BEEF PRODUCTION AND PROCESSING: RELATIONSHIPS FOR THE SLAUGHTER COW MARKET

Thesis for the Degree of M. S.

MICHIGAN STATE UNIVERSITY

PAUL L. KRAM, Jr.

1975

ABSTRACT

BEEF PRODUCTION AND PROCESSING:
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By

Paul L. Kram, Jr.

Erratic price movements of beef over the last few years have caused highly volatile earnings to cattle producers while injecting considerable uncertainty into the beef production and marketing system. Two groups of participants whose interest in how various changes will affect their respective activities are the meat processing industry and the food service industry. This study investigated the relationship of cow slaughter to beef production and to the beef processing industry which serves the needs of the food-away-from-home market. If beef supplies for meat processors and purveyors is partially derived from cow slaughter, predicting the available cow slaughter would benefit those firms utilizing cow beef as an important primary supply source.

A growing beef supply over time has been the result of increasing cattle numbers and increasing productivity of the cattle herd. However, the importance of productivity gains relative to increases in the size of the cattle herd has decreased over time. Therefore, future increases in the supply of beef are much more dependent on increases

in the size of the cattle herd.

Beef production can be divided into two major operations: (1) cow-calf operations and (2) cattle feeding operations. Cow-calf operations are characterized as relatively small sized production units, maintaining traditional production methods. These producers have increased their productivity to some degree by increasing calving percentages, decreasing death losses, and introducing larger-sized breeds. Forage production per acre has also increased. However in a general sense, the cow-calf enterprise is conducted today in a fashion quite similar to that of 25 years past.

In contrast with cow-calf operations, the cattle feeding industry has undergone a great deal of change. There has been a large decrease in the number of feedlots accompanied by a corresponding increase in the number of cattle fed per lot. However, changing grain-slaughter relationships suggest the need for continual adjustments by this segment of the beef production industry.

To examine relationships of beef processors to the beef production and marketing system, the functions of beef processors to purveyors were investigated. Information gleaned from a questionnaire received from 103 member firms of the National Association of Meat Purveyors was the major data source. The analysis concentrated on three areas: production aspects, supply logistics and disposition of finished products to the food service industry.

The major findings with respect to production aspects was that hamburger was the most important component of average total weekly beef production followed in descending order by chucks, boneless strips,

rib-eyes, short loins, butt, rib roasts, and bone-in strips. Processed pork, lamb, fish products and specialized meat items not listed in the questionnaire was the largest single category of the respondents weekly production composition. This category is an important portion of the purveyor business. The range of meat volume processed weekly by these firms was from 2,000 pounds to 7,500,000 pounds. The average amount processed weekly was 210,591 pounds, with a standard deviation of 813,659 pounds.

It was estimated that approximately 32 per cent of the responding firms raw product supply source came from cow beef sources. Ninety-three (93) per cent of the firms reported that their beef supply came from domestic sources. Order buying via telephone was the most common method of securing raw products. The average number of accounts serviced by responding firms was 568 accounts, although 79 per cent of the firms serve an average of 100 to 500 accounts.

The most important outlet for the processing firms' finished products was "in-service waitress restaurants," by institutions, other, hotels, and self-serve steak houses.*

A model of three equations was specified to forecast the number of: (1) beef cows on U. S. farms, (2) milk cows on U. S. farms, and (3) the estimated total cow slaughter. The equations were estimated by the ordinary least squares method utilizing time series data from 1954-1974. The model predicted 46,899,000 head

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*The various sizes of responding processor and purveyor firms served a variety of food service outlets; no conclusive pattern of product disposition existed.

of beef cows on farms for January 1, 1976 and 48,281,000 head for January 1, 1977. The number of milk cows on farms January 1, 1976 was estimated at 11,138,000 head and 11,042,000 head for January 1, 1977. The model estimated the annual cow slaughter for 1975 at 7,999,000 head and 8,447,000 head for the year 1976.

The findings of this study suggest the increasing interdependence of the participants of the vast and complex beef production and marketing system. The meat purveyors are a specialized and important link in the meat industry in terms of volume of meat processed and handled. The system participants should be aware of the factors determining beef supply. The understanding of trends and forces behind change can provide firm management with a basis for anticipating and/or projecting future change.

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Paul L. Kram, Jr.

A THESIS

Submitted to

Michigan State University

in partial fulfillment of the requirements

for the degree of

MASTER OF SCIENCE

Department of Agricultural Economics

1975

ACKNOWLEDGMENTS

I would like to express my sincere thanks to the numerous people who assisted, advised, and encouraged me throughout the duration of my graduate program.

Acknowledgment is due to:

Dr. Harold Riley, Dr. Lester Manderscheid and the Department of Agricultural Economics in appreciation for their financial assistance, academic guidance, and the use of departmental facilities.

Dr. Gerald Schwab, my major professor, who provided valuable guidance and counseling throughout this study.

Dr. John Ferris and Pam Marvel who provided advice and counsel throughout the course of this study.

Dr. Estes Reynolds and Dr. John Allen for their assistance in the research project.

Ms. Margaret Huston, Margaret White, Ms. Betty Peasgood for their valuable assistance in preparing the manuscript.

My family and Jane Lynch, whose patience, understanding, and encouragement I am deeply grateful.

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INTRODUCTION

A. Problem Setting

Livestock enterprises are of substantial importance to the domestic farm economy and meat is central in the American diet. Tight feed grain supplies, increasing demand for beef over time, and government price controls during 1973 are but a few of the acknowledged ingredients to the problems of erratic price movements of beef over the last few years. The consequences of these movements have included significant losses to cattle producers while injecting considerable price and cost uncertainty into the beef production and marketing system.

The U.S. cattle population has been increasing and changing in mix over the past twenty years. Dairy cow numbers have experienced a continuous decline since the early 1950's. Possible explanatory factors are increased per animal productivity, substitute non-dairy products, and a resultant reduced demand for dairy products. On the other hand, beef cattle numbers have been increasing rapidly and consistently since 1950. USDA data indicates that on January 1, 1975 there were 11,217,000 milk cows on U.S. farms while beef cows numbered 45,421,000 compared to 1955 when milk cows numbered approximately 22,000,000 and beef cows 24,966,000 head.

Livestock convert many kinds of feeds into palatable materials for absorption and assimilation by humans. In this country,

livestock consume corn and other grains that are often of a quality suitable for human consumption. Still, about 60 per cent of the feed consumed by livestock, mainly grasses and other roughages, is inedible by humans [1,p.1].[1]

The term "livestock-feed relationships" refers to both physical and economic interrelationships between livestock and feed. The quantity of livestock production is closely associated with quantity of available feed. Thus, when supplies of feed are large, feed costs decrease, ceteris paribus, and livestock production may also increase.

In 1973 and 1974, weather conditions contributed primarily to the decreased production of agricultural feedstuffs. At the same time, increasing domestic and world demand for feed grains were impacting on the feed grain situation. Consequently, feed costs for livestock producers soared. The American National Cattleman's Association statement for the Agriculture and Food Economic Summit Conference in September, 1974, indicated that the cattle industry incurred substantial losses in 1973-1974 due to the cost-price squeeze [24,p.6]. The U.S. average corn price for August, 1972 was $1.65 per bushel. In August, 1974, the U.S. average corn price was $3.45 per bushel, 51 per cent higher than in 1972. Interest expense in 1974 increased 40 per cent since 1972. By September of 1974, the cost of adding a pound of grain to a steer in a feedlot averaged 60 cents, compared with 30 cents

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[1]Bracketed number refers to items listed in bibliography. The second number indicates the page location within that reference.

in late 1972 [24,p.6].

The other side of the price-cost squeeze was the cattle price of choice steers at market. In September, 1972, the price of choice steers at Omaha was $34.28 per hundredweight, and $43.35 per hundredweight for September, 1974. The ratio of market beef prices to corn prices is known as the beef-corn ratio. This represents the relative profitability of feeding corn to cattle. Thus, the beef-corn ratio, which is calculated by dividing the market beef price by the price of corn per bushel, declined from 20.7 in September, 1972 to 12.5 in September, 1974.

Thus, the beef industry is faced with a complex set of emerging issues which include the world food situation, higher and more volatile grain prices, volatile beef prices, and changing consumer demand in reaction to these beef prices and to their own income goal. The fed-beef industry cannot survive in the long run if production losses continue as witnessed in recent time. In short, these types of relationships suggest significant changes ahead for the cattle feeding industry.

The food service industry consists of hotel, restaurant, and institutional food sales. This industry accounts for about 35 per cent of all wholesale meat packer sales [22,p.189].

> "By mid-1972, the food-away-from-home industry was described as a $40 billion industry. It has been estimated that in 1969 it required 'more than 34 billion pounds of feed to satisfy the American public's eating-out appetite ... (or) almost 20% of all the food produced in the U.S.'"

Since the food-away-from-home market historically "has been viewed as a part of or an adjunct of the broad grocery market, it is

virtually impossible to verify either size estimates or growth rates. Suffice to say that this industry is huge, important, and growing rapidly." [30,p.1]

The food service industry and consumers are also adjusting to cost-price squeeze conditions. Although per capita consumption of beef rose from 85 pounds in 1960 to 114 pounds in 1970, per capita consumption declined approximately 6 pounds per capita in 1973 as a result of consumer adjustments to higher meat prices. However, beef consumption in 1974 rebounded to a record high of 116 pounds per capita. The USDA projects per capita beef consumption for 1980 to be 127 pounds [27,p.1].

With prices for restaurant meals and snacks rising nearly as much as groceries, the all-food retail average for 1974 is expected to be up 15 per cent from 1973 [26,p.3]. Because of these many changes and interactions occurring in the beef industry, various types of steak house and beef restaurant chains are trying to assess these implications for their future business success.

Within this context, the future supply and demand for beef is a current topic of importance for all participants of the Beef Production and Marketing System. Two groups of participants whose interest in how various changes will affect their respective activities are the meat purveyors and the food service industry.

The essence of the problem to be investigated in this study is: Who are the meat purveyors and the food service industry? What are the relationships between meat purveyors and food service establishments? How do the implications for intermediate future beef

supply and demand forecasts affect these participants?

B. Thesis Objectives

Investigation of the research problem involves the following research objectives:

1. To describe the beef producing industry with respect to:
   a) The changes taking place in the last twenty years.
   b) The implications for future supply of beef.
2. To describe and analyze the functions performed by representative firms serving the beef needs of the food-away-from-home market.
3. To formulate a model for cow beef numbers and slaughter supply which would help predict one of the important supply sources for meat purveyors and food service outlets.

C. Plan of Study

The study is divided into four major parts. Chapter II describes the structural framework of the beef production chain and corresponding fundamental changes taking place. Chapter II describes and analyzes the functions performed by representative firms serving the needs of the food-away-from-home market. Information gathered is based on previous research and the results of this project's questionnaire. Chapter IV conceptualizes and formulates a simple econometric model for cow beef supply and slaughter. Empirical data will be used to test the appropriateness of a particular functional form of the supply equation. The final chapter summarizes the findings of this study and their implications.

CHAPTER II

DESCRIPTION OF THE BEEF PRODUCTION INDUSTRY

A. Introduction

As McCoy [22] points out, it is important to know the current situation at any given time, but of greater importance is an understanding of trends and forces behind change. Knowledge of this sort provides a basis for anticipating or projecting future changes. Market outlook, a subject of substantial interest among producers, basically is an attempt to evaluate the impact of ever changing market supply and demand factors on livestock prices.

The beef producing industry has been characterized by various changes throughout the production stages. The ultimate result of these changes has been an increased beef supply over the last twenty years.

The objectives of this chapter are:

1. To describe the basic structure of the beef producing industry.
2. To discuss recent production changes.
3. To set forth the economic relationships between feeder cattle, fed cattle and cow numbers which will serve as a partial basis for the beef cow supply analysis presented in Chapter IV.

B. Physical Determinants of Beef Production

Trimble [32,p.7] analyzes the physical determinants of total beef production. Basically, the quantity of beef supplied for any particular year is related to the number of animals held in farm inventories for production purposes and the number of pounds of beef each animal produces. Between 1930-1971, the increased beef supply over time has been the result of increasing cattle numbers and increasing productivity of the cattle herd. Trimble [32,p.8] presents the functional relationship between quantity of beef supplied, cattle numbers and the herd productivity in a production function relationship: Quantity supplied = F (cattle numbers and productivity). Productivity includes farm slaughter and the change in liveweight of the existing cattle inventories.

The most important factors which have contributed to increased productivity in the past have been:

1. Increased calf drop percentage.
2. Decreased death losses.
3. Increased number of animals held to mature size.
4. Increased number of beef cattle in the total herd.
5. Increased average dressed weights.
6. Increased number of cattle fed.

The productivity measures reflect technical efficiency in beef production. Major areas for further improvements will likely come from areas such as performance testing, hybrid vigor, reproduction, animal health, and forage production. Thus, to enlarge the future supply of beef may require much greater cow inventory to produce

feeder calves which are fed to produce the type of beef customarily demanded by consumers.

C. Trends in Beef and Milk Cow Numbers

Before 1950, there were more milk cows than beef cows in the United States. Beef cow numbers first exceeded milk cow numbers in 1954 and the difference has been increasing ever since. The number of beef cows has more than doubled in the last twenty years, increasing from 16.7 million in 1950 to 45.4 million in 1975 [14,p.6]. The Southeastern states are rapidly assuming a major position among cattle producers, with a twenty year increase of 6.0 million cows and a fourth of the present national total.

In 1950, milk cows numbered approximately 23 million head whereas by 1975, milk cows declined to 11.2 million head. The decline in the number of milk cows can be related to decreased per capita consumption of dairy products and to increased production per cow. Per capita consumption of milk in all dairy products fell from 653 pounds in 1960 to 564 pounds in 1970 [27,p.5]. Milk production per cow averaged 7,002 and 9,388 pounds in 1960 and 1970, respectively.

D. Structure and Changes in Beef Production

It is relatively difficult to generalize the entire U.S. cattle producing industry. But the important economic relationships may be clarified through the use of Figure II-1. Rectangles represent variables. Arrows show the direction of influence among variables (one-way or two-way), with heavy lines representing the critical flow of beef through the production system and the dashed

Figure II-1

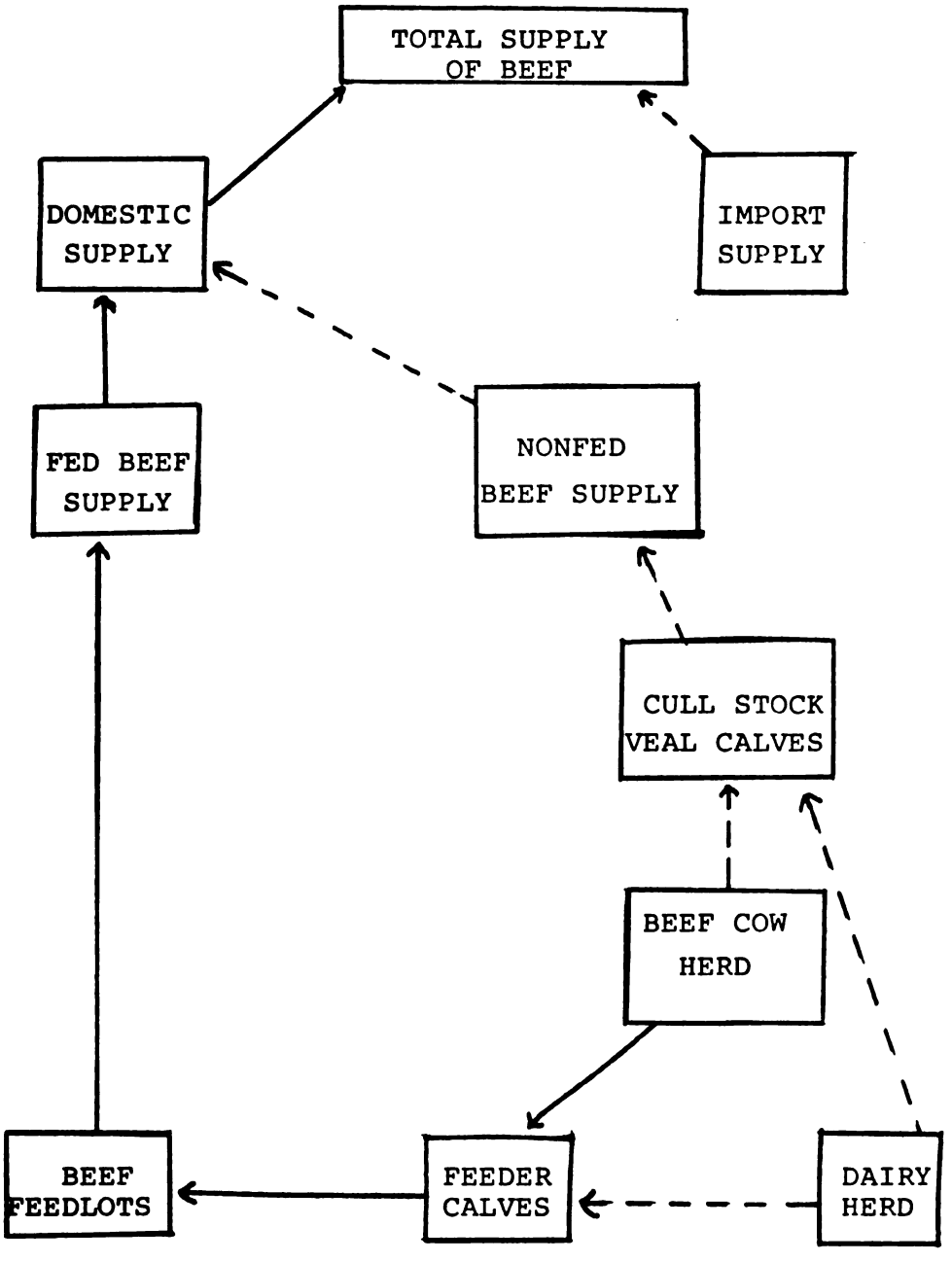

Figure II-1: Flow chart of beef producing industry.

lines indicating the less predominant or occasional paths of influence of beef through the production system.

1. Beef Cow-Calf Operations

The cow-calf operations supply the feeder calves for the cattle feeding industry. These operations have maintained, for the most part, traditional production methods. The beef cow herd has been typically characterized as a relatively small sized production unit which is of a supplementary income nature.

Table II-1 shows that on February 1, 1974, 15 states accounted for almost 70 percent of the total U.S. beef cow herd. On December 31, 1969, the average herd size in the U.S. was 26 cows, and average herd size exceeded 100 cows in only three of the 15 leading states. Thus, cow-calf operations are characterized as relatively small and widely dispersed.

Beef cow systems include cow-calf, cow-yearlings and various combinations of the two, with a finishing program sometimes integrated onto the same farm or ranch. In the cow-calf enterprises, calves are usually sold at a weight of less than 550 pounds. In the cow-yearling enterprise, the calves are held longer and grown further on pasture or other crop roughages to weights as high as 800 pounds.

Table II-2 shows the number of farms with beef cows by size of herd. There seems to be some trend toward farms with larger beef herds, especially for the Corn Belt and Lake State regions. Yet, the trend toward larger production units in the beef cow-calf industry has not been as pronounced as it has been in beef

Table II-1. Beef cow-calf operations in the United States: Inventories and average herd sizes for 15 leading states.

	February 1, 1974			December 31, 1969
	Beef cow inventory	Percentage of total U.S. inventory	Cumulative percentage	Average herd size
Texas	6,470,000	15.1	15.1	82.5
Okalahoma	2,594,000	6.1	21.2	57.8
Missouri	2,379,000	5.6	26.8	37.2
Nebraska	2,248,000	5.2	32.0	73.0
Kansas	2,058,000	4.8	36.8	59.3
South Dakota	2,050,000	4.8	41.6	76.6
Iowa	1,790,000	4.2	45.8	36.6
Montana	1,746,000	4.1	49.9	153.0
Mississippi	1,285,000	3.0	52.9	67.0
Kentucky	1,282,000	3.0	55.9	34.4
Florida	1,247,000	2.9	58.8	199.0
Tennessee	1,178,000	2.8	61.6	33.5
North Dakota	1,125,000	2.6	64.2	74.6
Colorado	1,125,000	2.6	66.8	106.1
Arkansas	1,096,000	2.6	69.4	54.0
Total U.S.	42,874,000	100.0	100.0	26.0

Source: United States Department of Agriculture, Statistical Reporting Service, Crop Reporting Board, Cattle, Washington, D.C., February 1, 1974.

U.S. Bureau of Census, Census of Agriculture, 1969, Volume V, Special Reports, Part 9, Cattle, Hogs, Sheep, Goats, U.S. Govt. Printing Office, Washington D.C., 1973.

Table II-2. Farms with beef cows, by size of herd and regions, 1964 and 1969.

Region	Size of Beef Cow Herd									
	1 to 19		20 to 49		50 to 99		100 and Over		Total	
	1964[a]	1969[a]	1964	1969	1964	1969	1964	1969	1964	1969
	Number									
Northeast	28,104	12,476	2,873	3,316	492	683	137	202	31,606	16,677
Cornbelt and Lake States	248,137	126,623	73,325	75,552	11,312	18,703	2,033	4,938	334,807	225,816
Southeast	354,056	92,648	70,184	58,846	18,357	20,063	9,901	10,654	452,498	182,211
Northern Plains	76,454	41,995	54,694	46,895	21,592	23,358	10,480	13,208	163,220	125,456
Southwest	142,366	38,360	55,045	46,228	18,719	21,993	13,655	15,454	229,785	122,035
Mountain	23,833	10,775	14,639	11,765	9,876	9,111	10,597	11,576	58,945	43,227
Pacific	35,949	10,135	7,845	6,146	3,848	3,324	4,280	4,049	51,922	23,654
48 States	908,899	333,012	278,605	248,748	84,196	97,235	51,083	60,081	1,322,783	739,076

Table II-2 (continued)

Region	Size of Beef Cow Herd									
	1 to 19		20 to 49		50 to 99		100 and Over		Total	
	1964[a]	1969[a]	1964	1969	1964	1969	1964	1969	1964	1969
	Percent of Beef Cow Herd in Each Size Category									
Northeast	88.9[a]	74.8[a]	9.1	19.9	1.6	4.1	0.4	1.2	100.0	100.0
Cornbelt and Lake States	71.4	56.0	21.9	33.5	3.4	8.3	0.6	2.2	100.0	100.0
Southeast	78.2	50.8	15.5	32.3	4.1	11.0	2.2	5.9	100.0	100.0
Northern Plains	46.8	33.5	33.6	37.4	13.2	18.6	6.4	10.5	100.0	100.0
Southwest	62.0	31.4	24.0	37.9	8.1	18.0	5.9	12.7	100.0	100.0
Mountain	40.4	24.9	24.8	27.2	16.8	21.1	18.0	26.8	100.0	100.0
Pacific	69.2	42.8	15.1	26.0	7.4	14.1	8.3	17.1	100.0	100.0
48 States	68.7	45.0	21.1	33.7	6.3	13.2	3.9	8.1	100.0	100.0

[a]Data not directly comparable 1964 numbers are on an all-farm basis and 1969 numbers are for farms with $2500 or more in gross sales (i.e., Class I-V farms only).

Sources: [6,34]

feeding operations [32,p.21].

Numerous studies indicate that beef cow operations are low profit in nature and can be a viable undertaking only where there are large amounts of under-utilized roughages which can be used by beef cows at a very low cost.[1/] Trimble [32,p.72] suggests that the unprofitability of an investment in a beef cow, when both fixed and variable costs are included suggests that the most important investment decision does not involve the land and other fixed factors that are used to support the cow. The relevant investment decision concerns the addition of a cow to an existing herd, or the substitution of a beef cow herd for an enterprise that uses the same fixed resources. Trimble's data pointed out that investment in a beef cow will generate revenue sufficient to cover all fixed and variable costs and provide a return on invested capital equal to the firm's cost of capital only if relatively high calf prices and low costs of capital exist.

2. Feeder Calf Supply

The potential supply of feeder calves in any given year is equal to the total production of calves from all beef and milk cows, plus imports, less calves needed for other purposes which includes calf veal slaughter and replacement stock.

All of the steer calves and a majority of the heifer calves produced by the beef and dairy cow herds are available

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[1/] Numerous studies are listed in the bibliography that have reached this type of general conclusion. See (3, 11, 19).

for placement in feedlots. The relationship between feedstuff and beef prices affect the degree of culling and the change in beef cow numbers. Beef heifers are needed for herd replacements and expansion. Dairy heifers are used for herd replacements, expansion, and veal. The impact of dairy-beef is limited due to declining dairy cow numbers, slaughter of veal male dairy calves, and reluctance to feed out due to relatively low quality grading of dairy beef. Some male animals are needed for breeding purposes in beef and dairy operations, but this number is small. The inventory of bulls amounts to about 5 per cent of cow numbers [14,p.13].

Estimating the number of calves that will become available as feeder cattle is a difficult task. One method that could be used as a trend indicator would be to assume a proxy set of production efficiency measures and utilize the January beef cow inventory figures published by the USDA. For example, if one takes the number of beef cows on hand January 1, assumes a 93 per cent calf drop, a 4 per cent death loss, a 20 per cent replacement rate, and a 1 per cent death loss in replacements, the number of calves available as feeder cattle can be estimated as 68 per cent of the number of beef cows on hand.

Many factors affect the number of cattle actually moving into the final feeder calf supply. Among these factors are: the number of beef and dairy calves slaughtered as nonfed beef; difference between estimated and actual rates of calvings; the extent of cow cullings; the need for breeding herd replacements;

and death losses.

3. Cattle Feeding

The beef cattle feeding industry has grown rapidly since World War II as the number of fed cattle marketings has more than doubled [14,p.3]. This growth has been based upon a readily available supply of feed grains especially abundant in the Corn Belt. More than half of the nation's cattle feeding is in six plains states - Texas, Oklahoma, Kansas, Nebraska, Colorado, New Mexico [23,p.1].

The notable trend in the past ten to fifteen years has been increased beef feeding conducted by decreasing numbers of producing units. The number of small feedlots (capacity of less than 1,000 head) has decreased during the 1962-1972 period while the number of large feedlots (capacity of 1,000 head or more) has increased [32,p.27].

As pointed out by Trimble [32,p.27], the change in number of cattle marketed by feedlot size has been more dramatic than the change in feedlot numbers, as illustrated in Table II-3. The proportion of cattle marketed by large feedlots has increased from 37 per cent in 1962 to 62 per cent in 1972. This 62 per cent fed by only 2,089 producing units while the remaining 38 per cent was fed by 151,347 producing units [32,p.27]. The Northern Plains, Southwest and Mountain regions have increased their proportion of cattle fed at the expense of other regions.

Research findings have attributed the trend towards

Table II-3. Number of cattle marketed and percentage by two feedlot capacity groups by regions, 1962, 1967, 1972.

Region	Number of Cattle Marketed by Feedlots with Capacity Under 1,000 Head			Number of Cattle Marketed by Feedlots with Capacity of 1,000 Head or More		
	1962	1967	1972	1962	1967	1972
	Number in 1,000 Head					
Lake States	1,069	1,339	1,397	58	106	133
Corn Belt	4,975	6,406	5,782	250	558	727
Northern Plains	2,258	2,756	2,558	789	2,249	4,398
Southwest	262	262	154	1,377	2,702	6,055
Mountain	372	404	246	764	1,455	2,720
Pacific	213	146	78	2,037	2,399	2,502
22 States	9,149	11,313	10,215	5,275	9,469	16,535
	Percent of Cattle Marketed by Feedlots with Capacity Under 1,000 Head			Percent of Cattle Marketed by Feedlots with Capacity of 1,000 Head or More		
	Percent					
Lake States	94.8	92.7	91.3	5.2	7.3	8.7
Corn Belt	95.2	92.0	88.8	4.8	8.0	11.2
Northern Plains	74.1	55.1	36.8	25.9	44.9	63.2
Southwest	16.0	8.8	2.5	84.0	91.2	97.5
Mountain	32.8	21.7	8.3	67.2	78.3	91.7
Pacific	9.5	5.7	3.0	90.5	94.3	97.0
22 States	63.4	54.4	38.2	36.6	45.6	61.8

much larger feedlots to the economies of size characteristics of beef feeding operations which have resulted in lower average costs of production.[2/]

a. Uncertainties in Cattle Feeding

The many uncertainties in cattle feeding, its highly specialized nature, and the large required investment in fixed facilities and feeder cattle make it an unusually high-risk enterprise. Basically, there are three broad groups of uncertainties: technical, price, and others.

Technical undertainties are those related to physical aspects of production and in general, affect costs of production.

Price uncertainties are those resulting from changes in prices of inputs and outputs. Substantial change in the price of slaughtered cattle is one of the most important factors affecting net returns of cattle feeders.

Other uncertainties include monetary policy as it affects interest rates, fiscal policy as it affects real disposable income, and management and behavioral variables.

b. Relationship of Margins to Net Returns

Net returns from cattle feeding are largely dependent upon achieving two favorable margins. The first, a feeding margin, is the difference between the feed cost per pound gained and the price received from the gain put on cattle.

[2/] Numerous studies are listed in the bibliography that have reached this general conclusion. In particular, see (7, 13, 15, 18).

This margin can be adversely affected by an increase in price of feeds or a decrease in price of slaughter cattle. The second, a price margin, is the difference between purchase and selling prices per hundredweight. A drop in market price for slaughter cattle can be disastrous for operators who buy heavy feeder cattle and then must bear the burden of a negative price margin on 75 to 80 per cent of the livestock weight sold.

A negative price margin does not necessarily indicate a loss, as it may be more than compensated if liveweight gains are a high proportion of final sale weight and the feeding margin is favorable. Conversely, positive price margins may not reflect a profit if they are offset by a poor feeding margin.*

E. Economic Relationships of the Beef Sector

Up to this point, the discussion has dealt with the structure of the beef cattle sector and the fundamental structural changes occuring at the various levels. One of the objectives of this study is to develop a simplified econometric model for cow beef supply and slaughter, which would help to predict one of the important supply sources for meat purveyors and their market, the Food Service Industry.

A quantitative approach to either price analysis or forecasting is to consider the relationships among variables. Tomek and

*However, neither of these margins reflect investment costs which also affect net returns of cattle feeding.

Robinson [31,p.311] state the following about model building:

> "Model building may be viewed as having two parts. One involves the specification of the economic model, that is, the general economic relationships. Economic theory can be thought of in terms of functions and certain variables within these functions. The second part of model building involves the explicit definition of equations which are to be estimated. For example, what variables appear in a particular equation, and how are these explicitly defined... Out of the answers to these and other similar questions, explicit equations are defined."

A model should be consistent with the logic and theory underlying the commodity sector being analyzed. A model of a particular economic sector may be thought of as one or more equations that describe the important relationships among the variables.

Demand and supply functions are examples of particular economic relationships.

1. Demand for Beef

From consumer demand theory, retail (consumer) demand for beef is postulated as a function of the price of beef, prices of close substitutes, prices of all other goods, consumer's real income, the number of consumers, and exports. The quantity of beef consumed and the average retail price of beef could be specified as being jointly dependent (endogenous) variables, as Unger suggests [33,p.60].

While a complete analysis of cattle demand might involve looking at each of the major end products - steak, roast, ribs, briskets, stew, ground beef, etc., aggregating beef products into beef *per se* will facilitate explaining the initial demand-supply relationships.

Thus, the first part of a static equilibrium situation, which simultaneously determines price and quantity, can be defined by two equations with the third equation specifying that in equilibrium quantity demanded must equal quantity supplied.

Equation II-1. Demand for Beef is represented as:

$QBEEF_t^d = f(PBEEF_t, POMEATR_t, DI/CPI, PPLN, BEXP)$

where:

$QBEEF_t^d$ = Quantity of beef demanded in time period t

$PBEEF_t$ = Retail price of beef in time period t

t is a time parameter in years. t = one year.

$POMEATR_t$ = Price of other meat at retail (weighted average of pork, lamb and mutton, veal and poultry meat) deflated by Consumer Price Index.

DI/CPI = Disposable personal income per capital ($) deflated by the Consumer Price Index (1967 = 100)

$PPLN_t$ = Population in time period t

$BEXP_t$ = Beef exports in time period t

2. Supply of Beef

The number of beef cattle which beef producers plan to keep on farms is partially determined by the expected price to be received for feeder calves or slaughter animals. A realistic first step towards a supply model for beef consistent with the peculiar nature of the product is the disaggregation of total beef slaughter into several components - steers, heifers, cows and bulls.

If we abstract from uncertainty, assume that firms maximize profits in a competitive industry, and assume given fixed technological conditions of production; output is related to variable input product prices, to substitute product prices, and to investment cost of capital items necessary for production.

The major factors thought to influence beef supply are incorporated in the following relationship:

Equation II-2. Supply of Beef

$$QBEEF_t^s = f(NBC_{t-1}, PS_{t-1}, PFC_{t-1}, PFG_{t-1}, RF_t)$$

where:

$QBEEF_t^s$ = Quantity of beef supplied in time period t

NBC_{t-1} = Number of beef cows on farms January 1, 2 years old and older

PS_{t-1} = Average price of choice steers at Omaha ($1/cwt) in time period t-1

PFC_{t-1} = Price of good-choice feeder calves at Kansas City in August to December ($1/cwt) divided by Index of Prices paid by farmers (1967 = 100) (IPP) in year t-1

PFG_{t-1} = Annual Average feed grain price paid by farmers in time period t-1

RF_t = Range feed condition in year t (USDA index)

t = During time period t. t = one year.

Lagged prices are used because many production decisions are made prior to the marketing year and lagged price is a reasonable proxy for expected price. While equation specification must emphasize the major factor thought to influence

supply, it is impossible to include an exhaustive set of variables.

Then according to economic theory, for equilibrium to occur, quantity demanded must equal quantity supplied as presented by the following equation:

Equation II-3.

$$QBEEF_t^d = QBEEF_t^s$$

F. The Cobweb Model

The cyclical pattern in numbers of cattle kept on farms, amount of beef produced, and the beef price level are explained in terms of "inventory cycles," "production cycles," and "price cycles." The factors which generate these cycles have been regarded as closely related to each other.

> "The cobweb model provides a theoretical explanation of the cyclical components of certain price-quantity paths through time. Prices and quantities are viewed as being linked recursively in a causal chain. A high price leads to large production; the large supply results in low prices, which in turn result in smaller production and so forth." [31,p.176]

The cobweb model exemplifies a recursive system of equations where the endogenous variables are determined sequentially as a chain through time rather than simultaneously. Moreover, it explains under specified conditions the movement of price and of quantities demanded and supplied around the hypothesized equilibrium price-quantity combination. This equilibrium point is determined by the intersection of supply and demand functions as producers and consumers react to price changes.

Cycles are generated by lagged responses to changes in prices

or other external events. Lagged responses are called lagged endogenous variables. Exogenous and lagged endogenous variables are grouped under the general heading of predetermined variables. Formal models incorporating such variables, especially lagged prices, have been developed which help to explain cyclical behavior [33,p.60].

Kim [16,p.25] notes that "the explanation of any cyclical phenomena in the strategic variables characterizing the cattle industry should be based on a systematically developed set of hypotheses from the fundamental activities of economic agents rather than a blind application of any existing economic theorems to a set of time series data of these strategic variables."

G. Economic Activities of the Beef Production Process

Kim's [16] dissertation provides a set of hypotheses to explain the fundamental economic activities of the economic agents of the beef production system.

The economic agents of the beef production system are the beef breeders (cow-calf operators), feedlot operators, and slaughterhouse operators. According to the vertical chain of the beef production process, the economic activities as stated by Kim [16,p.18] are as follows:

a) The economic activities of beef breeders depend on the aggregate demand for feeder cattle and for slaughter cattle on one hand and the aggregate breeding herd supply maintained on the other.

b) The economic activities of feedlot operators depend on

the aggregate demand for fed cattle (by slaughter-house operators) and the aggregate supply of feeder cattle (of various classes and grades).

c) The economic activities of slaughter-house operators depend on the aggregate demand for red meat (of various classes and grades) and the aggregate supply of slaughter cattle (of various classes and grades).

The vertical chain of the beef production process as stated by Kim may best be illustrated by Figure II-2.

1. Beef Breeders: Relationship of Activities to Total Beef Supply

The number of beef cows on hand is the key variable in the U.S. beef supply relationships [9,p.11]. The number of beef cattle which beef producers plan to keep on farms is partially determined by the prices expected to be received for feeder calves or slaughter animals. Changes in cow numbers are also related to random weather elements which affect range and pasture conditions and roughage supplies.

Kim [16,p.17] describes the causal mechanism for beef breeder behavior:

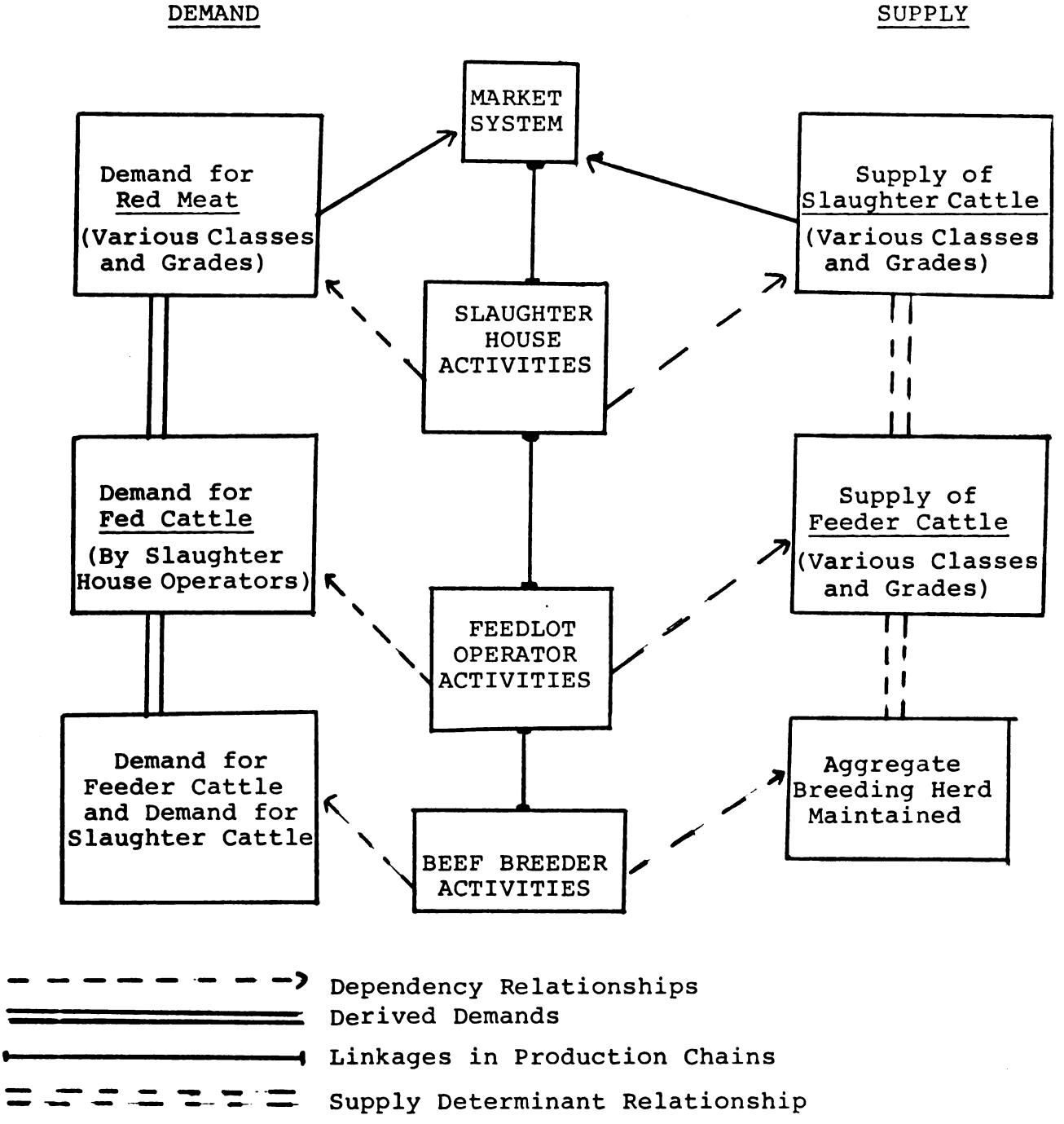
> "There can be no doubt that a beef breeder (or beef breeders as a whole) maintain a herd of breeding animals over time in order to produce a series of calf crops which in turn, yield a series of "economic returns."
>
> "Nor is it difficult to recognize the multiple role of breeding females in the herd: at any given point in time a female can be viewed as (a) a finished good, (b) a good in process or (c) a piece of fixed capital (or durable input). This is perhaps most dramatically apparent for a young heifer. If she has been well fed,

Figure II-2

BEEF PRODUCTION PROCESS RELATIONSHIPS

Conceptual Framework

Production Level



> she may be immediately marketable as medium or possibly better grade beef. Alternatively, she may profitably be fed intensively for a short period with a consequent increase in weight and possibly in grade. A third alternative is to retain her in the breeding herd to produce calves."

Figure II-1 demonstrates that factors which affect the beef cow herd have effects on the whole system and ultimately change the total beef supply in subsequent time periods. If the number of cows in the breeding herd is increased during the current period, this will result in more feeder calves being born within the next year. This increased supply of feeder calves will move through the feeding system in the following year to be slaughtered as fed beef. Thus, a change in the size of the beef herd may take two or three years before it is reflected through final slaughter; but it may influence total supply for sometime thereafter. The same can be said for a reduction in the size of the beef breeding herd.

Ferris points out that because the biological cycle in cattle stretches over several years, cow-calf operators must anticipate selling prices well in advance. Changing feeder cattle price is not likely to induce quick production adjustments by these operators in the short run.

Theory would tell us that the number of livestock units can be changed in the short run and the long run. The tendency for supply curves is to become more responsive (flatter) as more time is allowed for adjustments. Hence, the time dimension is important in defining supply relationships, but it is difficult to precisely define in terms of time units the meaning

of the very short run, the short run, the intermediate, and the long run as applied to supply.

Since the form of the price response relationship is not known, it might be presumed to approximate a distributed lag with more recent prices having greater influence on their expectations than price in the more distant past. To get some measurement of this distribution, Ferris used the following equation estimated by least squares using data for the period 1950-1972:

$$NBC_t = -9308 + \underset{(6080)}{1.045}\ NBC_{t-1} + \underset{(4.38)}{109.7}\ PFC_{t-2} + \underset{(.89)}{25.41}\ PFC_{t-3} + \underset{(2.29)}{52.16}\ FPC_{t-4} + \underset{(1.48)}{40.54}\ RF_{t-1}$$

$$\frac{2}{R} = .995$$

$$S.E.E. = 452$$

( ) Numbers in parenthesis indicate the calculated value of the t statistic for each beta coefficient. If absolute value is greater than or equal to 2.11, the coefficient is significant at the 5 per cent level of significance.

NBC_t = Number of beef cows on farms on January 1 in year t (1000 head)

PFC_t = Price of good choice feeder calves at Kansas City in August to December ($/cwt.) divided by the Index of Prices Paid by Farmers (IPP) (in year t) (1967 = 100)

RF_t = Range feed conditions in year t (U.S.D.A. index)

According to Ferris [9,p.12]:

"The long biological cycle and momentum effect is reflected in the highly significant coefficient on NBC_{t-1}. Of particular interest is the pattern on the values of the coefficients (and their significance) on PFC_{t-2}, PFC_{t-3} and PFC_{t-4}. As anticipated the value and

significance of the coefficient on PFC_{t-2} were the greatest. However, the coefficient in PFC_{t-4} was larger and more significant than PFC_{t-3}. A plausible explanation is that feeder prices may be more influential at the time a cow-calf operator is deciding on how many heifers to hold back. Normally, these operators would keep more heifers than they actually need for replacement purposes just to have some flexibility. But usually, most of the heifers to be sold as feeders are sold as calves rather than yearlings."

In conclusion, the economic relationships between cow numbers and the other components of the total beef supply can be summarized as follows:

1. Number of cows on hand is the key variable in supply relationships as the increases or decreases in cow herd numbers ultimately affect total beef supply in subsequent time periods.
2. Number of beef cattle kept on farms is due largely to the price the cow-calf operator expects to receive for feeder cattle and slaughter cattle in present and subsequent time periods. Expected price is based on prices received in past time periods.
3. The rate of change in cow numbers is indicative of the build-up or liquidation of breeding stock.
4. Decisions to breed more cows are usually made about July 1. If feeder cattle and slaughter prices in year t-3 are favorable, more cows are bred during the summer of year t-2. This results in a larger calf crop in year t-1 which is slaughtered in year "t".
5. The economic relationship of cow numbers is specified

in the equation:

$$NBC_t = a + NBC_{t-1} + PFC_{t-2} + PFC_{t-3} + PFC_{t-4} + RF_{t-1}.$$

(see previous page for variable definitions.)

2. Feedlot Operators: Relationship of Activities to Total Supply

The economic activities of feedlot operators depend on the aggregate demand for fed cattle (by slaughter-house operators), and the aggregate supply of feeder cattle (of various classes and grades).

In recent years, fed cattle have represented about two thirds of total slaughter [10,p.4]. The aggregate consumer demand for fed beef and beef by-products is translated through the retailer, wholesaler, and packer to the cattle feeder himself. The feeder, in turn, transmits this demand back to the producer of feeder cattle. As Ferris suggests, [10,p.14], the cattle feeders must predict slaughter prices to determine what he can pay for feeders. For this reason, the demand for feeders is based on expected slaughter prices.

The level of feed grain prices and the availability and price of hay and other roughages will also influence the demand for feeder cattle. The higher the feed costs, ceteris paribus, the lower the demand for feeder cattle.

Nonfed costs such as facility costs and outside investor behavior in the feeding business have a mixed effect on the feedlot operators. Large capital requirements for feeding cattle imply that interest rates might affect the demand for

feeder cattle [10,p.14].

An increase or decrease in cattle on Feed January 1 is associated with a change in demand for feeder cattle. The annual feeder price of the preceding year is an important determinant of several January inventory variables: cattle on feed, number of cows and heifers on farms, and others.

3. Cattle Slaughter and Total Beef Supply

The economic activities of slaughter-house operators depend on the aggregate demand for red meat (of various classes and grades), and the aggregate supply of slaughtered cattle (of various classes and grades).

Ferris [10,p.12] explains the relationship between the components of cattle slaughter and the total beef supply available to slaughter-house operators. Total U.S. cattle slaughter may be divided into two categories: 1) steer and heifer beef, and 2) domestic cow and bull beef plus imports.

a. Steer and Heifer Slaughter

The potential supply of steers and heifers for slaughter originates primarily from the number of beef calves produced domestically, and to a minor extent, from the number of dairy veal calves (mostly steers) dropped, and the number of feeder imports. The proportion of these steers and heifers actually carried to maturity will depend on such factors as the price of cattle, the price of feed, and range feed conditions.

Nearly all male type calves are eventually sold for

slaughter as mature animals, except for those "fat calves" or "baby beef calves" sold at weaning weights of 500-600 pounds. About 30-40 per cent of the heifer calves are generally retained as replacements for the beef herd, while most of the balance are fed out. Year to year changes in the proportion of heifer calves placed on feed lots depend on the relationship between the current demand for feeder cattle and expected future cattle prices. The rancher's decision to sell the heifer calf as a feeder or hold for herd replacement or expansion purposes is influenced by expected cattle prices, available range and pasture feed, and availability and cost of other resources used by cow-calf enterprises.

From the total supply of feeder cattle, total steer and heifer beef production is affected by the proportion of these feeders which go into feed lots and are classified as "fed cattle." Most steers and heifers move to slaughter as "fed cattle," the nonfed component has been of minor importance [10,p.12]. However, nonfed beef from steer and heifer sources may become more predominant at the retail level. This type of beef has been commonly called "economy beef" or "lean beef."

Since cattle fed on grain tend to be marketed at heavier weights than nonfed steers and heifers, a change in the proportion of cattle fed would tend to change total pounds of beef supply. Also, the average slaughter

weights of fed cattle and nonfed cattle do vary yearly and quarterly. Slaughter weights tend to be heaviest in the winter, and lightest in the summer [10,p.15]. Weight variations by cattle feeders is based on changing price expectation response of beef and of feed costs.

The other supply source of cattle is domestic cow and bull beef plus imports. In the 1960's, nearly all of this category went into boneless products, hamburger, and other processed beef products. However, this is changing in that meat technology is now capable of "fabricating" table cuts from cow beef.

b. Beef Cow Slaughter

As Ferris indicates [10,p.13], the size of the beef cow inventory becomes the base for establishing how many beef cows will be slaughtered. The length of time that a beef cow is held in a herd varies considerably. Culling rate is highly dependent on the outlook for feeder prices and to some extent on range and pasture conditions and feed prices.

c. Dairy Cow Slaughter

Chapter I illustrated the nature of the U.S. dairy herd composition for the last twenty years. Year to year variation in slaughter of dairy cows is usually small, especially in comparison to variations in beef cow slaughter. Culling rates for dairy cows are affected by milk prices, quality and price of feed grain and roughages, government regulations, and investment costs. Similarly, pasture conditions

also affect culling rate.

d. Bull Slaughter

Bull beef contributes a very small portion to total beef supplies. Bull beef has been running over 2% in total cattle slaughter and would be even higher in terms of beef pounds.

e. Imports

> "U.S. imports of beef and veal have been affected primarily by 1) supply and price of domestic cow and bull beef 2) foreign trade of our own and other countries 3) range conditions and stage of build up of our liquidation in exporting countries 4) beef prices in other major importing countries." [10,p.13]

Factor two above refers to import quotas set by the U.S. government of foreign beef imports, exchange rates, trade policies of importing countries affecting the U.S. beef export situation.

The tendency over time for imports is to increase when domestic production of cow and bull beef drops off and decrease when domestic production increases. The combined total has not changed much from year to year [9,p.16].

H. Summary

This chapter provided a descriptive explanation of the beef production industry and accompanying structural changes over the last two decades. A growing cattle herd and increasing productivity of the beef industry have both contributed to the general increase in the supply of beef over time. As Trimble points out, various factors have

contributed to the beef industry's ability to increase productivity in the past. Many of these factors have been fully exploited (calving percentage and death losses contributing to increased productivity). But, the importance of productivity gains relative to increases in the size of the cattle herd has decreased over time. As a result, future increases in the supply of beef are much more dependent on increases in the size of the cattle herd than in the past [32,p.137].

This chapter attempted to explain the economic relationships for the demand and supply of beef. The aggregate economic activities of the beef production system participants (the beef breeders, feedlot operators, and slaughter-house operators) underline the increasing interdependence of all participants of a vast and complex industry.

Now that beef production process has been explained, what services are performed by those firms involved in preparing and supplying meat to various food service outlets of the hotel, restaurant, and institutional trade? And what is their significance as a link in the total beef production and marketing system?

To this topic we now turn.

CHAPTER III

BEEF PROCESSORS AND PURVEYORS AND THEIR FUNCTIONS

A. Introduction

The meat packing and processing industry is an integral link in the beef system which transforms a raw product, meat animals, into a marketable retail product.

The firms responsible for supply beef needs to the food service industry are commonly referred to as purveyors or meat processors. Stafford [30,p.2] collectively refers to this group as "handlers."

For clarification, the following terms are functionally defined:

Meat packing companies - Firms that slaughter livestock and may or may not process meat animals.

Meat Processing firms - Firms that do not slaughter livestock but may purchase carcass, primals, or sub-primals; and manufacture table cuts, sausage and other meat products for various outlets.

Meat Purveyors - Firms that purchase carcass, primal or sub-primals and prepare and supply retail cuts for hotel, restaurant and institutional outlets.

Boners - Firms that typically buy cow carcasses and break them down into lean, retail cuts for various outlets.

The approach taken in this study utilizes the aggregate U.S. available information that describes those firms of the meat industry who primarily cater to the food service industry, while

focusing on those U.S. firms where primary data could be gathered. The information gathered is based upon a questionnaire forwarded to various beef slaughter, processing and purveying firms which supply the needs of various food service establishments.

B. Review of Literature

While studies have been made concerning the commercial slaughter plants and the economics of meat packing [2,18], information on firms in the meat purveying and processing business is generally lacking. According to Brasington [4,p.1], practically all beef processing firms in operation today, which he refers to as "custom service houses," are less than 25 years old. This relatively young age suggests why our knowledge of this industry is quite limited.

The Agricultural Research Service of the USDA has published two reports related to this area:

> Hotel and Restaurant Meat Purveyors-Improved Methods and Facilities for Custom Service Houses (1966) [5]
>
> Hotel and Restaurant Meat Purveyors-Improved Methods and Facilities for Supplying Frozen Portion Controlled Meat (1971) [4]

Both reports are engineering studies that provide custom service houses with cost and efficiency guides for selection of work practices, and suggest methods and equipment that will reduce the cost or time to perform specific operations.

In the area of frozen meat research, a Kansas State University Meat Research Team has studied frozen meat distribution, costs, acceptance, cooking and eating qualities [29]. Ezzell [8] found that about a 50 per cent saving in total meat retailing

costs could be made by shifting completely to frozen meat retailing.

Stafford [30] examined methods and costs of distributing beef to the food service industry.

C. An Overview of the Meat Packing and Processing Industry

Before describing and anlyzing the questionnaire responses of those firms participating in this study, an overview of the structure of the meat packing and processing industry is in order.

Industrial organization theory tells us that the structure of a relative market embraces such features as the number and size of buyers and sellers, the degree of product differentiation, the presence or absence of barriers to the entry of new firms, cost structure, and degree of vertical integration.

The meat packing and processing industry is composed of many different types and sizes of plants. Wissman [9,p.1] stated that:

> "The Standard Industrial Classification (SIC) 2011 includes packing houses and slaughter plants of which the USDA reports a total of 1,420 plants in 1972 that achieve a liveweight kill of greater than 2,000,000 pounds per year. In addition, the meat processing industry (SIC) 2013 includes 1,297 plants of all sizes as reported in 1972. These plants are located throughout the U.S. with numerous plants located in each state."

Given this classification system, the structure of the present industry summarized by Wissman is shown in Table III-1.

The structure of the top ten states by number of plants slaughtering, processing, and boning is shown in Table III-2. These figures are derived from USDA Animal and Plant Health Inspection Service Directory figures. A further explanation may be found in

Table III-1. Structure of Meat Packing & Processing Industries

Type and Size	Approx. Number of Plants		Approx. Number of Employees	% of Total Industry Volume
Meat Packing Industry (SIC) 2011	No.	% of Total Plant Number		
Large and X-Large	107	7.5	250	59.5
Medium	385	27.1	51-250	29.3
Small	928	65.4	50	11.2
TOTAL	1,420	100.0		100.0
Meat Processing (SIC) 2013				
Large	39	2.8	250	34.6
Medium	104	7.6	51-250	30.6
Small	418	30.4	10-50	28.4
X-Small	813	59.2	10	34.6
TOTAL	1,374	100.0		100.0

Table III-2

Structure of Meat Packing & Processing Industry
By States - November 1973
Top 10 States in Number of Plants:
Slaughtering, Processing, Boning

	Approx. # of Plants That:	% of U.S. Total
SLAUGHTER		
1) Pennsylvania	112	15.3
2) Missouri	70	9.6
3) Nebraska	54	7.4
4) Texas	53	7.2
5) Minnesota	40	5.4
6) Oregon	34	4.6
7) Montana	28	3.8
8) North Dakota	28	3.8
9) New York	25	3.4
10) Washington	25	3.4
Total	469	63.9%
PROCESS		
1) Pennsylvania	212	9.6
2) California	205	6.7
3) New York	179	5.9
4) Missouri	155	5.1
5) Texas	114	3.7
6) Minnesota	96	3.1
7) Illinois	95	3.1
8) Nebraska	90	2.9
9) Washington	85	2.8
10) Oregon	65	2.1
Total	1376	45.0%
BONE		
1) California	155	13.9
2) Illinois	75	6.7
3) Minnesota	69	6.1
4) Missouri	67	6.0
5) Nebraska	61	5.4
6) Oregon	60	5.3
7) Washington	56	5.0
8) Montana	44	3.9
9) New York	44	3.9
10) Texas	41	3.6
Total	672	59.8%

Appendix A.1.

D. Food Service Establishments

The Food Service Industry is a vast and complicated industry. The economic activities of the meat purveyors depend primarily upon the aggregate demand for red meat (of various classes and grades) by the Food Service Industry. This industry is a heterogeneous group of enterprises that can be classified into numerous segments. Kotschevar and Terrell [17,p.21] include the following types of food service facilities:

1. College food units
    a. Cafeteria service
    b. Coffee shop or snack bar
    c. Catering service
    d. Union buildings
    e. Faculty clubs
    f. Residence Halls
2. Commercial Restaurants
    a. Service Restaurants
    b. Cafeterias
    c. Coffee shops
    d. Drive-ins
    e. Take-out-food
3. Hospital Food Service
4. Hotel and Club food service
    a. Essential Meals
    b. Food for or with entertainment
    c. Catering for special needs
5. Employee food service
6. Industrial lunchrooms
    a. Executive dining rooms
    b. Seated service
    c. Cafeteria
    d. Mobile and vending service

7. School food service
8. Miscellaneous

There are many other types of classification schemes for describing the functioning food service operations. Van Dress and Freund [36] classify them as:

1. Separate eating places
2. Separate drinking places
3. Drug or proprietary stores
4. Retail stores
5. Hotels, motels or tourist courts
6. Recreation or amusement places
7. Civic, social or fraternal associations
8. Other public eating places
9. Factories, plants or mills
10. Hospitals
11. Sanatoria, convalescent or rest homes
12. Homes for children, aged, handicapped or mentally ill
13. Colleges, universities, professional or normal schools
14. Other institutions

Other food service outlets to consider would be those that function in elementary and secondary schools, the military services, federal hospitals, federal and state correctional institutions, in-transit feeding operations (e.g., planes, trains, ships) and boarding houses.

1. Franchising in the Food Service Industry

While the United States Department of Commerce does not collect information on the number of beef restaurant chains in the U.S. and the sales generated by their units, information is collected on fast food firms operated as franchisers. The franchise method of distribution is a significant part of the current marketing system, creating more and more new business opportunities, new jobs and new services as well as export opportunities.

The fast food franchise restaurants posted sales of $9.8 billion in 1974, up from $8.5 billion the year before. And regardless of economic uncertainties in 1975, the leaders of this business expect an annual improvement in sales volume of nearly 18 per cent, compared with the restaurant industry's annual average of 9 per cent. This thriving trade, numbering 40,084 establishments on January 1, 1974, predicts further expansion of about 4,600 more units during 1975 [35,p.4].

Designed to serve good food at relatively low cost and provide uniformity in menu and service, the fast food operation is a technological innovation. It has become a computerized, standardized, and premeasured production machine.

The structure of franchises in relation to all types of fast food restaurants is depicted in Appendix Table A.2.

Further background information on fast food restaurants by activities in terms of numbers and sales dollar are found in Appendix Tables A.3 and A.4.

E. Background in Describing Meat Purveyors

A primary objective of this research is to describe and analyze the functions performed by representative firms serving the needs of the food-away-from-home market. Those firms responsible for supplying the beef needs of the food service industry are commonly referred to as hotel-supply houses, purveyors or specialized meat wholesalers. This collective group of firms also includes independent purveyors, beef breakers, central commissaries and the specialized sales outlets of packing companies.

Aggregation problems associated with defining the structure and functions of beef purveyors include:

1) Heterogeneous group of activities performed by meat purveyors serving numerous types of food service facilities.

2) Definition of "meat purveyor." Inconsistent definitions are employed in categorizing firm numbers and changes in number of these firms.

As a starting point, Stafford [30,p.3] sheds light on the nature of beef:

> "Beef differs markedly from most manufactured products. Instead of starting with many new raw products, combining them into a finished good, and then distributing it, the beef distribution industry starts with a single complex product and produces many end products. Because of the nature of these products, much "manufacturing" or fabricating takes place throughout the system, thus the industry cannot be classified into the typical institutional framework of manufacturers, wholesalers and retailers ... each firm performs particular specialized marketing and "manufacturing" functions and the interrelationships of the firms can be viewed as a channel of distribution ..."

Further, a typical channel of distribution as described by Stafford might be:

> "A packer located in the midwest sells quarters to a breaker in Boston. The breaker cuts the quarters into primal cuts, selling some - for instance, the chuck and a few rounds - to retailers; others, such as ribs, loins and remaining rounds to purveyors; and the items left, such as flank, briskets and trimmings to processors and renderers. The purveyors, located nearby, fabricate the ribs, loins and rounds into steaks, roasts and hamburgers and sell them to restaurants in Boston or other cities. The restaurants may do some extra trimming on the product received and then cook and serve it to customers."

While this is not a study in distribution channels, the previous section suggests the complexities and interactions of moving beef from slaughter to the customer's plate in food service establishments.

A factor that has prompted this research effort is the growing importance of the meat purveying business. Brasington captures the industry's emergence saying:

> "The meat purveying business, already an important part of the meat industry, together with custom service houses, account for more than two thirds of the total volume of meat and meat products sold to the food service industry in 1966. The meat purveyors have had a spectacular growth within the past several decades, both in number of houses and volume of meat handled. The number of houses in 1964 was estimated as 1,000 - an increase of about 70 per cent since World War II."

Another factor which has enhanced the competitive position of meat purveyors is the trend toward specialization and resultant increased efficiencies. Meat procurement for hotel, restaurant and institutional firms is an important function. The trade magazines of the various segments of the food service industry have discussed

the merits of buying precut meats for many years. Wanderstock [37,p.60] states:

> "Changes in hotel and restaurant meat purchasing practices have been dramatic. There has been a decided shift from carcasses to quarters, to primal cuts, to prefabricated cuts, to portion control cuts, and even to precooked (rare, medium, well done) meat.
>
> "The only justification for buying carcass meat is when all parts of the carcass can be utilized in the food service operations. High labor costs and the relative unavailability of trained butchers in hotels and restaurants has led to the shift away from on-premise fabrication to purchasing ready to use meat from purveyors. These purveyors are able to utilize their expertise as well as the volume of meat processed to create a market for by-products which are of no use to hotels but can be sold through the appropriate channels."

1. National Association of Meat Purveyors

The National Association of Meat Purveyors is a non-profit organization of Hotel, Restaurant and Institutional supply houses who purvey (supply) meats and other food items to food service establishments. This organization was founded in 1942 in an effort to cope with problems that would arise under the Emergency Price Control Act of 1942 and the Office of Price Administration. The Association was successful in establishing the fact that the business of the hotel supply house was a distinct branch of the meat industry and performed essential services and functions, entitling it to a mark-up higher than to a packer or wholesaler. The 1974 Directory listed some 400 members of the organization, located throughout the United States and Canada.

2. Organization of the Study

Data for this portion of the study were gathered by surveying meat purveyor firms throughout the United States by the

questionnaire method. No existing secondary data was available. The author felt that industry information was needed to answer some questions on this portion of the beef industry supplying the food service industry.

Thus the problem was to secure industry participation. Time and money did not permit personally visiting and interviewing a large sample of meat purveyors throughout the country. So with the cooperation and support of the National Association of Meat Purveyors, a list of all 1974 member firms was acquired with the understanding that all information forwarded by the respective firms would be considered private information, and not available for public scrutiny. The identity of each firm would remain confidential.

Of special interest to the author were production aspects, supply logistics, and product disposition. Or essentially, from what sources was the raw meat product coming from and in what forms. How much processing and by whom was being accomplished; and finally, who bought the finished product?

Although only limited data was available on the cow-beef component of the total red meat beef supply, the author shared the belief that cow slaughter was one of the principal beef raw product supply sources for meat purveyors. And, if this was true, predicting the available cow slaughter for a given time period would benefit the purveyors relying on cow-beef as an important component of their raw product supply source.

In addition, the author was interested in the general operational arrangements of meat purveyors such as the types

of accounts serviced, (self-serve steak houses, hotels, restaurants with waitresses, and insititutions) the method of transacting their purchases, etc.

3. Collection of Data

Considerable time was taken in the beginning of the study to formulate an effective but brief questionnaire that would help to answer some questions about the meat purveying business and its interaction with the Food Service Industry. A pilot questionnaire was sent to a typical meat purveying firm for review of format, terminology, and length. The final questionnaire, the accompanying explanatory letter, and a self-addressed stamped return envelope was then forwarded.

4. Breakdown of Responses

Table III-3 presents the number of respondents and the per cents. Figure III-1 indicates the geographic distribution of the respondents.

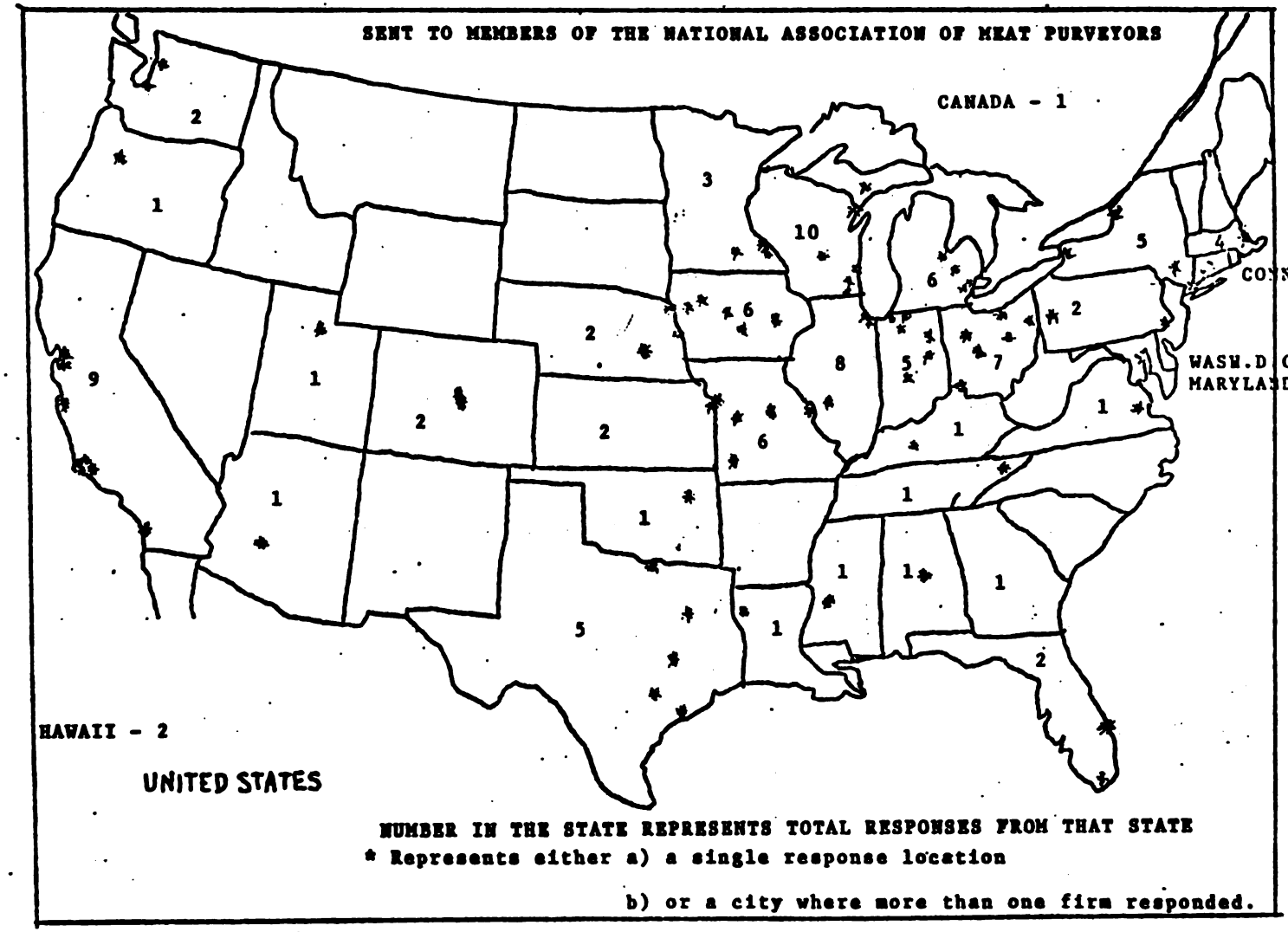
The accompanying letter and the questionnaire used in this study are found in Appendix B. The Statistical Package for the Social Sciences computer program was employed in analyzing the raw data from the questionnaire received. Specific procedures for editing, processing, and coding the data are found in Appendix B.

Table III-3

Breakdown of Responses to the Questionnaire

A.	Questionnaires Sent Out	
	First mailing to purveyors in Michigan and North Central Region (January 3, 1975)	54
	Second mailing to members of National Association of Meat Purveyors (January 31, 1975)	370
	Total Questionnaires Sent Out	424
B.	Questionnaires Received	
	Usable (having sufficient data to process)	104
	Non-Usable (not having sufficient information)	15
	Total Received	119
C.	Per cents	
	% Total Return	$\frac{119}{424} = 28\%$
	% Total Usable	$\frac{104}{424} = 24.5\%$

Figure III - 1.
DISTRIBUTION OF TOTAL RESPONSE TO THE QUESTIONNAIRE



F. Analysis of Information

This section presents and discusses the primary data gathered from the questionnaire responses.

1. Production Aspects

a. Operation Type

The following was the response to the question:

"Which of the following terms best describes your operation?

Beef Processor _____
Meat Purveyor _____
Slaughter Only _____
Both Slaughter and Process _____
Other (specify) _____"

	Absolute Frequency	Per Cent of Respondents
Beef Processor	12	11.5
Purveyor	38	36.5
Processor and Purveyor	45	43.3
Slaughter and Process	6	5.8
Other	3	2.9
Total	104	100.00%

Those firms responding as "other" indicated their activities as:

1) Trim and skin tenderloins
2) Beef boner selling cuts only
3) Frozen foods

b. Raw Product Form

The following was the response to the question:

"The types of raw product that you receive in order to produce your finished product are:

Carcass _____
Primal Cuts _____
Sub Primals _____"

	Absolute Frequency	Per Cent of Respondents
Carcass	15	14.4
Primal Cuts	7	6.7
Subprimals	17	16.3
Carcass and Primals	9	8.7
Primals and Subprimals	22	21.2
Carcass, Primals, Subprimals	25	24.0
Carcass and Subprimals	2	1.9
Others	1	1.0
Missing Observations (firms not responding to this question)	6	5.8
Total	104	100.00%

c. Production Line Activity

The breakdown to the question:

"In the production line, is the meat subject to a physical tenderizer? (yes or no)"

was as follows:

	Absolute Frequency	Per Cent of Respondents
Yes	38	36.5
No	48	46.2
Some	15	14.4
Missing Observations	3	2.9
Total	104	100.00%

"In the production line, is the meat subject to a vegetable enzyme? (yes or no)"

	Absolute Frequency	Per Cent of Respondents
Yes	20	19.2
No	72	69.2
Some	10	9.6
Missing Observations	2	1.9
Total	104	100.00%

d. Average Weekly Production Composition

In an effort to determine the composition of beef purveyors and processor firm's average weekly production, the following question was posed:

> "On the average, how many pounds of beef per week do you process into:
>
> _____short loins _____butts
> _____rib eyes _____bone in strips
> _____rib roast _____hamburger
> _____boneless strip _____chucks
> _____other
>
> _____Total pounds Per Week"

The returns were edited such that the sum of the parts equalled their total pounds per week value. Further, all figures were rounded to the nearest 1000 pounds. Where no number was indicated for a specific category, it was interpreted as zero and coded as 0. Where the whole question was left blank, the response was treated as a "missing observation."

The other difference to note is that this section of the analysis was computed with a total of 103 observations. The author discarded one of the original 104 respondents because the relatively large volume processed per week by this one particular beef processor so exceeded the average of the other 103 respondents that it tended to distort the mean upward. The mean or arithmetic average indicates the center of symmetry for a normal distribution. The standard deviation is a measure of the dispersion of the distribution. The standard deviation of a set of measurements is equal to the positive square root of the variance.

Table III-4

Beef Processed

Item	Mean (Lbs.)	Standard Deviation (Lbs.)	Minimum Lbs. Reported (Range) (Lbs./week)	Maximum Lbs. Reported (Range)
Shortloins	6,300	21,025	0	130,000
Rib Eyes	8,133	30,914	0	250,000
Rib Roast	5,024	10,079	0	60,000
Boneless Strip	10,952	32,655	0	200,000
Butts	6,157	15,870	0	125,000
Bone-in-Strips	4,470	15,675	0	100,000
Hamburger	53,747	145,115	0	1,200,000
Chucks	24,867	156,729	0	1,400,000
Other	104,229	545,127	0	4,693,000
TOTAL	210,591	813,560	-	7,500,000

Table III-4 presents the summary statistics for the components of the respondents average weekly production.

Short Loins

While thirty-six firms (35.0%) indicated they processed 0 short loins per week, the weekly average of pounds processed was 6,300. The wide range reflects the large variation in this category.

Rib Eyes

Twenty-five respondents (24.3%) indicated that they processed a weekly average of 0 pounds of rib eyes. The weekly average of rib eyes processed was 8,133 pounds.

Rib Roast

There were thirty-seven firms (35.9%) who answered they processed "0" average pounds per week of rib roast. The average number of pounds of rib roast processed per week by the responding firms was 5,024.

Boneless Strip

There were twenty-seven firms (26.2%) who answered they processed zero average pounds of boneless strip per week. The average amount of boneless strip processed by the responding firms was 10,952 pounds with a standard deviation of 32,655 pounds.

Butts

Thirty-two respondents (31.1%) indicated they processed on the average "zero" pounds of butts a week. The weekly average of butts processed by the responding firms was 6,157 pounds with a standard deviation of 15,850 pounds.

Bone-in Strips

Fifty-eight firms (56.3%) indicated no processing of bone-in strips. The average pounds of bone-in strips processed by the responding firms was 4,470 pounds weekly.

Hamburger

Hamburger was the most important item processed by the responding purveyor and processor firms. Only 1 respondent (1.0%) indicated no hamburger processing. The greatest variation in volume processed by any one category in this question was seen in hamburger, with a range of 0 to 1,200,000 pounds of hamburger processed weekly. The average amount of hamburger processed per firm per week was 53,747 pounds, with a standard deviation of 145,115 pounds. These results suggest that hamburger is the primary product that purveyors and processors supply the food service industry.

Chucks

Fifty respondents (48.5%) processed a weekly average of "0" pounds of chuck. The average amount of chucks processed weekly by the responding firms was 24,867 pounds.

Other

The products firms process in the "other" category could possibly include other cuts of beef not represented by the given choices, veal, specific types of portion control steak cuts, port and pork products, such as sausage, pork chops, pork roast, etc., lamb, and fish products.

According to one purveyor in Iowa, "This question does not include pork, veal, lamb, fish or shrimp which are a large portion of the purveyor business."

Perhaps for this reason, the range for this category was the largest, ranging from 0 to 2,693,000, and the largest mean of all, 104,229 pounds per week.

e. Total Pounds Processed Per Week

The average total pounds of product processed weekly by purveyor and processor firms was considered an important variable to ascertain by the author. While only 25% of the member firms of the National Association of Meat Purveyors responded to this project questionnaire, the variance of the data suggests that there may not be a typical firm. The total meat volume processed on a weekly average ranged from 2,000 pounds to 7,500,000 pounds for these responding firms. The average amount processed weekly was 210,591 pounds, with a standard deviation of 813,659. The large range suggests the heterogeneous nature of purveyor firms in terms of size and operation.

2. Supply Logistics

a. Raw Product Supply Origins

The following is the analysis to the question:

"What per cent of your raw product supply comes from:

a) commercial and utility grade cow beef _____
b) canner and cutter grade beef _____
c) standard or good grade bull, heifer, steer, or cow beef _____
d) choice grade heifer, steer beef _____

Table III-5 below summarizes the results of the response.

Table III-5

Summary of Raw Product Supply Sources

	Item	Mean %	Standard Deviation %	Range Minimum %	Range Maximum %
a)	Commercial & Utility Grade Cow Beef	19.2	26.06	0	95
b)	Canner & Cutter Grade Beef	12.9	22.83	0	100
c)	Standard or Good Grade Bull, Heifer, Steer, Cow Beef	12.7	20.04	0	90
d)	Choice Grade Heifer, Steer Beef	54.9	33.37	0	100
	Total	99.7	———	———	———

a) Commercial and Utility Grade Cow Beef

Beef purveyors and processor firms in this study on the average received 19.2% of their raw product supply from commercial and utility grade cow beef.

b) Canner and Cutter Grade Beef

The respondents indicated that the average amount of raw product supply coming from this source was 12.9%.

c) Standard or Good Grade Bull, Heifer, Steer, or Cow Beef

Forty-seven of the 104 respondents (or 45.2%) answered they received none of their raw product supply from standard or good

grade bull, heifer, steer, or cow beef. The average amount of raw product supply received from this source was 12.7%, while the highest amount from this source was 90% for 2 firms.

d) Choice Grade Heifer, Steer Beef

Only 9 firms (8.7%) said they received no supply from choice grade heifer and steer beef, while the average amount received by all the respondents from this source was 54.9%. This was the highest mean of the four supply source categories in the question asked and suggests that these beef purveyor and processor firms buy on the average over half their supply source from this relatively higher grade of beef. Yet, the high standard deviation indicates a large variation in the distribution of the total response. Supportive information to this question was probed by the 3 part question:

1) "The typical product that you buy from packers or sellers is grade _____"

Grades Indicated	Absolute Frequency	Per Cent
Prime and choice	5	4.8
Prime and cutter	1	1.0
Choice only	34	32.7
Choice and good	12	11.5
Choice and commercial	4	3.8
Choice and utility	7	6.7
Good only	1	1.0
Good and commercial	2	1.9
Good and utility	1	1.0
Commercial only	1	1.0
Commercial and utility	2	1.9
Utility only	6	5.8
All Grades	5	4.8
Missing Observations	23	22.1
TOTAL	104	100.00%

2) The response was coded by weight ranges and the results were as follows:

	Absolute Frequencies	Per Cent of Respondents
400-500 pounds	3	2.9
501-600 pounds	12	11.5
601-700 pounds	16	15.4
701-800 pounds	25	24.0
801-900 pounds	7	6.7
Over 1000 pounds	1	1.0
All weights	5	4.8
Missing observations	35	33.7
Total	104	100.00%

3) "The typical product that you buy from packers or cattle sellers is:

Class: Steer _____

Heifers _____

Cow _____

Bull _____."

Some respondents marked more than one categroy, accounting for a combined total of more than 104. The response was coded such that if any of the categories were marked with an x or check, this was interpreted as "yes" while blank meant "no." Totally unanswered were included in the "missing observations." The results were as follows:

	Absolute Frequency	Per Cent of Respondents
Steer		
Yes	75	72.1
No	20	19.2
Missing Observations	9	8.7
Total	104	100.00%

	Absolute Frequency	Per Cent of Respondents
Heifer		
Yes	37	35.6
No	59	56.7
Missing Observations	8	7.7
Total	104	100.00%
Cow		
Yes	44	42.3
No	52	50.0
Missing Observations	8	7.7
Total	104	100.00%
Bull		
Yes	7	6.7
No	89	85.6
Missing Observations	8	7.7
Total	104	100.00%

b. Geographic Supply Source

In an effort to determine the geographic origin of beef supply source, the following question was asked:

"An estimate of where your beef supply is obtained

Domestic _____% Foreign _____%

Table III-6 below summarize the results of the responses.

Table III-6. Geographic Supply Origins

Beef Supply Obtained From Source:	Mean %	Standard Deviation %	Range Minimum %	Range Maximum %
Domestic	93.1	13.91	40.0	100
Foreign	6.9	13.91	0.	60.0
	100.0			

a. Domestic Geographic Origins of Beef Supply

The following analysis represents the responses to the second part of the question which asked:

"Of your domestic supply, what % comes from the

Southeast _____%
Far West _____%
Central _____%
Plains _____%
Northwest _____%
Other _____%"

Figure III-2 on the following page indicates the regional breakdown by states of the above categories. However, since the areas were not defined specifically by states in the questionnaire, the individual firms were at their own discretion to mark the area they considered southeast, far west, etc.

Table III-7 summarizes the regional breakdown statistics pertaining to this question.

Table III-7. Domestic Beef Supply Origin

Percent of Domestic Supply Coming From:	Mean %	Standard Deviation %	Range Minimum %	Range Maximum %
Southeast	1.2	6.64	0	60
Far West	20.0	33.35	0	100
Central	54.5	38.26	0	100
Plains	18.8	29.48	0	100
Northwest	1.0	2.75	0	25
Other	4.5	14.31	0	100
	100.0%			

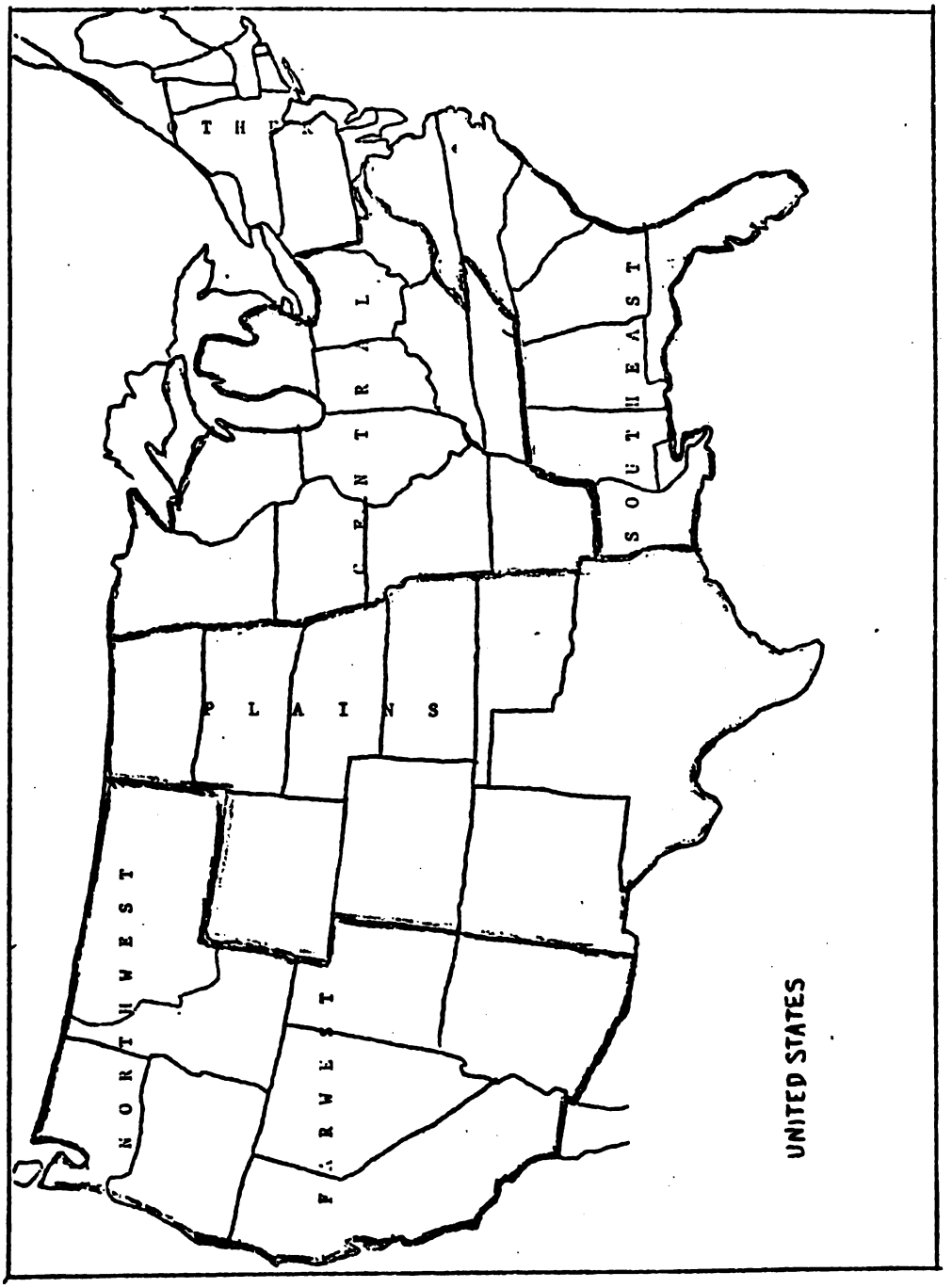


Figure III-2
DOMESTIC GEOGRAPHIC ORIGINS
OF BEEF SUPPLY

Southeast

Eighty-one (81) respondents (85.6%) said they received none of their beef supply from the southeastern states, whole the average amount of domestic supply derived from this area was 1.2%. Hence, this appears not to be a major meat securement area for the beef purveyors and processors surveyed.

Far West

There was a wide range of distribution here, from 0 to 100% of the firms supply coming from this area. Still, 62 respondents or 59.6% indicated they received none of their supply from this area. The average amount of supply coming from the far west states was 20.0%, suggesting it was the second largest supply area next to the central states.

Central

Twenty-four respondents (or 23.1%) said they received 100% of their beef supply from the Central states. The average amount of beef supply coming from this area for all the 104 respondents was 54.5%, making it the most important domestic beef supply region for these responding beef purveyors and processors.

Plains

Fifty per cent of the respondents noted that they received none of their beef supply from the Plains states, while the average total amount supplied by this area was 18.8%. Hence, this was the third most important beef supply region for these beef purveyors and processors.

Northwest

As shown, a negligible portion of beef supply for the responding firms comes from the Northwest. However, there is a slight problem of ambiguity in that many firms probably included Northwest into the Far West category.

Other

In retrospect, the question should have been formulated not to include an "other," but probably the category "eastern" or "southwest." Each category should then have been non-ambiguously defined by state components. Seventy-five per cent of the respondents did not mark "other" as a supply source. The average supply from this area was 4.5.

c. Raw Product Purchasing

The author attempted to determine the timing of raw product meat purchase by purveyor and processor firms. In the questionnaire, the wording of the question was:

"Up to how many months are raw products purchased?"

In retrospect, as indicated by the results of the return, this question was poorly worded and ambiguous. The question should have been worded as,

"How many weeks ahead do you forward purchase raw product supply?"

Thirty-six (36) of 103 respondents (35.0%) did not answer this question. Those firms responding to this question indicated a time period of seven weeks for purchasing ahead their raw meat products. However, 16% of the

respondents indicated they purchased weekly. In light of the high number of missing observations, further diagnosis would be misleading.

d. Purchasing on Contract

The following was the response to the question: "Are individual purchases of your product made on a contract (forward purchase) basis?

yes _____ no _____"

	Absolute Frequencies	Per Cent of Respondents
Yes	18	17.3
No	79	76.0
Some	5	4.8
Missing Observations	2	1.9
Total	104	100.00%

e. Storage Arrangements

The following question was posed:

"With respect to storage arrangements:

tons of meat storage available _____

length of storage before quality deteriorates _____"

This question received no response from almost half the respondents. For this reason, no anlaysis was conducted for this response.

f. Method of Securing Raw Product

The response to the question

"Method of securing raw product:

Order buying via telephone _____
Broker at supply source _____
Other (specify) _____"

was as follows:

	Absolute Frequency	Per Cent of Respondents
Order buying via telephone	58	55.8
Other	2	1.9
Order buying plus broker	23	22.1
Order buying plus broker plus other	8	7.7
Order buying plus other	11	10.6
Missing Observations	2	1.9
Total	104	100.00%

g. Firm Size Relative to Competitors

The participants were asked the following question:

"Firm size in terms of meat processed relative to your competitors

Small _____
Medium _____
Large _____"

The results were as follows:

	Absolute Frequencies	Per Cent of Respondents
Small	17	16.3
Medium	20	57.7
Large	26	25.0
Missing Observations	1	1.0
Total	104	100.00%

3. Product Disposition

a. Accounts Normally Serviced

The question was asked:

"Approximately how many accounts do you normally service?

_____#."

The responses were rounded off to the nearest hundred. The results were as follows:

Accounts Normally Serviced per Firm	Absolute Frequency of Responses	Per Cent of Total Response
100	8	7.8
200	24	23.3
300	18	17.5
400	13	12.6
500	12	11.7
600	5	4.9
700	1	1.0
800	1	1.0
900	1	1.0
1,000	3	2.9
1,200	2	1.9
1,500	2	1.9
2,000	1	1.0
3,000	2	1.9
5,000	2	1.9
Missing Observations	8	7.8
Total	103	100.00%

The firms serving on the average from 100 to 500 accounts represented 78.9% of the total response to this question, while the two firms serving on the average of 5,000 accounts were an exception to the average, accounting for only 1.9% of the total response. The average number of accounts serviced by the 103 responding purveyor and processor firms was 568 accounts.

Summary statistics for 'number of accounts serviced per firm'.

Mean	568	Standard Deviation	819		
Minimum	100	Maximum	5,000	Range	4,900

b. Disposition of Product: Accounts Serviced

In an effort to determine where the final product of beef purveyor and processor firms were going, the author

followed the "number of accounts normally serviced" question by the following:

"Of your accounts serviced:

	% of Business
Self-serve Steak Houses	_____
Hotels	_____
Institutions (hospitals, schools)	_____
In-service (waitress/steak house)	_____
Other	_____

Table III-8 summarizes the responses.

Table III-8

Disposition of Finished Product

	Food Service Outlet	Mean % of Business	Standard Deviation %	Range Minimum %	Range Maximum %
1)	Self-Serve Steak Houses	8.5	19.71	0	100
2)	Hotels	13.00	13.03	0	70
3)	Institutions	24.50	20.28	0	100
4)	In-Service (waitress/Steak House)	32.0	25.13	0	95
5)	Other	22.0	26.30	0	95
		100.0%			

Self-Serve Steak Houses

The self-serve steak houses are commonly referred to as the "economy steak houses" or the "family style self-serve restaurants." Of the 103 respondents, 45 (43.7%) said that none of their business dealt with this type of food service outlet. And, 35 (92.4%) of the respondents said they did less than 20% of their total business (including those who did 0 business) with self-serve steak houses. The average amount of business generated from self-serve steak houses

to the 103 responding purveyor and processor firms was only 8.5%, indicating that this type of outlet does not represent a significant portion of purveyor and processor firm sales for the majority of these firms.

Hotels

Seventy-three respondents (70.9%) do from 0 to 20% of their business to hotels, while only 17.4% do more than 20% with hotels. Missing observations accounted for 11.7% of the total response to this question. The average amount of business to hotels by purveyors and processor firms was only 13.0%, making it the second smallest outlet for these firms' products.

Institutions

Among the types of outlets included under institutions were hospitals, school lunch programs, sanatoriums, rest homes, state correctional institutions, elementary and secondary schools, and universitities. This category represented the second most important distribution outlet for these responding purveyor and processor firms' products. The average amount of business to institutions for this group was 24.5% of their business. The range was from 0 to 100% of total business going to institutions.

In-Service (Waitress) Steak Houses

The in-service waitress steak houses are the most important portion of the responding purveyor and processor firm's business, with an average of 32.0% of total business going to this outlet. Sixty-nine respondents (66.9%) said they did from 0 to 50% of their total business with in-service waitress restaurants.

Other

While not many of the respondents who indicated "other" as a component of their total business explained their outlets, those who did indicated that the types of outlets as other included:

1) fast food chains
2) taverns
3) retail grocery stores
4) drive-in restaurants
5) U.S. government bids
6) full line restaurants
7) airlines
8) distributors
9) wholesalers
10) coffee shops
11) dinner house clubs
12) clubs
13) vending outlets

The average amount of total business going to "other" sources than those listed in the question (self-serve steak houses, hotels, institutions, and in-service waitress steak houses) was 22.0% for the responding firms.

Additional Comments by Responding Firms

The author designed the last question of the survey as an open ended question in an effort to secure any salient production information or comments not covered by the previous questions. The question was posed:

"What factors or variables influence future production practices of technologies for the future of your operations?"

The feedback could be categorized as follows:

Operating Costs

increasing fuel costs
increased packaging costs and machinery costs
rising labor costs which necessitate the purchasing of labor saving equipment so as to maintain lower production costs

Market Conditions

changing customer demands
use of more "ready to serve items"
competition's prices and aggressiveness
beef supply and availability
seasonal usages
general condition of the economy (inflation rate, unemployment rates, etc.)

Institutional Influences

Government policies
Government purchasing programs
monetary policies
interest rates and finance costs

One respondent's answer to this question was:

"I am firmly convinced that all segments of the meat industry face a crisis in the next 10 years as a result of the increasing use of 'red meat substitutes' (some of which are nutritionally equal to meat in protein, etc.). For example, in 1973 and 1974, ground beef average price was $1.00 plus. Today, 1/31/75, a local chain advertised ground beef soya added for 39¢/lb.!!"

4. Crosstabulations

As previously mentioned, the author was interested in determining the source of raw meat products, raw meat breakout form, and how much product was being processed weekly, and finally, who purchased the finished product? The previous analysis based on the participating firms' responses began to answer these types of questions. The use of crosstabulations in this section enables one to view the relationships between variables.

a. Raw Product Types Used by the Various Operations

The objective of this crosstabulation was to determine the forms of raw product supply received by the various operation types. Results presented in Table III-9 indicate

Table III-9. Raw Product Types Used by the Various Operations

Summary

	Raw Product Forms (%)									
Operation Type	Missing Obs.	Carcass Only	Primals Only	Sub-primals Only	Carcass & Primals	Primals & Sub-primals	Carcass & Primals & Subprimals	Carcass & Subprimals	Other	Total
Beef Processor	0	33.4	0	8.3	25.0	16.7	8.3	8.3	0	100%
Purveyor	15.8	0	10.5	21.1	7.8	21.1	23.7	0	0	100%
Processor & Purveyor	0	11.2	6.7	17.8	4.4	22.2	33.3	2.2	2.2	100%
Slaughter & Process	0	80.0	0	0	20.0	0	0	0	0	100%
Other	0	33.3	0	0	66.7	0	0	0	0	100%

that for beef processor operations, carcasses and primals are the most important forms of raw product. For purveyors and for processors and purveyors; carcass, primals, and subprimals are the most important. For slaughter and process operations, carcass is the most important form of raw product supply. However, this suggests nothing about which form is the most economical form for firm types.

b. Average Total Pounds per Week Processed by Operation Types

The intent of this crosstabulation was to view the range of average total pounds of product processed weekly by the various types of operations conducted by the responding firms. [See Table III-10]

The 12 beef processors in this study are a large volume type firm: 49.8% of the beef processors process on the average from over 100,000 pounds weekly up to 500,000 pounds weekly.

Those 38 firms who responded as solely purveyors tended to process a weekly average volume lower than the other categories, with 63.8% of the respondents (excluding missing observations) processing a weekly average of less than 100,000 pounds per week.

Of the 45 operations categorized as processor and purveyor, 70.5% processed a weekly average of less than 100,000 pounds per week, with the remaining 21.0% of these types of firms processing a weekly average of products ranging from 105,000 pounds to 2,055,000 and the remaining 8.5% were coded as "missing observations."

Table III-10

Average Weekly Production by Processor Firms
Type of Operation

Summary

Average Total Pounds Processed per Week	Beef Processor	Purveyor	Processor & Purveyor	Slaughter & Process	Other
			Percent		
0	8.3	16.3	8.5	0.0	33.4
(Missing Observations)					
2,000	8.3				
5,000		5.3			
6,000			2.2		
7,000			2.2		
8,000		2.6			
10,000			2.2		
12,000		5.3			
13,000		2.6			
15,000		5.3			
18,000		2.6	2.2		
19,000			4.4		
20,000		2.6			33.3
21,000	8.3	2.6	2.2		
22,000			2.2		
23,000			2.2		
24,000				20.0	
28,000	17.0				
29,000		2.6	2.2		
30,000		2.6	2.2		
31,000		2.6			
32,000		5.3			
33,000		2.6			
35,000			2.2		
37,000		5.3			
38,000			4.4		
40,000		2.6	4.4		
45,000	8.3		2.2		
47,000		2.6			
48,000		2.6			
50,000			11.1		
51,000			4.4		
52,000		2.6	2.2		
57,000		2.6			
58,000		2.6	2.2		

Table III-10 (Continued)

Type of Operation

Summary

Average Total Pounds Processed Per Week	Beef Processor	Purveyor	Processor & Purveyor	Slaughter & Process	Other
			Per Cent		
64,000				20.0	
70,000					33.3
76,000			2.2		
78,000			2.2		
79,000		2.6			
80,000			4.4		
88,000			2.2		
100,000			2.2		
105,000			2.2		
114,000		2.6			
120,000	8.3				
127,000		2.6			
142,000			2.2		
150,000	8.3	2.6			
165,000			2.2		
185,000	8.3				
195,000	8.3				
198,000		2.6			
200,000		2.6	4.4		
301,000		2.6			
303,000	8.3				
350,000			2.2		
498,000			2.2		
500,000	8.3				
505,000			2.2		
600,000		2.6			
610,000				20.0	
1,500,000				20.0	
2,055,000			2.2		
7,500,000				20.0	
	100.00%	100.00%	100.00%	100.00%	100.00%

Five firms indicated their operations were slaughtering and processing. Three of these 5 (60%) firms processed a weekly average of greater than 610,000 pounds per week.

c. Use of Physical Tenderizers and Vegetable Enzymes by Operation Types

The intent of this crosstable was to determine to what extent physical tenderizers and vegetable enzymes were being utilized by the responding operation types. The actual process of "physically tenderizing" meat is performed by a mechanical tenderizer machine which consists of a large number of needle-like knives which penetrate the meat physically to sever the tissues within the meat to increase its tenderness. A vegetable enzyme is a chemical additive injected mechanically for taste, preservative, and tenderizing purposes. Generally, the lower grades of meat would tend to need this type of "fabrication" more than the higher grades of meat.

The results are indicated on Table III-11.

Table III-11

Use of Tenderizers and Enzymes by Operation Type

(Number of Firms)

Use Physical Tenderizer

Operation Type	M.O.	Yes	No	Some	Total # Firms
Beef Processor	0	4	6	2	12
Purveyor	0	15	18	5	38
Processor & Purveyor	3	16	19	7	45
Slaughter & Process	0	2	3	0	5
Other	0	1	2	0	3
Totals	3	38	48	14	103

Use Vegetable Enzyme

Beef Processor	0	3	8	1	12
Purveyor	2	8	25	3	38
Processor & Purveyor	0	8	32	5	45
Slaughter & Process	0	1	4	0	5
Other	0	0	3	0	3
Totals	2	20	72	9	103

M.O. = Missing Observations

By including the "some" and "yes" category from Table III-11, about one-half of the responding firms indicated use of physical tenderizers on their production lines. However, use of vegetable enzymes was less common.

d. Grade of Cattle Bought by Operator Types from Packers or Cattle Sellers

The purpose of this crosstable is to relate and differentiate the typical product grade of cattle purchased by the various operation types.

Missing observations (M.O.) accounted for 23 of 103 responding firms' returns. Choice grade cattle was the most typical grade of cattle supply source for these respondents with 34 of the 103 firms indicating this category. The summary results are below:

Table III-12

Cattle Grade Bought by Various Operations
By Operation Type (# of Firms)

	Operation Type					
Typical Product Grade Bought	Beef Processor	Purveyor	Processor & Purveyor	Slaughter & Process	Other	Total
M.O.	2	10	8	1	2	23
Prime & Choice	0	1	4	0	0	5
Prime & Cutter	0	0	0	0	1	1
Choice only	4	15	14	1	0	34
Choice & Good	0	6	5	1	0	12
Choice & Commercial	0	2	2	0	0	4
Choice & Utility	2	2	3	0	0	7
Good only	1	0	0	0	0	1
Good & Commercial	0	0	2	0	0	2
Good & Utility	0	0	1	0	0	1
Commercial only	1	0	0	0	0	1
Commercial & Utility	0	0	1	1	0	2
Utility only	1	2	3	0	0	6
All Grades	1	0	2	1	0	4
Totals	12	38	45	5	3	105

e. Use of Cow Beef As a Supply Source for Operation Types

The objective of this crosstable was to determine the use of cow beef as a typical supply source for the various responding operation types. Table III-13 merely indicates the firm's acknowledgment of cow beef as a typical supply

source of raw product for their operations.

Table III-13

Use of Cow Beef as Raw Product Source

Operation Type	M.O.	Yes	No	Total
Beef Processor	1	6	5	12
Purveyor	3	14	21	38
Processor & Purveyor	3	19	23	45
Slaughter & Process	1	3	1	5
Other	0	2	1	3
Totals	8	44	51	103

M.O. = Missing Observations

As noted earlier in this chapter's analysis, the average amount of raw product coming from commercial and utility grade cow beef was 19.2% for the responding firms; canner and cutter grade beef which would generally be cow beef was an average of 12.9% of the responding firms raw product supply source; while standard or good grade bull, heifer, steer and cow beef made up 12.7% of the responding firms raw product supply source. Hence, it could be estimated by adding the two categories of commercial and utility grade cow beef plus cutter and canner grade beef categories accounted for approximately 32.1% of the responding firms raw product supply source for their operations. This roughly represents the average amount of cow beef usage by these responding firms.

f. Disposition of Finished Product: by size of firm and typical product grade

The objective of these crosstables was to determine the

relationships (1) between purveyor and processor firm size based on numbers of accounts normally serviced and the disposition of their product to types of food service outlets, and (2) between the typical product grade bought by purveyor and processor firms from cattle sellers and packers and the disposition of the firms' finished product to types of food service outlets.

The conclusions of the findings follow Table III-14 and Table III-15.

Table III-14

Disposition of Finished Products

By Size of Firm

# Accounts Normally Serviced	# of Firms Responding in this Category	Types of Food Service Outlets					
		Self-Serve	Hotels	Institutions	In-Service Waitress	Other	Total
100	6	7	7	34	28	24	100%
200	23	3	10	27	31	29	100
300	18	15	11	27	34	13	100
400	12	7	17	24	35	17	100
500	10	4	21	15	38	22	100
600	5	22	10	14	30	24	100
700	1	5	15	35	25	20	100
800	1	20	10	10	50	10	100
900	1	0	40	8	48	4	100
1000	3	7	8	8	27	50	100
1200	2	5	5	40	10	40	100
1500	1	10	10	40	20	20	100
2000	1	100	0	0	0	0	100
3000	2	3	3	10	55	29	100
5000	2	0	15	50	15	20	100
Total	88	208	182	342	446	322	1500
Average % of Business		14	12	23	30	21	100

Table III-15

Disposition of Finished Product By
Typical Product Grade Bought
By Purveyors and Processors
From Cattle Sellers or Packers

Typical Product Grade Bought from Packers or Cattle Sellers By Responding Purveyor and Processor Firms	# of Firms Responding in this Category	Types of Food Service Outlets — Average Per Cent of Business					
		Self-Serve	Hotel	Institution	In-Service	Other	Total
Prime and Choice	5	4	17	8	63	8	100%
Choice	28	7	15	25	36	17	100
Choice and Good	10	4	13	32	23	28	100
Choice and Commercial	4	2	26	23	16	33	100
Choice and Utility	7	10	11	29	36	14	100
Good	1	0	0	30	20	50	100
Good and Commercial	2	3	5	12	70	10	100
Good and Utility	1	5	20	25	50	0	100
Commercial	1	70	5	5	10	10	100
Commercial and Utility	2	4	0	13	47	36	100
Utility	6	35	8	19	12	26	100
All Grades	4	6	9	20	29	36	100

The following conclusions may be drawn from these returns:

1) On the basis of these responses, the finest grades of beef, prime and choice, most frequently went to the "in-service waitress" restaurant outlets, suggesting this to be a higher quality restaurant based on the higher quality of meat purchased.

2) Choice grade beef is the most typical grade of raw product bought by the responding purveyor and processor

firms from packers and cattle sellers. The largest amount of choice grade beef goes to "in-service waitress" restaurants who generally carry a full line menu. The least amount of choice grade beef goes to the "self-serve steak houses" which are commonly cafeteria style or family style dining facilities.

3) The one respondent who indicated "commercial" as the typical supply source was channeling 70% of his business to the "self-serve steak house" outlets. Those 6 firms responding to "utility" as the typical supply source were averaging 35% of their business to "self-serve steak houses."

4) For those 3 firms who responded that the typical product grade was "good and commercial" and "good and utility," the per cent of finished product going to "in-service waitress" restaurants was 70% and 50%, respectively. This suggests that the "in-service waitress" restaurants do receive some lower quality meat in addition to the higher qualities of meat as indicated in paragraphs (1) and (2), above.

The sample size is not large enough to conclusively determine a fixed relationship between types of food service outlets and the quality of purveyor and processors finished product based on typical cattle grades bought from cattle sellers or packers.

G. Summary

The meat purveyor and processor firms serving the food-away-from-home market are a very specialized and important segment of the meat industry. The meat purveyors have enjoyed spectacular growth within the past several decades, both in number of houses and volume of meat handled. [See page 45, Chapter III]. The economic activities of meat purveyors and processors depend primarily upon the aggregate demand for red meat of various classes and grades by the Food Service Industry which serves this food-away-from-home market.

The Food Service Industry is a vast and complicated industry whose size is difficult to measure since the components are so diverse. The importance of the Food Service Industry to beef retailing was reflected in the A. T. Kearney & Company study in 1969 which estimated nearly 45% of all beef moved through the food-away from-home market.

Our society will continue to rely on the food-away-from-home market as an important link in food marketing system. Consumers will continue to demand quality food at a reasonable cost coupled with uniform products and services from a variety of food service outlets. Consequently, this competition for a reasonably-priced quality beef product will necessitate even further specialization and increased efficiencies from the purveyor and processing segment of the meat industry.

The bulk of questionnaire responses came from midwestern or central states, although the total usable responses (104) were scattered throughout the country. Nearly 80% of the responses were from firms that considered their operations as either "Purveyor" or "Purveyor and Processor" operations. Purveyors tend to fabricate more products from primals and

subprimals for hotels, restaurants, and institutional trade, while processors generally break down and process meat cuts from carcasses vis-a-vis primals or subprimals.

The most common types of raw product purchased by these respondents were, in descending order, primals, subprimals, and carcass.

Forty-six per cent of the firms indicated that a physical tenderizer was not used on the production lines as opposed to 50% who did. Also, 69% of the respondents indicated that a vegetable enzyme was not used on the production lines as opposed to 31% who do use a vegetable tenderizer.

The most important component of average total weekly beef production was hamburger, followed by chucks, boneless strips, rib eyes, short loins, butts, rib roasts, and bone-in strips. While the category "other" was the largest of all components of weekly production, this included items other than beef such as pork, lamb, and fish products which make up an important portion of the purveyor business.

The range of meat volume processed weekly by these firms was from 2,000 pounds to 7,500,000 pounds. The average amount processed weekly was 210,591 pounds, with a standard deviation of 813,659. Thus, the large range suggests the heterogeneous nature of purveyor firms in terms of size and operation.

In regard to supply logistics, the raw product supply source summary

by the firms was as follows:

Raw Product Supply Source	Average Per Cent of Total Raw Product Supply
a) Commercial & Utility Cow Beef	19.2
b) Canner & Cutter Grade Beef	12.9
c) Standard or Good Grade Heifer, Bull, Steer, or Cow Beef	12.7
d) Choice Grade Heifer, Steer Beef	54.9
	99.7%

Forty-four of the 103 respondents acknowledged the use of cow beef as a typical raw product supply source for their operations. It could be estimated by adding the two categories of commercial and utility grade cow beef plus cutter and canner grade beef accounted for approximately 32% of the firms' raw product supply. This roughly represents the average amount of cow beef usage for these firms' operations.

On the average, 93.1% of the respondent's beef supply comes from domestic sources as opposed to foreign sources, with the central states being the most important domestic beef supply region.

The most common method of securing raw product was order buying via telephone, with order buying plus the use of a broker being the second most important method. Such a system not utilizing written contracts necessitates a great deal of confidence and familiarity among cattle sellers and meat processors-purveyors in negotiating transactions.

Only 17.3% of individual purchases of processor and purveyor firms products are made on a contract basis, while 76.0% do not engage in this practice. The remainder do use this practice occasionally.

The most typical product grades bought by the responding firms

were choice, and choice and good, with the typical cattle class being steers and cows followed by heifers and bulls.

While 57.7% of the firms considered themselves "medium" size relative to their competitors, further analysis showed that there was no positive correlation between the size of firm relative to their competitors and the average total pounds per week processed or number of accounts normally serviced. Although the average number of accounts serviced by responding firms was 568 accounts, the firms serving an average of 100 to 500 accounts represented 78.9% of the total response to this question.

The following conclusions can be drawn in regard to the disposition of processor and purveyors' finished products:

1) The Food Service Industry is a heterogeneous group of enterprises that serve a variety of types of food service outlets. While the author felt that the categories of "self-serve steak house," "hotels," "institutions," "in-service waitress restaurants," were the more important types, the average per cent of business to the category "other" was 22.1%, which represented numerous types of outlets other than the four specified.

2) The "in-service waitress restaurants" were the most important outlet for the firm's finished products, followed in descending order by institutions, other, hotels, and self-serve steak houses.

3) There is insufficient data to suggest a correlation between the size of processor and purveyor firms (based either on total pounds of beef processed weekly or accounts normally serviced) and the disposition of product going to any one specific type of

food service outlet. Various sizes of processor and purveyor firms tended to serve various types of food service outlets. 4) Similarly, there is insufficient evidence to conclude that any one type of food service outlet receives finished products from firms who typically buy a certain grade of meat (prime, choice, utility, etc.) for their production.

CHAPTER IV

DEVELOPMENT OF A PREDICTION MODEL FOR FORECASTING ANNUAL COW SUPPLY AND SLAUGHTER

A. Introduction

The purpose of this chapter is to develop and interrelate beef and dairy cows supply equations with a cow slaughter equation that can be used for forecasting short run cow beef production in the United States. An illustration is presented on how the equations can be used to predict the quantity of beef and dairy cows on farms for 1976 and 1977 and cow slaughter for 1975 and 1976. The ordinary least squares method using time series data from 1954-1974 was employed to develop the short run supply equations. Longer range projections will require use of considerable subjective judgment concerning structural changes and level of exogenous variables.

B. Relationship of Cow Supply and Slaughter to Meat Purveyors and the Food Service Industry

Chapter II provided a descriptive explanation of the beef production industry and related structural changes. It also demonstrated the economic inter-dependencies among the participants of the total beef production and marketing system.

Data from this project's 103 responding purveyor and processor firms indicated that approximately 32 per cent of their raw product supply was coming from cow beef sources. Cow beef does represent an important raw product supply source for meat purveyors and their

market (i.e., the various types of food service outlets). Meat Processing technology utilizing physical tenderizing machines and/or vegetable enzyme applicators is capable of manufacturing retail table cuts from cow beef.

C. Definition of Variables

Estimation of the economic model requires the measurement of factors that are specified as influencing the cow beef numbers and slaughter. The following variables, as herein defined, will be functionally related in the form of the three equations to explain number of beef and milk cows on farms and cow slaughter during the 20 year period under analysis. The variables used in the anlaysis are now listed and defined.

DEFINITIONS OF VARIABLES

$NCSL_t$ = Estimated total number of cows slaughtered in year t, United States, (1000 head)*

NBC_t = Number of beef cows on farms on January 1 in year t, (1000 head)

NDC_t = Number of dairy cows on farms on January 1 in year t, (1000 head)

PFC_t = Price of Good-Choice-Feeder calves at Kansas City in August to December ($/cwt) divided by the index of prices paid by farmers (1967=100) in year t

RF_t = Range Feed and pasture conditions in year t (USDA Index)

GMM_t = Gross Margin ($) per hour of labor in milk production =[average price received by farmers per cwt - total concentrate costs per cwt of milk] ÷ [hours of labor required to produce 100 pounds of milk (LM)] ÷ [Index of prices paid by farmers (IPP) (1967=100)]

DUM_t = Dummy variable on milk production assuming the value of 0 for 1954-1964 and 1 thereafter, recognizing the structural change in the dairy industry

$PRIHAY_t$ = Annual average price in dollars per ton ($/ton) received by farmers for all hay baled

RWR_t = Real Wage Rates ($/hour) of workers in non-agricultural sector deflated by the Consumer Price Index

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*$NCSL_t$ = (Federally Inspected Cattle Slaughter number, U.S. ÷ per cent of total slaughter that is Federally Inspected) x per cent Federally Inspected Cow Slaughter).

D. Development of the Supply Functions: Equations to be Estimated

The development of this cow supply and slaughter model involves three equations: (1) the number of beef cows on farms, (2) the number of dairy cows on farms, and (3) estimated total cow slaughter. Prediction of total U.S. cow slaughter creates the need for prediction of the two separate components of cow slaughter; i.e., beef and dairy cow inventory levels.

1. Number of Beef Cows on Farms

The number of beef cows on farms is the key variable in the U.S. beef supply relationships. The preliminary work of Ferris [9] was utilized in deriving a supply equation for beef cows on farms. The specification of his model and results can be found in Chapter II.

a. The model specified and estimated is:

$$NBC_t = a + b_1 NBC_{t-1} + b_2 PFC_{t-2} + b_3 PFC_{t-3} + b_4 PFC_{t-4} + b_5 RF_{t-1}.$$

Using this equation it is possible to investigate the influence of each independent variable (those on the right hand side) upon the dependent variable (NBC_t).

b. Testing of 'Accounted-For' Variation

To test if a significant amount of variation of the endogenous variable, NBC_t, was accounted for by the exogenous variables in the equation, a null hypothesis was tested with the 'F' test.

$$H_o : B = 0$$

with the alternate hypothesis being:

$H_A : B \neq 0$; i.e., the total variation of the exogenous variable does account for significant amount of variation in the endogenous variable.

c. Testing Hypothesis about Single Coefficients

In order to test the significance of the individual coefficients in the equation, 't' tests were employed.

The general hypothesis being tested is:

$$H_o : B_i = 0$$

with the alternate hypothesis being:

$H_A : B_i \gtrless 0$ depending on sign or expected directional effect of the i^{th} coefficient.

Specified Alternative Hypothesis:

1) $H_A : b_1 > 0$ The number of beef cows on farms, NBG_{t-1}, in any particular year is expected to have a positive effect on numbers in the following year, NBC_t.
Expanding numbers of beef cows on farms in (t-1) would tend to increase the number of beef cows on farms in year t.

2) $H_A : b_2 > 0$ The number of beef cows on farms is believed to be positively related to the expected net returns over variable costs for that enterprise. As the feeder calf price is a principal ingredient of the profitability measure, and as calf prices expected to be received by farmers are believed to be influenced by past prices; a positive relationship is hypothesised for the lagged calf price with the number of beef cows on farms.

3) $H_A : b_3 > 0$

4) $H_A : b_4 > 0$

5) $H_A : b_5 > 0$ The range conditions that prevail during the period for decision to expand or liquidate beef cow numbers constrains the numbers of animals that can be grazed. Hence, we would expect NBC_t to be positively associated with $RF_{(t-1)}$.

d. Estimated Equation Presented

The relationship fitted to the years 1954 to 1974 was estimated and resulted in:

Equation IV-1

$$NBC_t = -4922 + 1.051\ NBC_{t-1} + 117.6\ PFC_{t-2}$$
(standard error t) (48.25) (3.14)

$$+ 18.35\ PFC_{t-3} + 51.31\ PFC_{t-4} - 3.03\ RF_{t-1}$$
(.42) (1.77) (.09)

$\bar{R}^2 = .995$; S.E.E. = 506

( ) Numbers in parenthesis are t-values.

Testing Results

(1) Rejection Criteria

The null hypothesis is rejected if the calculated F statistic $> Fv_1, v_2, \alpha$ or $F_{5,14,.05} = 2.9582$ where $V_1 = 5$ degrees of freedom in SSR calculation, $v_2 = 14$ degrees of freedom in SSE calculation, and the test is conducted at the 5% level of significance.

(2) Result of 'F' Test:

As the calculated F statistic is 555.49, H_o is rejected, H_A is accepted; and the variation accounted for by the predetermined variables is significantly different from zero at the 5% level of significance.

(3) Rejection Criterion for 'T' Test:

Reject H_o if calculated $T > T_{d.f,\alpha} = 2.145$ for 1-tailed test at the 5% level of significance. The calculated 't' values are presented below their respective coefficients in equation IV-1 and suggest the following:

Results of 'T' Tests:

1) Reject $H_o : b_1 = 0$

Accept $H_A : b_1 > 0$

Since the t value of B_1 is 48.25 and thus greater than 2.145, we reject the hypothesis that NBC_{t-1} is not significantly different from zero. We accept the alternative hypothesis that NBC_{t-1} does contribute significantly to the determination of NBC_{t-1}. The highly significant coefficient on NBC_{t-1} reflects the long biological cycle and the rapid upward trend in beef cow numbers.

2) Reject H_o : $b_2 = 0$

Accept H_A : $b_2 > 0$

The 't' value, 3.14, for the PFC_{t-2} coefficient indicates that we accept the alternative hypothesis that the feeder calf price in any particular year significantly influences beef cow numbers two years hence.

3) Accept H_o : $b_3 = 0$

The 't' value for the PFC_{t-3} coefficient was .42. Thus, we accept the null hypothesis that the t value of the coefficient for the variable PFC_{t-3} does not differ significantly from zero. The determination of NBC_t does not depend significantly on PFC_{t-3}.

4) Accept H_o : $b_4 = 0$

The 't' value for the PFC_{t-4} coefficient was 1.77. Therefore, we accept the null hypothesis that the 't' value of the coefficient for variable PFC_{t-4} does not differ significantly from zero. The determination of NBC_t does not depend significantly on PFC_{t-4}. The coefficient on PFC_{t-4} was larger than PFC_{t-3}. Ferris suggests that a plausible explanation is that feeder prices may be more influential at the time a cow calf operator is deciding how many heifers to hold back. Normally, these operators would keep more heifers than they actually need for replacement purposes just to have some flexibility. But usually, most of the heifers

to be sold as feeders are sold as calves rather than yearlings.

5) Accept $H_o : b_5 = 0$

The 't' value for the RF_{t-1} was .09. Thus, we accept the null hypothesis that the 't' value of the coefficient for variable RF_{t-1} does not differ significantly from zero.

As indicated by $\bar{R}^2$ 99.5 per cent of the quantity variation in beef cow supply was 'explained' by the variation of the specified independent variables. The equation missed direction changes once in year to year changes from 1954 to 1974. In this case, the error meant that the model indicated an increase in the estimated number from the previous year, whereas the actual number from the previous year declined.

For the period used in this analysis, the "fit" of the equation was not as close as in the period 1950-1972 analyzed by Ferris.

The above equation suggests the following relationships:

1) A strong upward trend is present in beef cow numbers.

2) A dollar increase in the deflated price of good-choice feeder calves at Kansas City in August - December in year t-2 will tend to increase the number of beef cows on farms in year t by about 117,600 head. Similarly, a

dollar increase for feeder calves for this period in years t-3 and t-4 will tend to increase number of beef cows on farms about 18,350 and 51,310 head respectively in year t. The actual effects, of course, cannot be measured this precisely. Other relevant statistical data are found in Appendix Table C-2.

2. Number of Milk Cows on Farms

The number of dairy cows in the U.S. has experienced a continued decrease since the early 1950's. The decline in the number of milk cows is related to the decrease in per capita consumption of dairy products and to increased production per cow. Per capita consumption of milk in all dairy products fell from 653 pounds in 1960 to 564 pounds in 1970 [1,p.5]. Milk production per cow averaged 7,002 and 9,388 pounds in 1960 and 1970 respectively.

While the number of milk cows has been declining consistently from year to year, the rate of decline has varied. Therefore, it seemed necessary to produce a model that would explain this variation. Conceptually, many economic forces impinge upon dairy farmers. To account for these influences in a supply equation, a number of variables would normally be required. To alleviate possible multicollinearity problems between a number of these supply-determining, cost-related variables, it was decided to use gross margin to simplify the supply equation.

a. The model specified and estimated is:

$$NDC_t = a + b_1\ NDC_{t-1} + b_2 GMM_{t-1} - b_3\ DUM_t - b_4\ RWR_{t-1}.$$

b. Testing of 'Accounted-for' Variation

To test if a significant amount of variation of the endogenous variable, NDC_t, was accounted for by the predetermined variables in the equation, a null hypothesis was tested with the 'F' test.

$$H_o : B = 0$$

with the alternate hypothesis being:

$H_A : B \neq 0$: i.e., the total variation of the exogenous variable does account for significant amount of variation in the endogenous variable.

c. Testing Hypothesis about Single Coefficients

In order to test the significance of the individual coefficients in the equation, 't' tests were employed.

The general hypothesis being tested is:

$$H_o : b_i = 0$$

with the alternate hypothesis being:

$H_A : b_i \gtrless 0$ depending on sign or expected directional effect of the i^{th} coefficient.

Specified Alternative Hypothesis:

1) $H_A : b_1 > 0$

The number of milk cows on farms in any particular year is expected to have a positive effect on numbers in the following year. The relationship between NDC_{t-1} and NDC_t is expected to be positive.

2) $H_A : b_2 > 0$

One of the main problems in using a gross margin analysis is determining what costs to include in the computations and the relative weight of each cost as a part of total costs. The availability of a data source for making computations is also a constraint.

Essentially, the GMM measure used gave a gross return over variable costs per hour of labor. This variable was then deflated by the Index of Price Paid by Farmers (IPP) (1967=100) to keep quantities in constant dollars. These data series are found in the Appendices B-6, B-7, B-8.

We would expect the relationship between GMM_{t-1} and NDC_t to be positive. As the net above variable costs for milk production increases, the number of milk cows is expected to increase.

3) $H_A : b_3 < 0$

To recognize a marked downward trend in the dairy cow numbers that occurred in the mid 1960's, a dummy variable is introduced. This dummy variable carries the value "zero" for 1954-1964, and the value "one" for 1965-1974. The relationship is expected to be negative.

4) $H_A : b_4 < 0$

The relationship between lagged real wage rates, RWR_{t-1}, and NDC_t is expected to be negative. As the real wage rate in dollars per hour for workers in the

nonagricultural sector increases, the opportunity cost incurred by these remaining on teh farm increases and provides incentive for movement off the farm.

d. Estimated Equation Presented

The estimated supply model is as follows:

Equation IV-2

$$NDC_t = 6438 + \underset{(1.23)}{} + \underset{(8.60)}{.767\ NDC_{t-1}} + \underset{(.26)}{34.33\ GMM_{t-1}} \underset{(-2.99)}{-603.0\ DUM_t}$$

$$\underset{(-.74)}{-1232.6 RWR_{t-1}}$$

$\bar{R}^2 = .996$ S.E.E. = 221

( ) Numbers in parenthesis are t-values.

Testing Results

1) Rejection Criteria

The null hypothesis is rejected if the calculated F statistic $> F_{v_1,v_2,\alpha}$ or $F_{5,14,.05} = 2.9582$ where $v_1 = 5$ degrees of freedom in SSR calculation, $v_2 = 14$ degrees of freedom in SSE calculation, and the test is conducted at the 5% level of significance.

1) Result of 'F' test:

As the calculated F statistic is 1094.22, H_o is rejected, H_A is accepted; and the variation accounted for by the exogenous variables is significantly different from zero at the 5% level of significance.

2) Rejection Criterion for 'T' Test:

The rejection criteria is the same as for the testing of the beef cow numbers on farm equations previously stated.

Results of 'T' Tests

1) Reject $H_o : b_1 = 0$

Accept $H_A : b_1 > 0$

Since the 't' value of B_1 is 8.60 and thus greater than 2.145, we reject the hypothesis that NDC_{t-1} is not significantly different from zero. We accept the alternative hypothesis that NDC_{t-1} does contribute significantly to the determination of NDC_t.

2) Accept $H_o : b_2 = 0$

The 't' value of B_2 is .26 and hence is less than 2.145. Thus, we accept the hypothesis that GMM_{t-1} is not significantly different from zero.

3) Reject $H_o : b_3 = 0$

Accept $H_A : b_3 > 0$

Since the 't' value of b_3 is 2.99 and greater than 2.145, we reject the hypothesis that DUM_t is not significantly different from zero. We accept the alternative hypothesis that DUM_t does contribute significantly to the determination of NDC_t.

4) Accept $H_o : b_4 = 0$

The 't' value of b_4 is .74 and hence is less than 2.145. Thus, we accept the hypothesis that RWR_{t-1} is not significantly different from zero, and is not an important determinant of NDC_t.

Although usage of the aggregated variables in this supply equation was intended to reduce multicollinearity problems, difficulties remained as shown in Appendix Table C-3. This simply is a case where two or more independent variables are so highly correlated that their separate effects upon the dependent variable cannot be distinguished. Acknowledging this structural weakness of the model, it is important to note that this will not jeopardize the prediction of the dependent variable, NDC_t.

The $\bar{R}^2$ value at .996 indicated a high percentage of the variation in NDC is explained" by the independent variables.

Equation IV-2 suggests that there is a strong downward trend effect on NDC which accounts for the major variation in supply of dairy cows.

3. Estimated Total Number of Cows Slaughtered

The need for a prediction equation for total cow slaughter stems from the reliance of meat purveyors and the food service industry's usage of cow beef as an important raw product supply source.

The first step in predicting cow slaughter was to predict the two separate components: beef cow numbers and dairy cow numbers. Since beef cows currently outnumber dairy cows almost 4 to 1, it was expected that the level of beef cow inventory would strongly influence the number of cows slaughtered.

a. The model specified and estimated is:

$$NCSL_t = a + b_1\ NBC_t + b_2 NDC_t - b_3(NBD_{t+1} - NBD_t) - b_4(NDC_{t+1} - NDC_t)$$

b. Testing of 'Accounted-For' Variation

The same criteria as explained for the beef and dairy cow models are employed here.

(1) Rejection Criteria

Similarly, the rejection criteria for the beef and dairy cow models is applicable here.

c. Testing Hypothesis about Single Coefficients

The same testing criteria for the beef and dairy cow models is used again for the cow slaughter equation.

Specified Alternative Hypothesis:

1) $H_A : b_1 > 0$ The relationship between NBC_t and $NCSL_t$ is expected to be positive. An

increase in the number of beef cows between years suggests that the heifer replacements entering the cow herd during the year would permit an increase in the culling of older beef cows; hence, an increase in cow numbers slaughtered.

2) $H_A : b_2 > 0$ The relationships between NDC_t and $NCSL_t$ is also expected to be positive for the same reasoning as stated for NBC_t.

3) $H_A : b_3 < 0$ The relationship between $(NBC_{t+1}-NBC_t)$ and $NCSL_t$ is expected to be negative. As the growth in beef cow inventory increases from year to year, slaughter would be expected to decrease and vice versa. As the rate of growth in beef cow numbers increases; more heifers are retained, mature cows are maintained for a longer period of time and thus, the number of cows slaughtered may tend to decrease during this growth phase.

4) $H_A : b_4 < 0$ The relationship between $(NDC_{t+1}-NDC_t)$ is also expected to be negative for the same reasoning as the beef cow inventory changes.

d. Estimated Equation Presented

The estimated supply model is as follows:

Equation IV-3

$$NCSL_t = -6195 + .2594\ NBC_t + .3617\ NDC_t - 1.148\ (NBC_{t+1}-NBC_t)$$

$$(-2.69) \quad (6.63) \qquad (4.67) \qquad (-11.47)$$

$$-.4960\ (NDC_{t+1}-NDC_t)$$

$$(-1.60)$$

$\bar{R}^2 = .995$ S.E.E. = 304

( ) Numbers in parenthesis are t-values.

Testing Results

1) Result of 'F' Test:

As the calculated F statistic is 304.11, H_o is rejected; H_A is accepted; and the variation accounted for by the predetermined variables are significantly different from zero at the 5% level of significance.

2) Rejection Criteria for 'T' Tests:

The rejection criteria is the same as for the beef and milk cow supply equations.

Results of 'T' Tests:

1) Reject $H_o : b_1 = 0$

Accept $H_A : b_1 > 0$

The 't' value of b_1 is 6.63 and hence greater than 2.145. Thus, we reject the hypothesis that b of NBC_t is not significantly different from zero and accept the alternative hypothesis that NBC_t does contribute significantly to the determination of $NCSL_t$.

2) Reject $H_o : b_2 = 0$

Accept $H_A : b_2 > 0$

Since the 't' value of b_2 is 4.67 and thus greater than 2.145, we reject the null hypothesis and accept the alternative hypothesis. The variation in the number of dairy cows explains a significant amount of variation of the total number of cows slaughtered.

3) Reject $H_o : b_3 = 0$

Accept $H_A : b_3 > 0$

The 't' value of b_3 is 11.47 and hence greater than 2.145. We reject the null hypothesis and accept the alternative hypothesis for the same reasoning as b_1 and b_2. As growth rate increases, the number of cows slaughtered decreases and vice versa.

4) Accept H_o " $b_4 = 0$

The 't' value of b_4 is 1.60 and hence is less than 2.145. Thus, we accept the hypothesis that the change in dairy cow numbers, $(NDC_{t+1} - NDC_t)$, is not significantly different from zero and is not a significant determinant of $NCSL_t$.

The above equation suggests the following relationships:

1. A 1000 head increase in the number of beef cows on farms January 1 in year t will increase number of cows slaughtered (NCSL) during year t by 259 head.
2. A 1000 head increase in the number of milk cows on farms January 1 in year t will increase NCSL during year t by 361 head.
3. A positive inventory change of 1000 in beef cow numbers on farms will decrease number of cows slaughtered

by 1,148 head during year t.

4. A positive inventory level change of 1000 in dairy cows on farms will decrease number of dairy cows slaughtered by 496 head during year t.

Over 95 per cent of the quantity variation in cow slaughter supply is accounted for by Equation IV-3. The equation missed direction changes four times in twenty years. The highly coefficient on $(NBC_{t+1}-NBC_t)$ reflects the relative importance of beef cow inventory lev el changes.

Other relevant statistical data can be found in the Appendix Tables C-4 and C-5.

4. Forecast of Beef and Milk Cow Supplies

Using the derived equations and assumptions about endogenous variables, estimates of beef and dairy cow numbers were made for 1976 and 1977. These results are presented in Tables IV-1 and IV-2.

Number of Beef Cows on Farms, January 1, 1976 and 1977

Based on published USDA figures for number of beef cows on farms, January 1 of 1975 and utilizing the derived equation, the model predicts 46,889,000 head of beef cows for 1976 compared with 45,421,000 head in 1975. This assumes normal weather yielding normal range and pasture conditions. This increase demonstrates the powerful momentum of the cattle numbers cycle. It is not likely that the cattle production cycle will turn down during 1975. Further, USDA estimates that heifers over 500 pounds for cow replacements numbered 13 million head on January 1, 1975, an increase of 7 per cent from January 1, 1974. This would

CHAPTER IV

PREDICTION STATISTICS

Table IV-1
Number of Beef Cows on Farms, January 1

$Year_t$	NBC_t	= a	+ b	$.NBC_{t-1}$	$+ b_2$	$.PFC_{t-2}$	$+ b_3$	$.PFC_{t-3}$	$+ b_4$	$.PFC_{t-4}$	b_5	RF_{t-1}
1975	45,421											
1976	46,889[1/]	-5922	+1.051	45,421	117.6	17.73	18.35	41.22	51.31	38.49	-3.03	85
1977	48,281[1/]	-5922	+1.051	48,131	117.6	18.92	18.35	17.73	51.31	41.22	-3.03	85

1/ Predicted

Table IV-2
Number of Milk Cows on Farms, January 1

$Year_t$	NDC_t	+ a	+ b	$.NDC_{t-1}$	$+ b_2$	$.GMM_{t-1}$	$- b_3$	$.DUM_t$	$- b_4$	RWR_{t-1}
1975	11,217									
1976	11,138[1/]	6438	.767	11,217	34.33	7.27	-603.0	1	-1232.6	2.88
1977	11,042[1/]	6438	.767	11,138	34.33	8.05	-603.0	1	-1232.6	2.93

1/ Predicted

Table IV-3
Estimated Total of Cows Slaughtered, U.S.

$Year_t$	$NCSL_t$	= a	+ b_1	$.NBC_t$	$+ b_2$	$.NDC_t$	$- b_3$	$NBC_{t-1} - NBC_t$	$- b_4$	$NDC_{t+1} - NDC_t$
1975	7999	-6195	.2594	45,421	.3617	11,217	-1.148	1468	-.4960	-79
1976	8447	-6195	.2594	46,889	.3617	11,138	-1.148	1392	-.4960	-96

tend to support the 1976 supply prediction, even if large cow slaughter occurred through 1975.

Using the 1976 predicted figures from above, the estimated number of beef cows on farms January 1, 1977 is 48,281,000 head. This assumes a deflated average feeder calf price at Kansas City of $18.92 during Fall, 1974. It also assumes normal range and pasture conditions.

Number of Dairy Cows on Farms, January 1, 1976 and 1977

U.S.D.A. figures indicated that the number of milk cows on farms, January 1, 1975 was 11,217,000 head. In order to predict 1976 milk cow numbers on farms utilizing the derived equations, it was necessary to estimate the gross margin per hundredweight of milk for 1975 and 1976. This entailed making the following assumptions about the dairy industry, based on judgment of a resident milk industry specialist:

1. Milk production per cow will increase 3 per cent, 2 per cent, in 1975 and 1976 respectively.
2. The average price received by farmers per cwt. of milk will be about $8.72 for 1975, assuming no drastic changes in the milk support prices. An 8 per cent increase for milk prices is embodied in the 1976 estimate.
3. The concentrates fed per cow in pounds will increase 6 per cent, assuming normal or good crop years in 1975 and 1976.
4. With adequate feedgrain supplies for these years, dairy ration costs per 100 pounds will decline to $5.96 for 1975 and 1976.

5. The Index of Prices Paid by Farmers will continue to parallel general inflationary trends, increasing about 10 per cent per year.

6. The labor required to produce 100 pounds of milk will decrease in 1975 and 1976. The Real Wage Rate (RWR) will stabilize around $2.88 per hour for 1975 and $2.93 per hour for 1976.

A summary of the assumptions is shown below:

Year	Milk Prod. Per Cow (lbs.)	Ave. Price Rec'd By Farmers Per Cwt. ($)	Gross Receipts From Milk Per Cow ($)	Concentrates Fed Per Cow (lbs.)
1975	10,545	8.72	915	4,346
1976	10,756	9.42	1012	4,606

Year	Dairy Ration Cost Per 100 lbs. Milk	Total Annual Concentrate Cost Per Cow	Gross Margin (GMM)	Index of Prices Paid by Farmers (1967 = 100)	Gross Margin/ IPP X 100%
1975	5.96	256	659	1.85	356
1976	5.96	274	738	1.95	378

Year	Labor Require. Per Cwt. (LM)	GMM/LM /IPP
1974*	.52	6.23
1975	.49	7.27
1976	.47	8.05

* The years 1974-76 are utilized since (LM) is a lagged variable.

The number of milk cows on farms January 1, 1976 is estimated at 11,138,000 head based on the above assumptions. This compares with 11,217,000 head on January 1, 1975. Similarly, the estimate for January 1, 1977 is 11,042,000 head of milk cows on farms.

5. Forecast of Total Cow Slaughter, 1975 and 1976

It is now possible to obtain the forecast of total cow slaughter under Federal Inspection for 1975 and 1976 based on the derived equation for cow slaughter which utilize the linking beef and milk cow supply estimates. Table IV-3 provides the necessary data.

The coefficient for the change in beef cow inventory levels is the most influential variable determining total cow slaughter. The other significant variables influencing total cow slaughter are the Janaury 1 inventory number of beef and milk cows on farms.

The estimated total cow slaughter for 1975 is 7,999,000 head. This compares with 7,542,450 head slaughtered in 1974 and amounts to about a 6 per cent increase.

The estimated total cow slaughter for 1976 is 8,447,000 head as compared with 7,999,000 head predicted in 1975. This estimate is based on the derived equation of the model and the 1975 estimations. The increase in the cow slaughter estimate for 1976 can be attributed to the effect of the deflated low average feeder calf prices in 1975, which affects the NBC in 1977 and in turn the cow slaughter estimate for 1976.

6. Comments on the Model

For the beef cow supply equation, 99 per cent of the variation in the supply is explained by the variables. It is worthwhile to review those structural variables that are theoretically considered to be important have little significance in the model. The range feed and pasture conditions had little effect on beef cow supply on farms. Yet, a priori knowledge of the industry would contradict this finding. A more refined model should weigh this index by geographic production areas (western, southern, etc.).

For the milk cow equation, although alternative supply equations were investigated, multicollinearity problems arose between variables as seen in the Appendix Table C-3. This deficiency is attributed to the strong trend factor in the dairy industry and is difficult to handle analytically. While the statistical properties of the gross margin variable suggest that this is not an important milk cow supply determinant, there is a strong 'a priori' economic rationale to believe that profit levels are important determinants of the rate of liquidation in dairy cows. It also suggests that a variable to represent certain fixed costs might be incorporated into the model. The real wage rate was not a significant variable in the equation, though there is good reason to believe that labor costs and opportunity costs for labor should be considered.

Finally, the value of a cow slaughter equation is dependent upon the reasonable estimates of the two components of total cow

slaughter: Beef and milk cow numbers on farms. Ninety-five per cent of the quantity variation in cow slaughter was accounted for in the derived equation. The possible deficiency lies in the 3 out of the total 4 directional errors which occurred in the last six years.

a. Consideration in Projecting Long Range Supplies

Long range projections are always difficult, but even more so when political, social, and economic changes occur so rapidly.

The short run supply equation of this chapter are of limited use in the long range projections since the exogenous variables in the equations have to be predicted also. Instead long range supply projections must also investigate demand cariables and trends such as population, per capita disposable income, tastes and preferences, industry structure, feed grain relationships and the cattle industry. However due to time and financial constraints, demand analysis is deemed outside the scope of this thesis.

7. Conclusion

Forecasting models of beef and milk cows on farms and estimates for total cow slaughter have been derived, each containing significant variables. While the statistical properties are important considerations of these equations, most important is that the equations represent what is known or can be readily explained about the industry. The models do a reasonable job of forecasting, but there is a small amount of variability

unexplained by the predetermined variables.

The number of beef cows on farms in the current year is primarily a function of the number of beef cows on farms the previous year and feeder cattle prices two years before the prediction year. The number of milk cows on farms is primarily a function of the number of milk cows on farms in the previous year and a downward supply trend, due to increased milk production per cow and decreased demand for milk products. Estimated total cow slaughter for a given year is primarily a function of the change in beef cows on farms numbers from one year to the next, the present number of beef cows on farms, and the present number of milk cows on farms.

CHAPTER V

SUMMARY, CONCLUSION AND IMPLICATIONS

A. Summary

1. Objectives of the Study

The basic objective of this study was to describe the economic relationships between meat purveyors and the food service industry. The meat purveyor's primary function is to supply the needs of hotels, restaurants, and institutions commonly referred to as the "food service industry." In conjunction with the basic research objective there were a number of more specific objectives. These objectives were to 1) describe the beef producing industry with respect to the changes taking place over the last few decades and the implications for future beef supplies, 2) describe the functions of meat purveyor firms and their interaction with the food service industry, and 3) formulate a simplified econometric model to forecast numbers of cows on farms and cows slaughtered. Such a model would help predict one of the important supply sources for meat purveyors and food service outlets.

The following discussion will present a short summary of the analyses associated with each of these objectives and the resulting conclusions. Following this, implications of the research findings are set forth.

2. The Beef Production Industry

A growing beef supply over time has been the result of increasing cattle numbers and increasing productivity of the cattle herd. Total cattle and calves on farms and ranches numbered approximately 79 million head in 1950 compared to 133.8 million head in 1975. [See Appendix C, Figure C-1] Various factors have contributed to this growth. The composition of the cattle herd has also changed: milk cows numbered approximately 20 million in 1950 compared with 11.2 million in 1975 while beef cows in 1950 numbered approximately 30 million in 1950 compared to 45.4 million in 1975.

Increased beef feeding is an example of an important structural change over the last two decades. During the past 15 years fed beef as a proportion of total beef slaughter has increased from approximately 27 per cent to 68 per cent [32,p.137].

Other factors that have contributed to increased productivity in the past are increased calving percentage and decreased death loss percentages.

"The importance of productivity gains relative to increases in the size of the cattle herd has decreased over time. As a result, future increases in the supply of beef are much more dependent on increases in the size of the cattle herd than in the past." [32,p.137].

Beef production can be divided into two major operations: cow-calf operations and cattle feeding operations. These two

operations have become somewhat distinct and separate over time. The primary function of the cow-calf operation is to supply the feeder calves for the cattle feeding industry. Cattle feeding operations feed feeder calves to slaughter weight.

3. Cow-Calf Operation

The beef cow herd has been typically characterized as a relatively small size production unit which is of a supplementary income nature. For the most part, these operations have maintained traditional production methods. A relatively large number of small cow-calf operations produce the feeder calves for the cattle feeding industry. In February of 1974, 15 states accounted for almost 70 per cent of the total U.S. number of beef cows. On December 31, 1969, the average herd size in the U.S. was 26 cows, and average herd size exceeded 100 cows in only three of the 15 states.

4. Cattle Feeding Operations

In contrast with the cow-calf industry, the cattle feeding industry has undergone a great deal of change during the past two decades. There has been a movement to a much smaller number of larger more efficient feedlot operations. The proportion of all cattle fed that were fed by feedlots with a capacity of 1,000 head or more increased from 37 to 62 per cent from 1963 to 1973 [32,p.139]. Research findings have attributed the trend towards much larger feedlots to the economics of size characteristics of beef feeding operations which have resulted in lower average costs of production.

Using this descriptive background of the beef industry,

a theoretical explanation of beef supply and demand relationships among the principal participants (the beef breeders, feedlot operators, and the meat packing and processing industry) was specified. The aggregate economic activities of the beef production system participants emphasized the increasing interdependence of all participants involved in vast and complex industry.

The thesis then turned to the basic question under consideration in this study: what services are performed by those firms involved in preparing and supplying meat to various food service outlets? And what is their significance as a link in the total beef production and marketing system?

5. Beef Processor and Purveyors and Their Functions

Data to describe the meat purveyors and their market, the food service industry, was obtained by sending a questionnaire to 424 firms who are members of the National Association of Meat Purveyors, headquartered in Tucson, Arizona. Information received from 103 firms located through-the United States was the major source of the data used for this study.

a. Relationship of Meat Purveyors and Processors To the Meat Packing Industry

Those firms who generally do not slaughter livestock but fabricate primals and subprimals into various types of meat cuts for hotels, restaurants, and institutional trade are commonly referred to as "meat purveyors," "custom service house," or "processors." These firms are a very specialized and important segment of the meat

industry. According to Brasington [4,p.1], the meat purveying business accounted for more than two-thirds of the total volume of meat and meat products sold to the food service industry in 1966.

b. Production Aspects

The most common type of raw product purchased in order to produce their finished product were, in descending order, primals, subprimals, and carcass for all the respondents. Forty-six per cent of the firms indicated they do not use a physical tenderizer on the production line compared with 54% who said they did. Also, 69% of the respondents indicated they do not apply a vegetable enzyme on the production line compared to 31% who do.

The most important component of average total weekly beef production was hamburger, followed by chucks, boneless strips, rib-eyes, short loins, butts, rib roasts, and bone-in strips. Processed pork, lamb, fish products, and specialized meat cuts not listed in the questionnaire was the largest single category of the respondents' weekly production composition. These non-beef components are an important portion of the purveyor business.

The range of meat volume processed weekly by these firms was from 2,000 pounds to 7,500,000 pounds. The average amount processed weekly was 210,591 pounds, with a standard deviation of 813,659 pounds, suggesting that heterogeneous nature of purveyor firms in terms of size and operation.

c. Supply Logistics

The raw product supply source of the firms was as follows:

Raw Product Supply Source	Average (Per Cent) of Total Raw Product Supply
a) Commercial and Utility Cow Beef	19.2
b) Canner and Cutter Grade Beef	12.9
c) Standard or Good Grade Heifer, Steer, Cow or Bull Beef	12.7
d) Choice Grade Heifer, Steer Beef	54.9
	99.7

Based on this data, it is estimated that 32% of the firms raw product supply comes from cow beef sources.

On the average, 93.1% of the respondent's beef supply comes from domestic sources as opposed to foreign sources, with the Central U.S. states being the most important domestic beef supply region for these respondents.

The most common method of securing raw product was order buying via telephone with order buying plus the use of a broker being the second most important method.

The most typical product grades bought by the responding firms were choice, and 'choice and good', with the typical cattle classes being steers and cows, followed by heifers and bulls.

While 57.7% of the firms considered themselves "medium" sized firms relative to their competitors, further analysis

showed that there was no positive correlation between the size of firm relative to their competitors and the average total pounds per week processed or number of accounts normally serviced. The average number of accounts serviced by responding firms was 568 accounts, although 79% of the firms serve an average of 100 to 500 accounts.

Only 24 per cent of the purveyor and processor firms purchase their products on a contract basis (forward buying of cattle), while 76.0% do not engage in this practice.

d. Disposition of Finished Products to the Food Service Industry

The food service industry is a heterogeneous group of enterprises that serve a variety of types of food service outlets. The author specified the categories of "self-serve steak houses," "hotel," "institutions," and "in-service waitress restaurants" as the more important types of outlets to analyze. However, the average per cent of purveyor and processor's business going to "other" types of outlets not specified above was 22.1%.

The "in-service waitress restaurants" was the most important outlet for the firm's finished products, followed by institutions, other, hotels, and self-serve steak houses.

There was insufficient data to suggest a correlation between the size of processor and purveyor firms (based either on total pounds of meat processed weekly or accounts normally serviced) and the disposition of products going to any one specific type of food service outlet. Various sizes

of purveyors and processors serve various types of food service outlets.

There was also insufficient evidence to conclude that any one type of food service outlet receives finished products from firms who typically buy a certain grade of meat (prime, choice, utility, etc.) for their production.

6. Development of a Prediction Model for Forecasting Annual Cow Supply and Slaughter

Based on the results of the project's questionnaire responses, cow beef represents an important raw product supply source for meat purveyors and their principal market, the various types of food service outlets. The thesis study then developed a beef and dairy cow supply equation and a cow slaughter equation that can be used for forecasting short-run beef production in the U.S. The ordinary least squares method was used for time series data from 1954-1974 in estimating the short-run supply equations for beef and dairy cows on farms for 1976 and 1977 and cow slaughter for 1975 and 1976.

Forecasting models of beef and milk cows on farms and estimated total cow slaughter were derived, each containing significant variables.

The number of beef cows on farms in the current year is primarily a function of the number of beef cows on farms the previous year and feeder cattle prices two years before the prediction year. Utilizing the derived equations, the model predicted 46,899,000 head of beef cows on farms and ranches for January 1, 1976 compared with 45,421,000 head for

January 1, 1975. Using the 1976 prediction figures, the model estimated 48,281,000 head of beef cows on farms and ranches for January 1, 1977.

The number of milk cows (or dairy cows) on farms is primarily a function of the number of milk cows on farms in the previous year and a downward supply trend. This trend is primarily due to increased milk production per cow and decreased demand for milk products. In order to predict 1976 and 1977 milk cow numbers on farms, utilizing the derived equation, it was necessary to estimate the gross margin per hundredweight of milk for 1975 and 1976. This estimation was based on a set of assumptions about the variables for gross margins [See Chapter IV, page 110]. The number of milk cows on farms January 1, 1976 was estimated at 11,138,000 head compared with 11,217,000 head on January 1, 1975. It further estimated 11,042,000 head of milk cows on farms for January 1, 1977.

Estimated cow slaughter for a given year is primarily a function of the change in beef cows on farm numbers from one year to the next, the present number of beef cows on farms, and the present number of milk cows on farms. Utilizing the linking beef and milk cow supply estimates, the model estimated the annual cow slaughter for 1975 at 7,999,000 head and 8,447,000 head for the year 1976.

B. Conclusions and Implications

The meat purveyors are a specialized and important link of the meat industry, in terms of the volume of meat processed and handled.

The food service industry constitutes the principal demand determinant for meat purveyor's finished products. This food service industry is serving a huge market of rapidly growing importance: the food-away-from-home market.

This study suggests managerial policy implications for the two major characters of this study: the meat purveyors and the food service industry.

Given the nature of beef production and its single complex product, management should be aware of the factors determining beef supply in the short run and over time, for operational planning. The understanding of trends and forces behind change can provide a basis for anticipating or projecting future change.

Since each purveyor firm performs particular specialized marketing and "manufacturing" functions, the interrelationships of the firms can be viewed as a channel of distribution. Generation of research and operational information as well as adequate dissemination of this information among purveyors can begin to overcome information deficits within channels of this industry.

The food service industry should also understand the forces impacting on the meat purveyors' operations as it in turn affects the food service outlets supply situation.

Finally, forecasting models for determining short-run supply estimates do a reasonable job of explaining cow beef supply and slaughter variation. Utilizing a simplified model can provide firm management with a useful planning tool for their operations.

C. Possible Future Studies

To make a study that would include every aspect of the meat purveying business and its interaction with the food service industry, the author would need considerably more time, industry participation and information, and patience. This study was an attempt to describe the salient features of production, supply logistics, and marketing aspects of meat purveyors and their relationship to the beef production system and the food service industry.

One area of continued study would be to study the economies of size of purveyor operations. No specific information is available on the plant size of these firms. This would help build plants of the most efficient size.

Another area would be studying how the companies buy their meat: the sources of supply, volume, quality and price determination.

Finally, there exists a need to explore the degree of specialization in marketing through direct selling, selling through wholesalers, or brokers and the like. Also, further research on direct operational aspects related to institutional and restaurant feeding should be considered.

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APPENDICES

APPENDIX A

ENUMERATIVE DATA FOR MEAT PACKING, PROCESSING, AND FAST FOOD FIRMS

Table A-1
U.S. Meat Inspection Establishments
Operating Under Federal Inspection
-November 1973-
Official Listing - Animal & Plant Health
Inspection Service - U.S.D.A.

State	SLAUGHTERING		PROCESSING*		BONING	
	Approx. # Plants	% of U.S. Total	Approx. # Plants	% of U.S. Total	Approx. # Plants	% of U.S. Total
Alabama	2	.2	11	.3	4	.3
Alaska	-	-	1	.0	-	-
Arizona	4	.5	9	.2	10	.8
Arkansas	5	.6	11	.3	2	.1
California	19	2.6	205	6.7	155	13.9
Colorado	14	1.9	38	1.2	31	2.7
Connecticut	2	.2	35	1.1	9	.8
Deleware	-	-	3	.0	1	.0
Dist. of Columbia	-	-	20	.6	10	.8
Florida	4	.5	31	1.0	13	1.1
Georgia	4	.5	25	.8	12	1.0
Hawaii	1	.1	4	.1	4	.3
Idaho	7	.9	8	.2	5	.4
Illinois	15	2.0	95	3.1	75	6.7
Indiana	10	1.3	29	.9	16	1.4
Iowa	16	2.1	23	.7	22	1.9
Kansas	15	2.0	37	1.2	28	2.5
Kentucky	17	2.3	61	2.0	7	.6
Louisiana	3	.4	11	.3	3	.2
Maine	4	.5	14	.4	2	.1

Table A-1 (cont'd)

State	SLAUGHTERING Approx. # Plants	SLAUGHTERING % of U.S. Total	PROCESSING* Approx. # Plants	PROCESSING* % of U.S. Total	BONING Approx. # Plants	BONING % of U.S. Total
Maryland	6	.8	28	.9	7	.6
Massachusetts	1	.1	65	2.1	28	2.5
Michigan	6	.8	26	.8	14	1.2
Minnesota	40	5.4	96	3.1	69	6.1
Mississippi	5	.6	8	.2	5	.4
Missouri	70	9.6	155	5.1	67	6.0
Montana	28	3.8	53	1.7	44	3.9
Nebraska	54	7.4	90	2.9	61	5.4
Nevada	4	.5	15	.4	9	.8
New Hampshire	-	-	10	.3	2	.1
New Jersey	5	.6	54	1.7	19	1.7
New Mexico	7	.9	11	.3	5	.4
New York	25	3.4	179	5.9	44	3.9
North Carolina	6	.8	24	.7	7	.6
North Dakota	28	3.8	33	1.0	19	1.7
Ohio	20	2.7	52	1.7	35	2.1
Oklahoma	5	.6	12	.3	4	.3
Oregon	34	4.6	65	2.1	60	5.3
Pennsylvania	112	15.3	292	9.6	33	2.9
Rhode Island	2	.2	17	.5	3	.2
South Carolina	3	.4	6	.1	4	.3
South Dakota	4	.5	3	.0	4	.3
Tennessee	10	1.3	35	1.1	16	1.4
Texas	53	7.2	114	3.7	41	3.6
Utah	9	1.2	12	.3	11	.9
Vermont	2	.2	6	.1	2	.1

Table A-1 (cont'd)

State	SLAUGHTERING Approx. # Plants	SLAUGHTERING % of U.S. Total	PROCESSING* Approx. # Plants	PROCESSING* % of U.S. Total	BONING Approx. # Plants	BONING % of U.S. Total
Virginia	11	1.5	37	1.2	12	1.0
Washington	25	3.4	85	2.8	56	5.0
West Virginia	-	-	2	.06	-	-
Wisconsin	11	1.5	31	1.0	23	2.0
Wyoming	1	.1	3	.09	-	-
U.S. TOTAL	729	100	3019	100	1113	100

*Processing Operations at Official Establishments Under USDA Animal and Plant Health Inspection Service Program Include:

Cured or Placed in Cure	Code No.
Beef Briskets	1012
Beef Other	1019
Smoked or Dried	
Beef	1110
Cooked Meat	
Beef	1210
Ground Beef	1465
Beef Boned (Manufacturing)	5350

Table A-2

FAST FOOD RESTAURANTS (ALL TYPES)

Item	1973	1974 1/	1975 1/	Percent Changes 1973-74	Percent Changes 1974-75
Total number of establishments	36,340	40,084	44,724	10.3	11.6
Franchisor establishments	8,316	9,643	11,121	16.0	15.3
Franchisee establishments	28,024	30,441	33,603	8.6	10.4
Total sales of products and services by:($1000)	8,534,094	9,756,383	11,488,224	14.3	17.8
Franchisor establishments	2,604,851	3,076,538	3,729,303	18.1	21.2
Franchisee establishments	5,929,243	6,679,845	7,758,921	12.7	16.2
Total sales of products and services by Franchisors to Franchisees ($1000)	233,375	274,817	325,576	17.8	18.5
Merchandise (non-food) for resale	1,737	2,994	4,839	72.4	61.6
Supplies (such as paper goods, etc.)	66,695	73,826	81,275	10.7	10.1
Food ingredients	141,507	167,990	206,083	18.7	22.7
Other	23,436	30,007	33,379	28.0	11.2

1/ Data estimated by respondents.

Table A-3

FAST FOOD RESTAURANTS: 1973-1975[1/]
DISTRIBUTION BY MAJOR ACTIVITY

Establishments

MAJOR ACTIVITY	1973				1974			1975		
	Firms	Total	Company-Owned	Franchisee-Owned	Total	Company-Owned	Franchisee-Owned	Total	Company-Owned	Franchisee-Owned
TOTAL	245	36,340	8,316	28,024	40,084	9,643	30,441	44,724	11,121	33,603
Chicken	21	4,927	1,062	3,865	5,357	1,188	4,169	5,915	1,320	4,595
Hamburgers, Franks, Roast Beef, etc.	104	21,375	3,300	18,075	23,015	3,766	19,249	25,249	4,273	20,960
Pizza	30	3,364	1,153	2,211	3,994	1,408	2,586	4,636	1,675	2,961
Mexican (Taco, etc.)	14	1,030	351	679	1,183	408	775	1,379	485	894
Seafood	11	540	217	323	726	281	445	915	387	528
Pancakes, Waffles	11	883	208	675	1,036	247	789	1,259	319	940
Steak, Full Menu	48	3,946	2,016	1,930	4,480	2,337	2,143	5,069	2,654	2,415
Sandwich and Other	6	275	9	266	293	8	285	318	8	310

1/ Estimated by respondents for 1974 and 1975.

Table A-4

FAST FOOD RESTAURANTS: 1973-1975[1/]
DISTRIBUTION BY MAJOR ACTIVITY
Sales ($000)

MAJOR ACTIVITY	1973				1974			1975		
	Firms	Total	Company-Owned	Franchisee-Owned	Total	Company-Owned	Franchisee-Owned	Total	Company-Owned	Franchisee-Owned
TOTAL	245	8,534,094	2,604,851	5,929,243	9,756,383	3,076,538	6,679,845	11,488,224	3,729,303	7,758,921
Chicken	21	1,129,496	301,031	828,465	1,206,791	322,333	884,458	1,304,006	347,748	956,258
Hamburgers, Franks, Roast Beef, etc.	104	4,883,094	1,160,959	3,722,135	5,675,340	1,447,763	4,227,577	6,788,348	1,803,059	4,985,289
Pizza	30	505,103	174,379	330,724	607,854	210,911	396,943	756,194	259,047	497,147
Mexican (Taco, etc.)	14	138,410	54,600	83,810	160,575	64,085	96,490	193,050	80,139	112,911
Seafood	11	95,245	39,861	55,384	114,100	47,185	66,915	142,705	62,960	79,745
Pancakes, Waffles	11	254,565	53,370	201,195	304,461	68,322	236,139	411,796	126,170	285,626
Steak, Full Menu	48	1,494,444	818,531	675,913	1,651,987	913,814	738,173	1,853,810	1,048,005	805,805
Sandwich & Other	6	33,737	2,120	31,617	35,275	2,125	33,150	38,315	2,175	36,140

1/ Estimated by respondents for 1974 and 1975.

APPENDIX B

GATHERING AND PROCESSING THE PRIMARY DATA

This appendix contains, in order, the cover letter and questionnaire sent to the 424 meat purveyors.

Following the questionnaire are some brief comments on editing and processing the primary data.

MICHIGAN STATE UNIVERSITY EAST LANSING · MICHIGAN 48823

DEPARTMENT OF AGRICULTURAL ECONOMICS · AGRICULTURE HALL January 28, 1975

Gentlemen:

How would you like to be able to forecast the volume of cow meat available to meat purveyors who service the hotel, restaurant and institutional trade?

That's a tough assignment but one incorporated into the objectives of my master's thesis here at Michigan State University. And frankly, gentlemen, I need your help and cooperation in developing this information.

The primary objective of the research is to describe the economic relationships between meat purveyors and their primary market, the Food Service Industry. A secondary objective is to formulate a model for processed cow beef which would help predict one of the primary supply sources for beef purveyors and beef restaurant chains.

In general, there is adequate price and volume data available at the packer/wholesale carcass level. However, to be successful, the research needs more practical industry information. The type of information I need now is outlined in the attached questionnaire.

I would appreciate it if you would take a few minutes to fill in the information requested in the attached questionnaire.

This thesis is under the direction of Dr. Gerald Schwab, Dr. John Ferris and Dr. Jack Allen of the Department of Agricultural Economics. The information you furnish will be held in strict confidence. In no case will numbers specific to your firm be available for public scrutiny. Published results will be aggregated so as not to divulge the identity of individual companies.

Will you please return the questionnaire no later than February 14. Published summary results of this study will be available from the Department of Agricultural Economics, Michigan State University, upon your request after March 1, 1975.

If you have any questions about the context, please call me at my University Departmental Office: (518) 353-7258. Your cooperation is greatly appreciated.

Sincerely,

Paul L. Kram, Jr.

Paul L. Kram, Jr.
Research Assistant

PLK:dw

MICHIGAN STATE UNIVERSITY EAST LANSING · MICHIGAN 48823

DEPARTMENT OF AGRICULTURAL ECONOMICS · AGRICULTURE HALL

Questionnaire Pertaining to a Study Entitled:

"Economic Relationship Between Meat Purveyors And The Food Service Industry"

Production Aspects

1. Which of the following terms best describes your operation?

Beef processor or Meat Purveyor i.e. prepare carcass, primals or sub primals for table cuts _____
Slaughter only _____
Both Slaugther and Process _____
Other (specify) _____

a) If beef processor, the types of raw product that you receive in order to produce your finished product are:

carcass _____
primal cuts _____
sub-primals _____

2. On the average, how many pounds of beef per week do you process into:

_____ short loins _____ butts
_____ rib-eyes _____ bone in strips
_____ rib roast _____ hamburger
_____ boneless strip _____ chucks
_____ other

_____ TOTAL POUNDS PER WEEK

3. In the production lines, is the meat subject to a physical tenderizer?

yes _____ no _____

A vegetable enzyme? yes _____ no _____

Supply Logistics and Product Disposition

1. What per cent of your raw product supply comes from;

a) commercial & utility grade cow beef _____
b) canner & cutter grade beef _____
c) standard or good grade bull, heifer, steer, or cow beef _____
d) choice grade heifer, steer, beef _____

2. An estimate of where your beef supply is obtained:

   Domestic _____% Foreign _____%

   Of your domestic supply, what % is from the;

   Southeast _____%
   Farwest _____%
   Central _____%
   Plains _____%
   Other _____%

3. Up to how many months are raw product purchased?

4. With respect to storage arrangements:

   tons of meat storage available _____
   length of storage before quality deteriorates _____

5. Method of securing raw product:

   order buying via telephone _____
   broker at supply source _____
   other (specify) _____

6. The typical product that you buy from packers or cattle sellers is:

   grade _____
   weight _____

   CLASS: Steer _____
   Heifers _____
   Cow _____
   Bull _____

7. Firm size in terms of meat processed relative to your competitors

   small _____
   medium _____
   large _____

8. Approximately how many accounts do you normally service?

   # _____

9. Of your accounts serviced:

	% of business
Self serve steak houses	_____
Hotels	_____
Institutions (hospitals, schools)	_____
In service (waitress) steak houses	_____
Other	_____

10. Are individual purchases or your product made on a contract (forward buying) basis?

    yes _____ no _____

11. What factors or variables influence future production practices or technologies for the future of your operation?

Editing and Processing the Data

Before coding, the data was edited to bring recorded responses in the questionnaire under a uniform set of terms. Missing information on a question was recorded as blank which in turn was represented as a "missing value" in the anlysis of the data.

The accompanying letter and the questionnaire used in this study can be found in the Appendix.

Coding

The Statistical Package for the Social Sciences computer program was designated as the means of analyzing the raw data from the questionnaires received. The functions performed by this program were frequency counts, ranges, means, standard deviations and crosstabulations. Thus, data was prepared for punched cards method of processing. The coding system used the raw data in its raw form, except for the following adjustments related to questions:

Part of the Questionnaire	Question No.	Procedure
Production Aspects	2	Rounded off to nearest 1000 Where ranges given, lower value in 1000 taken
Supply Logistics	1 (% of raw product)	Rounded off to nearest whole per cent that will total parts a, b, c, d to 100%
	4 (tons of storage)	Rounded off to nearest 1000 pounds
	6 (weight)	Coded by 100 pound ranges. When two different ranges given for two types of animals, middle weight range taken
	8 (accounts serviced)	Rounded off to nearest 100

Appendix B-1

NUMBER OF LIVESTOCK ON FARMS AND RANCHES
January 1, United States, 1965 to Date

Year	All Cattle and Calves (1,000 head)	Beef Cows* (1,000 head)	Milk Cows* (1,000 head)
1965	109,000	33,400	15,380
1966	108,862	33,500	14,490
1967	108,783	33,770	13,725
1968	109,371	34,570	13,115
1969	110,015	35,490	12,550
1970	112,369	36,689	12,091
1971	114,578	37,877	11,909
1972	117,862	38,807	11,778
1973	121,534	40,918	11,624
1974	127,670	43,008	11,286
1975	131,826	45,421	11,217

* cows that have calved.

Source: USDA
Livestock & Meat Situation
March 1975

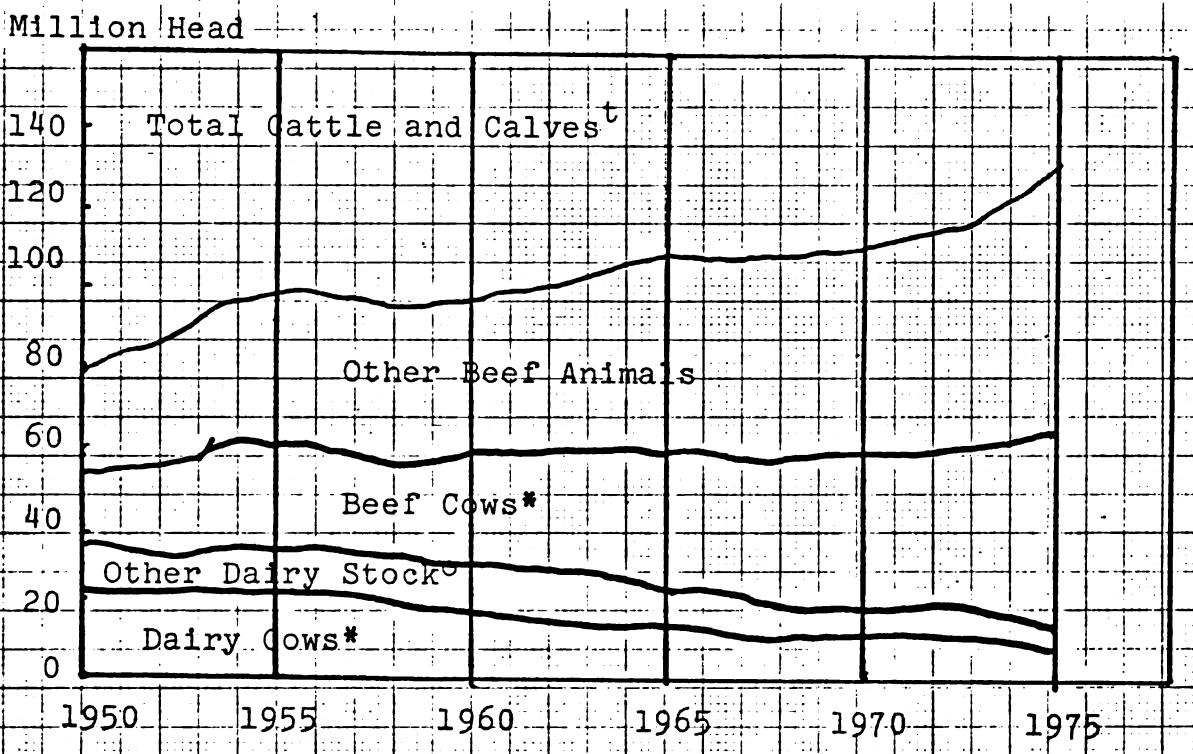
APPENDIX C

REFERENCE DATA FOR CHAPTER IV

FIGURE C - 1

CATTLE ON FARMS

JANUARY 1



* Cows that have calved.

t Reported all other data estimated prior to 1965

o Includes estimate of replacement heifer calves.

Appendix C-2

Simple Correlations of Supply Variables for Beef Cows on Farms Equation

	NBC	NBC t-1	PFC t-2	PFC t-3	PFC t-4	RF t-1
NBC	1.00					
NBC t-1	.9927	1.0				
PFC t-2	.3073	.2294	1.0			
PFC t-3	.1401	.0660	.4817	1.0		
PFC t-4	-.0772	-.1154	.2827	.4789	1.0	
RF t-1	.2405	.3305	.3781	.1097	-.0727	1.0

RESIDUALS FOR THE ESTIMATED BEEF COW SUPPLY EQUATION

Year	Actual Supply	Predicted Supply	Residual
1955	24,966.00	25,083.30	-117.30
1956	24,686.00	25,141.53	-455.53
1957	23,872.00	24,378.29	-506.29
1958	23,513.00	23,557.18	- 44.18
1959	24,434.00	23,835.98	598.01
1960	25,633.00	25,894.71	-261.71
1961	26,589.00	27,129.34	540.34
1962	27,916.00	27,943.78	- 27.78
1963	29,763.00	29,217.33	545.66
1964	31,909.00	30,998.74	910.25
1965	33,400.00	32,921.24	478.75
1966	33,500.00	33,770.26	-270.26
1967	33,770.00	34,010.99	-240.99
1968	34,570.00	34,368.38	201.61
1969	35,490.00	35,318.37	171.62
1970	36,689.00	36,455.45	232.54
1971	37,877.00	37,895.28	- 18.28
1972	38,807.00	39,344.09	-537.09
1973	40,914.00	40,485.93	432.06
1974	43,008.00	43,559.71	-551.71

ALTERNATIVE SUPPLY MODELS INVESTIGATED

Model	Dependent Variable	Independent Variables							R^2
		Constant	NDC t-1	GMM t-1	DUM	RWR t-1	GMM t-2	GMM + RWR	
1	NDC	6438	.767	34.33	-602.89	-1232.66	-	-	.996
	t	(1.23)	(8.60)	(.268)	(-2.997)	(-.7460)			
2	NDC	2606	.827	-29.91	-653.15	-	-	-	.996
	t	(2.82)	(21.13)	(.320)	(-3.49)				
3	NDC	5688.10	.779	138.90	-643.03	-995.59	-114.87	-	.996
	t	(.931)	(7.66)	(.330)	(-2.49)	(-.154)	(-.261)		
4	NDC	15677	.649	1461.24	-519.79	-3850.15	-	-4299.43	.996
	t	(.857)	(2.67)	(.540)	(-2.00)	(-.735)		(-.528)	

(Numbers in parenthesis are significance levels)

Simple Correlation Between Supply Variables

	NDC t-1	GMM t-1	DUM t	RWR t-1
NDC t-1	1.000			
GMM t-1	-.921	1.000		
DUM t	-.845	.823	1.000	
RWR t-1	-.985	.955	.867	1.000

Appendix C-4

RESIDUALS FOR THE ESTIMATED
MILK COW SUPPLY EQUATION

Year	Actual Supply	Predicted Supply	Residual
1955	22,000.00	22,256.57	-256.57
1956	20,758.00	20,767.74	- 9.745
1957	20,226.00	19,722.49	503.50
1958	19,266.00	19,280.71	- 14.71
1959	18,240.00	18,534.20	-294.20
1960	17,650.00	17,675.71	- 25.71
1961	17,390.00	17,165.77	224.22
1962	17,090.00	16,934.26	115.73
1963	16,570.00	16,628.87	- 58.87
1964	15,960.00	16,183.64	-223.64
1965	15,380.00	15,059.21	320.78
1966	14,490.00	14,555.92	- 65.92
1967	13,725.00	13,843.70	-118.70
1968	13,115.00	13,207.25	- 92.25
1969	12,550.00	12,679.92	-129.92
1970	12,091.00	12,224.47	-133.47
1971	11,909.00	11,884.67	24.32
1972	11,778.00	11,682.26	95.73
1973	11,624.00	11,471.78	152.21
1974	11,286.00	11,338.77	- 52.77

Simple Correlations of Supply Variables for
Estimated Cow Slaughter Equation

	NBC t-1	NDC t-1	NBCCHG	NDCCHG
NBC t-1	1.00			
NDC t-1	-.927	1.00		
NBCCHG	.461	-.534	1.00	
NDCCHG	.560	.750	.472	1.00

Appendix C-5

RESIDUALS FOR THE ESTIMATED COW SLAUGHTER EQUATION

Year	Actual Supply	Predicted Supply	Residual
1955	8737.00	8965.64	-228.64
1956	9285.00	9179.33	105.66
1957	9108.00	8918.63	189.36
1958	8417.00	8204.59	212.40
1959	6294.00	6326.50	- 32.50
1960	5213.00	5658.71	-445.71
1961	5960.00	5871.87	88.12
1962	5344.00	5619.54	-275.54
1963	5623.00	5367.15	255.84
1964	5387.00	5359.50	27.49
1965	6706.00	6433.27	272.72
1966	8281.00	8362.07	- 81.07
1967	7656.00	7808.78	-152.78
1968	6842.00	6916.39	- 74.39
1969	6924.00	6743.15	180.84
1970	6987.00	6404.42	582.57
1971	6145.00	6424.74	-279.74
1972	6426.00	6938.26	-512.26
1973	6039.00	5786.93	252.06
1974	6310.00	6394.42	- 84.42

Appendix C-6

SELECTED STATISTICS, U.S.

Year	NBC_t (1000 head)	NDC_t (1000 head)	PFC_{t-2} $	PFC_{t-3} $	PFC_{t-4} $	RF_t	GMM_t $	DUM_t	$PRIHAY_t$ ($/ton)	$NCSL_t$ (1000 head)	$NCSL_{t-1}$ (1000 head)
1954	24,374	23,816	32.67	45.66	43.88	78	1.60	0	21.90	8,737	7,883
1955	24,966	22,000 1)	22.69	32.67	45.66	82	1.73	0	22.50	9,285	8,737
1956	24,686	20,758 1)	25.22	22.69	32.67	71	1.94	0	22.40	9,108	9,285
1957	23,872	20,226 1)	24.91	25.22	22.69	83	2.05	0	19.40	8,417	9,108
1958	23,513	19,266 1)	24.46	24.91	25.22	87	2.14	0	18.80	6,294	8,417
1959	24,434	18,240 1)	30.35	24.46	24.91	82	2.24	0	22.10	5,213	6,294
1960	25,633	17,650	38.77	30.35	24.46	85	2.38	0	21.70	5,960	5,213
1961	26,589	17,390	34.74	38.77	30.35	83	2.53	0	20.70	5,344	5,960
1962	27,916	17,090	30.02	34.74	38.77	85	2.50	0	21.80	5,623	5,344
1963	29,763	16,570	31.53	30.02	34.74	77	2.60	0	24.60	5,387	5,623
1964	31,909	15,960	31.78	31.53	30.02	77	2.85	0	23.90	6,706	5,387
1965	33,400	15,380	28.24	31.78	31.53	84	2.96	1	23.20	8,281	6,706
1966	33,500	14,490	22.75	28.24	31.78	78	3.56	1	25.00	7,656	8,281
1967	33,770	13,725	26.15	22.75	28.24	85	3.93	1	24.50	6,842	7,656
1968	34,570	13,115	28.82	26.15	22.75	86	4.37	1	23.60	6,924	6,842
1969	35,490	12,550	27.87	28.82	26.15	85	4.82	1	24.70	6,987	6,924
1970	36,689	12,091	28.27	27.82	28.82	86	5.19	1	26.10	6,145	6,987
1971	37,877	11,909	30.17	28.27	27.87	85	5.52	1	28.10	6,426	6,145
1972	38,807	11,778	31.37	30.17	28.27	82	5.91	1	31.30	6,039	6,426
1973	40,918	11,624	31.67	31.37	30.17	87	5.84	1	34.60	6,310	6,039
1974	43,008	11,286	38.49	31.67	31.37	82	6.23	1	49.10	7,035	6,310

1) = Estimated from U.S.D.A. Series

Appendix C-7

SELECTED DAIRY STATISTICS, U.S.

Year unit	Milk Production Per Cow lbs.	Total Milk Production Mil. lbs.	Average Price Received by Farmers Per Cwt $	Gross Receipts From Milk Per Cow $	Concentrates Fed Per Cow lbs.	Dairy Ration Cost Per 100 lbs. $	Total Concentrate costs per cow $	Gross Margin (Gross per cow minus Concentrate costs) $	Index of Prices paid by Farmers (1967=100)	Gross Margin and Index of Prices paid by Farmers
1955	5,842	122.9	4.01	234	1,758	3.16	56	178	81	220
1956	6,090	124.9	4.14	252	1,825	3.06	56	196	81	242
1957	6,303	124.6	4.21	265	1,945	3.06	60	205	84	244
1958	6,585	123.2	4.13	272	2,003	2.94	59	213	86	248
1959	6,815	122.0	4.16	284	2,050	2.94	60	224	87	257
1960	7,029	123.1	4.21	296	2,259	2.92	66	230	88	261
1961	7,290	125.7	4.22	308	2,404	2.92	70	238	88	270
1962	7,496	126.3	4.09	307	2,533	2.95	75	232	90	258
1963	7,700	125.2	4.10	316	2,646	3.04	80	236	91	259
1964	8,099	127.0	4.15	336	2,800	3.03	85	251	92	273
1965	8,305	124.2	4.23	351	2,953	3.03	89	262	94	279
1966	8,522	119.9	4.81	410	3,000	3.15	94	316	98	322
1967	8,851	118.7	5.02	444	3,374	3.23	109	335	100	335
1968	9,135	117.2	5.24	479	3,519	3.10	109	370	104	356
1969	9,434	116.1	5.49	518	3,726	3.15	117	401	109	368
1970	9,747	117.0	5.71	557	3,979	3.28	131	426	114	374
1971	10,009	118.5	5.87	588	4,070	3.44	140	448	120	373
1972	10,250	120.0	6.07	623	4,298	3.52	151	472	127	372
1973	10,125	116.0	7.15*	729*	4,389*	4.88	214*	515	145	355
1974	10,286	115.4	8.30	853	4,100	6.27	257	597	169	353
1975	10,545**		8.72	915	4,346	5.96	256	659	185	356
1976	10,756		9.42**	1012	4,606	5.96	274	738	195	378
1977	10,971		10.27**	1126	4,606	6.00	276	850	204	417

* Preliminary

** Estimated from original USDA series

Appendix C-8

SELECTED STATISTICS, U.S.

Year	LM	IPP_t	$GMM - LM_t$	$GMM - LM - IPP_t$	RWR_{t-1} $/hr.	GMM_{t-1}	GMM_{t-2}	$GMM_{t-1} - RWR_{t-1}$
1954	2.09	.81	1.30	1.60	1.98[1]	1.48	1.36	1.34
1955	1.97	.81	1.40	1.73	2.05	1.60	1.48	1.28
1956	1.84	.81	1.57	1.94	2.13	1.73	1.60	1.23
1957	1.73	.84	1.72	2.05	2.21	1.94	1.73	1.14
1958	1.61	.86	1.84	2.14	2.24	2.05	1.94	1.09
1959	1.51	.87	1.95	2.24	2.25	2.14	2.05	1.05
1960	1.42	.88	2.09	2.38	2.31	2.24	2.14	1.03
1961	1.32	.88	2.23	2.53	2.36	2.38	2.24	.99
1962	1.24	.90	2.25	2.50	2.39	2.53	2.38	.94
1963	1.17	.91	2.37	2.60	2.45	2.50	2.53	.98
1964	1.07	.92	2.62	2.85	2.49	2.60	2.50	.96
1965	1.01	.94	2.78	2.96	2.54	2.85	2.60	.89
1966	.95	.98	3.49	3.56	2.59	2.96	2.85	.88
1967	.88	1.00	3.93	3.93	2.63	3.56	2.96	.74
1968	.82	1.04	4.54	4.37	2.68	3.93	3.56	.68
1969	.78	1.09	5.26	4.82	2.74	4.37	3.93	.63
1970	.72	1.14	5.92	5.19	2.77	4.82	4.37	.57
1971	.65	1.20	6.63	5.52	2.77	5.19	4.82	.53
1972	.60	1.27	7.50	5.91	2.83	5.52	5.19	.51
1973	.56[1]	1.45	8.48	5.84	2.93	5.91	5.52	.50
1974	.52[1]	1.69	10.54	6.23	2.94	5.84	5.91	.50
1975	.49[1]	1.85[1]	13.44	7.27				
1976	.47[1]	1.95[1]	15.70	8.05				

1> Estimated