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Title: An Economic Evaluation of Yield Grade Standards for Canadian Carcass Beef

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The basic objective of this thesis was to estimate the economic effects of yield grade standards for carcass beef on the various market sectors of the Canadian beef industry. The adoption of the standards was expected to enhance consumer demand, improve efficiency within the processing and marketing services sectors, and improve resource allocation and revenues of livestock producers.

A conceptual model showing the interrelationships among market sectors was developed and formulated into a system of equations for econometric estimation. The model contained variables relating to the supply and demand of market participants affected by the change in grading standards. Measurement of these variables was based on published quarterly data, including four years of yield grading, over the 1961-76 period.

The statistical results showed a significant economic

variables relating to the supply and demand of market participants affected by the change in grading standards. Measurement of these variables was based on published quarterly data, including four years of yield grading, over the 1961-76 period. Binary variables were incorporated in the model to identify any structural change in the relationships coincident with the grade change.

Problems in estimation arose due to the simultaneous nature of the model, and intercorrelation problems involving predicted prices for adjacent market levels in certain structural equations. Two alternative specifications of the processing and marketing services relationships were formulated to address this problem. First, variables relating to demand at the adjacent market level were substituted for the corresponding price. The second method involved the ratio of adjacent market level prices. Both specifications resolved the problem, but in the substitution case intercorrelation was transferred to other variables. Estimates of the parameters of the various equations were obtained by using the two stage least squares regression procedure.

The statistical results showed a significant economic impact of yield grades, as measured by the slope and intercept binary variables, in the estimated retailer demand and producer supply equations. But, these results cannot be considered conclusive. A lack of information concerning

impact of yield grades, as measured by slope and intercept binary variables, in the estimated retailer demand and producer supply equations. But, these results cannot be considered conclusive. A lack of information concerning historical costs in the processing and marketing sectors necessitated the use of proxy variables which may not have accurately captured the full impact of the grade change. A further problem was that potential yield grade adjustments in carcass weights were dominated by the effects of rapidly rising feed grain prices throughout the grade change period.

An Economic Evaluation of Yield Grade Standards for Canadian Carcass Beef

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Oliver Glenn Dawson

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CHAPTER I

INTRODUCTION

The primary purpose of this study is to investigate the significance of quality standards in determining prices for slaughter cattle and beef in Canada. Specifically, the industry change to a yield grade system in 1972 is evaluated in terms of its impact on industry supply and demand conditions. An attempt is made to quantify two types of adjustments. First, on the demand side, the change in standards is evaluated according to impacts on both consumer demand for beef as well as demand faced by the producer of slaughter cattle. The second type of adjustment relates to producer supply responses in terms of numbers and weights of animals produced.

Decisions to adopt, or change grading systems for beef, as well as other commodities, have been largely the result of competitive pressures in the markets. Theoretically, grading provides a means of commodity differentiation, somewhat synonymous to product differentiation, and the potential to increase aggregate demand for the commodity.

It is of interest to determine the extent to which the theoretical benefits of a grading system are realized and the distribution of these benefits within the market channel. In this study it is postulated that the net benefits to producers of a change in grading standards can be evaluated with reference to prices as determined by adjustments in market demand and supply conditions.

It has been argued that the pricing system in a free enterprise, competitive economy operates to allocate resources efficiently and provide an incentive to improve product quality [Adam Smith; Quirk and Saposnick. p. 125]. The price system is therefore charged with the responsibility of organizing economic activity to provide the goods and services desired by its participants. Prices provide the incentive for producer allocation of resources to the production, processing and distribution of products. Prices are also the determinants of the beneficiaries of production in terms of end users and distribution of income.

The key to efficient organization of economic activity is the availability and accuracy of market information. Consumers (buyers) and producers (sellers) must possess sufficient information to evaluate product characteristics and alternatives according to their respective want satisfying and income generating potentials. Specifically prices must relate to units of a product that are homogeneous, in certain identifiable characteristics, in the

eyes of both buyer and seller. In the case of food, the information requirement is perplexingly entangled with qualitative variations in physical characteristics and preferential differences among buyers.

Agricultural commodities are heterogeneous collections of goods possessing similar properties. Individual units may vary in age, size, shape, color and texture, as well as in other less observable characteristics. Factors contributing to this variability range from production conditions such as weather, location and management practices to genetic characteristics instilled by the use of different varieties, strains, or breeds of plants and animals. Within commodity groups perceived qualitative variations can have real as well as imaginary effects in determining value in particular end uses. For example, egg size and color, animal age and sex, fruit variety and shape, and vegetable color and texture are generally accepted as important qualitative characteristics. Although certain of these visual criteria may be questionable in terms of use value they are known to influence buyer decisions in the market place. As a result, the price of an unsorted commodity may not reflect all information concerning alternative end use values or buyer preferences.

The major economic inducements for qualitative stratification or grading of a commodity are the improvement of functional efficiency within the market. Marketing

efficiency, that is, how well marketing tasks are accomplished, is separable into two parts [Kohls 1967, p. 11]. Operational efficiency relates to the costs of performing the physical functions of assembly. processing. storage, transportation, and distribution which add form. place and time utility increments to products. The second component, exchange or pricing efficiency. involves the co-ordinating activities necessary in the performance of the physical marketing functions, these include the buying and selling function, which determines price, and the reporting function of disseminating price information. "The key to the achievement of both operational and pricing efficiency is the existence and transmission of complete and accurate market information" [Dahl 1977, p. 203].

The potential benefits inherent in a standardized system of commodity grades have been well documented [Williams 1962; Williams and Stout 1971; Shephard 1962; Dahl and Hammond 1977]. In general. at least from a theoretical point of view, marketing costs can be reduced through buying and selling according to grades. thus eliminating the time and cost involved in selection and bargaining over qualitative attributes. Accurate product specifications may also facilitate wider procurement and market boundaries, and encourage larger. more efficient processing and distribution facilities near raw material supplies and demand centers. Improvements in operational

efficiency (cost reductions) may increase producer total revenues either directly in the form of higher prices. or indirectly through increased sales at existing prices.

In terms of pricing efficiency. market information takes on increased meaning when prices and volumes relate to uniform classes of a commodity at specific locations. Grades provide a universal language by which qualitative variations in the supply can be identified and interpreted by market participants. Accurate price information facilitates the allocation of available supplies among alternative demands, and improved production decisions concerning future supplies.

The development and implementation of grading schemes have been primarily in the name of improvements in one or both of the components of marketing efficiency. For example, the need for more accurate price reports led to the promulgation of Federal grades for beef in the United States. Similarly, demand for improved qualitative as well as quantitative measures of end use values stimulated the incorporation of yield grade standards for carcass beef in Canada. In these cases, as with many efforts to attain commodity standards, the initial motivating force underlying the need for change was producer efforts to improve their economic well-being. Regardless of the source or reason for change, adjustments in quality standards may affect the costs and revenues of all segments of the market channel.

From an economic point of view the impact of grading standards on market prices and price relationships. as well as on supply and demand conditions in the market, are important considerations.

When viewed in the context of price theory. the economic rationale for commodity grading can be interpreted as a means of manipulating industry supply and demand schedules in such a way as to positively influence the revenues of one or more sectors of an industry. Conceptually, the demand faced by a sector of an industry is derived from the aggregate demand for final products. and is the difference between aggregate demand and the sum of marginal costs incurred between that sector and the final consumer. The interaction of appropriate supply and demand functions determine prices at each level of the market channel. In this study the economic effects of yield grade standards for carcass beef in Canada are evaluated within this price theory framework.

1.1 Beef Carcass Grading

Beef carcass grading has long been an institutionalized part of the Canadian beef industry structure. The Federal Grading Act of 1929 provided for "choice" and "good" carcass identification to be carried out under the supervision of government inspectors at the option of the packer. Many changes have since expanded and refined the system to serve

the needs of various industry sectors. Major changes established the service as a government function (1942). and expanded the system to include all mature classes of beef animals (1943). Revisions in the Grading Act of 1947 were designed to broaden the scope of grading by attempting to provide a means of producer settlement consistent with consumer preferences. Quality connotative grade names were reinstated in 1958 in order to provide a vehicle for product promotion at the consumer level. Changes in quality standards and yield assessment incorporated in the Grading Act of 1972 were expected to more accurately reflect consumer preferences and retail value.

Historically, developments in Canadian beef carcass grading, like those in the United States. have been..."conceived and born in controversy generated by conflicting economic interests..." [Rhodes 1960]. Initially, the United States Department of Agriculture sought grading as a means of providing a uniform language to facilitate development of a market news reporting service in 1916. Later, producer groups pressured for grading as a vehicle for the promotion of their respective types of beef. Conflicts between these and other producers, and packers precipitated the Kansas "Better Beef Convention" of 1926. The U.S.D.A. launched an official voluntary grading system for carcass beef in 1927 following an agreement reached between packer and producer representatives. Smith reports

events leading to the 1929 inauguration of a similar Federal Beef Grading Service in Canada based on the recommendations of a "Joint Beef Committee" appointed in 1927. A major issue faced by the committee was producer concern over the market's failure to identify sources of price variation within and between wholesale markets [Smith et al., 1974. p. 12]. Controversy over the relevance of subjective conformation standards as a determinant of either quality, or yield of salable meat surfaced at the "Canadian Beef Improvement Conference" in 1966. The dispute was eventually resolved, culminating in a joint brief prepared by the Meat Packers Council, Canadian Cattlemen's Association, and Canadian Federation of Agriculture in 1971, and the passing of the Beef Carcass Grading Regulations the following year.

The primary motivating forces underlying the evolution of beef grading have been economic in nature and, to a large extent, have originated within the livestock producing sector. Most changes have been aimed at improving market information as a means of enhancing industry performance. Producer grading resolutions have emphasized the need for a uniform system of grades to (1) reflect consumer preferences, (2) promote competition, (3) reduce marketing costs, (4) improve pricing accuracy, and (5) provide a basis for advertising and promotion. Retailers have relied on the system to identify quality differences, facilitate advertising, and more recently as a partial indicator of

cutability. Packers, although supporting the need for carcass classification, have often resisted change on the basis of merchandising complications, costs, accuracy of standards, or problems of relating standards to live animal characteristics. The economic implications of proposed changes in grading standards have been in the best interest of the proponent, but not necessarily in those of other industry participants, or the industry as a whole. Distributional effects have been an important source of conflict over grading issues.

1.2 Problem Situation

There is a need for an economic evaluation of yield grade standards for carcass beef. Standards may affect the accuracy and relevance of price information, and as a result influence pricing and operational efficiency in the market, as well as resource allocation within the industry. This is especially true in the case of current yield grade standards which, unlike previous standards, discourage carcass fat content. Producer adjustments may be limited to either (1) reduced carcass weight with existing breeds, or (2) utilization of larger breeds and crossbred animals which attain acceptable carcass weights without excessive fat deposition. Reduced fat content also has implications for processing and retailing efficiency, and is a component of consumer quality evaluations.

The economic impact of changes in carcass grading standards is complex. Factors such as the industry structure, trade practices, seasonal and cyclical marketing patterns, and accuracy of standards in measuring real quality or value differences complicate unequivocal determination of the economic benefits or costs associated with grading modifications. Decisions to adjust the system suggest some anticipated net benefits to the industry. but effects on industry supply, demand, prices, or costs have generally not been established.

Research work concerning the economic impact of yield grading is sparse. That work which is available has been specific to a particular aspect or component of the system and has not addressed some of the more general economic concerns. Technical issues such as accuracy of yield predictions for specific grades or types of animals, and price differentials in relation to yields or sexes of animals have been investigated. The result is a less than systematic body of knowledge.

A second problem is that economic studies relating to beef grading have generally paid little attention to the components of demand or supply at the various levels within the market system. Proponents of the change, primarily producers, anticipated increased revenues through the positive effects of the change on consumer demand and on reduced production and marketing costs within the industry.

Demand studies generally have considered beef in the aggregate and do not lend to generalizations concerning particular qualities or levels within the market channel. On the supply side studies have ignored the possible consequences of the yield grade system (eg. Haack et al., 1978).

Available research identifies alternative means for improving the accuracy or effectiveness of the yield grade system. These works are, however, not conducive to an economic evaluation of proposed modifications. Such deficiencies suggest a need for a comprehensive body of economic knowledge as the basis for determining demand, supply, and price adjustments, as well as the distributional effects of changes in grading standards.

1.3 Purpose and Scope

A major purpose of this dissertation was to construct an analytical framework in which the economic implications of changes in beef grading standards can be evaluated. Emphasis was placed on demand, supply and price relationships surrounding the adoption of yield grade standards for carcass beef in Canada. The study was confined to qualities of beef entering the retail or fresh markets. These grades constitute 75 to 80 percent of the total industry supply in Canada, and are almost entirely limited to immature, feedlot-finished animals. Although

research has been done to investigate the acceptability and technical limitations of the yield grade system. no attempt has been made to quantify the economic implications of yield grade standards.

1.4 Research Objectives

The overall research objective was to evaluate the economic impacts of yield grade standards in the markets for Canadian slaughter cattle and carcass beef. In meeting this objective certain sub-objectives were necessary to identify effects on components of supply for beef, and price relationships in the markets. More precisely, the sub-objectives were:

1) to determine the impact of yield grades on beef carcass weights,

2) to evaluate the effect of the change in quality standards on consumer demand for beef. and

3) to determine the effect of the change in grading systems on Canadian trade in fed beef with the United States.

It was anticipated that the adoption of yield grade standards was not a factor in consumer demand for beef. The system primarily relates to external fat thickness on carcass beef which determines the extent of retail trimming prior to purchase by consumers. The anticipated reduction in carcass weights and fat cover were, however, hypothesized

to have a significant positive affect on the trading relationship with the United States. In total. demand faced by producers was expected to increase as a result of industry savings in fat trim losses, labor requirements. and buying and selling costs.

1.5 Data Sources

The circumstances out of which the study objectives and hypotheses emerge dictates the use of published aggregate price information concerning beef industry supply and demand conditions spanning two methods of carcass grading. Geographical separation of markets and availability of price data limit the study to major producing and consuming centers. Prices recorded at the Calgary and Toronto markets were assumed representative of supply conditions in the two major producing regions. Similarly. carcass prices reported by the major consuming regions of Montreal. Toronto. and Calgary were used in the study. Quarterly price information for the period 1961 to 1976 form the basis for analysis. This period includes the four years following the adoption of the yield grade system.

CHAPTER II

THE CANADIAN BEEF INDUSTRY

The beef industry constitutes an important component of the Canadian agriculture economy. In 1976, the industry generated about one-fifth of the total farm receipts. On a regional basis, more than 60 percent of the revenues from cattle and calf sales were recorded in western Canada with Alberta contributing approximately one-third of the nation's total. About 80 percent of eastern Canadian sales were reported by Ontario (Appendix A). Of the more than 366.000 farms included in the 1971 census for Agriculture. over two-thirds reported a cattle enterprise. Statistics Canada indicated 15.1 million cattle and calves on farms during 1976. This total consisted of 5.9 million beef cows and heifers, 2.4 million steers, 4.0 million calves. 2.5 million dairy cows and heifers, and about 0.3 million bulls [Statistics Canada, cat. No. 23-004].

When viewed as a production and marketing system the beef industry is an aggregation of six major sub-systems starting with the cow-calf and cattle feeding sectors. and culminating with the retail sector providing meat to consumers. The animal production and consumption

sub-systems are linked by marketing, processing, and transportation services. Geographical separation of producing and consuming regions has been an important factor in determining the complex structure of the industry. About 80 percent of the beef cows, 20 percent of the dairy cows, and 65 percent of the slaughter capacity are located in western Canada (Table 2.1). This region accounts for less than 30 percent of the Canadian population. As a result, large flows of feeder cattle and beef from the western region are necessary to meet the needs of the eastern consumer.

TABLE 2.1 REGIONAL DISTRIBUTION OF BEEF INDUSTRY PRODUCTION AND PROCESSING CAPACITY, 1975

Region	Population (a) (000's)	Beef Cows (b) (000's)	Dairy Cows (b) (000's)	Slaughter Capacity (c) (head/week)
West	6,205	3,525	447	60,795
East	16,659	850	1,688	32,864

Source: a) Canadian Statistical Review, Statistics Canada (cat. No. 11-003)
b) Report on Livestock Surveys, Statistics Canada (cat. No. 23-004)
c) Beef Processing Capacity, The Food Prices Review Board

2.1 Livestock Production

2.1.1 Cow-Calf Production

Feeder cattle and calves destined for the beef industry

originate with the cow-calf sector of the industry and cull dairy-cattle and calves. Traditionally, the cow-calf sector has been an extensive form of agriculture endeaver requiring large acreages of abundant forages. Competitive pressures from other land uses, such as crops and dairy, have resulted in cow-calf production being primarily located in semi-arid, remote, and rough topographical areas of western Canada. Similarly, dairy production has centralized in close proximity to major consuming areas. Feeder animals move from these areas to feedlots in grain producing regions for further finishing.

2.1.2 Feedlot Production

Consumer demand for more highly finished beef has resulted in the beef feedlot sector becoming a well established sub-system of the beef industry. The location of feed grain supplies has been of critical importance in the location of fed beef production. Since it has been generally less expensive to move cattle to feed grains than the converse, feedlots have located in areas of surplus feed grains. In Canada these areas are primarily in southern Alberta and Ontario. An estimated 300,000 to 500,000 feeder calves and yearlings move by rail each year from the four western provinces to feedlots in Ontario [AERC, p. 01]. These animals account for about one-half of Ontario's fed beef production. Geographical separation of livestock

producing from consuming regions has important implications for pricing efficiency in the markets for livestock and beef.

2.2 Livestock Marketing

The role of the exchange mechanism in the market is to facilitate title transfer, and to formulate and communicate price and price related information in the market. In the beef industry this system comprises a variety of agencies involved in accomplishing the flows of calves, feeder cattle, and slaughter animals between regions and sectors of the industry. Producers utilize public livestock markets (PLM'S), country auction markets, and various direct selling methods. With the exception of the producer operated "Can-Fax" market reporting system, the PLM'S are the only source of daily market information. Certain local auction markets also publish news letters concerning their respective sales.

Public livestock markets, like terminal markets in the United States, have experienced a downward trend in both volume and market share. Table 2.2 indicates the disposition of cattle from the nine Canadian public markets during 1974. Although there is no objective means of determining the sales volume necessary for a market to be representative, it is apparent that certain markets are of greater significance than others for specific classes of

cattle sales. For example, almost half of the feeder cattle sales reported by PLM'S in Canada were recorded by the Edmonton market. Similarly, the Toronto. Calgary. and Winnipeg markets demonstrate substantial slaughter cattle activity.

TABLE 2.2 DISPOSITION OF CATTLE FROM PUBLIC LIVESTOCK MARKETS IN CANADA - 1974
(Number of Animals)

Market	Slaughter	Feeder	Other	Export	Total
Calgary	156,951	46,188		304	203.443
Lethbridge	6,709	7,090		83	13.882
Edmonton	65,685	118,449		1,129	185.263
Regina	24,662	28,102	3.111	19	55.894
Saskatoon	49,268	27,904	129		77.301
Prince Albert	23,077	21,132	1,069		45.278
Winnipeg	130,520	40,025	7,703	338	178.586
Toronto	389,666	60,122			449.788
Montreal	60,414	135	133	4,825	65.507
Total	906,952	349,147	12.145	6.698	1,274.942

Source: Livestock Market Review. 1974, Agriculture Canada

Direct sales of slaughter cattle by producers to packers, on a live-weight basis, has increased substantially in recent years. This trend is primarily the result of larger, more knowledgeable producers' efforts to gain greater control over sales of their animals and simultaneously reduce marketing costs. Producers using this method of selling are able to negotiate the price as well as the terms of sale prior to the animals leaving the feedlot.

During 1974, 55 percent of slaughter cattle sales were direct to packers, 30 percent were sold at public markets. and 15 percent were marketed at country auctions [Beef Inquiry Report, p. 18]. During the past two decades the public market's share of federally inspected cattle and calf slaughter has declined by more than 20 percent [Lowe 1976]. In the United States direct purchases of slaughter cattle by packers increased from 63 to 73 percent, terminal marketings declined from 21 to 12 percent, and auction market sales were stable at about 15 percent between 1969 and 1973 [USDA Packers and Stockyard Administration Report 1973]. On a regional basis, Table 2.3 indicates that, with the exception of British Columbia where there are no public livestock markets, the proportion of slaughter cattle purchased at public markets is lowest in the largest feeding area.

Table 2.3 LIVESTOCK RECEIPTS AT PACKING PLANTS-1974

Province	Public Markets	Other	Total	PLM Share
British Columbia		56,415	56,415	
Alberta	229,345	918,627	1,147,972	19.8
Saskatchewan	97,007	133,700	230,707	42.2
Manitoba	130,520	283,422	413,942	31.4
Ontario	389,666	503,878	893,544	43.7
Quebec	60,414	69,723	130,137	46.2
Atlantic Provinces		31,771	31,771	
Total	906,952	1,997,536	2,904,488	31.2

Source: Livestock Market Review, 1974. Agriculture Canada

The trend toward increased direct marketing of slaughter cattle raises serious questions concerning the relevance of public market information as an indicator of slaughter cattle market conditions. Should this trend continue a point will eventually be reached at which the gains in operational efficiency (reduced marketing costs) through direct marketing are more than offset by reduced pricing efficiency (accuracy and timeliness of price information) unless alternative sources of market information are developed. Prices reported from public market sales are the only available source of slaughter cattle market information published and distributed throughout the industry. For the purpose of this study it is assumed that prices recorded at the Calgary and Toronto public yards are representative of market conditions in the western and eastern regions of the country respectively. The Calgary facility accounted for about 68 percent of the 1974 Alberta total slaughter cattle sales through public markets. It is further assumed that interrelationships between markets, within regions, result in arbitrage and that a particular market cannot function independently as the price setting force in a region.

2.3 Slaughtering and Meat Processing

The slaughtering and meat packing sector of the beef

industry constitutes a complex of types and sizes of operations ranging from small country abattoirs to large. multi-species, full line plants involved in slaughtering and processing meats and by-products. Regulations restrict the movement of beef across provincial and international boundaries to meat originating from federally inspected facilities. Plants shipping to the United States are also subject to United States Department of Agriculture (USDA) standards. Approximately 85 percent of the cattle and calf slaughter is under federal government inspection and grading [AERC, p. 92]. During 1975 there were 477 federally approved plants employing over 33,000 people in operation in the country [Meat Packers Council 1977]. The major packers (Canada Packers Limited, Burns Meats Limited, Swift Canadian Company Limited, and Intercontinental Packers Limited) are large multi-plant firms involved in all aspects of the processing industry. These firms account for more than one-half the Canadian total and three-fourths of the western regional federally inspected cattle and calf slaughter.

In recent years the cattle slaughtering function has centralized in areas close to fed cattle supplies. In Ontario, these areas border major population centers. Plants in the region are characteristically "full line" operations supplying meat and meat products to surrounding markets. Ontario is approximately self-sufficient in fresh beef requirements. Dependence upon interregional and

international shipments of beef has been a major factor in the development of western Canadian packing plants. Although a small number of "full line" plants are in operation, most have been replaced by smaller, specialized "single-line", or "kill-chill-ship" facilities. These plants provide only limited cold storage capacity, and depend primarily on in-transit aging of beef. About one-third of the Alberta slaughter is shipped by rail to the Montreal market [AERC, p. 7].

A survey of the meat packing industry conducted by the Commission of Inquiry into the marketing of beef and veal in Canada, indicated that packing plants do very little processing beyond the carcass or primal state. "Carcass shipments represented 9.5 million cwt. or 76.4 percent of the 12.4 million cwt. of shipments made by the packers sampled" [Commission Research Report No. 1, 1976]. These results clearly indicate the prevalence of specialized plants in the western region to serve the beef deficit eastern region.

2.4 Beef Wholesaling

Wholesaling includes the performance of all activities and functions necessary to facilitate the movement or flow of beef between meat packing plants and retail stores. In Canada two distinct groups are involved in wholesaling beef: the packers, and the Montreal wholesalers. Outside of

Quebec the function is integrated with the slaughtering and processing functions. Local sales are either direct to retailer operated stores and centralized cutting facilities, or to firms specialized in further processing. Full-line packing plant sales may range from carcasses to boxed beef or primal cuts, and packaged processed meat products. Specialized plants are limited to the carcass market. Major packers operate branch houses to receive, process, store and distribute meats in markets more distant from plant facilities.

The Montreal market is unique in the distribution of beef in Canada in that packer branch houses and similar facilites operated by independent wholesalers are involved in the market. Montreal wholesalers are an important component of the beef system. They serve the second largest metropolitan area and the largest beef deficit area in the country. The flow of beef from Alberta to Montreal, amounting to about 6.3 million pounds per week, is the single most important market for surplus Alberta beef. Although Montreal is the most visible pricing point for beef in Canada, research conducted by the Agricultural Economics Research Council (AERC) concludes that the Toronto market is the dominant force in the market [AERC, p. 41]. Toronto's location between Montreal and major United States markets and the ease at which beef moves across the international boundary suggests Toronto prices should be highly responsive

to changing conditions in the U.S. markets for both live steers and for beef. The AERC discovered that 97 percent of the weekly variability in the Montreal wholesale A1-A2 steer carcass price could be explained by Toronto and Calgary A1-A2 steer prices, Toronto wholesale steer carcass price. and boneless imports of U.S. beef [AERC, p. 40].

For the purpose of this study. Calgary and Toronto wholesale prices, as reported by the Marketing Services Division of Agriculture Canada, are assumed representative of market conditions in western and eastern Canada respectively. Because there is no market facility for the exchange of beef products, reported prices, derived from weekly surveys of packers, are the best available source of wholesale market prices. These prices are suspect since they relate to asking prices and are not weighted by volumes of actual sales.

2.5 Beef Retailing

Food retailers are the final link between producers and consumers in the beef system. This sub-system includes grocer and independent butcher, as well as, hotel. restaurant, and institutional establishments. In terms of the value of beef sales, the retail grocers are by far the largest and most powerful segment of the retailing sub-system [Beef Inquiry, research report No. 1. p. 64]. Nationally, food retailing is dominated by corporate and

voluntary chains. Statistics Canada estimated that in 1972 corporate and voluntary chain sales represented 54.6 and 27.7 percent respectively of total food sales in Canada [Statistics Canada, Census of Canada. 1972]. The five largest chains (Loblaws, Dominion, Safeway, Steinbergs, and AP) account for more than 97 percent of chain store sales [Canadian Grocer, Feb. 1976]. Regionally, these firms operate 323 of 484, or 67 percent of the chain stores in the west and 853 of 1084, or 79 percent of the eastern facilities. In the west, 245 of the major chain stores are controlled by Safeway (Appendix A, Table 4). Centralized purchasing and involvement in processing facilities give the major chains considerable influence in the beef system.

Traditionally the role of the retailer has been the purchasing, further processing, and packaging of carcass beef into products for sale to consumers. In recent years technological advances in meat processing have made possible centralized breaking of carcasses and greater involvement in processing by wholesalers. Primal and boxed beef cuts represented almost one-fourth of the 1974 beef shipments by packers surveyed by the Beef Inquiry [Commission report p. 22]. Two major chains, Steinbergs and Safeway, operate centralized procurement, processing, and distribution facilities to service their many stores. Independent wholesalers and packer branch houses offer storage and processing services to meet specific retailer requirements.

The image of beef in the retail store has been a major factor in determining chain store purchasing policies. All chains concentrate on the highest quality grades of beef and display this policy to consumers. Prior to the change in grading standards "choice" beef was emphasized; since 1972 the "A" grade carcasses and particularly A1 and A2 have been specified. Certain large chains such as Dominion and Boeuf-Merite have a policy of purchasing only A grade steer carcasses [Commission of Inquiry, Report No. 1, p. 68]. Such rigid quality specifications by major chains handling the bulk of retail beef sales can have a significant impact on pricing efficiency within the beef system. Carcasses not qualifying for the major chain trade can be heavily discounted in the market. Retailer buying policies are therefore an important factor in the choice of grade standards by the industry.

CHAPTER III

ECONOMIC CONSIDERATIONS IN BEEF GRADING

The major force underlying the development of official grades for beef has been the potential improvement of market information as a means of promoting quality improvement and more efficient resource allocation. Theoretically, variations in preferences and degrees of substitutability between grades generate price differentials in accordance with relative supply and demand conditions. Differences in prices for the various grades, in relation to their production costs, affect producer net revenue and become the basis for producer adjustments. Reductions in marketing costs due to grading are also expected to benefit producers either directly through higher prices, or indirectly through the effects of increased consumer demand at existing prices. A basis for grading exists if 1) quality attributes are present in varying degrees, 2) consumers consider these attributes as a basis for acceptance or rejection, and 3) the attributes are not readily distinguishable to consumers [Williams and Stout p. 479].

3.1 Basis for beef Grading

The supply of carcass beef constitutes a heterogeneous

group of products originating from a variety of breeds, types, weights, sexes, and ages of slaughter cattle. Accordingly, these products vary greatly in such physical characteristics as shape, color, texture, distribution of lean and fat, and total composition of lean, fat, and bone. Carcasses also vary in quality. Differences in eating characteristics of taste, tenderness, and flavor (ie., dimensions of quality), have been detected by consumers. Research evidence suggests factors such as degree of marbling, color, texture, and extent of fat and bone trim, as well as price, may act as surrogate indicators of quality, and influence consumer preferences [Dunsing p. 336; Miller et al., p. 28; Juillerat, p. 771; and Danner]. Research evidence also suggests that consumers are not alike in their definition of quality [Rhodes et al., 1955 p. 20].

Retailers have also developed procurement standards based on the degree of presence or absence of certain physical characteristics as indicators of carcass yield of salable meat. Buyer specifications are by nature subjective. Precise criteria for stratifying physical characteristics (conformation criteria) as indicators of either eating qualities, or yield of salable meat have not been developed. As a result retailers may vary in their perception of consumer preferences, as well as in the qualitative or quantitative predictive power of specific carcass characteristics. Product specifications are

buyer-specific according to the retailers subjective assessment of perceived carcass characteristics and consumer-preference criteria in relation to aspects of profitability.

Individual rankings of groups, and subsequent differences in prices the various buyers are willing to pay. are projected back to producers through packer subjective evaluation and purchase of slaughter cattle. In the absence of official stratification criteria, market prices become confounded with differences in preferences and procurement practices of the various packer and retailer buyers. As a result, prices alone may not reflect to sellers what qualitative factors are important to buyers. An official grading system requires industry identification of classification criteria and acceptance of the resulting classes or grades as the basis for commodity trading within the industry. Such a system does not impose constraints on the preferences of traders, but simply relates prices to smaller, more homogeneous units of the commodity. Buyers may continue to impose their individual specifications on the market; their purchases, however, become translated into demand for the recognized grades from which selections were made. Grades provide a uniform language and mechanism for relating prices with quality differences within and between markets. For example, a grading system may allow consumers to reflect their varied preferences for beef in

the form of demand for different qualities. The ensuing price differentials may then be reflected to producers as a basis for quality adjustment in line with profit maximization criteria.

The efficacy of official grades is largely determined by the nature of the standards and their accuracy relative to existing buyer or consumer criteria in identifying important quality variations. Producer benefits and incentives to adjust or improve product quality are contingent upon price differentials relating quality differences in terms of characteristics over which the producer exercises some control. For example, price differentials generated through buyer reaction to maturity standards influence producer decisions concerning the age of slaughter animals. Buyer response to grades in the form of differences in willingness to pay, on the other hand, depends on the accuracy of grades in identifying preferences. Should grades provide a more accurate means of carcass selection than buyer standards, marketing costs may be reduced through displacement of costly buyer carcass selection with grade specification buying. An official grading system is, therefore, potentially more efficient than a network of individual buyer standards. The choice of classification criteria is an important factor in determining the extent of potential economic benefits realized by market participants through the adoption of an

official grading system.

3.2 Components of Beef Grading

Historically, beef quality grades have been determined jointly by characteristics selected as indicators of palatability and conformation. Factors such as maturity, color and texture of lean and fat, and marbling have been accepted by the beef industry as important to consumers. Marbling, or within-muscle fat deposition, has been associated with the palatability determinants of taste, juiciness, and flavor, and to a lesser extent with tenderness. Maturity, as measured by the degree of cartilage ossification, has been designated as the primary indicator of tenderness. The combination of marbling and maturity has had the greatest significance in quality grade determination. Conformation, which refers to visual assessment of carcass composition and distribution of fat, bone, and lean meat among the high and low-valued cuts, has been the basis for quantitative carcass evaluation. Since objective measures of quality and yield have not been available, standards have continually been the subject of controversy. For many years high levels of fat were accepted as the standard; Danner concluded that color of meat was the most important criterion and consumers visually discriminate against fat [Danner 1959].

Many studies have attempted to substantiate the role of

the various components of beef grades. Growth studies have generally found slaughter weight in relation to mature animal weight as the major determinant of carcass composition [Ellis 1974; Hendrickson and Monroe 1965; and Hedrick 1968]. These studies have also shown that as animals mature muscles become coarser, darker, stronger in flavor, and decline in moisture content. Dunsing reported visual and eating preferences of a consumer panel were significantly related to carcass age but not to grade. Eating preferences consistently favored steaks from younger carcasses. Visual characteristics of color and marbling were rated higher for older carcass short loins and younger carcass sirloins [Dunsing 1958]. This evidence suggests that existing maturity standards are probably closely aligned with carcass tenderness. There is, however, no substantial evidence to support high levels of fat deposition as a quality indicator. Field, Seuss, and others have found only weak relationships between marbling score and beef tenderness, juiciness, and flavor [Field et al., 1966; Seuss et al., 1966]. Blumer reviewed studies involving over 2,600 carcasses and found marbling accounted for about 5 percent of the variation in tenderness, and fat content explained only 16 percent of the variation in juiciness [Blumer 1963]. Parish in a study of the effect of degree of marbling on eating quality concluded..."internal cooking temperatures of rib steaks is

a much more important factor in palatability than marbling, and that degree of marbling, and its interaction with internal cooking temperature, have essentially no effect on palatability characteristics" [Parish et al., 1973]. These results tend to suggest that marbling is perhaps not a reliable indicator, and that several factors may influence quality.

The importance of marbling standards is further questioned by research evidence suggesting that high marbling scores may be synonymous with high levels of external fat deposition. Hedrick, in summarizing the works of Andrews (1958), Callow (1948), and Zinn (1967) states: "Fatty deposits appear in younger animals around viscera and kidney and, with increasing age and adequate caloric intake, between the muscles (intermuscular fat), beneath the skin (subcutaneous fat) and, lastly, in the form of marbling (intramuscular fat) between the muscle fibers" [Hedrick p. 15]. This evidence suggest that consumer preferences for low external and intermuscular fat levels are not compatible with high marbling content. An increasing body of research also suggests that carcass yield of salable meat declines as the level of external (subcutaneous) fat thickness increases [Fredeen et al., 1971; Cole et al., 1960; Cramer et al., 1964; Schupp et al., 1965; and Berg 1966]. These results not only question the merit of high marbling scores, but also the validity of conformation criteria which encourage

high levels of surface fat.

Conformation has for many years been incorporated in quality standards and provided a means of assessing relative carcass value in terms of salable meat. The relevance of conformation for either purpose has, in recent years, been questioned. Based on a survey of many studies, Hedrick concluded that "conformation as measured subjectively today is not a significant factor in the cutability of beef carcasses" [Hedrick p. 52]. Two thoroughly documented studies by Fredeen investigated the relevance of conformation criteria in identifying real differences in carcass yield of salable meat. The conclusions reached in these studies were that, after accounting for fat content, measurements of physical carcass characteristics associated with conformation were not significant factors in predicting yield, and that these results were independent of carcass type (ie. beef or dairy) [Fredeen 1970; Fredeen et al., 1974]. These and other studies determined that fat thickness, and rib eye area were closely associated with carcass yield variability.

3.3 Canadian Beef Grading System

The 1972 revisions to the Canadian beef carcass grading system involved the separation of qualitative and quantitative carcass characteristics in an attempt to reduce the degree of subjectivity embodied in carcass evaluation.

Under the new system, conformation standards as well as quality connotative grade names were replaced by a new definition of quality and an objective measure of carcass yield or cutability. The system was based heavily on research carried out by Fredeen at the Agriculture Canada Research Station at Lacombe Alberta, and industry discussions. Like the previous system, yield grading was offered on an optional basis as a free service of Agriculture Canada.

3.3.1 1958 Grading Standards

Under the previous grading system, slaughter cattle were classified into eleven classes or grades based on maturity and conformation criteria. Youthful animals, primarily from feedlots, were graded "choice", "good", and "standard" according to the degree of fatness. Conformation criteria required that the entire surface of carcasses be covered with fat in order to grade choice. Underfinished carcasses were labelled either standard or Utility 1, and over fat carcasses were graded Commercial 3. A description of the pre 1972 standards is presented in Appendix B. Prior to the change in grading standards youthful carcasses represented about 73 percent of the inspected slaughter of which 90 percent graded choice or good, eight percent standard, and about two percent commercial 3 [Livestock Market Reviews].

3.3.2 1972 Yield Grade Standards

In general, the yield grade system entails the assignment of carcasses into one of five major quality groups (designated by letter grades), two of which (C and D) are further stratified resulting in nine quality grades. The two immature, or youthful quality grades, A and B, are subdivided according to four fat levels to indicate differences in retail yield. A summary of yield grade standards is presented in Appendix B. In comparing the previous and present standards it is evident that no immature class has a counterpart in the other system (Table 3.1).

TABLE 3.1 COMPARISON OF 1958 AND 1972 BEEF GRADING CLASSIFICATIONS

1958 Classes	1972 Classes
Canada Choice, Good, Standard, and Commercial 3	Canada A
Canada Choice, Good, Standard, and Commercial 1, and 3	Canada B
Canada Commercial 1 and 2	Canada C
Canada Commercial 1 and 2, and Utility 1	Canada C 2
Canada Utility 2	Canada D 1
Canada Utility 2 and 3	Canada D 2
Canada Utility 3	Canada D 3
Canada Utility 1 and Manufacturing	Canada D 4
Canada Bull	Canada E

However, the choice and good grades of the previous system and the A and B designations of the present system do

account for the majority of fresh retail beef trade.

The need for revisions in the 1958 grading standards surfaced at the 1966 Beef Industry Conference held in Winnipeg, Manitoba. All major sectors of the industry expressed dissatisfaction with the accuracy and relevance of the existing standards. The retail sector claimed excessive fat levels in the choice category and the inadequacy of grades in describing buyer specifications; packers complained of losses in trimming excess fat from carcasses to avoid down grading to commercial 3; and producers indicated that if fat was not desirable then standards had to be revised to indicate the kind of carcasses the market required [Fredeen 1975]. An industry committee, representing all segments of the industry, was formed to study and recommend solutions to the issues presented at the conference. A research program was carried out, and the results provided the basis for incorporating yield grade standards in 1972.

The essential features of the yield grade system are the de-emphasis of fat and the use of fat thickness as a quantitative indicator. Quality, the potential cooking and eating characteristics, is determined primarily by maturity and texture assessment with some consideration given to color and marbling. Immature carcasses having bright red, firm, fine-grained lean meat with some marbling, and a firm, white fat cover qualify for the highest grade designation.

Carcasses are knife-ribbed between the 11th and 12th rib. and fat thickness is measured at the minimum point in the fourth quarter from the vertebrae along the longitudinal axis of the rib eye (Appendix C) [Agriculture Canada et al.. 1972]. Yield grades are inversely related to the level of fat thickness and numerically increase with the level of fat. The criteria for quality assessment include age, as measured by bone ossification; texture and marbling of the rib eye; and color and distribution of fat. Quantitative assessment of immature animals includes the fat thickness measurement and is stratified into four weight classes.

Adoption of yield grade standards brought a gradual realignment of carcass prices to coincide with the higher quality grades (A and B). The proportion of carcasses grading in these classes has remained much the same as those previously grading choice and good (ie. 71 to 73 percent). but the distribution has tended toward higher yield grades (Table 3.2). A relatively stable proportion falling into the B1 category, as a result of insufficient fat cover to qualify for the A1 grade, suggests producers have experienced little difficulty in adjusting to the yield grade specifications.

Producer adjustment to yield grades are primarily a matter of determining the live animal weights, or ratios of slaughter weight to mature animal weight, which describe the highest yield grade specifications. Growth studies have

found the ratio of fat to lean content to be primarily determined by slaughter weight as a function of mature animal weight, and not materially affected by feedlot ration formulation or management programs (Section 3.2). Producer response to yield grade discrimination against fat is therefore limited to adjusting carcass weights to conform with yield grade price relationships, or increasing mature animal weight through breeding practices.

TABLE 3.2 DISTRIBUTION OF CARCASS GRADINGS

	Percent of Total Carcasses Graded					
	A1	A2	A3	A4	B1	Total
Sept.-Dec./72	23.1	29.0	12.4	4.0	3.6	72.1
1973	27.5	28.8	9.7	3.0	3.9	72.9
1974	32.0	26.1	7.3	2.0	5.0	72.4
1975	33.5	24.2	5.4	1.1	4.4	68.6
1976	36.3	25.2	5.4	1.2	3.4	71.5
1977	39.6	24.5	4.5	0.9	3.0	72.5

Source: Livestock Market Reviews, Agriculture Canada

Wholesale prices were quick to adjust to the yield grade standards. A preference for lower fat levels was clearly indicated although the discounts within the A grade classes did not reflect estimated cutability differences (Table 3.3). The meat trade appears to be indifferent to A1 and A2 carcasses, and at times, applies excessive discounts to the A4 class.

These results suggest that the wholesale market has a

preference for certain characteristics of the A2 carcass which almost offset the yield advantage of the A1 group. Conversely, discounts in excess of the yield differential for A4 carcasses indicates that factors other than cutability enter buyer specifications. Variability in the average A3 and A4 discounts within and between regions suggests market forces of supply and demand may be involved in determining relative carcass values.

TABLE 3.3 SELECTED AVERAGE QUARTERLY TORONTO AND CALGARY A1 WHOLESALE CARCASS PRICES AND DISCOUNTS FOR YIELD GRADES a)

	Average A1 Price	Percent Discount A2	A3	A4
Calgary 1972-4	63.12	-0.6	-5.3	-10.1
1973-1	70.75	-0.4	-3.4	- 6.8
1974-1	84.39	-0.9	-5.1	- 9.1
1975-1	73.71	-0.5	-5.4	-10.4
Totonto 1972-4	64.12	-0.6	-3.1	- 8.2
1973-1	73.01	-0.1	-2.0	- 3.1
1974-1	86.53	-0.5	-5.0	-10.2
1975-1	78.33	-0.2	-4.8	-11.3
Estimate Yield Differences b) (500-700 lb. steers)		-2.3	-3.4	- 4.8

Source: a) Livestock Market Reviews, Agriculture Canada
b) Fredeen et al., 1975

3.4 Technical Evaluations

During the year following the implementation of carcass yield grading certain anomalies, or unexpected results were observed by the industry. Retail buyers were found to

discriminate against dairy type, heifer and bull carcasses. There was also some concern as to the accuracy and acceptability of the grading system to the various sectors of the industry. Four studies addressing these issues (Berg 1969; Fredeen et al., 1974; Smith et al., 1974; and Fredeen et al., 1975) were identified in the literature. In general, these studies confirmed that observed price differences were not justified by differences in retail yields. Although some discount on dairy type and heifer carcasses appeared warranted, young bulls should demand a premium.

Historically, the prices of heifers and heifer carcasses have been discounted relative to their steer counterparts of equivalent quality. Reasons for this practice include lower dressing and yield percentages as well as higher labor, packaging and handling costs per pound of salable meat from heifer carcasses. Berg reports that heifers dress about two percent less than steers of the same weight, and yield about three percent less salable meat. Rigid retailer buying policies also limit the market for heifer beef. In eastern Canada five of nine retail chains do not merchandise heifer beef; in the west three chains purchase heifer carcasses according to the level of price discounts applied [Food Prices Review Board 1975].

An investigation of sex differences in beef carcasses. involving over 2400 carcasses, was carried out by Fredeen.

The results of the study confirmed Berg's findings. Across weight groups both dressing percentage and yield for bulls. and dressing percentage for heifers and steers increased with increasing weight (Table 3.4). Retail yield decreased with increasing weight for steers, and was lowest for the heavy weight class of heifers [Fredeen et al., 1975].

On a grade constant basis heifers have a marginally higher dressing percentage in all A1 weight groups, and for the 500-700 pound A2 and A3 classes. In terms of yield heifers rate highest only in the case of under 500 pound A1 carcasses.

TABLE 3.4 AVERAGE SEX DIFFERENCES ACROSS GRADES

	Bulls	Heifers	Steers
Under 500 lbs.			
Dressing Percentage	57.4	58.3	58.5
Retail Yield	68.2	66.1	68.8
500-700 lbs.			
Dressing Percentage	59.7	59.7	59.4
Retail Yield	69.6	66.6	67.5
Over 700 lbs			
Dressing Percentage	62.0	61.5	61.2
Retail Yield	71.2	65.5	66.8

Source: Fredeen et al., 1975

The producer position concerning the trade practice of discounting dairy type carcasses was made clear in a motion passed by the Canadian Cattlemens Association committee on

grading. Recognizing that there was no scientific evidence to justify the use of the unofficial grade (A1X) for dairy type carcasses, the Association strongly opposed the use and official recognition of the grade until such evidence could be produced [Canadian Cattlemens Assocciation. grading resolution 1973]. A comparison of 500 beef and dairy carcasses established a 2.2 percent yield advantage in favor of beef type animals within the A1 grade [Fredeen et al., 1974]. The study identified the following differences in carcass measurements:

Rib eye area:	Beef greater by 12 percent
Graded Fat:	Beef greater by 16 percent
Carcass length:	Dairy greater by 5 percent
Leg length:	Dairy greater by 7 percent
Chest depth:	Dairy greater by 5 percent
Flank depth:	Dairy greater by 4 percent
Round thickness:	Beef greater by 4 percent
Percent retail yield:	Beef greater by 2.2 percent

In a study to assess the accuracy of the cutability classifications, Smith et al., concluded that within class yield variability is so great that grade categories are not reliable for the selection of individual carcasses [Smith et al., 1974]. The results were based on the analysis of 163 randomly selected carcasses within the A grade and included the unofficial A1X dairy type classification (Table 3.5).

TABLE 3.5 RETAIL CUTABILITY AS A PERCENT OF COLD CARCASS WEIGHT

Grade	Number	Mean	Standard Deviation	Between Grade Difference
A1	43	78.20	2.24	1.55 (A1-A1X)
A1X	29	76.65	3.28	.61 (A1X-A2)
A2	45	76.04	2.32	2.16 (A1 -A2)
A3	23	73.43	2.90	2.61 (A2 -A3)
A4	23	70.60	3.75	2.83 (A3 -A4)

Source: Smith, K. D. et al., 1974

These results suggest that considerable overlap exists among yield grade classes and that grade boundaries are to some extent arbitrary. This is not a surprising result since fat thickness and retail yields are continuous variables. The results summarized in Table 3.5 also indicate that, on average, dairy type A1 carcasses (A1X) more closely resemble the beef type A2 carcasses in terms of retail yield.

3.5 Economic Evaluation

The decisions to adopt or change beef grading standards have been primarily made in the interest of one or more sectors of the industry with some notion of net economic gain. A joint industry publication outlining the yield grade system suggests benefits to accrue to all sectors of the beef industry. The greater accuracy of the yield grades in describing and relating production to market demands

would assist producer decisions. Packers would also be able to more precisely meet retailer demands and pay producers according to these demands [Canada's New Beef Grading System]. An assessment of the economic impact of the system, during the first year of operation, is contained in Smith et al., 1974. The study considered the changes that had occurred and their impact on the individual sectors of the beef marketing system. Representatives of all sectors were interviewed, and butcher and consumer opinions were surveyed. Some of the more significant results of the Smith study were:

1) Cattle buyers indicated difficulty in estimating yield grades, and that the quality of market reporting on public markets had been reduced for similar reasons.

2) Meat packers indicated dressing percentages had been reduced by two to three percent due to lower fat levels. Knife ribbing of carcasses, although an aid in sorting carcasses, made handling more difficult and adversely affected cooler capacity. Trade resistance to A1 dairy type carcasses resulted in increased breaking of carcasses at a cost of two to three cents per pound.

3) Montreal wholesalers indicated that the quality of "top grade" beef had deteriorated, resulting in a greater need to break carcasses before they were acceptable to retailers. The A1 dairy type and bull

carcasses were not acceptable in the Montreal market.

4) Retailers were not generally concerned with grading except that every carcass had to display an "A" grade. They claimed that within grade variability necessitated the use of buyer specifications within grades to select carcasses. The A2 grade was considered best by most retail buyers.

5) Restaurants indicated the new grading system discouraged production of heavy ribs and loins resulting in greater dependence on U.S. sources. Knife ribbing specifications also favor U.S. methods which leave only one rib on the hind and five on the chuck.

6) Consumers experienced little or no direct effect from the new grading system.

The first year economic evaluation was primarily technical in nature, and although raising serious questions concerning the benefits of yield grading, did not address the economic impact of the new system. The researchers suggest the possibility of little or no benefits, and increased costs to retailers, wholesalers, and packers. Pricing efficiency may also have deteriorated as a result of cattle buyer and market reporter difficulty in estimating live animal grades.

3.6 Economic Implications of Yield Grades

The intended economic impacts of the yield grade system

were never precisely formulated. The system was conceived and implemented in the interest of improving marketing efficiency. All sectors of the industry were visualized as benefiting from a more accurate description of the beef supply according to the kinds of beef demanded in the market. No accounting of costs or possible effects on the industry's competitive position in export markets were documented. Lower fat levels and improved quality were expected to benefit consumers; specification buying and less waste were expected to result in reduced marketing costs; and producer revenues were expected to improve. The economic implications of yield grading were anticipated as having no direct effect on the general level of prices, and to benefit the entire industry through enabling the industry to supply the consumer with the kind of meat demanded [Canada's New Beef Grading System].

The immediate effect of the yield grade system appears to be the alignment of prices within quality grades, according to yield predictions. Whether this indicates greater accuracy over previous standards as a basis for buyer individual carcass selection is not clear since not all carcasses of a given weight and quality grade are priced according to their respective yield grades. Buyers continue to impose their own specifications in selecting carcasses. It is possible that prices within grades may be as variable under the yield grade system as they were within the

previous grades. Research evidence presented in sections 3.4 and 3.5 suggests the economic implications of the change in standards are complex and involve benefits as well as costs in the various sectors of the industry.

3.6.1 Consumer Demand

Consumer demand for lower fat content in meats was one of the underlying factors in the development of yield grade standards. It was anticipated that a reduction in fat levels would enhance the competitive position of beef in the retail market. A consumer survey conducted by Smith et al., (1974) indicated a lack of consumer awareness concerning the new standards, and an inability of consumers to visually detect quality improvements. It was concluded that consumers experienced little or no direct effect from the new standards (Section 3.5). This conclusion overlooks the possibility of improvements in eating characteristics not visually detectable to consumers (a major reason for grading). Increased eating satisfaction addresses one of the determinants of demand and would be reflected in beef purchases. Consumers are generally not offered a choice of beef qualities in the retail store. Chains limit their purchases to a subset of the total system of grades. Qualitative improvements in the beef offered to consumers would, therefore, increase the competitiveness of beef relative to alternative meats in the market, resulting in a

shift in the consumer demand schedule for beef.

3.6.2 Cost of Processing and Marketing Services

The cost of processing and marketing services are a major determinant of the prices paid by consumers and prices paid to producers. Reductions in these costs were expected to be a major benefit of beef carcass yield grading. The system was to provide retail buyers with an accurate means of purchasing carcass beef in the absence of costly buyer evaluations and selection. Retailer marketing margins were expected to benefit through reduced labor and losses involved in fat trim, and capitalization of some of the qualitative benefits realized by consumers. Packers and wholesalers costs were similarly expected to decrease through reduced losses and greater accuracy in purchasing to meet market demands. At least part of the benefits accruing to consumers and retailers could be expected to be passed down to packers and producers.

The technical and economic evaluations carried out since the introduction of yield grading (Section 3.4 and 3.5) suggests that reductions in the costs of processing and marketing services have not materialized to the extent originally anticipated. Savings in packer and retailer trim losses have likely been realized, but retail buyers continue to impose their standards in selecting carcasses. This does not suggest the grades are not useful in carcass

procurement. They may greatly assist in selecting the most valuable carcasses within the extreme variability identified in each yield grade. Difficulty in relating standards to live animal characteristics suggest packer risks involved in purchasing may have increased. Packers also experienced increased costs in the form of lower dressing percentage, increased carcass breaking, and reduced cold storage efficiency.

In general, the net effect of yield grading on the various components of processing and marketing services are translated in terms of willingness to pay or to serve the market. Costs or savings may be absorbed within a particular sector or passed on to other sectors in the form of price increases (decreases) on the supply side or price decreases (increases) on the demand side. As a result, the implications of the change in grading systems within the processing and marketing sectors are difficult to quantify.

3.6.3 Producer Supply

Economic impact of yield grading is potentially greatest in the livestock production sector. Stratification of price information according to fat levels, and the corresponding alignment of prices within cutability grades, have important implications for producer decisions. The premium on lower fat levels under the system has probably removed any incentive to feed animals to heavier, more

highly finished slaughter weights. The association of price with carcass fat thickness does not necessarily account for other factors involved in livestock feeding decisions.

Adjustments in feeding programs, such as the use of low energy or high roughage diets, as a means of influencing yield grades does not appear feasible. Research evidence presented in sections 3.2 and 3.4 suggest fat levels are related to slaughter weight as a function of mature animal weight. Preston indicates that..."within practical dietary possibilities, plane of nutrition will not have any material effect on the carcass composition of cattle when evaluated at similar body weights" [Preston 1971]. Producer adjustments to attain the highest yield grade or price are, therefore, limited to either reduced carcass weights, or the selection of larger breeds of animals. Either adjustment will affect the profitability of feeding.

In general, feedlot profits accrue from two major sources: 1) the spread between feeder cattle input price and slaughter price, and 2) the difference between revenue and cost of the live weight gain produced. Both sources are affected by changes in slaughter price. Yield grading removes any possible increase in price spread, due to feeding, once the minimum fat thickness is attained. Under the previous grading system, increasing spread through further feeding to a higher grade provided a positive profit increment, and in certain cases the only source of feedlot

profits. In situations where cost of gain is greater than or equal to the returns from the gain, then price spread becomes the sole source of profit. Mathematically. the feedlot total revenue function of the form $TR=P_2Q_2$ can be expressed to compare the price effects due to grading and additional weight gain: $TR=P_2Q_2=P_1Q_1+(P_2-P_1)\ Q_1+P_2(Q_2-Q_1)$ where P_i and Q_i are slaughter prices and weights respectively for two adjoining grades. Under a yield grade system, the second term is negative since the price. P_2. relating to the heavier weight (and lower grade) is less than P_1 corresponding to the highest yield grade. Because this term applies to the entire slaughter weight. and the third term consists of only the weight change, rarely would the positive effect of the third term offset the negative impact of the second, or grade change term on total revenue. That is, only in situations where the price change is small relative to the weight change would it be profitable to exceed the highest yield grade since P_1Q_1 would usually exceed P_2Q_2 above.

Theoretically, in an unconstrained profit maximization situation, with fixed input and output prices, the optimal slaughter weight occurs at that weight for which the level of input usage equates the value of the marginal physical productivity of each input with its respective price (VMPx=Px). This formulation results in maximum profits per animal fed for a given feeding period and class of feeder

animals. In practice the firm may be concerned with maximizing annual profits rather than profit per head fed. The length of the feeding period and class of feeder animals then become important variables in the firm's profit maximizing objective function. Average daily gain in pounds of beef produced generally declines with the degree of finish (fattening) and cost per pound of gain increases. Since the firm may vary the length of the feeding period and feedlot turnover rate by adjusting either animal starting or finishing weights, the relevant firm objective becomes profit maximization per unit of time. Dillon indicates that the best operating conditions over time involve lower levels of the variable inputs than are implied by the timeless criterion [Dillon p. 75]. As a result, optimal slaughter cattle weights will be less than that determined by maximum profits per head.

3.6.4 Trade Relationships

Changes in Canadian slaughter cattle and beef supplies attributable to the yield grade system may have important implications for Canada's competitive position in the North American beef market. Livestock and meat move relatively freely across the international boundary in response to changing market conditions. As supplies in Canada decrease relative to those of the United States prices in Canada tend

to rise until an import basis is established. Lower slaughter weights result in reduced supplies and could influence the amount, as well as the direction of trade flows with the United States. Qualitative changes, such as reduced fat levels, if preferred by United States and Canadian buyers, would enhance the value of Canadian supplies causing prices to rise relative to those in the United States. Differences in carcass weights and ribbing methods, on the other hand could offset the impact of qualitative improvements. Restaurateurs in Canada have indicated a preference for United States carcass weights and ribbing methods.

It is important to determine the economic consequences of yield grading on the beef industry. Technical and market efficiency evaluations carried out since the adoption of the standards suggest the economic benefits of the system may be less than anticipated, and that the distribution of benefits, and costs may be different than originally expected.

The economic implications of the system can be viewed as affecting four aggregate relationships within the market: 1) the consumers demand for beef, 2) the processing and marketing services supply of beef, 3) the processing and marketing services demand for carcass beef and slaughter cattle, and 4) the producers supply relationship for slaughter cattle. In this context, the impacts of the

change in grading standards become translated into adjustments in the willingness of market participants to pay or supply the market. This kind of information is a necessary ingredient for future policy decisions concerning changes in grading standards. Previous studies have been primarily designed to investigate technical limitations. and discover possible means of improving the accuracy and use of the standards. This study is designed to investigate the economic impact of yield grades on the demand and supply relationships in the beef industry.

CHAPTER IV

ECONOMIC CONSIDERATIONS AND THE CONCEPTUAL MODEL

The purpose of this chapter is to review economic theory in order to examine the general nature of production and marketing interrelationships, and to develop a conceptual model as a means of evaluating the economic implications of a change in commodity grading standards. The first section of this chapter examines the neoclassical economic theory principles relating to aggregate demand and supply in the industry. Mathematical characteristics of important relationships are identified and their relevance in terms of this research are outlined. The second section of this chapter formulates these relationships in a manner which permits estimation of their parameters.

The conceptual model considers the major production and marketing decisions, affected by changes in quality standards, and their interrelationships within the industry. The approach is largely based on the concept of derived demand and supply, as presented by Friedman, and grading literature, particularly Williams, who suggests the relevance of aggregate functions as a means of evaluation [Friedman 1962; Williams 1962]. The essence of the conceptual model is the stratification of the market into

final consumption, processing and marketing services, and agricultural production sectors. Quantities and prices in the market are determined by the interrelationship of consumer demand, supply and demand of the processsing and marketing sector, and producer supply. This section draws heavily on Foote's discussion of econometric techniques for demand and price analysis [Foote 1958].

4.1 Consumer Demand

The basis for the hypothesis that qualitative improvements may influence consumer demand for a product lies in the theory of consumer behavior. "The consumer's ordinary demand function (sometimes called a Marshallian demand function) gives the quantity of a commodity that he will buy as a function of commodity prices and his income" [Henderson and Quandt p. 23]. According to the law of demand the quantity purchased varies inversely with the price of the commodity. Besides income, two factors: tastes and preferences and prices of other goods, determine the level of demand. Changes in these components shift the entire demand schedule, whereas commodity price changes are synonymous with movements along the demand curve. Improvements in product quality address the consumer taste and preference determinant of demand in an effort to shift consumer purchases more favorably toward the product.

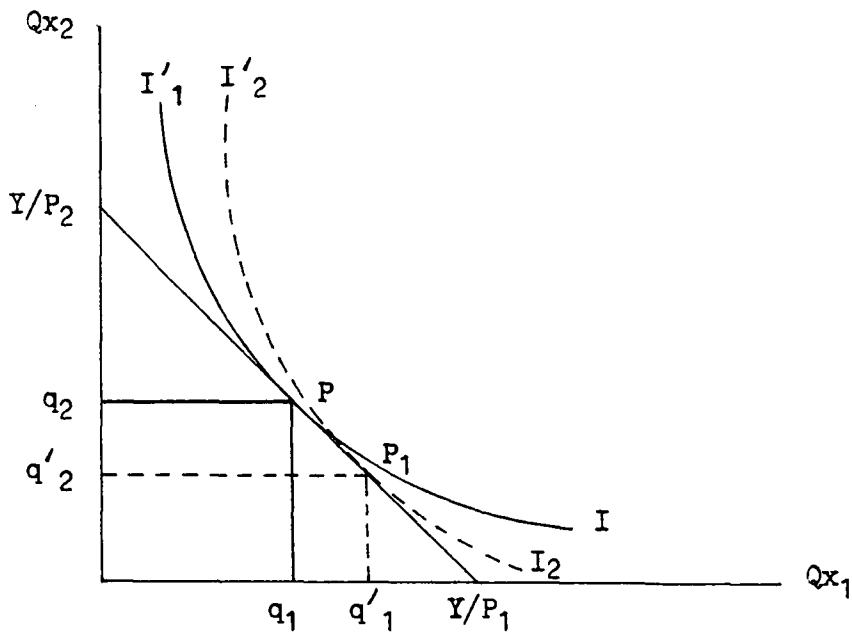
Demand theory is based on the notion that consumers

attempt to allocate their limited money income in such a way as to maximize want satisfaction through consumption of goods and services. The consumer is assumed to possess perfect knowledge of the prices and want satisfying capabilities of the goods and services available to him. He is also assumed to derive satisfaction or utility from consuming goods, and has a preference function which ranks alternatives according to their want satisfying merits. Mathematically, the consumers demand function can be derived by solving the first order conditions for utility maximization.

Changes in product quality affect the consumers assessment of a product's want satisfying capabilities and can, therefore, be assumed to be equivalent to changes in tastes and preferences for the product. The impact of a qualitative improvement on consumer satisfaction can be illustrated with the aid of indifference curve analysis.One example of the effects of a quality change is demonstrated in figure 4.1. Points along an indifference curve represent combinations of goods which yield the same level of satisfaction or utility. The curves are everywhere dense in that every possible combination of goods in the commodity space lies on one such curve. Higher curves (more distant from the origin) indicate levels of higher satisfaction. Consumers are assumed to prefer more of a good to less (indifference curves do not intersect), and the more of a

good they possess the more of it they are willing to substitute for a unit of the other good (indifference curves are concave from above). The rate at which the consumer is willing to substitute one good for another is given by the slope of the indifference curve at that point, and is termed the marginal rate of substitution. The rate at which he is able to substitute is determined by the price ratio of the goods, or slope of the budget constraint. Maximum satisfaction results at the point of tangency between the budget line and highest possible indifference curve. At this point the marginal rate of substitution equals the price ratio (point P in figure 4.1).

Figure 4.1. Indifference curves showing the effect of a quality improvement on consumer preferences



Prior to an improvement in the quality of good X_1 the consumer maximizes his satisfaction consuming q_1 units of X_1 and q_2 units of X_2 as determined by the tangency of the

budget line Y/P_2 , Y/P_1 and indifferences curve $I_1' I_1$ at point P. The qualitative improvement shifts the indifference curve to $I_2' I_2$ indicating the consumer is willing to give up fewer units of X_1 for an additional unit of X_2 at any level of consumption. The point of tangency between the new indifference curve and the original budget line at P_1 indicates the consumer maximizes his satisfaction by consuming more of X_1 and less of X_2. Although total expenditure, Y, remains unchanged, a larger portion of consumers money income is allocated to consumption of X_1 after the quality improvement. By varying the price of the good, X_1, the consumers demand function for X_1 can be derived. The curve is the locus of price and quantity points corresponding to the series of price ratio-indifference curve tangency points generated. Mathematically, the improved quality of X_1 would be reflected in the consumer's utility function describing the satisfaction he derives from various quantities of goods and services. Increased satisfaction from consuming X_1 would result in an increase in the marginal utility of X_1 at the previous level of consumption. As a result, the marginal rate of substitution, determined as the ratio of marginal utilities for X_1 and X_2 , would no longer equal the price ratio. In order for the consumer to maximize his satisfaction, consumption of X_1 must rise relative to X_2, causing the marginal utility of X_1 to fall relative to that

of X_2 , until the equivalency of their ratio and the price ratio is restored. Increased consumption of a good in the absence of a price change results in an outward shift in the demand curve.

4.2 Aggregate Demand

The aggregate, or market demand for a good or service is the horizontal summation of the demands of each consumer in the market. A market demand function describes the maximum quantities of a commodity that will be purchased at a particular price and time given that other determinants of demand remain constant. Aggregate demand is an important determinant of both product and factor market prices. Elasticity values indicating the responsiveness of demand to changing commodity prices, incomes, and prices of close substitutes are of particular importance to industry participants. Mathematically the general form of the individual consumer demand function can be written:

$$Q_i = f(P_i, P_j, Y)$$

and if a linear relationship exists, the function can be specified as:

$$Q_i = b_o + b_1 P_i + b_2 P_j + b_3 Y$$

where Q,P, and Y refer to quantity, prices and income respectively.

In the case of a commodity such as beef, the average quantities and prices are not only averaged over all

consumers, but are also weighted according to the various cuts of beef purchased by consumers.

The complexity of the demand for beef has serious implications for estimating the demand function. The commodity, beef, at the retail level consists of many different cuts and types of beef. Retailers also have different merchandising policies which inject variability into both the kind and quality of cuts as well as price structure. As a result there is no single price of beef to represent consumer willingness to purchase the commodity. Moreover, data relating to retail beef prices are not recorded. Two procedures are available to overcome this problem: 1) A retail price index for specific cuts of beef may be assumed representative of the variability in total beef prices, and 2) wholesale prices may be substituted into the aggregate demand function. In this study some importance is attached to the elasticity of demand, which suggests either an index of prices for a particular cut, or composite of selected cuts should be used. Similar procedures have been used by Kulshreshthra and Wilson (1970), Kulshreshtha (1978), and Hassan and Katz (1975) in estimating consumer demand for beef in Canada. Substitution of wholesale prices would result in a derived demand function and would require additional variables that relate to the behavior of retailers [Foote p. 103].

4.3 Derived Demand

The derived demand for a factor shows the maximum quantity of that factor that will be purchased per unit of time at each price for a given state of technology, conditions of final demand, and supply of the other factors [Friedman p. 173]. By definition, derived demand..."is the difference at each level of quantity between aggregate consumer demand and the sum of the marginal costs of marketing" [Williams p. 23]. In the case of beef, final demand is expressed in terms of consumer willingness to pay for the various cuts of beef offered in the market. The retailers' demand for carcass beef and packers' demand for slaughter cattle are derived from the final demand and include all of the costs incurred in transforming and moving the respective products through the system. The demand faced by the seller of an intermediate product or factor is, therefore, influenced by consumer demand as well as all other factors affecting costs and prices in transforming and moving the factor to final consumption.

In the most simple case, that of the firm in a competitive market, the demand, Q_i, faced by the seller of a given quality of input, is the buyers marginal value product, VMP_i, curve. The buyer's profit maximizing level of input use is determined at that level of usage which equates VMP_i with the price of the input, P_i. In less than perfectly competitive input and output markets the optimal

condition becomes marginal factor cost, MFC, equals marginal revenue product, MRP, since firm decisions concerning output affect both input and ouput prices. Regardless of the market structure, the profit maximizing level of input use occurs where the marginal cost of an additional unit of output equals the marginal revenue accruing from that unit.

The suggestion that market supply and demand curves are the summation of firm level marginal cost and marginal value product curves respectively is valid only in certain cases. The marginal value product curve is the firms input curve providing all other inputs remain fixed and the output price is constant. Changes in these factors shift the MVP curve such that the firm's input demand becomes the locus of equilibrium points across MVP curves. Similarly, changing input prices shift the firm's marginal cost curve, and the industry supply curve becomes the sum of the resulting firm level quasi-supply curves [Friedman p. 80].

Qualitative improvements may influence the demand for a factor either directly through improvements in the marginal product of the factor, or indirectly through the impact of higher output prices. The marginal productivity principle states that profit maximizing firms will adjust the level of input until the marginal value product is equal to the input price. Should a qualitative improvement enhance the productivity of the input, firms can be expected to increase their use of it until the maximization condition is

restored. Similarly, as was indicated in section 4.1 and 4.2, qualitative improvements that affect consumers preferences are reflected in aggregate demand and may result in higher product prices. An increase in output prices will increase the value of the marginal product and result in increased demand for the factor.

4.4 Producer Supply

The producer supply function in a competitive industry is the sum of the marginal costs of each of the producing firms providing there are no pecuniary or technical externalities to the firm. By definition the supply function describes the maximum quantity that would be supplied to the market at specified prices, or the minimum price necessary for a specified quantity to be supplied [Friedman p. 74]. The supply curve assumes some level of technology, prices of closely related commodities, and the supply of inputs used in producing the commodity. Changes in these factors will affect the shape and location of the supply curve. For example, a change in the price of a factor of production will shift the supply curve. Given the factor prices the firm expands output along its marginal cost curve. If as all firms expand output the prices of one or more factors are affected the firm will expand along it's quasi supply. That is, for each set of factor prices the firm has a marginal cost curve. As factor prices change the

firm shifts from one curve to another. The locus of such points is termed the firms quasi supply function. The industry supply function is then the sum of firm level quasi supply functions.

The relationship between costs and output of the firm depend primarily on the production function and the conditions of supply of the factors used in the productive process. For a single product firm, the production function simply relates the maximum potential level of output per unit of time for any given combination of inputs. Mathematically, the relationship may be written as:

$$Q=f(X_1,X_2).$$

where Q is the level of output or product, and X_1 and X_2 refer to two variable inputs. The firm total cost and total revenue functions become:

$$TC=P_1X_1+ P_2X_2 +FC, \text{ and } TR=P_qQ$$

where P_1 and P_2 are the prices of the variable inputs respectively, and P_q is the output price. From these conditions it becomes apparent that a precise relationship exists between the profit maximizing firm's marginal cost and marginal physical productivity. The unconstrained profit function, π, can be written:

$$\pi=P_qQ - (P_1X_1+ P_2X_2 + FC)$$

and the first order conditions state

$$\frac{\partial \pi}{\partial X_1}=P_q\frac{\partial Q}{X_1}-P_1= 0 \qquad \text{and,} \quad \frac{\partial \pi}{\partial X_2}=P_q\frac{\partial Q}{X_2}-P_2= 0$$

Then solving for the product price, P_q,

$$P_q = P_1 \; / \; MPP_1 = MC_q$$

$$P_q = P_2 \; / \; MPP_2 = MC_q$$

That is, the marginal cost of output is equal to the price of the output. Solving this system for the input prices results in:

$$P_1 = MPP_1 P_q$$

$$P_2 = MPP_2 P_q$$

each of which is the firms demand for an input given product price and quantity of the other input. Thus the basic cost components are inversely related to their corresponding marginal products. These relationships have particular significance in the case of a qualitative change in a product. It was demonstrated in section 4.3 that such changes may influence input, or derived demand within the system. In this section it has been demonstrated that marginal costs may be affected, in which case the producer as well as the industry supply curve may be shifted.

4.5 Aggregate Supply

The aggregate supply function for a product in a competitive industry is the sum of the producer supply and the marginal costs incurred in transforming and moving the product to final consumption. An increase in the cost of production or marketing will be reflected in an increase in

the supply function. The resulting decrease in supply will equal the decrease in consumption since fresh beef is perishable and is generally not stored. Any change in marketing costs will also affect derived demand in the system.

4.6 Conceptual Model

The conceptual model summarizes the important economic consideration of sections 4.1 to 4.5 into a system of equations relating consumer demand for beef to the production of fed cattle. This system provides a framework for understanding the economic impact of a change in grading standards on sectors of the industry.

The theoretical basis for adjustments in consumer demand in response to a qualitative change was presented in section 4.1. In general, consumers are not offered a choice in fresh beef quality. Retailer buying and merchandising policies (Section 2.5) limit retail supply to "A" grade beef. Should the change in quality be detected by consumers as an improvement, then consumers would be expected to increase their preference for beef relative to alternative meats. This would be reflected in a shift of the aggregate demand function.

Derived demand for particular grades of beef by the processing and marketing services sector of the industry is more complex than consumer demand. This sector of the

industry is faced with a choice of fresh beef grades in terms of the quantitative or yield component of the "A" grade. If yield grades relate to factors that are important to the sector, then demand for the various grades may differ significantly. The derived demand for carcass beef and slaughter cattle is the aggregate of demands for individual grades.

The equilibrium or profit maximization conditions for the packer indicate that input (slaughter cattle) and output (carcass beef and by-products) prices, and the marginal physical productivity of the input are paramount in the packers slaughter cattle procurement decisions. Since the major output of the packing sector (carcass beef) becomes an input to other sectors, primarily retailers, the demand faced by the packer is, for given product demand and supplies of other inputs, the marginal value (revenue) product of the retailer. Similarly the retailers' profit maximizing level of carcass beef utilization is determined by retail beef prices together with carcass prices and productivities, and other factors influencing in store processing and marketing costs. The demand faced by the producer of slaughter cattle is a reflection of consumer demand for beef, marketing and processing costs, and the productivity of slaughter cattle and carcass beef in yielding intermediate and final products respectively.

Specification of the derived demand functions for various classes of slaughter cattle and carcass beef is, to some extent, constrained by the availability of data corresponding to the factors identified as determinants of demand. A lack of information concerning marketing and processing costs, retail prices on a carcass equivalent basis, and marginal productivities of slaughter and carcass beef necessitates the use of proxy variables or estimates of certain critical variables. In other cases assumptions, or hypotheses about behavioral relationships facilitate specification of a functional form, but condition the interpretation and implications of the results. For example, wholesale prices are quoted on a grade basis with no sex designation, slaughter volume is disaggregated according to sex, and public market sales of slaughter cattle are identified according to both sex and grade. There is not necessarily a one-to-one relationship between grades at different levels.

On the supply side, changes in marginal costs affecting derived demand will also be reflected in the aggregate supply function. In addition, reductions in carcass weights suggested in section 3.6 will have a direct effect on industry supply. Reduced carcass weights may also affect the marginal costs of producers resulting in a further shift of the aggregate supply function. Figure 4.2 presents a summary of the structural relationships potentially affected

by the change in grading systems.

Figure 4.2 Structural Relationships in the Beef Industry

Consumer Demand; Q_r:P_r,Ps,Y

Supply by Retailer; Q_r:P_r,P_w,Z_1

Demand by Retailer; Q_w:P_r,P_w,Z_1

Supply by Packer; Q_w:P_w,P_p,Z_2

Demand by Packer (Domestic); Q_p:P_w,P_p,Z_2

Demand by Packer (Import); Q_m:P_w,P_p,Pd,Z_2

Supply by Producer; Q_p:P_p,Z_3

where, Q_i= quantity of fed beef in carcass weight equivalents,

P_i= price of fed Beef,

Ps = price of substitute meats,

Pd = wholesale price difference between Canadian and United States fed beef markets,

Y = disposable income,

Z_j = factors relating to retailer (1), packer (2), and Producer (3) costs.

Subscripts (i) refer to retail (r), wholesale (w), producer (p), and imported (m) fed beef.

The formulation of the conceptual model into a set of structural equations for econometric estimation is presented in Chapter five.

CHAPTER V

ECONOMETRIC ESTIMATION

In this chapter the conceptual model. as summarized in figure 4.2, is formulated into a simultaneous system of equations, and estimated using the two stage least squares procedure. Binary variables are applied to both slope and intercept terms of each equation as a means of measuring the possible impact of the change in beef grading standards on certain structural relationships in the system. Zero values were used for the pre-grade change period (1961 to September 1972).

A relatively high degree of intercorrelation between pairs of predicted variables in the processing and retailing sectors of the model was cause for concern over the magnitudes of the standard errors associated with the estimated parameters for these variables. A discussion of this issue is presented by Klein [Klein 1974]. Accordingly, two alternative specifications. involving price ratios and the elimination of a price variable. were formulated to address the problem.

Other problems encountered in the specification of the model relate to the lack of accurate data concerning such key variables as costs of marketing services and beef

carcass weights. Indices of retailer and packer wage rates were used as proxy variables for the cost of services performed by packers and retailers in transforming and moving beef and beef products through the marketing system.

The proxy variables essentially tie changes in the cost of marketing services to labor rates which are not only highly correlated with the income variable, but do not reflect possible changes in the amount of labor required. Reduced fat content and more accurate carcass descriptions were postulated as having a positive effect on marketing operational efficiency. That is, yield grades were expected to result in reduced retailer procurement and processing labor utilization as well as to improve retailer and packer merchandising efficiency. These benefits would be reflected in total labor costs and prices. and are essentially independent of the wage rate paid.

A lack of data concerning weights of both slaughter cattle and carcass beef prior to the change in grading standards necessitated the construction of a proxy variable based on United States weights. The average carcass weight of fed cattle is an important determinant of beef supply, and was expected to be significantly reduced as a result of the fat discriminating yield grade system. For the purpose of this research, Agriculture Canada provided estimated fed cattle weights, determined by United States class weights and Canadian total slaughter weight. using a Lagrangian

constrained maximization procedure. Accordingly, pre-grade change weights reflect United States conditions which may not accurately depict the Canadian situation.

5.1 The Econometric Model

The beef industry consists of three main market levels: farm level, wholesale level, and retail level. Conceptually each of these components can be visualized as consisting of a supply and demand relationship interacting to establish a price for some given quantity of product transferred. At the retail level, consumer demand interacts with the retailer's supply to determine the retail price; at the wholesale level, the retailer's demand interacts with the packers supply to establish the wholesale price; and at the farm level the packer's demand interacts with the producers supply to establish the producer price. This set of behavioral relationships forms the framework for the econometric model of the industry. In addition equations are also specified to account for the packers demand for imported beef from the United States, and the carcass weight component of the producer supply equation. Table 5.1 outlines the set of behavioral equations and identities used in the model. A brief description of the equations that are important to this research is presented in the following sections. Endogenous variables are identified by asterisks (*).

The simultaneous equation system for the beef industry consists of ten equations including ten endogenous, and ten predetermined or exogenous variables. For the purpose of this research only the four demand equations, producer supply, and carcass weight relationships are estimated. Because some of these equations include two or more endogenous variables the two stage least squares procedure is used to estimate the model. A retail pork price relationship is specified to collapse a separate submodel of the pork industry into a single equation. With the exception of a pork quantity variable, the remaining exogenous variables in this submodel are a subset of those that appear in the beef industry submodel.

TABLE 5.1 ECONOMETRIC MODEL OF THE BEEF INDUSTRY

1) Consumer Demand:
   PDFB*: D,D•RPB*,RPB*,RPP*,PCDY

2) Retailer Demand For Carcass Beef:
   QFBS*: D,D•WPSE*,WPSE*,RPB*,ECWT*,RPP*,RWR

3) Packer Domestic Demand For Slaughter Cattle:
   QFBP*: D,D•PSSE*,PSSE*,WPSE*,ECWT*,BPV,PWR,RPP*,SHR

4) Packer Import Demand For Carcass Beef:
   QFBI*: D,D•PSSE*,PSSE*,WPSE*,WPD*,BPV,RPP*

5) Producer Supply Of Slaughter Cattle:
   QFBP*: D,D•PSSE*,PSSE*,$PFSW_{t-2}$,PFW,SHR

6) Carcass Weight:
   ECWT*: D,D•PSSE*,PSSE*,PFW,SHR

7) Packer Supply Balance:
   QFBS* = QFBP* + QFBI*

TABLE 5.1 Continued

8) Canada - U.S.A Wholesale Price Difference:
WPD* = WPSE* - PUS

9) Per Capita Disappearance Of Fed Beef:
PDFB* = QFBS*/POP

10) Retail Price of Pork:
RPP* = PDP,QFBS*,PCDY

Where,

PDFB* = Apparent per capita domestic disappearance of fed beef in pounds,

QFBS* = Total fed beef supply (production + imports) in million pounds, includes choice and good, or A grades,

QFBP* = Total fed beef production in million pounds. includes choice and good, or A grade inspected and uninspected heifer and steer slaughter.

QFBI* = Total fed beef imports in million pounds, includes bone in and boneless fresh beef on a bone in basis.

ECWT* = Average carcass weight of slaughter steers and heifers in Canada. Prior to October 1973 weights were estimated on the basis of variations in the corresponding carcass weights in the United States.

RPB* = Retail price index for sirloin beef. deflated by consumer price index,

RPP* = Retail price index for pork, deflated by consumer price index,

WPSE* = Wholesale price of choice and A1 carcass beef in Toronto, deflated by consumer price index.

PSSE* = Price of choice and A1 slaughter steers in Toronto. deflated by consumer price index.

WPD* = Wholesale price difference between Canada choice or A1 steer carcasses and United States choice steer beef in Canadian dollars, deflated by consumer price index,

PCDY = Per capita disposable income in Canada. deflated by consumer price index,

RWR = Average weekly retail wage rate in dollars. deflated by consumer price index.

PWR = Average weekly packer and meat processing wage rate in dollars, deflated by consumer price index.

BPV = Index of United States packer by-product values.

SHR = Ratio of total steer slaughter to total heifer slaughter,

PFW = Price of feed grains in western Canada. deflated by consumer price index,

$PFSW_{t-2}$ = Price of good feeder steers in western Canada, deflated by consumer price index lagged two quarters,

POPN = Canadian population,

PDP = Apparent per capita domestic disappearance of Pork in pounds,

PUS = Wholesale price Chicago choice steer beef. in Canadian dollars deflated by consumer price index.

D = Quarterly binary variable - 0 assigned to the 1961(1) - 1972(3) period, and 1 to the 1972(4) - 1976 period.

5.1.1 Consumer Demand

Consumer demand for fed beef is specified in the quantity dependent form with dummy variables applied to the intercept and slope terms as a means of identifying any structural change coincident with the adoption of yield grades. Variations in per capita consumption are postulated as being determined by changes in the real price of sirloin beef, real price of pork, and deflated personal income (per

capita). The price of hamburger, was included as a substitute for fed beef in a preliminary specification based on the assumption that non-fed and low quality imported beef were the major sources of manufacturing beef. A 1975 report on the market for heifer beef in Canada revealed most retail market hamburger originated from trim and low valued cuts from fed beef carcasses [Food Prices Review Board 1975]. Accordingly, the price variable was highly correlated with the price of sirloin and was removed from the equation.

5.1.2 Retailer Demand

The formulation of the retailer's demand for fed beef carcasses (demand faced by the packer) is based on the assumption that retailer beef purchases are influenced by the potential for profit from beef sales, taking into account current pork market conditions. Variations in the quantity of beef demanded by retailers are specified as being dependent upon deflated prices for sirloin beef and pork at the retail level, and for fed beef carcasses at the wholesale level. A carcass weight variable is also included in the equation to reflect retail buyer discrimination against heavy carcasses containing excessive levels of fat. A retail wage rate variable is included as a proxy measure for variations in the cost of services performed by the retail sector. Binary variables are applied to the slope and intercept terms as a means of identifying a possible

structural change in the relationship coincident with the change in grading standards.

5.1.3 Packer Domestic Demand

The formulation of the packer domestic demand for steers and heifers (demand faced by the producer) logically follows the specification of the retailer's demand. That is, the profitability of slaughtering fed cattle is of major concern to the packer. The quantity of fed cattle demanded is stated as being dependent upon slaughter cattle and wholesale prices, by-product values, and processing costs as measured by a packer wage rate proxy variable. Other factors affecting profitability include carcass weights and the sex composition of slaughter, both of which influence average carcass dressing percentages. Because many of the larger beef processing plants in Canada are multi-species plants, the price of pork was included in the demand relationship to reflect the impact of pork processing profitability on packer willingness to purchase slaughter cattle. The retail price of pork was used as a proxy measure for variation in the difference between wholesale and producer pork prices. Wholesale pork prices are quoted on the basis of numerous individual cuts, and a weighted average price is not available. The proxy variable assumes the magnitude of the price difference increases with the level of pork prices.

5.1.4 Packer Import Demand

Major packers in Canada are also the principal importers of carcass beef from the United States. The import demand relationship reflects the packers' opportunity to service the wholesale market from either domestic slaughter cattle or imported carcass beef sources. Variations in the quantity of beef imported are postulated to be accounted for by changes in the level of wholesale and slaughter cattle prices, and the wholesale price difference between the Canadian and United States markets. By-product values are specified in the equation to reflect lost revenues from the purchase of carcasses as compared to live animals. The inclusion of the pork variable is consistent with the reasoning established for the packers' domestic demand relationship above. Wage rates are excluded in the case of import demand on grounds that packers do not process imported carcass, and may distribute carcasses directly to retailers thus limiting their involvement to a facilitating role.

5.1.5 Producer Supply

The supply of slaughter steers and heifers available in the market at any given time is the aggregate of a very complicated set of forces beginning with the breeding decisions of the cow-calf producers and ending with the

feeding and marketing decision of the feedlot operator. For the purpose of this research the supply, in terms of numbers of animals, on a quarterly basis is assumed to be predetermined. The producer supply relationship, therefore, involves only those factors affecting the length of feeding period and final market weight. The predetermined nature of the supply can be further justified on grounds that the study period has been selected to avoid possible changes in breeds or breeding practices in response to the change in grading standards. Such long term adjustments would most likely involve a period longer than the four years of yield grade experience included in this study.

Specification of the producer supply relationship for fed beef reflects the profitability in feeding cattle. Variations in the quantity of steers and heifers (pounds) supplied are stated as being dependent upon the price of slaughter cattle, price of feeder animals at the start of the feeding period, price of feed, and sex composition of slaughter. The price of feeder animals is lagged two quarters to reflect the input cost of animals entering the feedlot in relation to the current slaughter price. Differences in producer supply response, as a result of the change in grading standards, are expected to be reflected in the slope and intercept binary variables.

5.1.6 Carcass Weight

Average carcass weights for fed slaughter cattle will vary for two reasons. First, the steer-heifer composition of total slaughter, depends on the stage of the cattle cycle. During periods of relatively high calf prices many heifers are usually held back for breeding, and the proportion of steers in the total slaughter increases. Conversely, during the contraction phase of the cycle heifers are sold for slaughter. As the proportion of heifers slaughtered increases, the average carcass weight is reduced as a result of the lower slaughter weight and dressing percentages for heifers.

A second reason for variations in carcass weights concerns the profitability of feeding animals to heavier weights. If the expected slaughter cattle price increases relative to feed and feeder cattle prices, the feedlot operator has an incentive to further feed animals to heavier weights. To some extent this incentive has been reduced by the yield grade price discounts on excess fat levels. There is, however, some flexibility between the minimum yield grade one and maximum yield grade two fat levels over which slaughter weights may vary. The market does not discriminate between the two highest yield grades.

The formulation of the carcass weight relationship attempts to capture the sources of variation in carcass weights. Average weight is specified as being dependent

upon slaughter prices, as measured by the price of slaughter steers, price of feed, and the ratio of steers and heifers in the fed cattle slaughter mix. Feed prices, as well as the composition of slaughter are considered as exogenous variables in the equation. Price discounts for fat thickness in excess of the maximum level within yield grades were expected to be sufficiently high so as to discourage "over-finishing" animals. Accordingly a decrease in the average carcass weight of slaughter steers and heifers was anticipated. Binary variables attached to the slope and intercept terms of the carcass weight equation are designed to measure the impact of the change in standards on carcass weights.

5.1.7 Alternative Specifications

As indicated at the beginning of this section, a problem with the magnitudes of the standard errors was anticipated with predicted prices for adjacent market levels appearing in the retailer and packer behavioral relationships. Thus, two alternative specifications for these equations were formulated prior to estimating the model. First, factors determining the demand in the adjacent market level were substituted for the price variable at that level. For example, the prices of substitutes (pork) and income from the consumer demand equation replaced the retail price in the retailers demand

equation. Similarly, these factors plus the proxy for the cost of retailer services (retail wage rates) were substituted for the wholesale price in the packer demand equations. Mathematically, these retailer and packer derived demand equations are developed by the elimination of a price variable through the equilibrium condition that the quantity supplied at one level equals the quantity demanded at the adjacent level [Foote p. 101]. The resulting derived demand equations are as follows:

a) Retailers Demand
QFBS*: D,D•WPSE*,WPSE*,ECWT*,RPP*,RWR,PCDY

b) Packers Domestic Demand
QFBP*: D,D•PSSE*,PSSE*,ECWT*,BPV,PWR,SHR,RPP*,PCDY

c) Packers Import Demand
QFBI*: D,D•PSSE*,PSSE*,BPV,WPD*,RPP*,PCDY

A second alternative specification of the derived demand relationships involved the use of the ratios of prices for adjacent market levels. The resulting equations are as follows:

a) Retailer Demand
QFBS*: D,D(RPB*/WPSE*),RPB*/WPSE*,ECWT*,RPP*,RWR

b) Packers Domestic Demand
QFBP*: D,D(WPSE*/PSSE*),WPSE*/PSSE*,ECWT*,BPV,PWR,
RPP*,SHR

c) Packers Import Demand
QFBI*: D,D(WPSE*/PSSE*),WPSE*/PSSE*,WPD*,BPV,RPP*

The nonlinear combinations of endogenous price variables

such as in the form of price ratios, as suggested by Chernoff and Rubin, may be treated as though they are single variables [Friedman and Foote p. 67]. An alternative procedure, which Friedman and Foote believe may be preferable, involves the use of a formula suggested by Klein, to transform the nonlinear combinations of exogenous and endogenous variables into linear approximations [Klein 1953]. For the purpose of this research involving pairs of endogenous variables the Chernoff-Rubin procedure was used [Chernoff and Rubin 1953].

5.2 The Econometric Estimates

The estimated coefficients for the behavioral equations are presented in Table 5.2. Quarterly data covering the sixteen year period from 1961 to 1976 were used in estimating the parameters. Binary variables were applied to the slope and intercept terms using zeros prior to the grade change and a value of one from 1972(3) to 1976. Estimates of the parameters of the various equations were obtained by using the two-stage least squares regression procedure. In the first stage, the endogenous variables appearing on the right hand side of the equations to be estimated (identified by asterisks) were estimated individually as functions of the predetermined variables in the system (Appendix D). These estimates then replaced the endogenous variable in the equations for the second stage estimation. The resulting

estimated parameters are discussed in the following sections.

TABLE 5.2 ESTIMATED FUNCTIONS FOR THE BEEF MODEL

Consumer Demand for Fed Beef

$$PDFB = 15.820 + \underset{(1.07)}{7.313}D \underset{(1.07)}{-.069}D \cdot RPB \underset{(1.71)}{-.072}RPB - \underset{(2.39)}{.042}RPP + \underset{(9.38)}{.019}PCDY$$

Retailer Demand for Carcass Beef

$$QFBS = -2086.492 + \underset{(2.85)}{323.141}D \underset{(2.32)}{-4.299}D \cdot WPSE - \underset{(2.74)}{5.190}WPSE + \underset{(3.06)}{3.823}RPB + \underset{(6.54)}{3.746}ECWT + \underset{(1.14)}{.957}RPP + \underset{(.38)}{.110}RWR$$

Packer Domestic Demand for Fed Slaughter Cattle

$$QFBP = -1397.691 + \underset{(.47)}{57.201}D - \underset{(.66)}{2.229}D \cdot PSSE - \underset{(.62)}{1.373}PSSE - \underset{(.72)}{1.467}WPSE + \underset{(2.57)}{1.950}ECWT - \underset{(.71)}{15.005}BPV + \underset{(4.28)}{2.902}PWR + \underset{(2.78)}{2.429}RPP + \underset{(1.15)}{16.964}SHR$$

Packer Import Demand for Carcass Beef

$$QFBI = 7.026 + \underset{(.78)}{6.442}D - \underset{(.66)}{.148}D \cdot PSSE - \underset{(.73)}{.132}PSSE - \underset{(.24)}{.048}WPSE + \underset{(2.53)}{.414}WPD + \underset{(4.23)}{6.762}BPV - \underset{(1.25)}{.059}RPP$$

TABLE 5.2 Continued

Producer Supply of Fed Slaughter Cattle

$$QFBP = +406.464 + \underset{(4.25)}{539.216}D - \underset{(3.06)}{11.202}D \cdot PSSE - \underset{(1.59)}{3.385}PSSE + \underset{(2.80)}{5.612}PFSW_{t-2} - \underset{(4.80)}{1.092}PFW - \underset{(1.15)}{14.253}SHR$$

Average Carcass Weight

$$ECWT = 626.435 - \underset{(.05)}{2.051}D + \underset{(.70)}{.773}D \cdot PSSE - \underset{(.50)}{.333}PSSE - \underset{(5.18)}{.360}PFW + \underset{(1.00)}{4.066}SHR$$

Numbers in parentheses are t- values.

5.2.1 Consumer Demand for Fed Beef

The demand for fed beef at retail was found to be positively related to incomes, and negatively related to its own price and the price of pork. Other studies have indicated an unexpected sign and lack of significance on the pork substitute as being a not unusual result in beef demand studies [Nelson 1977].

A comparison of the estimated consumer demand for fed beef with the results of other studies relating to aggregate beef demand indicates a lower value for the price elasticity of demand for fed beef (-.465) estimated at the mean values of RPB and PDFB. Estimates by Yeh (1961), Holmes (1968),

Yankowski (1970), Kulshreshtha and Wilson (1972). and Tryfos and Tryphonopoulos (1973) indicated a range of price elasticities from -.521 to -.801 for various periods between 1947 and 1970 [Hassan and Katz 1975]. A higher elasticity value was anticipated for this study since the value relates to fed beef, as measured by the price of sirloin beef. which was expected to be more responsive to price changes than beef in the aggregate. The calculated value suggests fed beef consumption is only moderately responsive to price changes. That is, a one percent increase in the price of fed beef would generate a .465 percent reduction in the quantity of fed beef demanded. Some caution should be exercised in the interpretation of the elasticity result since the price of sirloin was assumed representative of the market conditions for fed beef. Estimation based on a composite cut price could generate a different response value. The calculated income elasticity value of .802 for the estimated consumer demand equation falls within the range of values reported by the above researchers (ie. .393 to 1.044).

The most significant result of the consumer demand estimate, in terms of the objectives of this study, is the lack of significance for both binary parameters. Although this result is not conclusive, it does suggest there was no structural change in the demand for fed beef coincident with the change in grading standards. There is reason to suspect

only minimal consumer reponse to the change in standards. Yield grades relate primarily to external fat cover which, in the course of retailer processing, is trimmed to retailer specifications prior to sales. Any reduction in internal fat deposition or marbling probably went undetected by the consumer.

The stability of the consumer demand equation over the grade change period also suggests any benefits from the yield grade system were either not passed on to consumers, or were too small to be reflected in a structural change in consumer demand. The impact of the system was expected to be improved quality at the consumer level, in which case consumers were expected to either pay higher prices for the same quantity, or purchase more beef at the same price. Both sets of circumstances would be reflected in a structural shift in the demand relationship as measured by the binary variables.

5.2.2 Retailer Demand for Carcass Beef

The retailers demand for fed beef carcasses was found to be positively related to the retail price of beef and pork, as well as to retail wage rates and carcass weights, and negatively related to the wholesale price of beef. A relatively high correlation (r=.772) between predicted wholesale and retail prices in the equation, however, suggests some caution should be exercised in inferring

retailer response to price changes.

In general, the positive sign on the pork proxy variable was expected to the extent the variable reflects pork processing profitability. Similarly as retailer costs (as measured by wage rates) increase retailers may attempt to maintain overall profit levels by increasing beef sales. A negative sign on the wage rate variable would have been more consistent with the neoclassical model. Carcass weights, on the other hand, were expected to have a negative impact on retailer demand. A major reason for the adoption of yield grades was to provide a mechanism to objectively discriminate against overweight, excessively fat carcasses. The positive sign on this variable could indicate the overfinished carcass situation has historically been a temporary situation, and on average, carcass weights have been less than the preferred weight of retailers.

The significance of the parameters on both binary variables suggests retailer demand for carcass beef has been affected by the change in grading standards. The negative value on the slope dummy indicates that, for given values of the other factors, retailers demand less beef and are more sensitive to changes in the wholesale price of beef under the yield grade system. A positive value on the intercept dummy suggest an increased demand under the new grading system. The combined effect of the slope and intercept binary variables, as measured at the mean values of the

independent variables, is an increase in the retailer quarterly demand for beef. A survey of retailer impressions conducted by Smith indicated retailers continued to select and trim carcasses within grades, and were not directly concerned with grading except that every carcass they purchased had to be graded within the A category [Smith 1975].

Two alternative specifications of the retailer carcass demand equation were formulated to address the anticipated problem with standard errors for predicted prices from adjacent levels of the market channel. First, factors relating demand at the retail level were substituted for the retail price in the derived demand equation. The two stage least squares estimate of the resulting structural equation was:

$$\begin{aligned} QFBS = -1171.498 &+ \underset{(1.45)}{143.135D} - \underset{(1.26)}{1.983D \cdot WPSE} - \underset{(1.76)}{2.110WPSE} \\ &+ \underset{(4.40)}{2.356ECWT} + \underset{(.48)}{.316RPP} - \underset{(1.27)}{.317RWR} + \underset{(6.50)}{.342PCDY} \end{aligned}$$

With the exception of the binary variables, the results for the first alternative are generally similar to those of the original specification. The signs on all variables were as expected, although the magnitude of the coefficient for the wholesale price was reduced significantly. In the case of the wage rate a relatively high correlation (r=.912) with

the income variable may be involved. In comparison to the original estimate, the alternative specification suggests retailers are not as sensitive to changing wholesale prices as previously indicated. A lack of significance on the parameters for both binary variables suggests retailer demand was not affected by the change in grading standards.

The second alternative specification of the retailer carcass demand equation involved the ratio of retail and wholesale prices as a variable in place of the two separate price variables. The estimated equation was:

$$\begin{aligned} QFBS = {} & -2562.869 - \underset{(2.60)}{414.337}D + \underset{(3.04)}{271.316}D(RPB/WPSE) \\ & + \underset{(2.07)}{147.126}(RPB/WPSE) + \underset{(7.78)}{4.171}ECWT + \underset{(1.86)}{1.415}RPP \\ & + \underset{(.37)}{.102}RWR \end{aligned}$$

The results for the second alternative bear a remarkable resemblance to the original estimate. The sign on the price ratio was as expected, indicating retailers demand more beef as the retail price increases relative to the carcass, or wholesale price of beef. The estimated equation does not involve any intercorrelation problems such as were experienced with the original estimate and the first alternative specification. The positive value on the slope dummy suggests retailers are more sensitive to the margin between retail and wholesale beef prices than was experienced under the previous grading system.

5.2.3 Packer Domestic Demand for Slaughter Cattle

The estimated packer domestic demand equation is not consistent with a priori expectations. Although a negative sign on the slaughter cattle price was anticipated, the signs on the wholesale and by-product price variables cannot be rationalized in terms of theoretical expectations concerning packer behavior. The results suggest packers demand more fed cattle as output prices (wholesale carcasses and by-products) decline. A possible reason for these unexpected responses may involve the close relationship between predicted slaughter cattle and wholesale prices (r=.876).

With the exception of the two price variables, appropriate signs were observed on all variables. Packer demand for slaughter cattle was found to be positively related to processing costs (as measured by the wage rate proxy variable), retail pork prices, carcass weights and the sex composition of slaughter. Packer returns are to some extent related to the dressing percentage or ratio of carcass to live animal weight, which has been shown to be higher for steers and heavier animals. An increase in the steer-heifer ratio is coincident with a reduction in the proportion of heifers in the slaughter mix and a corresponding increase in the average dressing percentage. A positive sign on the wage rate proxy variable could indicate packer efforts to increase slaughter margins during

periods of increasing processing costs.

A lack of significance for the parameters of the binary variables suggests packer demand for slaughter cattle was not materially affected by the change in grading standards. A statistical test of the combined effect of slope and intercept binary variables resulted in failure to reject the hypothesis that the sum of the binary terms was equal to zero.

Two alternative specifications of the slaughter cattle demand equation, formulated to address the intercorrelation problem, were based on 1) the substitution of factors affecting the retailers demand for the wholesale carcass price, and 2) the replacement of the adjacent market level price variables with the ratio of their respective prices. In the first case the estimated equation was:

$$
\begin{aligned}
QFBP = {} & -1083.568 + \underset{(1.32)}{125.371}D - \underset{(1.51)}{3.822}D{\cdot}PSSE - \underset{(1.58)}{2.202}PSSE \\
& + \underset{(2.53)}{1.724}ECWT - \underset{(.61)}{11.478}BPV + \underset{(1.53)}{1.169}PWR + \underset{(1.37)}{1.177}RPP \\
& + \underset{(.92)}{11.785}SHR + \underset{(3.67)}{.236}PCDY
\end{aligned}
$$

The estimated equation resulted in an unexpected negative sign on the by-product price variable. Slaughter steer and heifer demand is shown to be negatively related to the price of fed cattle, and positively affected by carcass weights, steer-heifer ratio, pork prices and income. By-product values, and the wage rate proxy are not significantly different from zero. A high level of

intercorrelation (r=.912) involving the income and proxy variable suggests some caution should be exercised in inferring demand responses to changes in these variables. The lack of significance on the parameters of both binary variables supports the results of the original estimate.

The estimate for the second alternative specification of the packer demand for slaughter cattle continued to display inappropriate signs on the price variables. Estimation based on the removal of the by-product variable resulted in the appropriate signs, but the price ratio was not significantly different from zero. The estimated equation was:

$$
\begin{aligned}
QFBP = {} & -1927.530 - \underset{(2.27)}{1426.898}D + \underset{(2.22)}{783.764}D(WPSE/PSSE) \\
& + \underset{(.70)}{42.901}WPSE/PSSE + \underset{(2.58)}{2.438}ECWT + \underset{(3.92)}{2.671}PWR \\
& + \underset{(2.94)}{2.882}RPP + \underset{(1.18)}{15.764}SHR
\end{aligned}
$$

As with the two previous estimates, the packer demand for fed slaughter cattle was positively related to the carcass weight, processing costs (as measured by the wage rate proxy), pork prices and the sex composition of slaughter.

Positive and significant coefficients for the slope and intercept binary variables suggests packer demand for steers and heifers increased as a result of the change to yield grade standards. This result contradicts the two previous estimates which indicated no change in the structural

relationship during the post 1972 period. A negative impact on packer demand was anticipated on the basis that knife ribbing would reduce carcass storage and handling efficiency. Difficulties in relating yield grades to live animal purchases were also expected to have an impact on packer willingness to pay.

5.2.4 Packer Import Demand for Carcass Beef

The packer demand for imported fed beef carcasses from the United States was found to be positively related to the price difference between United States and Canadian carcass beef, and the value of packer by-products; and negatively related to the prices of wholesale beef, slaughter cattle and retail pork. The lack of significance and, as in the case of the slaughter demand formulation, the relatively high correlation between predicted live animal and carcass prices (r=.876) condition any inferences concerning packer response to price changes. A positive sign on by-product values is difficult to rationalize since increasing values enhance packer profit opportunities and were accordingly expected to result in a preference for live animals. With the exception of a minimal amount of fat trim, carcass beef does not contain any by-products.

In general, the import demand estimate contains only two significant variables, one of which has a questionable positive sign. Attempts to resolve these problems did not

meet with success, although some questions were raised concerning the accuracy of the available trade data used in the analysis. The methods used in reporting international movements of beef do not necessarily distinguish between carcasses and wholesale cuts, or different qualities of beef. Quarterly aggregation of trade data may also not reflect market conditions in a particular week of period in which the actual trade took place.

Two alternative specifications of import demand did not improve the results of the equation. In the first alternative, factors associated with the retailer demand for carcass beef were substituted for the wholesale price. The two stage least squares estimate of the first alternative specification of the import demand relationship was:

$$\begin{aligned} QFBI = {} & 5.714 + \underset{(.85)}{6.210D} - \underset{(.55)}{.124D \cdot PSSE} - \underset{(.73)}{.120PSSE} + \underset{(3.17)}{6.128BPV} \\ & + \underset{(.99)}{.280WPD} - \underset{(1.32)}{.081RPP} + \underset{(.42)}{.003PCDY} \end{aligned}$$

The results of the first alternative indicate packer import demand is positively related to by-product values and the wholesale price difference. A negative, but not significant coefficient on the slaughter animal price was not anticipated. Imports are most likely to occur during periods of high domestic prices for slaughter cattle. Similarly high pork prices and incomes could be expected to

enhance the demand for beef and, therefore, have a positive impact on beef imports.

The second alternative specification, based on the ratio of wholesale and live animal prices also suggests a positive relationship between imports and the wholesale price difference between Canada and the United States. The estimated equation was:

$$\begin{aligned} QFBI = &- 5.061 + \underset{(.31)}{12.965}D - \underset{(.26)}{6.002}D(WSPE/PSSE) \\ &+ \underset{(1.02)}{4.826}(WPSE/PSSE) + \underset{(2.38)}{.259}WPD + \underset{(2.75)}{4.571}BPV - \underset{(1.37)}{.063}RPP \end{aligned}$$

The positive signs on the price difference and price ratio suggest packers demand more imported beef the larger the price difference between markets, and the greater the spread between live animal and wholesale prices in the domestic market. The positive sign on by-product values, like the previous estimate, was not expected.

The structure of the import demand equation appears to have been insensitive to the change in yield grade standards. The slope and intercept binary variables were not significantly different from zero in the estimates for the three specifications of the equation. This result was not expected since yield grades were expected to lower the fat content of Canadian beef carcasses compared to the previous system, and especially in comparison to the United States supply. Speculation as to why a structural change

was not identified may involve the quality of trade data available to the study. It could also be indicative of only minor differences between the fat levels of yield graded Canadian beef and the quality of beef imported from the United States. There is reason to suggest carcass fat content in both countries may have been reduced substantially during the 1973-76 period of the study when Canadian yield grades were in effect. This point will be pursued in the following producer supply and carcass weight sections.

5.2.5 Producer Supply of Fed Slaughter Cattle

The producer supply equation is possibly the most important in the beef industry model. As indicated in a previous chapter, one of the primary reasons for the adoption of yield grade standards concerned the potential transfer of benefits from the system to the producing sector of the industry. Cost savings resulting from the increased operational efficiency, reduced labor and trim losses, and enhanced consumer demand for beef were expected to be reflected to producers in the form of higher prices for a given supply, or conversely increased sales at any particular price. The estimated supply equation indicates that the quantity of steers and heifers supplied, in terms of weight, is positively related to the price of feeder cattle (lagged 6 months), and is negatively influenced by

the price of slaughter cattle, sex composition of slaughter, and price of feed. Although the feeder cattle price, and price of feed were significant, the signs on the slaughter and feeder cattle price variables were not expected.

The positive impact of the lagged feeder cattle price on producer supply was not anticipated. One would expect prices to be inversely related to the supply of feeder cattle demanded and, therefore, the supply of slaughter steers and heifers available at the end of the feeding period. The sex composition of slaughter, as measured by the ratio of the number of steers to number of heifers in the slaughter mix, is also an indicator of total supply conditions. An increase in the ratio usually indicates a hold back of heifers for breeding purposes and a resulting decline in the total number of animals slaughtered.

Feed grain prices were expected to have a negative impact on both the number and average weight components of the total quarterly fed beef supply. During periods of high grain prices it is possible for producers to reduce the energy content of rations and as a result delay the projected slaughter date of feedlot animals. The significant negative coefficient on the feed price variable suggests such substitutions may have taken place during the study period. In a study of grain-roughage substitution in the beef sector Brokken concluded..."high concentrate rations remain economical on a profit per head basis even at

relatively high grain prices...and that...lowering of ration energy concentration is even less economical when the criterion of optimization is to maximize feedlot profits per unit of time" [Brokken 1975].

The most important result concerning the estimate of fed cattle response is the significance of both slope and intercept binary variables. This result suggests there was a structural shift in the response equation attributable to the change in grading standards. The combined effect of the slope and intercept binary variables, as measured at the mean values of the independent variables, is an increase in the producer quarterly supply of fed beef. Although some caution should be exercised in the interpretation of the estimated equation due to the inconsistent signs on feeder and slaughter cattle prices, it does appear that yield grade standards may be significantly different than the previous standards in determining feeding practices affecting the producer supply relationship. It should also be emphasized that feed grain prices increased rapidly starting at about the same time the yield grade standards were adopted, and prices remained high for most of the remainder of the study period. The significance of feed grain prices in determining carcass weight is discussed in the following section.

5.2.6 Average Carcass Weights

Average fed cattle carcass weights were expected to decline as a result of the adoption of yield grade standards. The inverse relationship between retail yield of salable meat and external carcass fat thickness, as demonstrated by Fredeen, formed the basis for the yield predicting standards. In general, the wholesale price for most carcasses became a decreasing function of fat thickness, and therefore, live animal weight in relation to mature weight. The estimated equation failed to identify any impact on weights as a result of the adoption of the yield grade system. Both slope and intercept binary variables were not significant indicating no change in the carcass weight structural relationship coincidental with the adoption of the new grading system.

Carcass weights were found to be positively related to the sex composition of slaughter, and negatively influenced by the prices of slaughter cattle and feed. The negative sign on slaughter prices could be rationalized in terms of producer expectations concerning the profitability of feeding animals to heavier weights in comparison to the purchase of feeder cattle for a new feeding period. An increase in slaughter prices may be interpreted by the decision maker as an indicator of increased feeding margins during the next feeding period. Because feeding efficiency

declines throughout the feeding period. profits per unit of time would be enhanced by selling heavier animals and feeding lighter animals.

An important result of the carcass weight estimate is the negative coefficient on feed grain prices. Steer and heifer weights were expected to vary inversely with feed prices. As suggested above, this situation can be attributed to reduced feed efficiency, and therefore higher costs per pound of gain as animals approach their mature weight. Feed grain prices in Canada increased dramatically from $95.70 per ton during the third quarter of 1972 to a peak of $252.10 by the end of 1974, then declined to $216.50 by December of 1976. These unprecedented increases in the cost of feeding cattle coincided with the adoption of the yield grade system (September 1972). As a result, it is not possible to determine the impact of the change in grading standards on carcass weights. The coefficients of the slope and intercept binary variables suggest the structural relationship was stable over the period studied. In the absence of changes in the price of feed a structural change may have been identified.

CHAPTER VI

SUMMARY, CONCLUSIONS AND IMPLICATIONS FOR FURTHER RESEARCH

This chapter briefly summarizes the content of the research and outlines the conclusions that have been drawn from the empirical results. The conclusions and implications for further research are to a large extent conditioned by factors relating to the costs of processing and marketing beef and beef products in the industry.

6.1 Summary

The opening chapter of this thesis discussed the rationale for beef carcass grading, and factors underlying the adoption of a yield grade system in the Canadian beef industry. The primary reason cited for the development and institutionalization of grading standards into the beef industry has been in the name of market information as a means of improving marketing efficiency. Grading provides a means of classifying a heterogeneous supply of a commodity into smaller, more homogeneous units such that the variation in quality within any particular group is less than over the entire range of the commodity. Price information relating to the more uniform subsets of the commodity facilitates the allocation of available supplies among alternative demands,

and improved production decisions concerning future supplies.

Historically, beef carcass grading has involved an assessment of quality, in terms of consumer preferences, and quantity, in terms of yield of salable meat. Factors such as maturity, color and texture of lean and fat, and marbling have been accepted as being important to consumers. Marbling has been associated with the palatability determinants of taste, juiciness, and flavor, and to a lesser extent with tenderness. Maturity has been designated as the primary indicator of tenderness. The combination of marbling and maturity has had the greatest significance in quality grade determination. Conformation, which refers to visual assessment of carcass composition and distribution of fat, bone, and lean meat among the high and low-valued cuts, has been the basis for quantitative carcass evaluation. High levels of external fat cover have for many years, been associated with both high retail yields and high marbling scores.

Many studies have attempted to substantiate the role of the various components of beef grades in determining carcass value. Growth studies have established slaughter weight in relation to mature animal weight as the major determinant of carcass composition. Fatty deposits appear in young animals around viscera and kidney and, with increasing age and adequate caloric intake, between muscles, beneath the skin,

and lastly in the form of marbling between muscle fibres. An increasing body of research indicates carcass yield of salable meat declines as the level of external fat thickness increases. These results, not only indicate that quality, as determined by marbling scores, and carcass yields are indirectly related, but seriously question the validity of existing conformation criteria as a quantitative indicator.

The development of Canadian yield grade standards for carcass beef was based on controversy concerning the relevance of the previous conformation and marbling scores in determining both qualitative and quantitative attributes of beef carcasses. All sectors of the beef industry expressed dissatisfaction with standards at a 1966 beef industry conference. Retailers claimed excessive fat levels were not preferred by consumers and resulted in costly trim losses. They also indicated the inadequacy of grades in describing buyer specifications. Packers claimed losses in trimming over-fat carcasses to avoid lower prices from downgrading to Commercial 3. Producers demanded that grades reflect the kind of carcasses the market required, and expressed their discontent with a system which encouraged fat, but which discounts in certain cases.

The essential features of the yield grade system are the de-emphasis of fat and an objective measure of carcass yield based on fat thickness. Quality standards remain primarily determined by maturity with reduced marbling

requirements. Carcasses are knife-ribbed between the 11th and 12th rib and assessed for fat thickness, color and texture of lean and fat, and marbling content. Yield grades are inversely related to the level of fat thickness. Adoption of the system in September of 1972 brought about a realignment of carcass prices to coincide with the higher yield predicting grades.

Theoretically, the economic rationale underlying the adoption of the yield grade system involves the manipulation of the supply and demand schedules of at least some market participants in such a way so as to positively influence the revenues of one or more sectors of the industry. It was anticipated that lower carcass fat content would enhance consumer demand for beef and reduce trim and trimming costs of retailers and packers. The greater accuracy of yield grades in describing retailer specifications were expected to eliminate costly buyer evaluations and selections of carcasses. Specification buying could also improve packer storage and handling efficiency. At least part of these benefits were expected to be transferred to producers in the form of increased demand for slaughter cattle. Producers were also expected to benefit through improved feeding efficiency from feeding animals to lighter slaughter weights. Research evidence indicates carcass fat content is determined by slaughter weight in relation to mature weight. and is not materially affected by the plane of nutrition or

management practices.

Because of the complexity of the beef production and marketing system, and the many possible effects of yield grade standards, it was decided that estimates of the economic impacts on supply and demand relationships within the industry may provide useful information concerning the magnitude and distribution of net benefits generated by the change in standards. The economic effects on the demand faced by producers and the producer supply relationship. which interact to determine slaughter cattle prices, were of particular concern. The primary objective of the research was to construct an analytical framework and evaluate the economic impacts of yield grade standards in the markets for Canadian slaughter cattle and beef.

A conceptual model outlining the important interrelationships among market sectors of the beef industry was developed and formulated into a system of equations for econometric estimation. The model considered the major production and marketing decisions, affected by changes in qualitative and quantitative standards, which determine retail, wholesale, and farm prices in the beef industry. These relationships include consumer demand, retailer supply and demand, packer supply and demand, and producer supply. In addition packer import demand and carcass weight relationships were specified to account for the impact of trade and changing carcass weights on supplies within the

industry.

The essential feature of the beef industry model is the linkage between consumer demand and the derived demands of the various market sectors. This feature allows for changes in the demand at a particular level to be reflected in the demand faced by producers (packer domestic demand). The impact of the change in grading standards on the livestock producing sector was of particular concern in this research.

The correlation of predicted values for adjacent market level prices in the processing and retailing sectors of the model was cause for concern over the magnitudes of the standard errors associated with the estimated parameters for these variables. Two alternative specifications of these relationships were formulated to address this problem. First, variables relating to demand at the adjacent market level were substituted for the corresponding price. The second method was based on the ratio of adjacent market level prices.

Other problems encountered in the specification of the model relate to the lack of accurate data concerning such key variables as the cost of processing and marketing services and beef carcass weights. Changes in these variables, attributable to the adoption of yield grades. were expected to have a significant impact on demand and supply relationships within the beef industry. In the absence of any better measure, indices of retailer and

packer wage rates were used as proxies for the costs of services performed by packers and retailers in transforming and moving beef and beef products through the marketing system. Although it can be argued that the impact of the grade change on packer and retailer costs would be reflected in wage rates, many other factors are also involved. The proxy variables, therefore, may not capture the full impact of the grade change on their respective market sectors.

A lack of data concerning weights of both slaughter cattle and carcass beef prior to the change in grading standards necessitated the use of estimated fed beef carcass weights in the model. For the purpose of this research Agriculture Canada provided estimated weights based on total slaughter weight, sex composition of slaughter, and trends in United States carcass weights over the 1961-72 period. Interrelationships between factors affecting Canadian and United States beef markets probably result in reasonable estimates.

The econometric model developed for the beef industry consists of ten equations including ten endogenous and ten predetermined, or exogenous variables. The simultaneous nature of the system required the use of the two stage least squares regression procedure to obtain estimates of the parameters. For the purpose of this research, only the demand equations, producer supply, and carcass weight relationships were estimated. Slope and intercept binary

variables were used to identify any structural changes in the system coincident with the change to yield grades. In general, the coefficients of most variables which were conceptually important proved to be significant and consistent with expectations. The coefficients on the binary variables for the retailer demand and producer supply equations were significant, suggesting there was a structural change in these relationships coincident with the adoption of yield grade standards.

A negative value on the slope dummy in the retailer demand relationships indicates that, for given values of the other variables, retailers demand less beef and are more sensitive to changes in the wholesale price of beef under the yield grade system. A positive value on the intercept dummy suggests an increased demand under the new grading system. The combined effect of the slope and intercept binary variables, as measured at the mean values of the independent variables, indicates an increase in the retailer quarterly demand for beef. Estimation based on the ratio of adjacent market level prices produced similar results, suggesting retailers are more sensitive to the relationship between retail and wholesale prices since the change in grading systems. A second alternative estimate, based on factors determining consumer demand substituted for the retail price, failed to identify any structural change in the retailer demand relationship coincident with the change

in grading systems.

In the case of the producer supply estimate. a negative coefficient on the slope dummy suggests that, for given values of the other variables, producers supply less beef and are more sensitive to changes in slaughter cattle prices under the yield grade system. The combined effect of the slope and intercept binary variables, as measured at the mean values of the independent variables, indicates an increase in the producer quarterly supply of fed beef. Inappropriate signs on both feeder and slaughter cattle prices, however, suggest some caution should be exercised in inferring producer response to the change in grading standards.

6.2 Conclusions and Implications for Further Research

A number of conclusions regarding the empirical results have been suggested in the previous chapter. This section breifly summarizes the conclusions as they relate to the various sectors of the beef industry and agencies involved in decisions concerning grading and grade specifications. Implications for further research which could prove beneficial in terms of evaluating future changes in the grading system are also presented.

6.2.1 Consumers

Two conclusions can be drawn from the research

concerning the consumer demand for beef. First, reduced fat levels in beef did not appear to have any impact on consumer willingness to purchase beef. This result suggests that, providing yield grades were effective in reducing carcass fat levels, consumers are essentially indifferent to a wide range of fat content in terms of marbling when retail trim specifications are taken into account. A second conclusion relates to the importance of price in determining consumer demand for the higher valued cuts of beef. In this study the price of sirloin beef was assumed representative of retail fed beef prices. Consumer demand was shown to be less responsive to price changes than has been reported by other studies based on aggregate retail beef prices.

6.2.2 Retailers

Conclusions concerning retailer response to yield grade standards are to some extent conditional upon the accuracy of the wage rate proxy variable in representing the cost of processing and marketing beef at the retail level. The empirical results suggest retailer demand for carcass beef may have been significantly affected by the change in grading standards. Since there was no apparent impact on consumer demand, this result suggests that benefits in terms of savings in trim loss and trimming labor, and procurement costs may have accrued to the retailing sector of the beef industry. A previous study indicated potential cost

reductions available to retailers in the form of specification buying did not materialize.

Although the empirical results suggest retailers responded positively to yield grade standards, further research is necessary to determine the accuracy of wage rates in describing beef procurement, processing and marketing costs at the retail level. The extent of fat trim losses and trimming costs within present yield grades is of particular concern. Yield grading is not without costs, and should these costs exceed the benefits of reduced fat levels then serious questions arise concerning the continued use of the system.

6.2.3 Processors

The lack of packer response to yield grade standards indicated by the research results is conditional upon the accuracy of a proxy variable representing processing costs. There is reason to suspect the proxy fails to capture the full impact of yield grading on processor efficiency. Because retailer specification buying did not materialize, packer benefits from yield grading may be limited to minor savings in trim costs resulting from the occassional over-fat carcass. Costs, on the other hand, may have increased. Previous research indicated cattle buyers experienced some difficulty in relating yield grades to live animal purchases. Lower dressing percentages resulting from

reduced carcass fat content would also have an adverse effect on processor efficiency.

Supporting evidence indicating a lack of packer response to yield grades is suggested by the stability of packer demand for carcass beef from the United States. Increased profitability in processing domestic slaughter cattle could be expected to result in reduced demand for imported beef. Although there is some question concerning the quality of trade data available to this study. the empirical results did not identify any structural change in packer demand for imported beef carcasses.

A primary area for further research involves the identification and quantification of costs associated with beef grading at the processing level of the industry. The estimates in this research were hindered by a lack of information concerning 1) packer processing storage and handling costs including the frequency and extent of carcass fat trim, and 2) cost of performing the grading function. Utilization of the wage rate proxy variable was a last resort, and probably fails to identify the impact of the grade change on processing efficiency. Costs associated with the performance of the grading function are also imported to an assessment of the overall benefits and costs of yield grading in comparison to alternative standards. In Canada, the grading function is the responsibility of Agriculture Canada, and cost information is not available.

6.2.4 Producers

The lack of any significant structural change in the demand faced by producers (packer domestic demand) essentially limits conclusions concerning producer response to the yield grade system to the producer supply relationship. The empirical results suggest there was a structural shift in the producer supply equation coincident with the change in grading standards. The combined effect of the slope and intercept binary variables, as measured at the mean values of the independent variables, translates into an increase in the producer quarterly supply of fed beef. This result tends to suggest improved feeding efficiency with yield grade standards.

The major impact of the yield grade system was expected to be in terms of reduced carcass weights. The lack of any carcass weight response to yield grade standards in the study, may have been dictated by two factors. First, the estimated carcass weights for the pre-grade change period may have biased the results. A second, and perhaps more important factor is that producer decisions concerning slaughter weights are, among other things, determined by feed prices. A structural change in grain prices, coincident with the adoption of yield grade standards, dominated the estimated carcass weight relationship. In the absence of any change in feed prices it is possible that

yield grades could have dictated a similar adjustment in slaughter cattle weights.

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APPENDIX A

AGRICULTURAL STATISTICS

Table A.1. Total Farm Cash Receipts from the Sale of Livestock, Canada (1970/76)

	Cattle Calves	Hogs	Dairy	Poultry eggs	Livestock Total	Other	Total Income
1970	976	484	679	436	2,575	1,676	4,251
71	1,060	429	706	414	2,609	1,955	4,564
72	1,205	570	778	460	3,013	2,438	5,451
73	1,480	825	849	682	3,836	3,037	6,873
74	1,681	778	1,096	741	4,296	4,630	8,926
75	1,818	886	1,343	680	4,727	5,301	10,028
76	1,963	840	1,331	762	4,896	5,142	10,038

Source: Agriculture Canada: Selected Agricultural Statistics for Canada, 1978

Table A.2. Regional Distribution of Cattle and Calf Farm Cash Receipts

	Alberta	West	Ontario	East
1970	267	524	333	453
71	273	579	354	482
72	304	675	390	529
73	427	874	437	606
74	529	986	563	694
75	585	1,118	564	701
76	633	1,188	619	774

Source: Agriculture Canada: Selected Agricultural Statistics for Canada, 1978

Table A.3. Inspected Slaughter (Canada - 1970/76)

	Cattle	Calves	Total	Hogs	Sheep/Lambs
1970	2,701	499	3,200	8,280	181
71	2,787	464	3,251	9,743	205
72	2,878	402	3,280	9,001	215
73	2,878	292	3,170	8,722	234
74	2,976	393	3,369	8,939	185
75	3,338	682	4,020	7,656	187
76	3,676	655	4,331	7,493	188

Source: Agriculture Canada: Selected Agricultural Statistics for Canada, 1978

Table A.4. Regional Distribution of Retail Food Chains in Canada, 1976

	West	East	Total
A and P		119	119
Canada Safeway	245	29	274
Dominion	16	371	387
Loblaw's (Westfair)	62	149	211
Steinberg's		185	185
Other	161	231	392
Total	484	1,084	1,568

Source: Canadian Grocer, August 1976

APPENDIX B

A COMPARISON BETWEEN THE 1972 AND THE 1958 BEEF GRADING ACTS

TABLE B.1

A COMPARISON BETWEEN THE 1972 AND THE 1958
BEEF GRADING ACTS

MATURITY: Physiological age, not calendar age - as determined by the degree of ossification (hardening of cartilage).

QUALITY: Color, texture, and firmness of the fat and lean.

MEAT YIELD: As determined by the fat covering. Research has shown that there is a relationship between the amount of fat covering and the meat yield. Carcasses will be knife-ribbed between the 11th and 12th ribs to measure fat covering.

---

1. CANADA A (Choice, Good, Standard, and Commercial 3)
   a. Maturity Class 1 (youthful)
   b. Lean - firm, fine texture, bright red color
      - slight marbling(minimum)
   c. Fat - firm, white or slightly tinged
   d. Muscling-free from marked deficiency
   e. Yield grade fat levels:

Warm Carcass Wt. (lbs.)	A-Yield Grade Fat Levels 1.	2.	3.	4.
300-499	.2-.3	.31-.5	.51-.7	.71+
500-699	.2-.4	.41-.6	.61-.8	.81+
700 +	.3-.5	.51-.7	.71-.9	.91+

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2. CANADA B (Choice, Good, Standard, and Commercial 1,3)
   a. Maturity Class 1 (Youthful)
   b. Lean - Moderately firm, somewhat coarse texture
      - bright to medium dark red,
      - no marbling (Minimum)
   c. Fat - firm or slightly soft,
      - white to pale yellow
   d. Muscling - free from marked deficiency
   e. Yield grade fat levels:

Warm Carcass Wt. (lbs.)	B-Yield Grade Fat Levels 1.	2.	3.	4.
300-499	.1-.3	.31-.5	.51-.7	.71+
500-699	.1-.4	.41-.6	.61-.8	.81+
700 +	.2-.5	.51-.7	.71-.9	.91+

TABLE B.1 (continued)

3. CANADA C-1 (Commercial 1,2)
   a. Maturity Classes 1 and 2 (Youthful and Intermediate)
   b. Lean - moderately firm
      - bright to medium dark red
   c. Fat - firm or slightly soft, light covering
      - white to pale yellow, no excess proportion
   d. Muscling - low medium to excellent
   e. To include carcasses with less than Fat Level 1, Canada B with Canada B quality and carcasses less than 300 lbs.

4. CANADA C-2 (Commercial 1,2, and Utility 1)
   a. Maturity Classes 1 and 2 (Youthful and Intermediate)
   b. Lean - Soft, coarse and sinewy texture
      - bright to extremely dark red
   c. Fat - firm to soft, slight covering
      - white to lemon yellow, no excess proportion
   d. Muscling - excellent to deficient
   e. To include carcasses with less than Fat level 1, Canada B and less than Canada B quality; also less than 300 lbs.

5. CANADA D-1 (Utility 2)
   a. Maturity Class 3 (Select cows)
   b. Fat - firm, white to pale yellow
      - well over rib, loins, hips, and chucks
   c. Muscling - good to excellent with no marked deficiency

6. CANADA D-2 (Utility 2,3)
   a. Maturity Class 3 (medium cows)
   b. Fat - firm to slightly soft, white to lemon yellow
      - cover most of surface, no excess proportion
   c. Muscling - medium, may have some deficiency

7. CANADA D-3 (Utility 3)
   a. Maturity Class 3 (plain cows)
   b. Fat - soft, white to deep lemon yellow
      - light to slight covering
      - no excess proportion
   c. Muscling - fair muscling, may have marked deficiency

TABLE B.1 (continued)

8. CANADA D-4 (Utility 1, Manufacturing)
   a. Maturity Class 3 (manufacturing cows); but to include carcasses extremely deficient in muscling from maturity Classes 1 and 2.
   b. Fat - little or none to an excess proportion
      - to include those with excess proportion from Maturity Class 2
   c. Muscling - poor

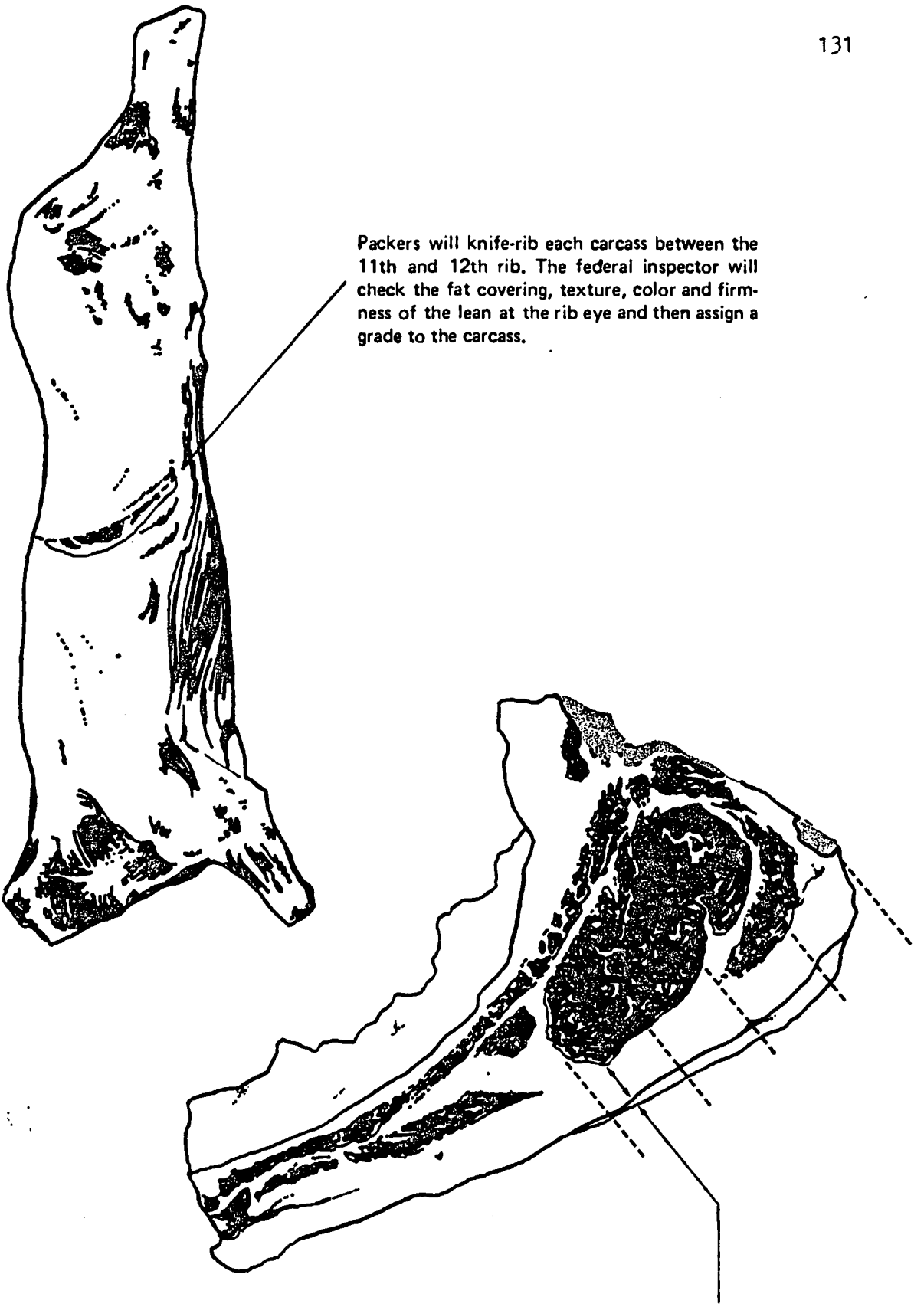
9. CANADA E (Bull)
   a. Maturity Class 3 (stags); but may include more youthful animals
   b. Lean - coarse and sticky
      - dark

Note:
All beef carcasses which are graded must be branded as follows:

Canada A-1,A-2,A-3, and A-4	- Red Ink
Canada B	- Blue Ink
Canada C	- Brown Ink
Canada D and E	- Black Ink

APPENDIX C

CARCASS RIBBING SPECIFICATIONS



Packers will knife-rib each carcass between the 11th and 12th rib. The federal inspector will check the fat covering, texture, color and firmness of the lean at the rib eye and then assign a grade to the carcass.

Federal inspectors will measure fat at the minimum point in the fourth quarter from the vertebrae along the longitudinal axis of the rib eye (see arrows). Research has established a direct link between the amount of fat and lean meat yield.

APPENDIX D

REDUCED FORM EQUATIONS

REDUCED FORM EQUATIONS

	PCDY	RWR	BPV	PWR	$PFSW_{t-2}$	PFW	SHR	D	R^2	d	F
PDFB = 11.594	+ .013	- .017	-2.038	+ .023	- .082	- .031	+1.067	+1.876	.844	1.43	43.72
	(5.31)	(1.73)	(3.33)	(.94)	(2.08)	(3.71)	(3.14)	(2.07)			
QFBS =126.133	+ .308	- .371	-48.906	+1.219	-1.262	- .688	+16.064	+50.559	.901	1.22	72.50
	(5.35)	(1.54)	(3.33)	(2.09)	(1.33)	(3.42)	(1.97)	(2.33)			
QFBP =152.601	+ .314	- .353	-53.475	+1.034	-1.306	- .692	+15.184	+50.777	.897	1.22	69.68
	(5.52)	(1.48)	(3.70)	(1.79)	(1.40)	(3.48)	(1.89)	(2.37)			
QFBI =-26.613	- .005	- .019	+4.544	+ .184	+ .052	+3.878	+ .857	- .223	.693	1.45	18.79
	(1.03)	(.92)	(3.64)	(3.72)	(.65)	(.22)	(1.24)	(.12)			
RPB = 31.346	+ .043	- .616	+8.446	+ .341	+1.368	+ .108	-7.363	-6.611	.564	1.32	11.19
	(3.28)	(2.33)	(2.46)	(1.59)	(6.16)	(2.39)	(4.08)	(1.35)			
RPP =140.283	+ .045	-1.271	+19.557	+ .442	- .243	+ .037	-10.238	+17.272	.546	.75	10.48
	(1.94)	(2.70)	(3.20)	(1.15)	(.61)	(.46)	(3.18)	(1.97)			
WPSE =-12.258	- .002	- .263	+11.255	+ .315	+1.081	+ .097	-2.495	-5.961	.571	1.46	11.49
	(.15)	(1.23)	(4.04)	(1.81)	(5.99)	(2.65)	(1.70)	(1.49)			
PSSE = -3.980	+ .0003	- .152	+ 7.338	+ .150	+ .632	+ .045	-1.496	-2.737	.585	1.46	12.09
	(.05)	(1.20)	(4.48)	(1.46)	(5.96)	(2.09)	(1.73)	(1.17)			
WPD =-37.157	+ .012	+ .063	-2.709	+ .073	+ .627	+ .027	- .091	+ .489	.703	1.52	19.60
	(1.34)	(.35)	(1.16)	(.50)	(4.16)	(.90)	(.07)	(.14)			
ECWT =542.541	+ .012	- .308	-16.744	+ .408	+1.343	- .255	+6.194	+14.807	.613	1.46	13.48
	(.48)	(.60)	(2.54)	(.99)	(3.15)	(2.96)	(1.78)	(1.57)			

Numbers in brackets are t values

APPENDIX E

DATA

PDFB	QFBS	QFBF	QFBI	D	PCDY
11.541	208.791	207.138	1.653	0	457.81
13.064	237.407	236.436	.971	0	476.07
13.401	244.019	243.209	.81	0	548.33
11.348	208.323	206.776	1.547	0	489.1
11.767	216.905	215.738	1.167	0	481.54
12.267	227.045	226.335	.71	0	502.91
11.677	217.187	216.231	.956	0	595.01
10.55	197.102	196.214	.888	0	504.19
12.61	236.645	236.046	.599	0	484.72
13.39	252.352	251.654	.698	0	515.99
12.643	238.043	237.216	.827	0	615.61
12.624	240.129	239.479	.65	0	520.46
13.728	262.107	261.203	.904	0	516.54
13.962	267.712	266.531	1.181	0	517.47
14.78	284.819	283.949	.87	0	614.96
15.155	293.416	292.248	1.168	0	537.85
14.847	289.537	288.761	.776	0	538.57
14.551	284.88	283.322	.558	0	536.66
15.208	299.269	298.767	.502	0	650.18
14.141	279.668	278.986	.682	0	567.53
14.345	284.856	283.819	1.037	0	562.33
15.348	306.739	305.435	1.304	0	567.19
15.394	308.645	307.095	1.55	0	677.74
14.973	301.824	300.346	1.478	0	581.28
14.9	301.396	298.074	3.322	0	579.95
16.191	328.77	326.356	2.414	0	593.95
14.985	305.876	304.001	1.875	0	673.68
14.172	290.646	289.147	1.499	0	599.54
15.394	316.824	315.67	1.154	0	574.75
16.271	335.901	334.815	1.086	0	615.86
16.04	332.493	331.49	1.003	0	702.98
15.887	330.678	329.468	1.21	0	618.27
16.182	338.006	336.859	1.147	0	605.21
14.768	309.392	307.704	1.688	0	624.09
15.855	333.391	331.962	1.429	0	712.33
17.891	377.702	376.431	1.271	0	634.34
15.864	336.035	334.694	1.341	0	619.71
15.768	334.971	333.33	1.641	0	636.18
17.15	365.712	363.754	1.958	0	704.81
16.275	348.284	345.897	2.387	0	647.34
17.802	334.278	328.961	5.317	0	637.61
16.345	351.802	345.483	6.319	0	679.68
17.194	371.312	367.814	3.498	0	762.24
15.883	344.097	339.026	5.071	0	688.29
15.935	346.171	340.101	6.07	0	687.84
17.375	378.443	369.743	8.7	0	739.99
17.685	386.385	378.839	7.546	0	788.18

PDFB	QFBS	QFBF	QFBI	D	PCDY
17.649	386.717	377.522	9.195	1	736.98
16.599	364.919	355.982	8.937	1	707.72
16.454	362.755	354.288	8.467	1	772.23
17.996	380.156	369.017	11.139	1	891
18.33	407.049	394.04	13.009	1	771.16
16.101	359.159	349.515	9.644	1	735.12
17.179	384.529	381.327	3.202	1	788.73
16.607	373.317	372.301	1.016	1	887.16
15.832	357.393	349.114	8.279	1	770.55
17.774	402.749	395.428	7.321	1	763.54
17.324	393.886	389.928	3.958	1	799.19
17.496	399.453	396.999	2.454	1	908.38
16.111	369.316	366.845	2.471	1	791.3
19.712	453.329	445.958	7.371	1	844.78
20.285	467.835	457.023	10.812	1	911.64
21.418	495.686	488.583	7.103	1	1000.47
21.036	488.691	483.793	4.898	1	903.22

RPB	RPP	WPSE	PSSE	WPD	ECWT
94.3	123.59	58.04	32.54	-1.01	569.84
91.22	119.03	54.14	30.8	1.15	562.36
91.63	122.52	52.78	30.68	-1.28	553.27
94.95	121.94	59.31	34.03	2.02	564.3
96.68	117.88	60.03	33.93	-.98	568.1
96.91	118.12	59.48	34.03	-1.48	564.64
106	131.1	65.53	37.58	1.42	555.9
106.63	129.23	65.41	38.06	-1.16	557.9
97.48	126.5	55.84	32.06	-3.88	577.39
91.5	119.51	54.23	31.57	-2.24	577.53
101.85	123.4	60.22	34.62	1.32	569.52
95.02	119	54.92	31.34	-.05	581.98
88.68	115.26	52.35	30.04	-1.42	586.84
90.99	115.35	54.34	30.93	3.26	563.97
94.59	120.15	53.9	30.96	-2.75	566.66
91.22	118.65	51.64	29.73	-3.61	580.42
90.24	117.34	52.35	29.77	-1.8	575.19
92.27	118.12	54.61	31.5	-4.25	563.86
101.24	134.4	56.08	32.45	-2.61	563.05
96.27	140.26	55.68	32.13	-.28	572.22
100.85	151.72	58.89	33.12	.05	581.93
99.36	138.3	55.17	32.18	-.7	585.41
102.3	142.02	55.32	31.13	1	579.24
99.01	137.48	57.5	32.96	4.25	590.78
99.68	128.66	58.69	33.35	5.44	588.36
97.09	124.26	56.4	32.2	2.72	586.11
106.98	124.14	60.33	34.24	6.75	572.98
107.64	120.3	61	34.22	9.35	583.34
100	115.93	56.26	31.3	3.62	588.86
96.8	112.85	54.83	31.09	2.86	593.34
104.2	119.56	58.15	32.48	5.37	582.79
102.33	125.05	56.24	31.3	3.86	608.62
101.38	125.12	55.27	31.13	1.64	588.53
107.99	122.53	63.25	36.03	3.6	587.53
108.82	128.59	59.75	33.96	4.66	587.49
95.01	130.4	53.43	30.37	3.18	606.55
98.58	130.88	59.23	33.5	6.19	612.66
101.68	122.96	59.37	33.83	7.03	599.67
104.88	117.23	56.33	32.5	5.19	586.59
95.49	109.87	56.86	31.79	10.01	605.23
96.84	101.8	61.26	33.92	9.22	606.72
98.96	98.42	61.3	34.49	7.24	591.76
104.36	99.07	59.14	33.88	5.7	587.2
99.7	100.66	61.52	34.77	8.37	602.09
101.56	107.3	64.04	36.34	8.75	600.35
101.09	111.51	63.45	35.99	9.61	592.56
106.33	119.25	60.59	34.71	8.98	591.93

RPB	RPP	WPSE	PSSE	WPD	ECWT
96.91	122.72	60.05	34.72	10.23	604.1
103.83	129.14	67.11	39.95	6.3	591.81
105.87	129.23	69.92	41.03	7.05	580.21
117.16	142.51	78.09	45.9	16.2	607.93
108.3	143.49	71.81	40.42	16.72	616.48
112.6	134.06	73.01	41.16	13.05	603.67
108.22	115.27	68.12	38.19	17.45	597.15
123.31	122.13	71.78	41.26	17.09	582.89
109.84	127.91	69.16	39.41	21.88	591.42
105.1	128.31	59.61	32.5	14.85	586.24
102.08	131.23	61.28	34.16	2.11	587.35
117.97	155.73	62.22	34.98	3.55	576.53
113.8	159.15	61.93	34.53	9.58	581.24
100.14	148.86	53.56	29.47	11.21	584.42
97.99	140.64	53.19	30.24	10.83	601.75
93.47	141.47	48.01	26.57	10.54	593
88.39	128.69	48.44	27.06	8.8	595.3

RWR	BPV	PWR	PFSW	PFW	SHR
69.16	1.34	112.23	26.4	126.17	2.39
69.53	1.43	116.35	26.7	126.34	2.79
69.18	1.48	113.87	27.72	136.85	2.54
69.29	1.45	114.19	27.21	144.02	2.27
69.71	1.39	115.15	26.03	149	2.38
70.33	1.47	118.21	27.94	151.06	2.82
70.83	1.46	115.4	28.76	150.85	2.15
70.17	1.45	115.25	30.67	143.32	1.89
70.81	1.28	115.5	32.66	138.12	2.55
70.81	1.21	118.91	32.55	136.02	3.04
70.94	1.2	116.27	29.7	134.58	2.41
70.78	1.17	116.5	31.14	132.95	2.67
69.81	1.08	116.68	31.28	132.05	2.84
70.8	1.16	117.61	27.46	132.53	3.05
72.13	1.21	117.41	26.78	131.81	2.47
71.98	1.21	118.83	28.18	131.9	2.6
69.34	1.13	118.08	25.99	129.77	2.54
71	1.27	120.92	24.64	127.43	2.41
71.77	1.4	118.5	24.8	126.45	2.14
71.71	1.39	121.57	27.15	124.85	2.08
70.66	1.48	117.82	27.15	121.38	1.88
72.44	1.5	118.57	26.67	121.75	2.81
72.98	1.45	121.19	29.93	123.81	2.6
72.74	1.21	121.44	30.31	123.58	2.22
73.1	1.13	125	28.28	125.59	2.09
72.73	1.01	129.5	28.99	127.09	2.85
73.45	.95	130.76	29.27	127.23	2.22
73.43	.91	129.75	29.82	126.34	2.16
74.08	.9	128.76	29.71	123	1.92
75.43	.92	132.1	29.62	122.46	2.49
77.15	.93	131.74	27.67	122.21	2.04
78.06	.98	131.05	29.05	117.94	2.12
77.3	.96	131.41	29.41	114.66	2.06
78.59	1.38	131.25	28.05	109.59	2.34
80.98	1.19	133.15	29.08	103.16	1.88
82.46	1.14	134.56	35.07	94.35	2.36
84.19	1.15	135.31	33.58	92.74	2.63
86.55	1.12	143.16	31.34	92.7	2.74
90.41	1.05	141.86	34.92	90.99	2.27
89.45	1.02	140.82	34.16	93.03	3.12
87.3	.95	145.35	31.39	96.12	2.81
92.35	1.03	150.07	32.12	95.07	2.56
96.45	.99	144.7	33.08	94.85	2.1
95.98	1.03	146.69	33.14	91.73	2.58
93.96	1.23	145.78	32.44	91.54	2.39
96.16	1.5	153.67	33.47	91.22	2.66
99.25	1.66	150.43	34.91	90.45	2.32

RWR	BPV	PWR	PFSW	PFW	SHR
100.47	1.85	151.76	36.2	95.97	3.1
97.17	1.92	149.12	33.93	110.94	2.5
100.48	2	155.05	34.95	117.25	3
101.78	2.25	149.77	36.38	132.6	3.17
100.6	1.81	150.06	37.88	166.52	3.48
97.62	1.75	148.59	42.03	181.64	2.85
100.36	1.32	145.61	39.96	185.73	3.54
102.54	1.36	154.61	36.88	182.28	2.15
102.89	1.04	152.88	33.62	193.33	1.88
99.88	.85	155.9	30.34	186.12	1.63
103.65	1.16	163.85	30.81	177.75	2.55
105.54	1.26	161.8	26.02	170.81	1.82
104.5	1.19	161.96	28.28	168.27	1.53
10.55	1.15	163.41	25.98	162.98	1.45
106.89	1.29	165.17	25.56	159.74	2.28
108.89	1.3	167.51	24.52	155.2	1.99
112.45	1.27	167.16	26.43	142.25	1.64

APPENDIX F

CORRELATION MATRICES

CORRELATION MATRIX OF DATA VARIABLES

	PDFB	QFBS	QFBP	QFBI	PCDY	RPB
QFBS	.981					
QFBP	.981	.999				
QFBI	.633	.664	.635			
PCDY	.857	.905	.902	.658		
RPB	.188	.284	.278	.296	.528	
RPP	.191	.237	.238	.149	.329	.333
WPSE	-.070	.090	.069	.489	.308	.788
PSSE	-.040	.036	.015	.465	.263	.754
WPD	.627	.689	.675	.721	.723	.567
ECWT	.677	.668	.661	.565	.482	.201
RWR	.819	.888	.879	.762	.917	.453
BPV	.010	.028	-.060	.478	.178	.214
PWR	.859	.920	.914	.728	.912	.433
PFSW	.210	.250	.236	.457	.266	.440
PFW	.020	.103	.099	.113	.271	.297
SHR	-.090	-.144	-.158	.179	-.194	-.180

	RPP	WPSE	PSSE	WPD	ECWT	RWR
WPSE	.082					
PSSE	.087	.987				
WPD	.081	.578	.508			
ECWT	-.025	.245	.191	.266		
RWR	.197	.380	.329	.789	.580	
BPV	.362	.490	.562	.113	-.013	.208
PWR	.186	.312	.251	.768	.603	.974
$PFSW_{t-2}$	-.198	.657	.650	.570	.567	.416
PFW	.465	.224	.179	.262	-.224	.231
SHR	-.327	.238	.277	.029	.230	-.084

	BPV	PWR	$PFSW_{t-2}$	PFW
PWR	.086			
$PFSW_{t-2}$	.306	.343		
PFW	.091	.180	-.044	
SHR	.380	-.146	.494	-.161

CORRELATION MATRIX OF INCOME, WAGE RATES
AND PREDICTED PRICES (*)

	PCDY	RWR	PWR	RPB*	RPF*	WPSE*
RWR	.645					
PWR	.912	.675				
RPB*	.669	.437	.548			
RPF*	.423	.066	.239	.463		
WPSE*	.390	.447	.395	.772	.234	
PSSE*	.217	.213	.217	.587	.213	.876