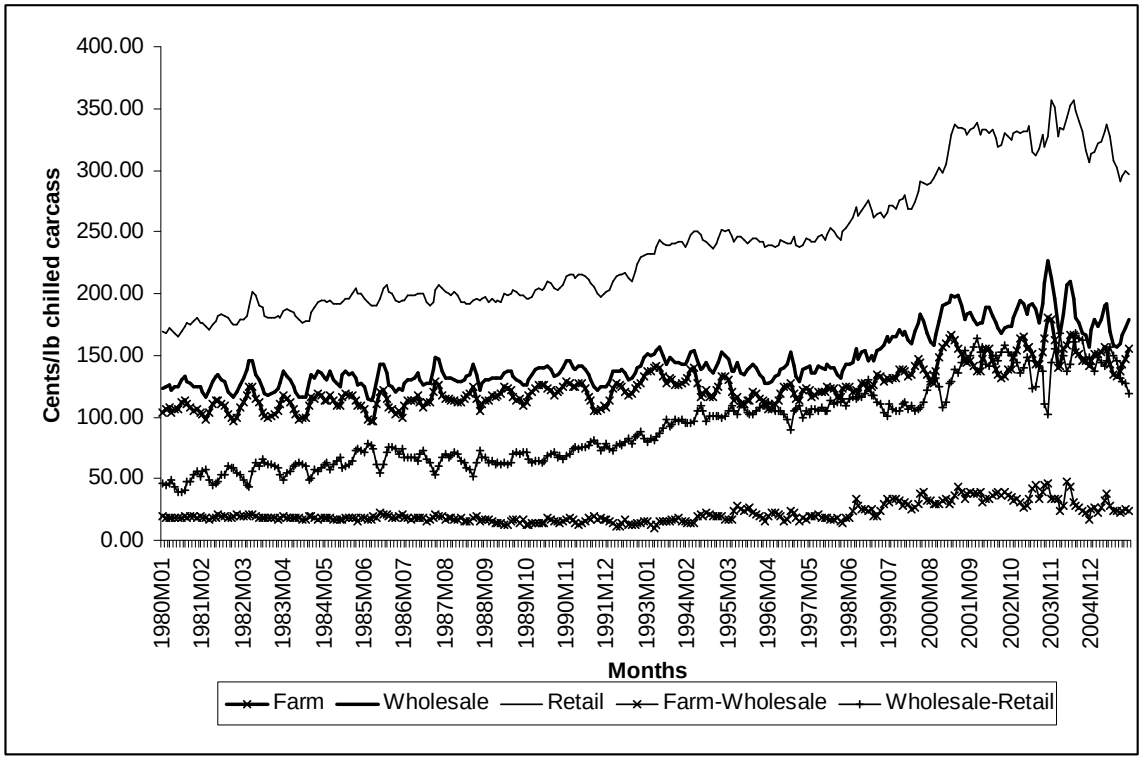


Fig. 22. Prices and Spreads for U.S. Steers and Heifers (1980-2005)



The evolution of Canadian cattle prices during the first three months after the BSE incidence are presented in Figure 23 and 24.

Fig. 23. Price loss following the First Three Months of BSE Incidence in Canada (May - September 2003)

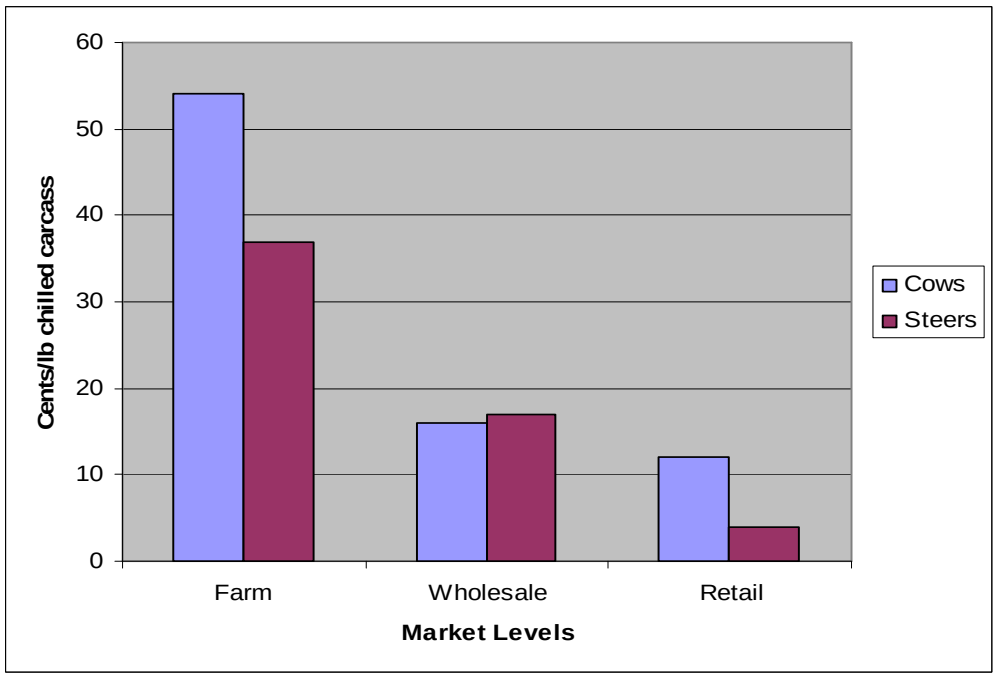


Fig. 24 Price gain in the U.S. following the First Three Months of BSE Incidence in Canada(May - September 2003)

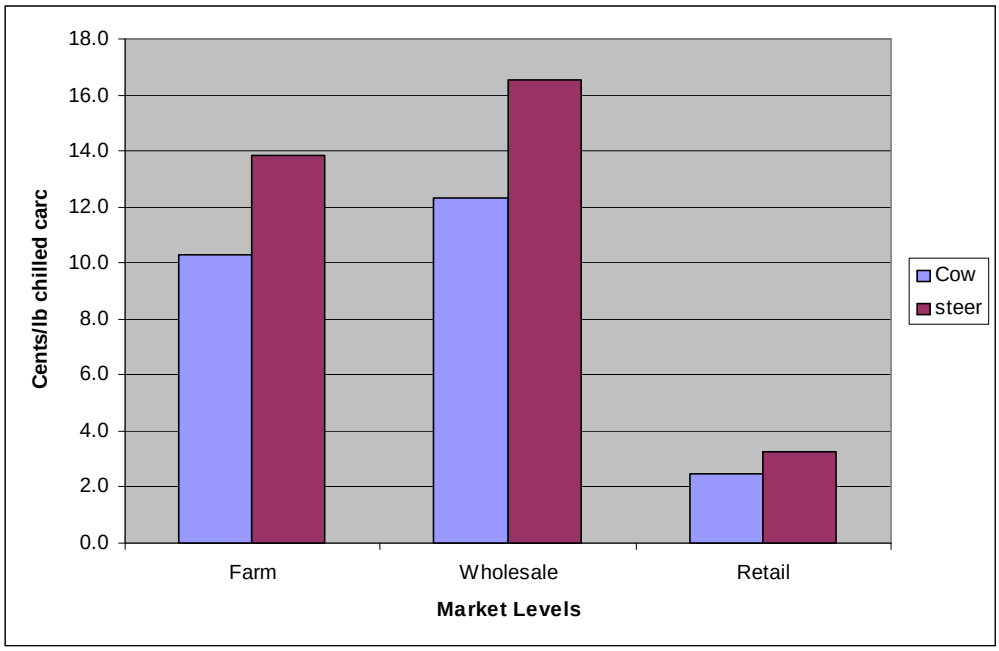
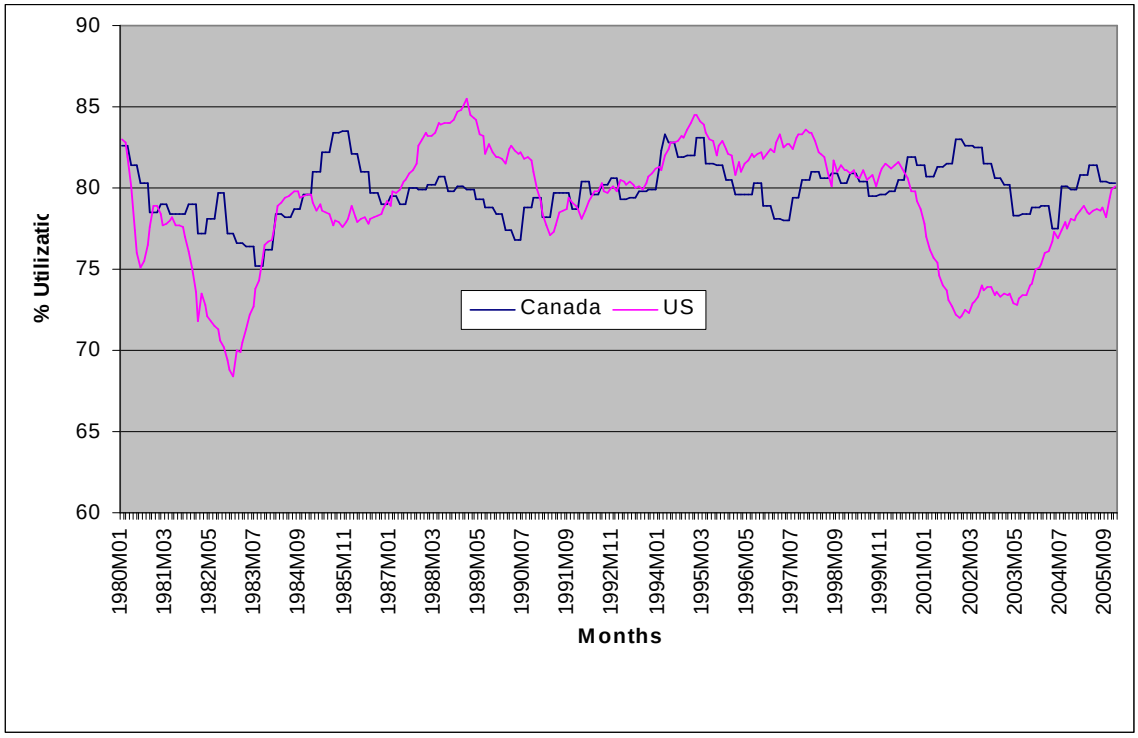


Figure 25 shows the capacity utilization rates of meat processing/ packing plants for both the U.S. and Canada.

Fig.25 Meat packing/processing plants capacity utilization rates in Canada and the U.S. (1980-2005)



The summary descriptive statistics for the data is presented in Tables 8 to 10. The extraordinary increase in the mean of prices for wholesale and retail market levels after the BSE shock is evident. Meanwhile, the decrease in the mean of the farm prices is indicative of a loss at the farm level. The standard deviation, a measure of the spread of a distribution, indicates that for the wholesale and retail price variables, there are large deviations from the mean and small deviation on the farm price from the mean. Considering the data before and after BSE, it is evident that the wholesale and retail variability of price setting behavior has been declining for all animal types, given the large decrease in the standard deviation after BSE. In comparison, the farm prices have, on average, either remained the same or become slightly more variable as seen in the data for Western Canada.

Table 8: Descriptive Statistics; Farm, Wholesale and Retail Heifer Prices for Canada in Cents/lb chilled carcass (1980-2005)

	Observations	Mean		Median		St. deviation	
		West	East	West	East	West	East
Farm Price (FP)	312.00	86.79	90.93	85.50	90.15	11.12	10.50
Before BSE	281.00	87.32	92.30	85.60	91.10	10.99	9.72
After BSE	32.00	81.92	78.49	85.50	78.30	11.32	9.15
Wholesale Price(WP)	312.00	189.63	189.63	187.75	187.75	51.49	51.49
Before BSE	281.00	181.72	181.72	180.30	180.30	47.98	47.98
After BSE	32.00	261.32	261.32	264.00	264.00	10.09	10.09
Retail Beef price(RP)	312.00	274.85	274.85	285.60	285.60	81.59	81.59
Before BSE	281.00	262.54	262.54	282.80	282.80	76.39	76.39
After BSE	32.00	386.46	386.46	388.20	388.20	15.64	15.64

Table 9: Descriptive Statistics; Farm, Wholesale, Retail Steer Prices for Canada and U.S. in cents/lb chilled carcass (1980-2005)

	Observations	Mean			Median			St. deviation		
		West	East	US	West	East	US	West	East	US
Farm Price (FP)	312.00	90.63	93.27	124.26	89.70	92.50	120.85	10.42	10.12	16.65
Before BSE	281.00	91.66	94.61	121.28	91.30	93.40	119.10	9.78	9.29	14.28
After BSE	32.00	81.26	81.13	151.20	85.20	81.30	151.20	11.49	9.28	11.69
Wholesale Price(WP)	312.00	189.63	189.63	145.87	187.75	187.75	138.25	51.49	51.49	22.35
Before BSE	281.00	181.72	181.72	141.94	180.30	180.30	136.80	47.98	47.98	19.09
After BSE	32.00	261.32	261.32	181.53	264.00	261.32	178.60	10.09	10.09	17.76
Retail Beef price(RP)	312.00	274.85	274.85	237.94	285.60	285.60	231.25	81.59	81.59	52.52
Before BSE	281.00	262.54	262.54	228.39	282.80	282.80	212.80	76.39	76.39	45.89
After BSE	32.00	386.46	386.46	324.50	388.20	388.20	326.90	15.64	15.64	18.42
By-product Prices	312.00	12.88	13.65	15.31	12.70	13.80	15.35	2.53	2.46	2.53
Before BSE	281.00	12.93	13.86	15.23	13.10	14.10	15.30	2.66	2.51	2.61
After BSE	32.00	12.46	11.76	15.98	12.60	11.80	15.50	0.38	0.38	1.52

Table 10: Descriptive Statistics; Farm, Wholesale and Retail Cow Prices for Canada and the U.S. in cents/lb chilled carcass (1980-2005)

	Observations	West	East	US	West	East	US	West	East	US
Farm Price (FP)	312.00	56.17	57.91	92.70	57.65	60.55	90.15	12.41	12.29	12.42
Before BSE	281.00	59.23	61.40	90.48	58.70	61.30	88.90	8.58	6.45	10.65
After BSE	32.00	28.41	26.30	112.81	27.50	26.30	112.80	5.12	5.49	8.73
Wholesale Price(WP)	312.00	189.63	196.10	108.83	187.75	213.06	103.10	51.49	39.90	16.67
Before BSE	281.00	181.72	188.88	105.89	180.30	213.06	102.10	47.98	35.12	14.25
After BSE	32.00	261.32	261.00	135.43	264.00	257.03	133.30	10.09	10.08	13.25
Retail Beef price(RP)	312.00	250.69	265.42	177.68	260.10	281.53	194.52	74.17	46.84	39.14
Before BSE	281.00	239.50	265.09	170.55	256.10	275.10	187.70	69.45	38.47	34.19
After BSE	32.00	352.09	352.09	242.09	355.50	342.30	242.80	14.73	14.74	13.74

Tables A3.1 to A3.11. in Appendix 3 contain the unrestricted estimates for each of the cattle classes for the U.S, eastern and western Canada, with three equations for price spreads, farm/wholesale and Wholesale/ retail demand and farm commodity supply. The signs of parameter estimates are in line with those from Holloway (1991) and Wohlgenant (1989). The market demand (retail or wholesale) variables appear to have a positive impact on prices and a negative impact on spreads. The commodity supply variable was somewhat less significant across equations, but where it was significant, it had the expected negative impact on farm, wholesale and retail prices.[10]

We tested for perfect competition in the marketing of the three classes of animals considered for both Canada and the U.S. Both restrictions for the necessary and sufficient conditions for perfect competition were imposed and tested, and the results are presented in Table A3.1. When the first restriction necessary for perfect competition is imposed, we find not a uniform assessment of market structure across animals and regions. It is more difficult to reject the restriction that $\theta = 0$ after BSE than before BSE in all three regions. With the imposition of the second restriction necessary for perfect competition, the statistical test for perfect competition is rejected more frequently prior to BSE in Canada and never after BSE. Similar results occur for the U.S. where results show imperfect competition prior to the incidence of BSE in North America, and more frequently than Canada, in the second period under consideration. It is worth noting that the statistical tests for perfect competition after BSE could, in most cases, not be rejected, across all regions and animals.

Significant structural breaks can be seen across most of the US market levels and animal types in May of 2003. This is evident in the large values for the Chow test, particularly in the retail level prices and wholesale retail level spreads. It is surprising that this study did not find significant evidence of structural changes in the Canadian markets where BSE had (and continues to have) negative effects on cattle and beef prices. Our findings suggest that the underlying relationships have not changed structurally, although the levels of prices have clearly changed.

[10] The Durbin's-h (D-h) statistics shows that first-order correlation of our variables doesn't seem to be a problem in the model.

IV.6. Conclusions and Implications

We have estimated price spreads and developed hypotheses to test for imperfect competition in the Canadian and U.S. beef cattle industry. The theory of conjectural variations formed the basis of the analysis, using prices and cost indices as the core structural variables. Consistent price spread data based on chilled carcass weight was developed for all classes of cattle and beef, and was used to estimate price-cost spreads among the three different market levels. While there were no noticeable differences between western and eastern regions of Canada, large disparities in spreads were found between Canada and the US. Competition issues were not too dissimilar in the two countries with some evidence of imperfect competition pre-BSE (1980- May, 2003) in Canada and US, but much less evidence after May 2003 in both countries.

Further analysis in terms of estimating the models in first differences of logarithms (imposing constant elasticities over the estimation period) might provide additional clarity on the determinants of price spreads and issues of market power. Further structural modeling with endogenous cattle supply, slaughter and trade would also enhance the analysis. Our results suggest that further work is needed at the wholesale level. Further, firm level data is desirable in order to use more sophisticated modeling technique that could improve the validity of econometric analysis.

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Appendix 1

Table A1.1. Summary of Statistical Results of the Logit Model (Beef Alliance Participation)

	Coefficient	Standard Error	Marginal Effects	Expected Sign
Constant	4.08**	1.17	0.51***	N/A
Survey Type	-1.38**	0.67	-0.17**	N/A
Producer Type	-1.28*	0.68	-0.15***	-
Age	1.11*	0.58	0.14*	+
Beef Cowherd Size	-2.30**	0.77	-0.35***	-
Education	-1.02*	0.63	-0.13*	-
Income	0.15	0.67	0.02	N/A
Information Activity	0.69	0.65	-0.17	+
Retained Ownership	-1.39*	0.81	0.09*	+
Contracting Farming	0.54	0.57	0.07	+
Log Likelihood	-44.36			
Restricted Log Likelihood	-60.15			
x^2	31.58			
P-Value	0.00			
McFadden's R^2	0.26			
No. of Observations	110			

** Significant at the 5% significance level. ***Significant at the 1% significance level. Marginal effects are calculated by taking the probability differences. Otherwise, marginal effects are evaluated at the median.

Table A1.2. Summary of Statistical Results of the Choice Experiment

Variables	Descriptions	Model 1		Model 2	
		Coefficient	Standard Error	Coefficient	Standard Error
S1	Sell to alliance, NO profit sharing	-0.34**	0.15	-0.42***	0.16
S2	Sell to alliance, bonuses based on animal performance	0.37	0.24	0.43*	0.25
S3	Retain Ownership, No profit sharing	-0.18	0.20	-0.19	0.21
S4	Retain ownership, profit sharing	0.15	0.17	0.18	0.17
D1	Live performance, per pen	-0.21	0.14	-0.23	0.14
D2	live performance, individual data	0.70***	0.21	0.43**	0.22
D3	Carcass, group data	-0.53***	0.18	-0.41**	0.18
D4	carcass, individual yield & grade data	0.04	0.16	0.20	0.17
P1	No restrictions on vaccination and use of antibiotics & No min. number of animals required	-0.12	0.16	-0.10	0.17
P2	No restrictions on vaccination and use of antibiotics & min. number of animals required	0.08	0.16	0.14	0.16
P3	Restrictions on vaccination and use of antibiotics & No min. number of animals required	0.05	0.17	-0.01	0.17
P4	Restrictions on vaccination and use of antibiotics & min. number of animals required	0.00	0.18	-0.04	0.18
FEE	$0,$5,$10,$20	-0.02**	0.01	-0.02**	0.01
SRT	Survey Method:1=on-site;otherwise,0			0.75***	0.20
Log-likelihood		-215.05		-208.08	
Restricted Log-likelihood		-231.37		-231.37	
The log-likelihood ratio test		32.64		46.58	
McFadden R^2		0.07		0.10	

*Significant at the 10% significance level. ** Significant at the 5% significance level. ***Significant at the 1% significance level.

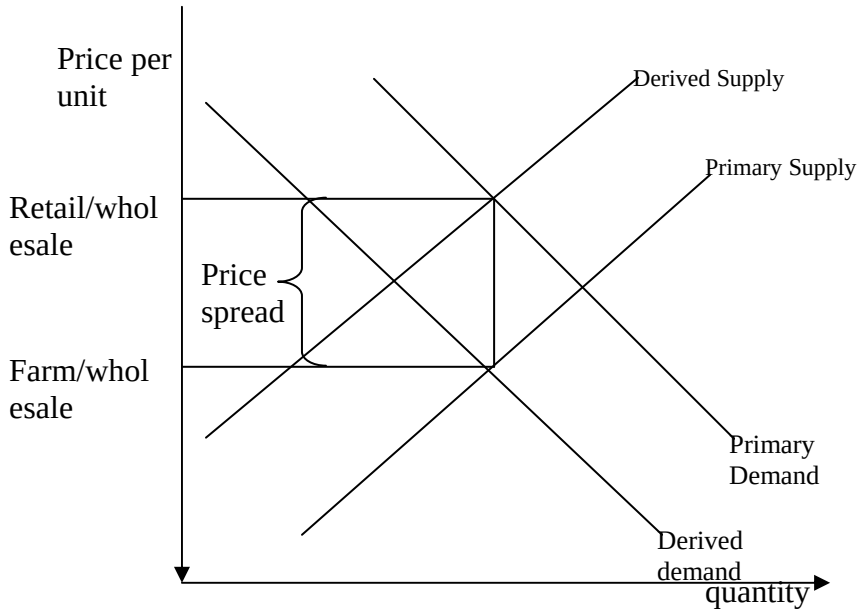
Appendix 2

Appendix 2.1.: Theory Surrounding Price Spreads and Market Power

Scott (1983) defines price spread as the difference between the primary and derived demand curves for a product. Alternatively, price spreads are the difference between the prices two market levels in an industry per equivalent unit at equilibrium, and represent the price of marketing services such as processing, storage, wholesaling and retailing. The primary demand is joint demand for all the inputs that have gone into the final product while the derived demand is the demand schedule for inputs used to produce a consumer product. Therefore price spreads represents the difference between the two demands. A perfectly competitive industry graphical representation of the relationship between primary and derived demand and supply and the resulting price spread is shown in figure XX.

Price spreads behavior depends upon the slopes of the demand and supply functions relative to each other. Using Gardner's (1975) theoretical framework, a perfectly competitive firm uses an agricultural commodity and marketing services to produce food, and retail food demand is determined by the retail price and exogenous demand shifters-such as income or prices of alternate products.

Figure A2.1. Primary and Derived Demand and Supply Under Perfect Competition



Neoclassical consumer theory is based on the assumption that resources are scarce and individuals are concerned with maximizing utility subject to a budget constraint. The resulting

Marshallian demand functions are a function of prices of the goods consumed, income, prices of substitutes, and other variables that might affect the demand for such good(s).

In accordance with Gardner (1975), the primary demand for a retail food, say beef, can be written as:

$$X = D\,(P_x, N), \qquad (1)$$

where P_x is the retail price of the commodity and N is an arbitrary exogenous demand shifter which in this case, population is used as in Wohlgenant (1989).

On the industry side, the theory of the firm is based on the assumption that firms maximize profits subject to a production function that involves the use of inputs to produce outputs. This theory results in an output supply function and input demand functions for the firm at the point of profit maximization.

Thus competitive firms do the following:

$$Max.\ \Pi = P_yY - P_xX - F,$$

$$\text{Subject to } X = f\,(a\ ,\ b) \qquad (2)$$

$$\text{Resulting in: } S = f\,(P_y\ ,\ P_x)\ \ and\ D = f\,(P_y\ ,\ P_x) \qquad (3)$$

where P_y and P_x are output and input prices respectively, F is the fixed cost, and a and b are inputs, say cattle and other marketing inputs, used in producing the firm's output.

At profit maximization in a competitive market, firms would demand inputs a and b when thevalue of their marginal product equals their respective prices. That is,

$$P_a = P_x\ .\ Mp_a \qquad (4)$$

and,

$$P_b = P_x\ .\ Mp_b \qquad (5)$$

Therefore, the supply equations emanating from *(4)* and *(5)* are

$$P_a = m\,(a;\, W), \qquad (6)$$

$$P_b = n\,(b;\, T). \qquad (7)$$

(6) is the inverse supply function of the *a* output and *(7)* is the supply function of *b* to the firm or the input demand function of the firm. *W* and *T* are the exogenous shifters of the supply of *a* and *b* as defined in Gardner (1975).

Six equations (1,2,4,5,6,7) are used to solve for equilibrium for the endogenous variables (prices and quantities at two market levels).

In a perfectly competitive market, prices will be related directly to marginal costs. In an imperfectly competitive market, price spreads between farm and retail can be wider than in other markets (Holloway, 1991).

In order to introduce imperfect competition and to test for the hypothesis of market power, a conjectural variation model can be included in the estimation process in calculating the different demand aand supply elasticities (Holloway, 1991). It is assumed that the firm (likely the processing firm) forms beliefs about the extent to which their strategic behavior affects the quantity decisions of other firms in the industry when making their output decisions. Several studies[11] have addressed the issues of market power using this approach. Although the approach is not without shortcomings, it can provide a useful initial characterization of economic behaviour in the North American beef/cattle sector.

This concept as presented by Appelbaum (1982) includes the maximization of the profit function of a firm in an industry with *N* firms producing homogeneous products, *Y.*

$$Max\ \Pi^j = P \cdot Y^j - C^j(Y^j, W_i) \qquad (8)$$

[11] Appelbaum (1982), Lopez (1984), Shroeter (1988), Azzam et al. (1990, 1995, 1996)

where P is the output price and Y^j the firm's output quantity, $P \cdot Y^j$ is the revenue function; Y^j is the firm's output and W_i is the firm's input cost while $C^j(Y^j, W_i)$ is the firm's cost function.

Taking the first derivative of the profit equation yields the CV elasticity, a measure of market conduct and structure:

$$P_x\left(1+\frac{\theta^j}{\eta_{y,p}}\right)=MC \qquad (9)$$

where $\theta^j=\frac{\delta Y}{\delta Y^j}\bullet\frac{Y^j}{Y}$, (10)

the conjectural variation elasticity for firm j and

$$\eta_{yp}=\frac{\delta Y}{\delta P}\bullet\frac{P}{Y} \quad , \qquad (11)$$

the own price elasticity of demand for the retail product in the industry. *MC* is the firms' marginal cost.

In equation (9), the two extremes of θ are easily estimated as perfect competition if $\theta=0$ or monopoly, or cartel behavior if $\theta=1$. However, as Holloway mentions, the closed definition of θ gives it any intermediate value reflecting Cournot behavior. Hence, $\theta \in [0,1]$ provides a convenient index of competition within which a broad spectrum of behaviors can be captured.

It is important to note that the assumptions that firms possess homogeneous technologies and produce homogeneous products result in the fact that MC, P_x and η are common to all firms in each region. Therefore $\theta_i=\theta_j=\theta, \ \forall \ i, j \in \{1,2,...,n\}$.

Appendix 2.2.: Data

Farm Level Data

Price series for A1/A2 steers and heifers, and D1/D2 cows at Toronto and Calgary were collected for the last week of the month. Data for 1980-1990 were obtained from the Canada Livestock and Meat Trade Report on pages 15-16 titled: Average prices for selected classes

and grades of cattle (hard copies from Department of Rural Economy resource room) and for 1991-2005 were obtained online from the AAFC website: http://www.agr.gc.ca/redmeat/almrcalendar.htm. It is titled "Livestock market review-Annual livestock and meat report schedule" with table titled: slaughter cattle monthly average cattle prices per 100 lbs. In order to adjust farm prices of cattle in dollars per hundred weights live to a chilled carcass equivalent, dressing and cooler shrink percentages were used.

A1/A2 steer/heifer or D1/D2 cow carcass equivalent for Ontario/Alberta = Monthly prices in $/cwt live + dressing percentage and cooler shrink percentage.

A constant value for both dressing and cooler shrink percentages as used by Scott (1982) was used due to lack of varying historic data. Specific warm carcass dressing percentage according to grades and associated cooling percentage[12] and the 1976 beef inquiry report[13] provided chilled carcass dressing percentage for steers, heifers and cows (see table below).

Chilled Beef carcass dressing Percentages

A1/A2 steer carcass equivalent = A1/A2 steer price in cents/cwt live + **0.558** (dressing % Ontario & cooler shrink %

A1/A2 steer carcass equivalent = A1/A2 steer price in cents/cwt live + **0.553** (dressing % Alberta & cooler shrink %

A1/A2 heifer carcass equivalent = A1/A2 steer price in cents/cwt live + **0.541**(dressing % Ontario & cooler shrink %

A1/A2 heifer carcass equivalent = A1/A2 steer price in cents/cwt live + **0.537**(dressing % Alberta & cooler shrink %

A1/A2 cow carcass equivalent = A1/A2 steer price in cents/cwt live + **0.498** (dressing % Ontario & cooler shrink %

A1/A2 cow carcass equivalent = A1/A2 steer price in cents/cwt live + **0.485** (dressing % Alberta & cooler shrink %

[12] Sourced from Dr. R. Osborne, University of Guelph, Department of Animal Science.

[13] Richard Daniels (1976). Farm to Retail Price Spreads for Beef in Canada. Commision of inquiry into the marketing of beef and veal , Report 2, Ottawa.

Packer Level Data

Data for the six major cuts (brisket, shank, flank, ribs, square cut chuck, loin and hip) that constitute the carcass weight of a beef carcass as recognized by the Canadian Beef Information Centre[14] were used to calculate the wholesale prices. The Montreal wholesale prices of beef cuts as reported by the Canada Livestock and Meat Trade Report (1980-1990), page 3 titled: Wholesale prices-primal and sub-primal beef cuts, and 1991-2005 from the AAFC website, http://www.agr.gc.ca/redmeat/almrcalendar.htm. It is titled "Livestock market review-Annual livestock and meat report schedule" with table titled: Montreal wholesale prices - Primal and Sub-primal Beef Cuts and Fresh Pork

To build a composite carcass from these cuts, we use the following formula:

Packer (wholesale) price in cents/lb chilled carcass weight = major cut price in Cents/lb X (percentage composition of cut in carcass X respective carcass weight).

Respective constant percentages of cuts used are as follows:

- Brisket = 6 % of carcass by weight
- Shank = 4 % of carcass by weight
- Flank = 6 % of carcass by weight

} Full brisket 16%

- Square cut Chuck = 29% of carcass by weight
- Rib = 11 % of carcass by weight
- Loin = 21 % of carcass by weight
- Hip = 23 % of carcass by weight

Retail Level Data

Percentage yield from a chilled carcass estimated for all retail cuts from beef carcass is used to estimate retail carcass value. Due to restrictions imposed by data availability, six retail cuts from Statistics Canada CANSIM II database[15] from the University of Alberta library are used for both Ontario and Alberta. These cuts are: sirloin steak, round steak, prime rib roast, blade

[14] http://www.beefinfo.org/retail_specs.cfm. check view detailed carcass and specs to see wholesale cuts percentages

[15] Cansim II tables 3260012: Average retail prices for food and other selected items

roast, stewing beef and ground beef. This six retail cuts account for 48% of the carcass weight. The Daniel's (1976) unpublished correlation research of 21 beef cuts as used in Scott (1983) is used to develop a weighing scheme allowing the six cuts to approximate the total retail value of the carcass. Daniel correlated 87 time series observations of the six cut prices with twenty one beef cuts in Toronto.

The resultant weighing scheme for high quality beef (A1and A2 steers & heifers) retail cuts for Toronto and Calgary is given below:

Sirloin steak	18.53 % of the packers carcass weight
Round steak	10.62 % of the packers carcass weight
Prime rib roast	6.74 % of the packers carcass weight
Blade roast	12.54 % of the packers carcass weight
Stewing beef	20.40 % of the packers carcass weight
Hamburger	6.72 % of the packers carcass weight
	75.55%

The remaining 25% made up of bones (13%), fat (10%) and shrink (2%).

For low quality cow beef (economy beef), data on cutting test from Steinberg of Montréal is correlated using the D. Ricard's method to arrive at a weighting scheme for retail cuts in Toronto and Calgary as shown below:

Sirloin steak	15.22 % of the packers carcass weight
Round steak	12.74 % of the packers carcass weight
Prime rib roast	6.16 % of the packers carcass weight
Blade roast	15.88 % of the packers carcass weight
Stewing beef	1.57 % of the packers carcass weight
Hamburger	25.40% of the packers carcass weight
	77.05%

Retail prices in cents/lb in chilled packer carcass = retail quoted price of cut in cents/lb X (% composition of cut in carcass X respective Carcass weight).

By-product prices from CANFAX were divided by respective carcass weights for Alberta and Ontario steers and multiplied by a 100 to arrive at the values in cents/ pound chilled carcass

packer value. Data from 1980 to 1991 is obtained from Canada Livestock and Meat Trade Report, page 8 in table titled-Total by-product price (dressed carcass basis $ per 100 pounds) (hard copies from Department of Rural Economy resource room), and 1992-2005 are high price by-product values in $ per head steer report by CANFAX from Kevin Grier, Senior Market Analyst of the George Morris Centre (see attached excel file titled: Raw BP)

In the U.S. case, the spreads is already calculated in US cents per pound retail weight as found in the USDA, ERS website[16] on meat price spreads data set titled: Historical monthly price spread data for beef, pork, broilers, turkeys, and eggs, which was converted to cents/Canadian pound chilled carcass weight by multiplying by the respective dressing percentages and exchange rate.

U.S. Dressing percentages are calculated from data obtained from the USDA, ERS Red Meat Yearbook (94006)[17] excel spreadsheet titled- averagedressedweight.xls, table 2, 3 and 4 and averageliveweight.xls, table 15 using the formular:

[18]Dressing Percentage for steer, heifer or cow = Carcass Weight of steer, heifer or cow/
Live Weight of cattle X 100

However, constant values that have been in use by the USDA and Agricultural Marketing Service of the USDA are 63% for steers and heifers and 47% for cows.

Carcass weights data from 1980-1996 are obtained from the Canada livestock and Meat trade report on page 8 titled: Average warm carcass weights for federally and provincial inspected packing plants (Lbs); 1997-2001 from Janet Hovis of CANFAX, and 2002-2005 is annual data also obtained from Ann Dunford of CANFAX.

[16] for an explanation on this see: http://www.ers.usda.gov/briefing/foodpricespreads/meatpricespreads/
[17] See details from: http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1354
[18] See http://ars.sdstate.edu/MeatSci/May99-1.htm; http://www.safarix.com/013046256X/ch23lev1sec5

Appendix II.3.: The Model

Following Gardner (1975), Holloway (1991) and Wohlgenant's (1989) empirical assumptions, we will assume, initially, that farm commodity supplies of cattle are exogenous since most of these supplies in the cattle market section are predetermined over a long period of time, sometimes through contracting, hedging and captive supply agreements. Secondly, the *N* variables in *(1)*- population, pork CPI that affect cattle/beef demand- are considered exogenous. Thirdly, the supply of non-farm inputs[19] is perfectly elastic, making P_b in *(7)* exogenous.

With the empirical assumptions in place and assuming the estimation of elasticities at all levels of the market, the elasticities of a price spread between any two market levels can be expressed as:

$$E_{r,z} \equiv E_{px,z} - E_{pa,z} \qquad (12)$$

where E_r is the spread elasticity between two market levels, *r* is the spread between market levels and $Z \in \{N, a, P_b\}$, *N* is the demand shifter, P_x and P_a are the prices at wholesale/retail for beef and farm for cattle respectively.

The first term on the right hand side of *(12)* is the supply elasticity at the wholesale or retail level with respect to Z while the second term is the elasticity at the farm level[20].

Three alternative equations are estimated for each region and cattle type.

The three estimated equations, where equation *(13)* is either farm-wholesale or wholesale-retail farm spread, equation *(14)* is the inverse supply equation for the retail or wholesale levels and equation *(15)* is the inverse supply equation at the farm gate or for cattle producers are as follows:

$$R^*_{t,k} = c + \beta_{R,x}N^*_{t,k} + \beta_{R,a}a^*_{t,k} + \beta_{R,b}P_{b,t,k} + \beta_{R,pa}P^*_{a,t,k} + \beta_{R,R}RL^*_{R,t-1,k} + \beta_{R,bp}BP^*_{bp,t,k} + \beta_{R,t}DUM_{t1},.....,+\beta_{R,t}DUM_{t11} + \varepsilon_{R,t,k} \qquad (13)$$

[19] This is represented by the processing and retail costs indices at the packer and retail levels

[20] These different elasticities are not shown in this paper but see Holloway (1991) for the empirical derivation.

$$P^*_{x,t,k} = c + \beta_{x,x} N^*_{x,k} + \beta_{x,a} a^*_{t,k} + \beta_{x,b} P_{b,t,k} + \beta_{x,pa} P^*_{a,t,k} + \beta_{x,R} RL^*_{R,t-1,k} + \beta_{x,bp} BP^*_{bp,t,k} + \beta_{R,t} DUM_{t1}, \ldots\ldots\ldots, + \beta_{R,t} DUM_{t11} + \varepsilon_{R,t,k} \quad (14)$$

$$P^*_{a,t,k} = c + \beta_{a,x} N^*_{t,k} + \beta_{a,a} a^*_{t,k} + \beta_{a,b} P_{b,t,k} + \beta_{a,pa} P^*_{a,t,k} + \beta_{a,R} RL^*_{R,t-1,k} + \beta_{a,bp} BP^*_{bp,t,k} + \beta_{R,t} DUM_{t1}, \ldots\ldots\ldots, + \beta_{R,t} DUM_{t11} + \varepsilon_{R,t,k} \quad (15)$$

where $\beta_{j,q,}$, $j = \in \{R, x, a\}$ and $q \in \{x, a, b, pa, R, bp, PD, t1, ..., t11\}$ are coefficients to be estimated for every cattle class and region; and $\varepsilon_{j,t,k}$, $j \in \{R, x, a\}$, are disturbance terms which are assumed to be normally distributed. *N, a, P_a and P_b* are as stated earlier, and *RL, BP, and DUM* represents independent variables for lagged dependent variables (dynamic adjustments), by-product prices, and seasonal dummies respectively. These equations *(13)* to *(15)* are estimated for steers, heifers and cows for Canada eastern and western regions, and the U.S. Data are expressed in the first set of estimations reported here in level form. Ordinary least squares estimation method is used to estimate each equation since there are no cross equation restrictions, and the fact that each equation has the same type of independent variables appearing on the right hand side.

From the elasticity equations, necessary and (almost) sufficient conditions for perfect competition (where H_0 : *θ=0)* in the cattle/ beef markets are developed[21] to be *(i)* $E_{pa,N} = -E_{pa,a}$, *(ii)* $E_{px,N} = -E_{px,a}$, and *(iii)* $E_{R,N} = -E_{r,a}$.

The sufficient condition is satisfied for perfect competition by imposing $\beta_{xb} = 0$, where β_{xb} is the coefficient on the price of the processing/retail costs index.

To test for market power pre and post BSE, each estimated equation is done for pre (1980-May 2003) and post BSE (May 2003-December 2005). Tests for the presence of structural change in the Canadian cattle/beef industry in May of 2003 are also carried out using standard Chow tests.

[21] Also see Holloway (1991) for proof of these propositions.

Appendix 3.

Table A3.1: Estimates of the Spread equations, Farm Price, Wholesale and Retail Prices Equations under the Null Hypothesis of Perfect Competition and Cost Economies in Marketing. (1980:1 to 2003:5; and 2003:6 to 2005:12)

	Western Canada Estimates				Eastern Canada Estimates				U.S. Estimates			
	H_0; θ = 0		H_0; σ =0		H_0; θ = 0		H_0; σ =0		H_0; θ = 0		H_0; σ =0	
Equations	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
F-W S	12.65*	3.15***	12.23*	1.63	18.96*	1.53	8.69*	0.07	2.83***	1.51	11.82*	4.91**
FP S	18.86*	3.20***	0.50	2.24	11.34*	1.05	1.34	0.16	24.15*	3.80***	0.01	6.59**
WP S	15.50*	0.004	5.64**	0.04	16.68*	0.01	4.44**	0.07	17.82*	6.03**	0.85	10.48*
W-R S	1.52	0.26	0.12	0.43	3.25***	0.33	0.05	0.53	5.76**	2.85	5.81**	3.57***
RP S	2.17	2.12	4.95**	2.12	0.002	2.10	4.82**	2.10	9.47*	0.21	1.77	0.25
F-W H	13.07*	2.82	18.19*	1.54	33.11*	1.35	13.34*	0.05	11.11*	1.43	11.11	4.08***
FP H	2.83***	3.14	0.55	2.30	4.29**	0.2E-05	4.69**	0.47	12.28*	4.71**	0.01	4.48**
WP H	6.75**	0.02	4.85**	0.09	15.04*	0.01	4.24**	0.06	14.76*	6.68**	0.71	8.06**
W-R H	0.36	0.38	0.07	0.58	2.17	0.35	0.04	0.48	6.62**	3.11	4.59**	2.98
RP H	1.34	2.22	3.24***	2.06	0.21	2.29	5.16**	2.03	7.22**	0.17	2.32	0.06
F-W C	20.97*	0.07	18.55	1.08	43.04*	0.90	15.15*	1.29	7.03**	0.93	7.03*	1.24
FP C	0.07	0.04	2.65	0.32	0.02	0.03	0.01	0.07	6.64**	3.15***	0.23	2.10
WP C	13.09*	0.08	5.88**	0.17	25.43*	0.63	4.19**	0.24	7.40**	4.74**	0.03	6.74**
W-R C	4.16**	0.08	0.11	0.79	2.84***	0.07	0.21	0.97	6.38**	2.09	5.51**	1.06
RP C	0.18	1.67	5.64**	1.47	0.14	1.05	3.14***	1.61	4.69**	0.02	1.09	2.54

Hypothesis based on F-statistics at 1%, 5% and 10 % (* ,**, and *** respectively.)

Note:

F-W S= farm to wholesale price spread for steer *FP S= farm price for steer*

WP C=wholesale price for cow

F-W H= farm to wholesale price spread for heifer *RP S= change in retail price for steer*

cow *RP C= retail price for cow*

F-W C= farm to wholesale price spread for cow *WP S= wholesale price for steers*

FP C= farm price for cow

W-R S= wholesale to retail price spread for steer *WP S= wholesale price for steer*

W-R H= wholesale to retail price spread for heifer *FP H= farm price for heifer*

W-R C= wholesale to retail price spread for cow *WP H= wholesale price for heifer*

WP H= wholesale price for heifer *RP H= retail price for heifer*

Table A3.2. Regional Unrestricted Parameter Estimates for the Farm ,Wholesale, Retail and Price Spread equations Pre and Post BSE (1980:1-2003:5; and 2003:6 -2005:12)

	Regression coefficients for steer in Western Canada									
	Farm-Wholesale equation		Wholesale – Retail equation		Farm Price equation		Wholesale Price equation		Retail Price equation	
Variables	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**
Constant	-51.07*	1890.58	21.32	606.10	-20.22*	-2498.21	-54.76*	-41.91	-10.86	1254.13
Populatn.	2.42*	-64.28***	-1.03	-21.99	1.35*	86.26***	3.05*	3.18	0.35	-41.25
LDV	0.77*	0.44**	0.85*	0.22	0.87*	0.52**	0.86*	0.36	0.97*	0.12
CPI Pork	-0.03	1.37**	0.20*	1.16***	-0.06**	-0.55	-0.08**	0.96	0.03	2.55*
BPW	-0.22**	-1.03	0.01	-0.15	0.04	1.52***	-0.11	0.26	-0.02	-0.09
Cost Ind.	0.15	0.84	-0.02	0.49	0.01	-1.39	0.12	-0.17	0.08**	0.75
Qty	-0.1E-07	-0.15E-07	-0.1E-08	0.25E-08	-0.4E-07	0.16E-07	-0.5E-07*	-0.57E-09	-0.2E-07	0.11E-08
T2	-0.18	-0.94	2.56	-10.70	-0.95	4.77	-1.27	2.17	1.57	-10.90***
T3	1.02	0.22	0.62	-15.76	0.12	11.80	0.90	8.39	1.41	-12.37
T4	4.12**	6.95	2.05	-15.00	-1.08	5.79	2.61	10.44	4.16*	-7.41
T5	4.00**	9.98	0.50	-8.23	-1.80**	1.78	1.42**	10.23	1.13	0.31
T6	-0.18	10.53	6.38*	-12.59	-3.19*	1.03	-4.42*	9.82	1.47	-4.49
T7	-0.84	5.46	8.82*	-10.13	-1.71**	-1.31	-3.49**	1.44	5.15*	-9.32
T8	-1.72	-3.20	4.08***	-7.02	-0.47	4.34	-2.98	-3.78	0.43	-14.27***
T9	-1.61	-9.53	4.29***	-12.95	-1.70**	15.04	-3.89**	1.05	-0.02	-15.50**
T10	-2.34	-3.62	-0.56	-16.90	0.45	10.55	-2.34	3.43	-3.11**	-18.67**
T11	-3.07***	4.65	2.71	-9.18	0.33	5.48	-2.99	8.78	-0.07	-2.12
T12	-1.80	5.07	5.57**	-6.51	-1.64**	-0.02	-3.53***	5.67	2.19	-0.30
R^2	0.96	0.86	0.83	0.71	0.92	0.82	0.96	0.73	0.98	0.94
D-h	-4.47	-1.32	-0.71	0.87	6.04	1.19	-1.82	0.85	0.73	2.79
Chow Test	0.041		0.07		0.05		0.12		0.58	

Table A3.3.: Regional Unrestricted Parameter Estimates for the Farm ,Wholesale, Retail and Price Spread equations Pre and Post BSE (1980:1-2003:5; and 2003:6 -2005:12

	Regression coefficients for heifers in Western Canada									
	Farm-Wholesale equation		Wholesale – Retail equation		Farm Price equation		Wholesale Price equation		Retail Price equation	
Variables	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**
Constant	-69.63*	1662.06	10.50	705.74	1.35	-2158.59	-30.57**	-142.81	11.46	1244.44
Populatn.	3.22*	-56.86	-0.52	-25.44	1.17***	75.18	1.97**	6.66	-0.69	-40.90
LDV	0.65*	0.43	0.84*	0.23	0.58*	0.47**	0.86*	0.37	0.98*	0.12
CPI Pork	-0.04	1.38**	0.18**	1.18	0.00	-0.54	-0.05	0.93	0.06	2.55
BPW	-0.34**	-1.04**	-0.6E-03	-0.24*	-0.02	1.53***	-0.11	0.36	-0.01***	-0.07
Cost Ind.	0.27*	0.78	-0.02	0.56	0.03	-1.26	0.11**	-0.25	0.06	0.73
Qty	-0.6E-08	0.2E-07	0.00	0.00	0.00	0.00	0.61E-08	0.00	0.00	0.00
T2	1.10	-1.68	-0.4E-07	-10.99	-1.19	5.34	-0.94	2.48	1.73	-10.84*
T3	1.66	0.88	0.61	-16.34	0.50	10.49	0.98	9.08	1.43	-12.27
T4	4.94**	6.35	1.72	-15.42	-0.77	6.12	2.03	11.00	4.07*	-7.28
T5	4.96**	8.69	-0.03	-8.49	-1.46	2.96	0.73	10.69	1.12	0.46
T6	3.99***	10.62	5.97**	-13.26	-6.69*	1.08	-5.54*	10.73	1.14	-4.23
T7	-2.08	4.27	8.42*	-10.76	-0.74	-0.46	-4.24**	2.25	5.04*	-9.07
T8	-0.48	-5.66	3.89***	-7.84	-2.30	5.92	-3.71***	-2.73	0.17	-13.98
T9	-1.66	-9.90	4.19**	-13.61	-2.07	14.58	-4.26**	1.90	-0.14	-15.25*
T10	-2.05	-4.76	-0.44	-17.53	-0.39	11.44	-2.52	4.35	-3.30**	-18.43*
T11	-1.93	2.92	2.69	-9.55	-0.62	7.36	-2.81	9.34	0.04	-1.94*
T12	-1.42	3.47	5.33	-5.89	-1.45	1.34	-3.34***	5.10	2.47	-0.36
R^2	0.92	0.87	0.83	0.71	0.68	0.83	0.96	0.72	0.98	0.94
D-h	-4.24	-3.8-1.155	-0.57	0.69	-3.85	0.92	-1.49	0.65	0.72	2.55
Chow Test	0.01		0.18		0.388		0.01		0.20	

Table A3.4.: Regional Unrestricted Parameter Estimates for the Farm ,Wholesale, Retail and Price Spread equations Pre and Post BSE (1980:1-2003:5; and 2003:6 -2005:12

	Regression coefficients for Cows in Western Canada									
	Farm-Wholesale equation		Wholesale – Retail equation		Farm Price equation		Wholesale Price equation		Retail Price equation	
Variables	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**
Constant	-77.89***	576.56	27.89**	412.74	11.53*	99.47	-41.70*	602.86	-0.43	1494.58
Populatn.	3.57	-16.74	-1.38**	-16.57	0.10*	-1.89	2.48*	-16.56	-0.18	-48.74
LDV	0.75*	0.36	0.85*	0.25	0.83*	0.42*	0.86*	0.38	0.98*	0.20
CPI Pork	-0.08	1.41	0.19*	1.00	0.02	-0.52	-0.06	0.87	0.03	2.16*
BPW	-0.38	1.19867***	-0.01	-0.57	0.10	0.19	-0.13	1.15	-0.01	0.37
Cost Ind.	0.28	-0.73	-0.02	0.63	-0.05**	0.29	0.12**	-0.34	0.07**	0.61
Qty	0.00	8.76E-08	0.00	0.29E-07	0.00	0.00	0.00	0.00	0.00	0.00
T2	1.39**	1.579	2.80	-10.65	-2.62	1.89	-1.14	3.28	1.84	-9.34
T3	1.66	7.341	0.54	-16.54	-1.03	4.35	0.68	10.95	1.24	-9.45
T4	5.23*	13.94	2.15	-16.45	-3.26	0.01	1.78	13.48	3.90*	-5.20
T5	3.71**	17.49	0.32	-11.55	-3.13	-2.58	0.15	14.19	0.38	1.25
T6	-1.92*	14.37	6.60*	-14.97	-3.41*	1.86	-5.94*	15.41	1.10	-0.96
T7	-2.12**	8.11	7.93*	-13.17	-2.69**	1.03	-4.88**	7.78	3.72*	-6.18
T8	-0.87*	6.09	4.44**	-11.44	-3.70**	-0.26	-4.33**	3.93	0.37	-10.57
T9	0.37*	9.36	5.03**	-15.80	-5.63**	1.61	-4.85**	9.10	0.44	-10.03
T10	4.18**	13.7	1.14	-20.62	-7.28	0.95	-2.77	12.74	-1.52	-12.20
T11	4.02*	21.5	3.12	-11.16	-6.88	-1.79	-2.91	17.75	0.32	4.78
T12	0.10***	11.69	5.56**	-7.59	-3.37**	2.64	-3.54***	12.72	2.12	5.02
R^2	0.78	0.74	0.81	0.67	0.96	0.79	0.96	0.73	0.98	0.94
D-h	-3.70	-2.37	-0.81	0.29	-1.62	-1.61	-1.62	2.19	1.09	1.57
Chow Test	0.07		0.11		0.10		0.10		0.73	

Table A3.5:. Regional Unrestricted Parameter Estimates for the Farm ,Wholesale, Retail and Price Spread equations Pre and Post BSE (1980:1-2003:5; and 2003:6 -2005:12

	Regression coefficients for steers in Eastern Canada									
	Farm-Wholesale equation		Wholesale – Retail equation		Farm Price equation		Wholesale Price equation		Retail Price equation	
Variables	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**
Constant	-54.38*	1124.35	-1.277**	693.24	-9.729**	-1505.72	-45.69*	-138.25	-3.45	693.24
Populatn.	2.71*	-37.06	0.845**	-24.99	0.840*	51.15	2.71*	6.44	0.01	-24.99
LDV	0.77*	0.57	0.190*	0.23	0.886*	0.42	0.86*	0.37	0.97*	0.23
CPI Pork	-0.03*	0.89*	0.200*	1.17***	-0.061**	-0.25	-0.08	0.94	0.03	1.17***
BPW	-0.37	0.24	-0.013	-0.23	0.188*	0.16	-0.05	0.34	0.05	-0.23
Cost Ind.	0.12*	0.14	0.000	0.55	0.022	-0.41	0.10**	-0.23	0.07**	0.55
Qty	0.00*	-0.2E-07	0.7E-07	0.00	0.000**	0.00	-1.16E-07**	0.00	-0.1E-07	0.00
T2	0.46	8.34	2.675	-10.93	-1.484**	-3.73	-1.13	2.39	1.72	-10.93
T3	2.18	10.76	0.572	-16.24	-0.942	-0.25	0.93	8.89	1.44	-16.24
T4	3.08	12.57	1.613	-15.33	-0.043	-1.34	2.41	10.80	3.92*	-15.33
T5	2.47	14.27***	0.308	-8.42	-0.905	-3.91	0.72	10.46	0.78	-8.42
T6	-2.13**	14.75***	6.053**	-13.11	-2.253*	-4.09	-5.29*	10.33	0.98	-13.11
T7	-1.14	13.68	8.708*	-10.60	-2.334*	-12.85	-4.09**	1.87	4.85*	-10.60
T8	-1.23	4.50	3.996***	-7.64	-1.812**	-8.55	-3.54***	-3.19	0.11	-7.64
T9	-0.90	4.52	4.180**	-13.45	-2.723*	-2.80	-4.06**	1.47	-0.15	-13.45
T10	0.307	11.60	-0.688**	-17.37	-2.156*	-5.79	-2.26	3.91	-3.14	-17.37
T11	-2.81***	12.89***	2.561	-9.44	0.678	-3.89	-2.64	8.99	0.05*	-9.44
T12	-3.17**	11.94	5.619**	-5.93	-0.177	-7.26	-3.63***	5.05	2.21*	-5.93
R^2	0.96	0.89	0.84		0.92	0.78	0.96	0.73	0.98	0.71
D-h	-4.53	-0.11	-0.7	0.72	5.28	2.13	-1.68	0.20	0.86	0.72
Chow Test	1.22		510		4.41		0.01		0.22	

Table A3.6: Regional Unrestricted Parameter Estimates for the Farm ,Wholesale, Retail and Price Spread equations Pre and Post BSE (1980:1-2003:5; and 2003:6 -2005:12)

	Regression coefficients for heifers in Eastern Canada									
	Farm-Wholesale equation		Wholesale – Retail equation		Farm Price equation		Wholesale Price equation		Retail Price equation	
Variables	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**
Constant	-109.82*	977.50	21.70	668.1	-2.42	67.82	-47.70*	-91.27	1.27	1259.22
Populatn.	5.40*	-32.48	-1.11	-24.1	1.35**	-0.06	2.85*	4.88	-0.25	-41.37
LDV	0.56*	0.56	0.85*	0.2*	0.54*	-0.37	0.86*	0.37	0.98*	0.12
CPI Pork	-0.08	0.93*	0.18**	1.2***	-0.04	0.23	-0.09	0.95	0.04	2.55
BPW	-0.63*	0.20***	0.18	-0.2	0.33**	-0.42	-0.03	0.32	0.05	-0.07
Cost Ind.	0.22*	0.12	-0.01	0.5	0.10**	0.49	0.10**	-0.21	0.08**	0.74
Qty	0.00	-0.5E-07	0.73E-07	-0.52E-0.0	0.00**	0.00	-0.2E6***	0.00	0.49E-07	0.00
T2	0.90	6.94	2.62	-10.8	-1.16	-7.66	-1.08	2.31	1.77	-10.86
T3	2.88	11.06	0.62	-16.0	-0.75	-10.05	0.85	8.71	1.46	-12.30
T4	4.95**	13.91	1.89	-15.1**	-0.07	-8.15	2.16	10.68	3.80	-7.31
T5	4.60**	13.41***	0.48	-8.3***	-0.94	-6.07	0.43	10.40	0.81	0.42
T6	3.47	13.91***	6.31*	-12.8***	-5.41*	-6.34	-5.62*	10.20	0.95*	-4.29
T7	-1.66	12.80***	8.91*	-10.3	-0.74	-14.74	-4.43**	1.76	4.87*	-9.12
T8	-0.39	4.69	4.19***	-7.2	-2.33	-17.47	-3.91**	-3.35	0.12**	-14.02
T9	0.07	3.57	4.39***	-13.1	-3.92**	-11.20	-4.46**	1.40	-0.15**	-15.26
T10	1.01	10.72	-0.49	-17.0	-3.56**	-14.86	-2.61	3.82	-3.17	-18.42
T11	-1.29	11.04	2.77	-9.2	-1.80	-5.88	-3.06	9.01	0.06	-1.90
T12	-2.96	9.52	5.65**	-6.0	-1.02	-3.67	-3.90**	5.38	2.34***	-0.21
R^2	0.93	0.89	0.84	0.89	0.57	0.79	0.96	0.72	0.98	0.79
D-h	-3.19	0.28	-0.71	0.28	-4.62	1.80	-1.63	2.02	0.85	1..80
Chow Test	1.24		0.43		0.12		0.06		0.18	

Table A3.7: Regional Unrestricted Parameter Estimates for the Farm ,Wholesale, Retail and Price Spread equations Pre and Post BSE (1980:1-2003:5; and 2003:6 -2005:12)

	Regression coefficients for cows in Eastern Canada									
	Farm-Wholesale equation		Wholesale – Retail equation		Farm Price equation		Wholesale Price equation		Retail Price equation	
Variables	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**
Constant	-83.54*	3490.94	20.27***	-1224.69	3.96***	-337.84	-53.81*	3244.23	-5.10	2827.04
Populatn.	4.37*	-108.28	-1.02***	34.99	-0.02	11.44	3.46*	-99.90	0.15	-90.82
LDV	0.67*	0.41***	0.84*	0.27	0.95*	0.42*	0.79*	0.37	0.97*	0.18
CPI Pork	-0.05	0.97***	0.17**	1.06	0.01	-0.25	-0.06	0.78	0.03	2.15*
BPW	-0.35**	3.57	0.16	-2.10	0.04	0.05	-0.05	3.48	0.08	1.51
Cost Ind.	0.20*	-0.59	-0.03	0.69	0.00	0.11	0.10**	-0.37	0.06***	0.62
Qty	-0.12E-05*	0.9E-06	-0.1E-06	-0.5E-06	0.12E-02	0.61E-08	-0.1E-5*	0.96E-06	-0.3-06***	0.48E-06
T2	-1.00	1.98	2.65	-12.16	-0.38	3.91	-0.97	5.31	1.78	-8.41
T3	2.27	11.64	0.34	-19.52	-1.75*	4.64	1.23	15.16	1.24	-7.65
T4	5.12*	15.24	1.95	-20.56	-2.36*	5.02	2.95	19.65	4.01*	-2.36
T5	2.11	22.28	-0.11	-17.61	-0.84***	1.64	1.11	23.57	0.30	5.68
T6	-3.80**	23.27	6.23*	-22.81	-1.24**	4.57	-4.94*	27.42	1.02	4.77
T7	-3.43**	18.53	7.54*	-23.17	-2.05*	4.97	-4.45**	23.03	3.51*	1.29
T8	-2.25	19.07	4.09***	-23.13	-3.35*	3.64	-4.21**	21.51	0.18	-2.08
T9	-1.92	26.95	4.71**	-29.05	-4.03*	3.52	-4.76**	29.11	0.27	-0.31
T10	1.05	38.87	1.01	-35.94	-4.67*	-1.13	-2.78	36.16	-1.59	-0.98
T11	0.84	45.82	3.03	-27.25	-3.79*	-2.20	-2.88	42.68	0.28	16.93
T12	-1.71	41.45	5.36**	-24.03	-1.52*	-2.24	-3.66**	38.67	1.99	17.86
R^2	0.96	0.83	0.81	0.68	0.93	0.89	0.97	0.74	0.98	0.94
D-h	-1.51	-1.4	-0.71	2.00	1.64	-0.62	-1.19	0.18	1.03	1.35
Chow Test	0.15		0.32		0.54		0.05		0.36	

Table A3.8: Regional Unrestricted Parameter Estimates for the Farm ,Wholesale, Retail and Price Spread equations Pre and Post BSE (1980:1-2003:5; and 2003:6 -2005:12)

	Regression coefficients for steers in the US									
	Farm-Wholesale equation		Wholesale – Retail equation		Farm Price equation		Wholesale Price equation		Retail Price equation	
Variables	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**
Constant	-11.42*	-573.25	-41.40*	1906.64	-9.43**	-2023.55***	-18.32*	-2446.89**	0.05	-0.24
Populatn.	35.47***	2385.74	155.41**	-7354.97	230.08*	7204.54***	221.15*	9091.68**	-24.56*	385.27
LDV	0.82*	0.26	0.84*	0.52*	0.82*	0.51	0.04	-1.78*	175.90*	-1556.36
CPI Pork	-0.01	-0.31	0.03	0.93	-0.11*	0.63	0.87*	0.87*	0.95*	0.14
BPW	-0.24*	-0.14	-0.02	4.62**	0.27**	1.90	-0.12*	0.09	-0.07**	1.81*
Cost Ind.	0.06*	-0.63**	0.09**	1.22***	0.3E-02	-1.40**	0.08*	-2.33	0.25	8.74
Qty	0.00**	0.13E-04	0.2E-05	-0.15E-04	-0.8E-4*	0.38E-04	-0.1E-4**	0.3E-04	-0.9E-05**	0.18E-04
T2	-0.53	-3.35	1.69	9.21	-1.36	11.81	-1.59	8.93	0.28	8.90
T3	0.37	3.44	0.70	-13.85	0.41	19.32***	0.95	28.97**	1.89	4.62
T4	1.81*	14.98*	1.65	-10.10	-0.56	19.01**	1.35	32.91*	3.22*	20.47*
T5	3.65***	9.51	-0.85	1.47	0.03	12.71	3.54*	14.28	2.97**	22.56*
T6	1.61*	1.88	3.33**	4.19	-1.20	-2.86	0.13	-5.21	3.75*	0.79
T7	-0.09	-1.86	5.05*	3.94	-1.03	-6.30	-1.28	-4.87	3.88*	-6.25
T8	1.44**	2.18	1.00	-5.73	1.77	3.26	3.12	13.67	4.06*	-3.15
T9	0.92	0.87	2.58***	-13.87	-0.70	4.37	0.25	10.91	2.70**	-10.01
T10	0.60	3.18	0.38	-17.61	1.19	11.63	1.82	17.91***	2.04**	-9.99
T11	1.39**	-5.06	1.07	3.24	0.24	6.49	1.89	3.39	2.80*	-2.58
T12	1.55	-3.03	1.16	-0.50	-1.67	-1.49	-0.04	2.44	0.91	-5.10
R^2	0.92	0.89	0.97	0.88	0.91	0.82	0.94	0.92	0.99	0.95
D-h	-0.5	-2.47	2.31	-1.4	6.38	0.81	5.14	1.11	1.95	-1.22
Chow Test	5.35		17.87		0.28		0.13		25.33	

Table A3.9: Regional Unrestricted Parameter Estimates for the Farm ,Wholesale, Retail and Price Spread equations Pre and Post BSE (1980:1-2003:5; and 2003:6 -2005:12)

	Regression coefficients for heifers in the US									
	Farm-Wholesale equation		Wholesale – Retail equation		Farm Price equation		Wholesale Price equation		Retail Price equation	
Variables	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**
Constant	-19.61*	-484.96	-38.84*	1817.68	-12.02**	-2077.34**	-19.60*	-2440.11**	0.05	-0.11
Populatn.	168.13*	2207.36	155.68**	-6791.9	139.0*	7278.00**	168.12*	8966.16**	-24.66*	302.93
LDV	0.03	0.32	0.84*	0.56*	0.86*	0.70**	0.03	-1.41**	144.54*	-1290.21
CPI Pork	0.89*	-0.48***	0.03	0.81	-0.07**	0.17	0.88*	0.95*	0.94*	0.12
BPW	-0.08**	-0.88	0.03	3.62***	0.318***	1.65	-0.08**	-0.22	-0.05	1.63*
Cost Ind.	0.11	-0.53***	0.08**	0.94	-3.88E-3	-1.02**	0.10	-2.44	0.28***	9.04*
Qty	-0.77E-8	0.00	0.14E-08	-5.71E-08	6.48E-09	0.9E-07	-7.72E-9	0.73E-07	-0.77E-8	0.03E-07
T2	-0.93	-4.28	1.23	10.33	-7.17E-3	8.82	-0.92	5.24	0.36	6.39
T3	1.00	5.38	0.51	-8.2	0.711	12.97	1.00	22.98**	1.59	2.48
T4	0.56	13.69*	1.19	-10.27	-0.94	17.69**	0.563	29.96*	1.75	18.84*
T5	1.42	9.74***	-1.19	1.212	-2.0***1	11.60	1.42	11.76	0.31	20.22*
T6	-1.80	5.57	2.64**	5.12	-3.*2	-0.66	-1.79	-3.52	1.05	0.17
T7	-2.75**	1.96	4.08*	4.52	-2.6**2	-2.76	-2.74**	-2.45	1.45	-6.72
T8	1.65	6.15	0.75	-3.58	-0.02	6.17	1.6513	14.95	2.42	-3.98
T9	-0.13	4.42	2.09	-9.39	-0.96	3.75	-0.134	9.96	1.95**	-10.71
T10	1.67	6.29	0.29	-10.8	0.90	7.67	1.66	14.18	1.92***	-11.64
T11	1.86	-3.46	0.56	5.32	0.99	4.67	1.86	1.84	2.28**	-3.96
T12	-0.37	-0.10	0.63	1.57	-1.39	-2.28	-0.37	2.18	0.04	-5.40
R^2	0.95	0.89	0.97	0.89	0.93	0.82	0.95	0.91	0.992.9	0.95
D-h	5.24	-1.9	2.43	-1.68	6.63	0.88	5.24	1.39	24.75	-.068
Chow Test	0.028		17.67		0.7		0.28			

Table A3.10: Regional Unrestricted Parameter Estimates for the Farm ,Wholesale, Retail and Price Spread equations Pre and Post BSE (1980:1-2003:5; and 2003:6 -2005:12)

	Regression coefficients for cows in the US									
	Farm-Wholesale equation		Wholesale – Retail equation		Farm Price equation		Wholesale Price equation		Retail Price equation	
Variables	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**
Constant	-5.570**	-344.48	-30.00*	1200.63	-6.54	-1424.28	-11.02	-1778.43**	-15.89**	180.18
Populatn.	27.290**	1511.26	119.55**	-4600.22	81.15**	5275.04***	95.62*	-1.06763**	83.72**	-377.68
LDV	0.863*	0.23	0.84*	0.52*	0.90*	0.60***	0.92*	6791.97**	0.95*	0.071
CPI Pork	-0.011	-0.40***	0.02	0.88**	-0.08*	-0.06	-0.08*	0.845*	-0.06**	1.32
BPW	-0.166**	-0.43	0.00	5.03*	0.49*	0.38	0.34***	-0.37	0.51*	8.98*
Cost Ind.	0.038*	-0.31	0.07**	0.55	-0.01	-0.77	0.059	-2.81	0.03	-0.425-*
Qty	-0.5E-06	0.38E-03	-0.71E-5	-0.11E-03	0.24E-05	0.47E-04	0.30E-05	4.50E-05	0.6E-05	0.20E-03
T2	-0.776	-1.85	0.88	6.07	-0.08	10.07	-0.85	8.00	-0.16	2.70
T3	0.080	3.58	0.08	-10.69	-0.32	18.18**	-0.21	24.98*	-0.50	9.24**
T4	1.077**	13.38*	0.36	-11.66	-1.99***	15.99***	-0.92	26.64*	-1.03	15.34**
T5	2.588*	10.67***	-1.76	-5.45	-3.19*	14.06	-0.66	14.32	-2.85*	16.59**
T6	0.964**	5.19	1.30	-4.08	-4.21*	5.49	-3.36*	1.39	-2.31*	1.11
T7	-0.550	1.71	1.79	-4.79	-4.41*	1.78	-5.06*	-0.518	-3.61*	-9.40
T8	0.624	3.50	-1.39	-8.98	-3.00*	8.32	-2.37**	12.35***	-4.13*	-4.97
T9	-0.004	1.89	-0.23	-13.19**	-3.60*	7.61	-3.56*	9.75	-3.94*	-9.68***
T10	-0.100	2.66	-1.86***	-13.97***	-2.35**	10.92	-2.42**	13.17***	-4.26*	-8.24
T11	0.317	-3.75	-0.72	0.72	-0.44	4.76	-0.04	0.780	-0.59	-7.02
T12	0.689	-1.59	-0.08	-1.44	-1.42	1.92	-0.70	3.58	-0.69	-3.61
R^2	0.92	0.89	0.97	0.90	0.91	0.80	0.94	0.90	0.90	0.96
D-h	0.127	-1.5	1.83	-0.73	0.66	1.84	6.109	2.21	-0.72	2.88
Chow Test	7.44		19.55		0.91		0.48		24.20	