AN ECONOMIC ANALYSIS OF THE EFFECT OF MONETARY POLICY ON THE BEEF INDUSTRY

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ABSTRACT

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By

Richard Leon Trimble

Recent increases in the price of beef have raised questions concerning the reasons for these increases. An increasing demand for beef is believed to be the major force behind the rising prices, but the supply of beef may have also contributed. This study looked at the supply of beef to answer the question: Do the monetary and credit actions of the Federal Reserve System as it attempts to control rising prices in the general economy have an adverse effect on the supply of beef in subsequent time periods? If it does, then the restrictive monetary policies that were used three or four years ago may have contributed to the high beef prices currently being experienced.

The long run supply of beef is determined by two major factors: 1) the number of animals in the national beef herd, and 2) the pounds of beef produced per animal in the beef herd (productivity). Both have been increasing over time, but many of the sources of past increases in productivity have been exhausted. Therefore, future increases in the supply of beef will be much

more dependent on increases in the size of the beef herd than has been true in the past.

The beef industry can be divided into two major functional subindustries, the feeder calf industry and the beef feeding industry. The feeder calf industry has maintained its traditional structure and method of production. Feeder calves are still produced by a large number of small producers who use resources that have few, if any, alternative uses. These producers have increased their productivity to some degree by increasing calving percentages and decreasing death losses, but there have been no great technological changes take place in the feeder calf industry.

In contrast, the beef feeding industry has undergone vast structural change due to changes in the technology of cattle feeding. There has been a large decrease in the number of feedlots and a correspondent increase in the number of cattle fed per lot. The industry has increased the productivity of the beef industry by feeding an ever increasing proportion of all animals slaughtered. But, this source of productivity has been exhausted and will not be available in the future.

To examine the effect of monetary policy on the beef industry, the investment in both the feeder calf and beef feeding industries was investigated. Ordinary least squares regression analysis was used to relate the cost and availability of credit to investment and disinvestment in the feeder calf industry during the period 1952 to 1971. This analysis found that a one percentage point increase in the rate of interest resulted in a six percent decrease in the annual investment and an increase in the annual disinvestment of three to 14 percent.

To see how restrictive monetary policies may have contributed to the current high beef prices being experienced, the effect on investment and disinvestment were traced through the beef production process. The interest rate during 1969 and 1970 was about 1.7 percentage points higher than it was in 1967 and 1968. This higher interest rate would result in a beef cow breeding herd that was from 802,400 to 1,392,300 head smaller in 1970-1971 than it would have been if the interest rate had remained at the 1967-1968 level. This reduction in the size of the beef cow herd would reduce the supply of steer and heifer beef in 1972 and 1973 by two to four percent. This reduced supply could have resulted in a 3.7 to 6.4 percent increase in the farm price of steers and heifers. Thus, restrictive monetary policies during 1969 and 1970 could have resulted in a farm price of fed beef that was one to two dollars per hundred pounds greater than it would have been in the absence of such tight money policies.

The study also looked at the investment in the beef feeding industry during the period 1962 to 1972. The results of this analysis were quite mixed and inconsistent. General indications were that the cost of credit did not tend to limit feedlot investment, but credit availability did limit investment.

Thus, the effect of restrictive monetary policies on the feeder calf industry and the resulting supply and price of beef in subsequent time periods indicates that monetary policy did have an impact on the beef industry. This is not to imply that monetary policy has been fully responsible for the higher beef prices that have been experienced recently. It has not. But the tight money policies during 1969 and 1970 would seem to have contributed to the higher beef prices we have recently experienced. Considering the possibility that future increases in the supply of beef will depend more heavily on increases in the size of the beef herd, the impact of monetary policy on the beef industry may be greater in the future than it has been in the past.

These findings suggest that policy makers should recognize this effect of monetary policy on the beef industry. The Federal Reserve System, Congress and the USDA should be aware of the effect tight money has on the beef industry and how this could alter the outcome of policies that might have been or will be designed to change the supply and price of beef in the future. In addition, these findings suggest that other agricultural industries may be adversely affected by restrictive monetary policies. Further, this raises a very basic question: Does restrictive monetary policy control inflation or create it?

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INTRODUCTION

PROBLEM SETTING

The price of food is a current topic of concern to many people. Food prices have been going up for a number of months and the immediate prospect for lower food prices does not appear very hopeful. The growing concern of the general public and policy makers over the food price problem has made national news headlines. Recent articles in two popular publications exemplify the feelings of consumers [66] and [125].[1]

The price of beef has created the greatest concern among consumers. While the price of food has been steadily increasing for some time, the price of meat and beef prices, in particular, have been increasing faster than food prices in general. Table I-1 demonstrates this fact. By comparing the Consumer Price Index for all food with the Consumer Price Index for beef and veal one can see that beef prices have been increasing faster than food prices during the past few months.

As a result of consumer reaction to rising beef prices, government policy makers have taken action to slow the price rise.

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[1] Bracketed numbers refer to items listed in the bibliography.

Table I-1. Selected price indexes, 1952-1972.

	Annual Average of Respective Price Index (1967=100)							
	Consumer Price Indexes					Wholesale Price Indexes		
Year	CPI	Food	Meat, Poultry and Fish	Beef and Veal	Pork	WPI	Farm Products	Livestock
1952	79.5	84.3	94.7	99.4	80.2	88.6	117.2	113.8
1957	84.3	84.9	85.8	78.9	86.7	93.3	99.5	90.9
1962	90.6	89.9	91.5	93.9	86.3	94.8	98.0	96.5
1967	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1968	104.2	103.6	102.2	104.1	100.2	102.5	102.5	103.7
1969	109.8	108.9	110.8	114.5	109.1	106.5	108.8	117.0
1970	116.3	114.9	116.5	119.5	115.9	110.4	111.0	116.7
1971	121.3	118.4	116.9	124.9	105.0	113.9	112.9	118.3
1972	125.3	123.5	128.0	136.6	121.6	119.1	125.0	142.5

Source: [170].

The major changes have involved a relaxation of beef import restrictions and allowing farmers to graze diverted acres. It was hoped that each of these changes would increase the supply of beef, and thereby, reduce the price. Many observers believe that the relaxation of import restrictions will help little due to high beef prices on the world market. Also, the beef imported into the United States is normally used as processed meat. Therefore, it will have little impact on the price of fresh beef.

Many experts feel that allowing farmers to graze diverted acres will have little effect on beef prices [69]. If it does affect the supply of beef, it will be an adverse effect in the short run as farmers hold back more heifers to take advantage of the diverted acres. In the longer run such action should result in larger supplies of beef.

In addition to the attempts to increase the supply of beef, there have also been suggestions that action should be taken by the Federal Reserve System (FRS) to limit the demand for beef through its administration of monetary policy [32]. To do this the FRS would maintain a more restrictive monetary policy to control the rate of growth of consumer incomes and thereby aggregate demand. This reduction in aggregate demand would then be reflected in a reduced demand for beef. It is uncertain whether the FRS has adopted this position at this time, but there are indications that it has. Thus, it appears that policy makers have taken actions to slow the rise in the price of beef in the short run. But what are the effects of these actions in the long run?

If we look at the attempts to increase the supply of beef, there seems to be little conflict between the short and the long run effects of the changes. The same cannot be said for the attempts to limit demand.

The action of the FRS to limit the demand for beef in the short run may reduce the supply of beef in the long run. Tight credit and monetary policies affect many economic decision units besides the consumer. As the FRS assumes a tight money policy, this forces the interest rate up and reduces credit availability. In response to these changes, investments to expand beef production may be reduced. If so, the reduced investment would serve to reduce the supply of beef in the future and would thereby result in higher future beef prices. This is the essence of the problem to be investigated in this study.

PROBLEM STATEMENT

Questions to Be Answered

The problem under investigation in this study can best be stated in the form of a simple question: "Do the monetary and credit actions of the Federal Reserve System as it attempts to control rising prices in the general economy have an adverse effect on the supply of beef in subsequent time periods?" More formally the problem may be stated in the form of an hypothesis.

General Hypothesis to Be Tested

The Null Hypothesis

The null hypothesis can be stated: Monetary policy does not affect the supply of beef.

The Alternative Hypothesis

The alternative hypothesis can be stated: Monetary policy to control inflation in the general economy through its effect on consumer demand has resulted in reduced beef supplies in subsequent time periods. This implies that beef prices in subsequent periods become higher than they would have been in the absence of such restrictive monetary policy.

To facilitate testing of the stated hypothesis there are a number of specific research objectives to be carried out in the study.

RESEARCH OBJECTIVES

Investigation of the research problem involves the following four specific research objectives:

1. To investigate the beef producing industry to determine:
   - A. What changes have taken place during the past 20 years and what implications these have for the future supply of beef.
   - B. The critical links in the beef production process both historically and in the future.

2. To set forth the theoretical relationship between monetary policy and the supply of beef.
3. To construct one or more econometric models to test this theoretical relationship.
4. To describe the effects of monetary policy on subsequent supplies and prices of beef.

PLAN OF STUDY

The study is divided into five major parts. Chapter II describes the changing beef production process pinpointing the major historical changes and suggests the implications these changes have for future beef production. Chapter III presents the theoretical relationship between monetary policy and the supply of beef. Chapters IV and V look at empirical data concerning this theoretical relationship. Chapter IV examines monetary policy and how it affects the production of feeder calves while Chapter V explores the relationship of monetary policy to the beef feeding industry. The final chapter summarizes the findings of the study and their implications.

Chapter II

THE CHANGING NATURE AND STRUCTURE OF THE BEEF INDUSTRY

The beef producing industry has been characterized by change, but the rate of change has been vastly different according to production process. The beef feeding industry has been a very dynamic industry while the cow-calf industry has maintained its traditional production methods. The following chapter will look at these changes and some possible implications for future beef production.

PHYSICAL DETERMINANTS OF INCREASED BEEF PRODUCTION: 1930-1971

The ultimate result of the changes in beef production has been an increased beef supply. But, what factors have contributed to this increased supply of beef?

The Determinants of Total Beef Production

The total quantity of beef supplied in the United States in any year is a result of the number of cattle and calves slaughtered and the weight of these animals. Therefore, 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. Total quantity of beef supplied (beef and veal slaughter), cattle and calf numbers, and liveweight of production[1] per head for the years 1930-1971 are presented in Table II-1. As one can see, each has an upward trend over time. Thus, it appears that the increased beef supply over time has been the result of increasing cattle numbers and increased productivity[2] of the cattle herd [140].

The functional relationship between quantity of beef supplied, cattle numbers, and herd productivity can be set out in a simply production function relationship:

Quantity Supplied = F(cattle numbers and productivity).

This relationship would be an identity if productivity was measured as the actual pounds of beef slaughtered, but it is not. As defined here, productivity includes farm slaughter and the change in liveweight of the existing cattle inventories. Therefore, the equation could be specified and estimated statistically using ordinary least squares regression analysis. But, the coefficients associated with the factors (cattle numbers and productivity) used to explain the quantity of beef supplied would differ from one (which would be obtained if the relationship was in fact an identity) due to noise

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[1]Production is defined as the total liveweight of livestock marketed, farm slaughter and custom slaughter consumed on farms where produced, minus liveweight of inshipments, and plus the increase or minus the decrease in inventory liveweight.

[2]As used here and in the following discussion, productivity is defined as the total liveweight of production during the year divided by the total inventory of cattle on farms at the beginning of the year [140, p. 13].

Table II-1. Total beef production, number of cattle and calves in January 1 inventory, liveweight production per head and factors associated with changes in productivity, 1930-1971.

Year	Commercial Beef and Veal Slaughter X_1^a	January 1 Cattle and Calf Inventory X_2^a	Productivity X_3^b	Calf Crop X_4^a	Death Loss X_5^b	Cattle Slaughter X_6^b	Beef Cattle X_7^b	Average Dressed Weight of Slaughter X_8^a	Fed Cattle X_9^c
	mil. lb.	no. in 1,000	lb.	% of 2 yr. old cows in inventory	% of inventory	% of total slaughter	% of inventory	lb.	% of total slaughter
1930	6709	61003	217.4	78	5.2	60.8	45.8	491	
1931	6832	63030	212.4	77	5.1	60.0	46.1	497	
1932	6611	65801	216.3	78	5.1	60.1	46.3	483	
1933	7331	70280	219.2	78	4.9	60.5	47.6	491	
1934	9591	74369	195.5	76	4.8	62.4	48.9	428	
1935	7631	68846	198.3	74	5.6	60.6	47.2	446	
1936	8433	67847	212.8	78	5.0	61.4	47.7	463	
1937	7906	66098	208.0	79	5.3	59.7	47.3	446	
1938	7902	65249	215.3	80	5.0	61.4	46.7	466	
1939	8002	66029	229.9	83	4.9	61.4	46.0	480	
1940	8156	68309	229.9	84	5.0	62.2	46.7	482	
1941	9118	71755	237.3	87	5.0	64.0	47.9	495	
1942	9994	76025	244.2	88	5.1	65.0	48.9	492	
1943	9738	81204	235.9	85	5.3	64.2	50.4	482	
1944	10850	85334	231.0	86	5.3	68.2	51.7	461	
1945	11940	85573	228.1	79	5.0	61.4	52.2	474	
1946	10816	82235	231.0	81	5.0	62.0	53.1	473	
1947	12037	80554	237.5	82	4.9	62.0	53.2	466	
1948	10498	77171	238.5	82	4.7	60.8	53.1	473	
1949	10773	76830	250.9	85	5.0	62.2	54.1	503	
1950	10764	77963	271.7	86	4.8	63.9	54.5	514	
1951	9896	82083	280.1	85	4.7	65.7	56.9	519	
1952	10819	88072	283.1	87	4.6	66.5	60.0	520	
1953	13953	94241	290.8	88	4.3	66.7	61.9	508	
1954	14610	95679	288.3	87	4.2	66.1	62.3	502	

1955	15147	96592	290.9	86	4.2	67.4	63.4	510	27.3
1956	16094	95900	287.1	86	4.1	68.1	64.3	521	27.8
1957	15728	92860	286.0	85	4.1	68.7	64.1	525	28.6
1958	14516	91176	293.6	86	4.2	71.4	64.9	547	34.6
1959	14588	93322	303.0	86	4.2	74.6	67.1	572	40.4
1960	15835	96236	299.2	86	4.3	75.1	68.6	567	38.5
1961	16342	97700	306.1	87	4.1	76.6	69.6	579	41.0
1962	16311	100369	306.6	86	4.1	77.4	71.0	570	42.4
1963	17357	104488	313.7	87	3.9	86.1	73.2	587	48.6
1964	19442	107903	322.8	86	3.9	86.8	75.2	583	47.4
1965	19719	109000	312.0	86	3.9	86.7	76.6	565	49.6
1966	20604	108862	321.7	88	3.7	88.5	78.0	578	53.5
1967	20976	108645	330.7	88	3.7	89.6	78.9	590	57.4
1968	21580	109152	333.2	90	3.7	90.1	79.6	589	59.4
1969	21799	109885	338.0	90	3.8	90.7	80.3	594	63.6
1970	22240	112303	351.9	90	3.9	92.1	81.1	612	67.6
1971	22416	114470	354.9	90	3.9	92.7	81.6	609	68.2

[a]Taken directly from [144] and [156].

[b]Computed from data contained in [155] and [156].

[c]Estimated from data contained in [21] and [163]. Available only for years shown.

introduced into the relationship by changes in farm slaughter and inventory liveweights.

But, by simple observation of the data in Table II-1, one can see that cattle numbers have increased faster than productivity[3] during the period 1930 to 1971. The compound rate of growth of the cattle herd was 1 1/2 percent while productivity increased at a rate of 1 1/4 percent during the period. If we divide the period into two subperiods, 1930 to 1950 and 1951 to 1971, we can see that the differences in the rate of growth are even greater.

During the period 1930 to 1950, the cattle inventory grew at a rate of 1 1/4 percent and productivity grew at a rate of 1 1/8 percent. From 1951 to 1971, the cattle herd grew at a rate of 2 percent while productivity grew at a rate of just over 1 1/8 percent. Thus, the contribution of productivity to increased quantities of beef being slaughtered has decreased somewhat over time. But, what has this change in the relative importance of productivity taken place? What does this imply for the future of beef supplies?

The Determinants of Cattle Herd Productivity: 1930-1971

There are, undoubtedly, many factors that have contributed to increased productivity of the beef herd. The most important factors which have contributed to increased productivity in the past have been [140]:

1. Increased calf crop percentage.

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[3]For further discussion of the importance of productivity see [140].

2. Decreased death losses.

3. Increased number of animals held to mature size.

4. Increased number of beef cattle in the total cattle herd.

5. Increased average dressed weights.

6. Increased number of cattle fed.

It is fairly easy to see how each of these factors has tended to increase productivity over time, but the relative importance of each is uncertain. To examine their relative importance we can functionally relate productivity to each of these factors:

$$Y = F(X_4, X_5, X_6, X_7, X_8, X_9).^{4}$$

Where:

Y = Cattle herd productivity as previously defined.

X_4 = Calves born as percent of cows and heifers two years old and older in January 1 inventory.

X_5 = Total cattle and calf deaths as a percent of total January 1 inventory of cattle and calves.

X_6 = Cattle slaughter as a percent of total cattle and calf slaughter.

X_7 = Beef cattle as a percent of all cattle and calves.

X_8 = Average dressed weight of cattle slaughter.

X_9 = Estimated fed cattle slaughter as a percent of total cattle and calf slaughter.

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[4]Table II-1 presents the annual value of each of the above defined variables.

Table II-2 presents the estimated relationships between productivity and selected factors hypothesized to affect it for various time periods using ordinary least squares regression analysis. In general, the results are consistent with a priori expectations. The two exceptions involve the change in sign of the regression coefficients of death losses (X_5) and cattle slaughter (X_6) between different time periods.[5]

It is apparent that X_4, X_7, and X_8 have consistently contributed to increases in productivity over time, but such a conclusion concerning X_5 and X_6 would be more tenuous. The most interesting result of this analysis concerns the change in relative importance of each factor over time. If we compare the 1930-1950 period (period I) with the 1951-1971 period (period II), we can see these changes. Comparison of the size of the regression coefficients indicates that calving percentage (X_4) has remained quite important over time and may have become relatively more important in period II than it was in period I. Beef cattle as a percent of all cattle and calves (X_7) and average dressed weight (X_8) both

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[5]There was no apparent reason for the unexpected results concerning X_5 during the 1951-71 period. It could be related to the fact that decreased death losses resulted in increased inventory numbers which decreased the productivity measure, ceteris paribus. This would result in the positive relationship between death losses and productivity. The unexpected results with respect to X_6 for the periods 1930-1971 and 1930-1950 may be due to the fact that increased cattle slaughter during the 1930-1950 period came from the breeding herd, rather than from increased numbers of fed animals as experienced during the 1951-1971 period. This would result in fewer calves being born and, thereby decrease productivity as it is measured here.

Table II-2. Estimated relationships between cattle herd productivity and selected explanatory variables, various time periods.

Period of Analysis	Explanatory Variables						Constant Term	R^2
	X_4 (Calf Crop)	X_5 (Death Loss)	X_6 (% Cattle Slaughter)	X_7 (% Beef Cattle)	X_8 (Dressed Weight)	X_9 (% Cattle Fed)		
1930-1971	+273.60 (9.38)[a]	-265.64 (-.57)	-118.86 (-4.49)	+273.01 (7.64)	+.30 (6.45)		-183.12	.99
1930-1971	+320.36 (7.83)	-695.25 (-1.04)	-64.10 (-1.76)	+309.79 (6.07)			-110.42	.98
1930-1950	+243.42 (5.26)	-306.22 (-.61)	-104.03 (-1.30)	+244.57 (6.90)	+.33 (5.68)		-167.02	.96
1930-1950	+405.79 (6.49)	-377.81 (-.44)	-296.37 (-2.38)	+235.73 (3.87)			-16.03	.88
1951-1971	+357.88 (3.59)	+1520.32 (1.38)	+20.48 (.31)	+201.25 (1.85)	+.10 (1.10)		-279.87	.97
1951-1971	+326.92 (3.40)	+2102.08 (2.16)	+42.44 (.66)	+237.92 (2.28)			-262.06	.96
1955-1971	+179.47 (1.12)	+1113.98 (.80)		+57.19 (.45)		+121.06 (1.94)	+15.56	.97

[a]Numbers in parenthesis are T values. Due to extreme multicollinearity, little can be said concerning the statistical significance of any variable.

seem to have decreased in relative importance in their contribution toward increasing productivity.

To gain further insights into the increased productivity, we can also look at the effect of increased feeding of concentrates to cattle being fattened for slaughter. The increased number of cattle that are put through feedlots has allowed feeders to increase the rate of gain and the average dressed weight of slaughter cattle and thereby increase beef herd productivity. In the last equation shown in Table II-2, estimated fed cattle slaughter as a percent of total cattle and calf slaughter (X_9) was substituted for X_6 and X_8 (since they are similar measures) for the period 1955-1971. Due to this substitution, the coefficients of X_4, X_5, and X_7 were greatly reduced in size. This indicates beef feeding has been a very important determinant of productivity during the past 20 years.

The previous analyses have shown that the increased supply of beef over time has resulted from an expanding cattle herd and gains in productivity. It has also been shown that productivity has become relatively less important in recent years. Further, it has been shown that there have been changes in the relative importance of various factors that have contributed to productivity growth in the past. But, what does this say concerning the supply of beef in the future?

Implications of Findings Concerning Cattle Herd Productivity

The apparent reason for the decreased importance of cattle herd productivity over time is the fact that many of the factors have reached their logical, biological, or economic limits. Technological breakthroughs have not been forthcoming to allow productivity to increase. The data presented in Table II-1 tend to confirm this idea. But, what will happen to the determinants of productivity in the future?

Death Losses

Death losses as a percent of total cattle and calf inventory have been declining very consistently for quite some time. But, this factor is reaching its logical limit. It may continue to slowly decline from its present level of 3.9 percent, but it cannot go much further. Zero is the absolute, and unattainable, limit. Therefore, this factor will contribute little to future increases in productivity.

Number of Animals Held to Mature Size

During the past 20 years, there has been a very rapid increase in the number of animals that are held to maturity. The change has involved a diversion of calves from veal slaughter to the feedlot [85]. But, as with death losses, this cannot continue to increase as it has in the past. It may continue to increase from its present level of 93 percent, but it is quickly reaching its logical limit of 100 percent.

Beef Feeding

There have been large increases in the number of animals fed, and it appears that there is room for expansion of beef feeding, but this is misleading. As defined and presented in Table II-1, fed beef slaughtered as a percent of total slaughter compares fed beef with all other animals slaughtered. Most of the other animals slaughtered currently are mature animals that have been culled from breeding herds. Thus, while they may be available for feeding, the process of putting them through a feedlot will not add that many additional pounds of production. Therefore, while there appears to be some possibility of increasing the number of animals fed to increase productivity, it is not nearly as promising as it might initially appear.

Beef Cattle in the Total Cattle Herd

The makeup of the cattle herd has been rapidly changing over the past 20 years. Beef cattle as a percent of total cattle have been increasing rapidly and consistently since 1950. This is because the beef herd has been growing while the dairy herd has been decreasing. Future increases in this ratio will likely be much slower. The dairy herd has experienced a rapid decrease since the early 1950's due to large increases in productivity and a reduced demand for dairy products. But it appears to be reaching its equilibrium size [142, p. 82]. During this time of decline, many dairy farms were shifting from dairy to beef herds [142, p. 8]. Therefore, the decrease in the number of dairy animals has provided an impetus to the growth of the beef cow herd. But, it does not seem possible that this will continue in the future. If the dairy herd has reached, or is quickly approaching, an equilibrium size, there will be less enterprise shifting in the future. Therefore, any growth of the ratio of beef cattle to total cattle in the future will require substantially greater increases in the absolute number of animals added to the beef herd.

Calving Percentage

One of the most consistent contributors to the growth of productivity in the past has been the increasing calving percentage. This factor also holds promise of continuing to increase productivity. Not only is there a possibility of expanding the calving percentage from the 90 percent experienced recently to something closer to 100 percent, but there is also the possibility of technological advances that would provide for multiple births (i.e., calving percentage in excess of 100 percent). If such advances were to take place this could increase the calving percentage at a faster rate that has been experienced in the past. But, such advances are not expected to take place for some years; and widespread adoption of the new technology would take even longer. Thus, the future looks bright for improved calving rates, but this is subject to a great deal of uncertainty and is probably some time off.

Average Dressed Weights

Another factor that shows some promise for the future is that of increasing the average dressed weight of cattle slaughtered. While this is a viable possibility, there are two major problems. Increasing the average sale weight of cattle currently being fed is quite costly due to poor feed conversion by heavy animals [87]. Also,

such cattle tend to produce fatter cuts of beef that may not be acceptable to the consumer. Therefore, feeding to heavier weights may require widespread feeding of different cattle breeds that produce larger and leaner final carcasses. But, the economics of feeding such cattle is uncertain. It may not be any more economical to feed these to heavier weights than it is the traditional type of feeder animal. Thus, we again have uncertain prospects for increasing cattle herd productivity.

Summary

Analysis of past increases in the beef supply from a physical production standpoint indicate that the beef producing industry probably has exhausted some of the sources of increased productivity which it has enjoyed in the past. The ability to produce more pounds of beef from a given size of inventory may be greatly curtailed in the future. Therefore, to enlarge the supply of beef in the future may require much greater increases in the cattle inventory than it has in the past. In particular, there will have to be much larger increases in the number of beef cows in the cattle inventory to produce feeder calves which are fed to produce the type of beef demanded by consumers. This suggests that one should look at past changes in the methods of producing and feeding beef animals to gain further insights into past and future increases in the beef supply, a topic to which we now turn.

RECENT CHANGES IN METHODS OF BEEF PRODUCTION

The Feeder Calf Industry

Traditional Sources of Feeder Calf Supplies

Traditionally, feeder calves have come from both the beef and dairy herds. In general, almost all of the calves produced by the beef herd that are not kept as replacement animals are put through a feedlot before they are slaughtered. In addition, a large part of the calves produced by dairy herds, which are not used for replacements or sold as vealers, also go through feedlots before slaughter. During the past 10 to 15 years, there has been a tremendous decrease in the number of animals that are slaughtered as veals. These appear to have been dairy calves that have been diverted from veal slaughter to the feedlot. But, the number of calves that the dairy herd can provide has about reached its limit. In fact, a dairy herd that continues to slowly decrease to an equilibrium size will provide fewer feeder calves in the future. Thus, it appears that the beef industry will necessarily have to increase the size of the beef breeding herd if it is to increase the supply of feeder calves in the future.

Feeder Calf Production by Beef Herds

Maintenance of Tradition

In general, the method of producing feeder calves by beef herds has not changed a great deal over time. The beef cow herd has typically been characterized as a relatively small enterprise which is normally of a supplementary nature. This is still the case today. Tables II-3 and II-4 point out this fact.

Table II-3 shows the distribution of beef cows by size of herd for 1964 and 1969. However, the data are not directly comparable between time periods.[6] The 1964 number of beef cows is on an all-farm basis while the 1969 numbers are for farms with gross sales of $2,500 or more. To lend comparability, the number of beef cows on farms with $2,500 or more in gross sales are included in Table II-3.

It would seem reasonable that the majority of the farms and, therefore, beef cows that are not accounted for in the 1969 data would include beef cow herds in the smallest size group. If one compares only the change in beef cow numbers by size of herd for larger herd sizes, it appears that there has been some movement toward larger herds. Nevertheless, the majority of the beef cows are still in relatively small size production units, since a herd of 100 cows would not be considered an extremely large agricultural enterprise by today's standards.

Table II-4 shows the number of farms with beef cows by size of herd. Again, the data are not comparable between years. But, if one compares the larger herd size groups, there seems to be some trend toward farms with larger beef herds. This is particularly true for the corn belt and lake states region. Yet, the trend toward larger production units in the beef cow industry has not been as pronounced as it has been in beef feeding, as will be shown later.

[6] Lack of data comparability is due to a change in the method of reporting by Census of Agriculture.

Table 11-3. 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
	1964	1969	1964	1969	1964
			Number		
Northeast	143,215	89,396	81,156	96,735	32,222
Corn Belt and Lake States	1,925,374	1,172,146	2,102,916	2,249,136	722,998
Southeast	2,318,764	839,325	2,047,382	1,782,770	1,209,959
Northern Plains	718,500	439,947	1,689,675	1,476,247	1,451,791
Southwest	1,165,508	396,775	1,643,318	1,455,180	1,253,000
Mountain	179,167	97,005	469,469	382,230	691,188
Pacific	202,350	78,033	240,146	192,129	266,545
48 States	6,652,878	3,112,627	8,274,562	7,634,427	5,627,703
			Percent		
Northeast	51.4[a]	33.6[a]	29.1	36.2	11.6
Corn Belt and Lake States	38.0	21.7	41.5	41.7	14.3
Southeast	29.6	13.2	26.1	28.0	15.5
Northern Plains	12.2	7.3	28.7	24.5	24.6
Southwest	15.2	5.5	21.4	20.2	16.3
Mountain	4.5	2.4	11.8	9.3	17.3
Pacific	10.7	4.7	12.7	11.5	14.2
48 States	20.4	10.0	25.3	24.6	17.3

[a]Data not directly comparable since 1964 numbers are on an all-farm basis and 1969 numbers are for farms with $2,500 or more in gross sales (i.e., Class I-V farms only).

Size of Beef Cow Herd						
50 to 99	100 and Over		Total		Total for Class I-V Farms, 1964
1969	1964	1969	1964	1969	
Number						
44,148	22,080	36,111	278,673	266,390	181,264
1,216,989	320,185	752,942	5,071,473	5,391,213	4,244,542
1,321,500	2,258,288	2,419,305	7,834,393	6,367,900	5,395,583
1,584,534	2,033,166	2,518,985	5,893,132	6,019,713	5,630,201
1,483,560	3,623,792	3,888,222	7,686,118	7,223,737	6,022,175
637,563	2,650,601	2,973,763	3,990,425	4,090,561	3,760,093
228,909	1,176,375	1,170,003	1,885,416	1,669,074	1,664,143
6,517,203	12,084,487	13,759,331	32,639,630	31,028,588	26,898,021
Percent					
16.6	7.9	13.6	100.0	100.0	
22.6	6.2	14.0	100.0	100.0	
20.8	28.8	38.0	100.0	100.0	
26.3	34.5	41.9	100.0	100.0	
20.5	47.1	53.8	100.0	100.0	
15.6	66.4	72.7	100.0	100.0	
13.7	62.4	70.1	100.0	100.0	
21.0	37.0	44.4	100.0	100.0	

Sources: [166] and [167].

Table II-4. 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

					Percent					
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	74.1	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 since 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: [166] and [167].

Reasons for Maintaining Tradition

There has been a relatively small amount of recent research concerning the beef cow industry.[7] Therefore, little is known about why there has been little change from the traditional method of producing feeder calves. It is generally attributed to the fact that a beef cow operation is relatively low profit in nature and can only be a viable undertaking where there are large amounts of under-utilized roughage which can be used by beef cows at a very low cost.[8] Therefore, beef cow operations have normally developed as a supplement to some other major farming operation or as a part time farming operation or where the resource base was suited to very few alternative agricultural enterprises. Thus, the industry has developed and maintained its structure of a very large number of small production units.

The increases in number of beef cows on farms have been due to both an increase in the average size of herd and the formation of new herds which have resulted from a shifting of agricultural enterprises. The major shifts in enterprise have involved the replacement of beef cows on many farms that were previously dairy farms. Also, there has been some expansion of the beef cow herd in the southeastern region of the United States [53, 114, 123].

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[7]For a very recent comprehensive study of cattle raising in the United States, see [142].

[8]Numerous studies are listed in the bibliography that have reached this type of general conclusion. In particular, see [8], [53], [98].

Therefore, it appears that the beef cow industry has not experienced the trend toward increased concentration of production which has characterized other agricultural industries. This maintenance of the traditionally small beef cow herd may have important implications for the supply of beef in the future, as will be pointed out later.

The Beef Feeding Industry

Recent Changes

In comparison with the beef cow industry, the beef feeding industry appears to adopt changes much more readily. As was shown in Table II-1, there have been sizable increases in the feeding of beef in the past 10 to 15 years. The increases in beef feeding have been carried out by a decreasing number of producing units as shown by the data in Table II-5. 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. However, the full extent of the changes that have taken place are not readily apparent with this analysis of change in number of feedlots.

The change in number of cattle marketed by feedlot size has been more dramatic than the change in feedlot numbers, as illustrated by the data in Table II-6. The proportion of cattle marketed by large feedlots has increased from 37 percent in 1962 to 62 percent in 1972. And, this 62 percent was fed by only 2,089 producing units while the remaining 38 percent was fed by 151,347

Table II-5. Number of cattle feedlots and percentage in two feedlot capacity groups by regions, 1962, 1967, 1972.

Region	Feedlots with Capacity Under 1,000 Head			Feedlots with Capacity of 1,000 Head or More		
	1962	1967	1972	1962	1967	1972
			Number			
Lake States	38,470	35,597	28,727	34	53	73
Corn Belt	129,394	116,740	85,692	106	260	308
Northern Plains	49,718	43,224	33,044	385	536	728
Southwest	3,950	2,874	1,785	360	447	360
Mountain	2,647	2,286	1,463	163	216	351
Pacific	1,493	997	636	384	381	269
22 States	225,672	201,718	151,347	1,432	1,893	2,089
	Percent of Feedlots with Capacity Under 1,000 Head			Percent of Feedlots with Capacity of 1,000 Head or More		
			Percent			
Lake States	99.9	99.8	99.7	.1	.2	.3
Corn Belt	99.9	99.8	99.6	.1	.2	.4
Northern Plains	99.2	98.8	97.8	.8	1.2	2.2
Southwest	91.6	86.5	83.2	8.4	13.5	16.8
Mountain	94.2	91.4	80.6	5.8	8.6	19.4
Pacific	79.5	72.3	70.3	20.5	27.7	29.7
22 States	99.4	99.1	98.6	.6	.9	1.4

Sources: [164] and [163].

Table II-6. 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

Sources: [164] and [163].

producing units. This supports the general idea that there is a much higher degree of concentration of production in beef feeding than there is in feeder calf production, or many other agricultural industries. In addition, there has been a trend toward geographic concentration of production. The northern plains, southwest, and mountain regions have increased the proportion of cattle they feed at the expense of the other regions.

Reasons for Change

There has been extensive research into why the changes in beef feeding noted earlier have taken place.[9] By and large, the research findings have attributed the trend of much larger feedlots to the economies of size characteristic of beef feeding operations.[10] Economies of size have resulted in lower average costs of production and, thereby encouraged feedlot operators to expand their producing units. The reasons for the geographical concentration involve the availability and cost of productive inputs. The increases in cattle feeding in the southwest, as well as other areas, have largely been associated with the increased availability of feed grains, feeder cattle, credit, good climatic conditions and other necessary resources [126, 84].

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[9]For comprehensive studies of cattle feeding in the United States, see [121 and 60].

[10]Numerous studies are listed in the bibliography that have reached this general conclusion. In particular, see [25, 59, 71, and 182].

In review, one can see that unlike the feeder calf industry, the beef feeding industry has undergone change. It has moved toward fewer producers with more sizable operations while beef cow herds have maintained their tradition of small production units. This incommensurate rate of change between the two major sectors of the beef production system could have an important impact on the supply of beef in the future.

Implications of Disproportionate Rates of Change

To achieve economies of size in beef feeding, feedlot operators have had to undertake large capital investments. These capital investments have tended to lower average variable costs of production. But, this reduced average variable cost has come about at the expense of increased fixed costs as a result of the added fixed investment. This type of change has two effects on the beef production system.

First, the lower average variable cost of production makes it possible for large feedlots to continue to feed animals during periods of low output prices that would force smaller feedlots to cease production [39]. Economies of size also allow larger feedlots to bid up the price of feeder calves above what a smaller operator would be able to pay. Since the larger feedlots have a lower cost per pound of gain, they can pay more for a feeder calf than small feedlots and still make a profit. As a result, the large feedlot has a demand for feeder calves that is at a somewhat higher level and more stable over time than that of the small feedlot. Therefore, the aggregate demand for feeder calves should tend to take on the characteristics of the large feedlot's demand since large feedlots are becoming more dominant in the industry.

Secondly, the increased investment in fixed productive inputs acts as a deterrent to the firms shifting from one enterprise to another. In particular, the large feedlots with more specialized fixed inputs cannot easily shift from beef feeding to feeder calf production. During the cycles which the cattle industry has experienced in the past, there were often shifts in production between cow-calf and feeding operations depending upon the comparative advantages of each enterprise [14]. The net result of these two particular effects makes expansion of the beef cow herd more difficult now than it has been in the past. First, the increased price for feeder calves makes investment in heifers for herd expansion more costly. Secondly, the failure of producing units to shift from beef feeding to beef cow herds reduces the rate of expansion of the beef cow herd. Therefore, it may be more difficult to expand the beef cow herd in the future than in the past. In addition, the growth in the size of feedlots may be a partial explanation of the fact that beef cow herds have not recently experienced the cyclical nature of expansion and contraction which was characteristic of the industry prior to 1959.

Why have beef cow herds remained relatively small? The answer would seem to involve the economies of size in feeder calf production. Either economies of size do not exist in feeder calf production, or the required investment has been great enough to discourage large gains in beef cow herd size. While little research has been done in the economies of size of cow-calf operations, there are indications that economies of size exist in cow-calf operations, which may be significant [11, 188]. This suggests that the prohibitive nature of the investment requirement may be the reason for the maintenance of relatively small beef cow operations.

SUMMARY

For the most part, this analysis of the beef industry suggests that increased beef production in the future may be more difficult to achieve than it has been in the past. A large part of past increases in beef production has been due to increased productivity. But, it may be more difficult to achieve increased productivity in the future. In addition, it may be more difficult to expand cattle numbers in the future than it has been in the past. So all in all, future increases in the supply of beef may come much more slowly and with greater difficulty than they have in the past.

Chapter III

THE THEORETICAL RELATIONSHIPS BETWEEN MONETARY POLICY AND THE SUPPLY OF BEEF

INTRODUCTION

The previous chapter described the historical changes that have taken place in the beef producing industry. That analysis pointed out the possible bottlenecks that have developed or may develop in the future. The major findings pointed out that the expansion of the beef cow herd is critical to growth of the supply of beef in the future. In addition, it was pointed out that future growth of beef feeding facilities may also be important, but relatively less important than expansion of the beef cow herd.

The opening remarks of this study hypothesized how one factor may have inhibited the expansion of the beef industry in the past. This factor was monetary policy and the effects it has had on the cost and availability of credit to the beef industry. This chapter will set out the theoretical relationship between monetary policy and the beef industry. To do this we will look at the theoretical and empirical research which has been carried out concerning other sectors of the economic system and apply similar reasoning to the agricultural sector and the beef industry in particular.

MONETARY POLICY

Definition of Monetary Policy

Before we can explain the theoretical relationship between monetary policy and any facet of the economic system, we must define what we mean by monetary policy. There are undoubtedly many definitions of monetary policy. One of the most simple and concise has been set forth by Samuelson [135, p. 55].

> By monetary policy we mean primarily Federal Reserve actions designed to affect the tightness and easiness of credit conditions, and the behavior of the total supply of money and money substitutes (that is, the supply of currency, checkable bank deposits, various categories of time deposits, and other liquid instruments).

Administration of Monetary Policy

The administration of monetary policy is the responsibility of the Federal Reserve System. There are a number of tools the Federal Reserve can use in regulating the supply of money and credit conditions. The primary tools of the Federal Reserve include open market operations, reserve requirements, the rediscount rate, various interest rate regulations, security margin requirements, and moral suasion [187]. While the Federal Reserve has all of these major tools which it can use to manage the nation's money supply and credit conditions, the most important tool on a general day-to-day basis is open market operations. In practice, most of the other policy tools have less actual impact on the economic system or are used less frequently to implement changes in monetary policy on a short term basis, but act as a body of rules and regulations within which the monetary system must operate.

Open market operations by the Federal Reserve involve the buying and selling of government securities in the money market. This buying or selling of government securities is the primary method of controlling the supply of money and credit conditions in the short term.[1] As the Federal Reserve goes to the market and offers to buy and sell government securities, it acts to change the existing market prices of government securities and thereby the yield of such securities. Since government securities are substitutes for other forms of investment, the open market activity also affects the market prices and yields of investment alternatives in the money markets. This participation of the Federal Reserve in the open market has both an initial and a secondary effect on the economic system [135].

The Initial Effect of Monetary Policy

The initial effect of monetary policy on the economic system results from the Federal Reserve's open market activities. As it enters the money market to buy or sell securities, it changes the security prices and yields immediately. This in turn causes

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[1]The Federal Reserve both buys and sells government securities in the money markets as it services the nation's banking system. Therefore, monetary policy implementation through open market operations is a result of the net effect of these day-to-day buying and selling operations. Future use of the terms buy and sell refer to the net effect unless otherwise specified.

other participants in the market to change their supply and demand bids on government securities and other securities as well. For example, if the Federal Reserve is attempting to reduce the money supply it would go into the market and sell government securities. This selling of securities in effect increases the supply of securities and forces the security prices down and the yield on securities up.

In essence, this selling of securities by the Federal Reserve has forced the public to trade their holdings of cash and demand deposits for government securities thus reducing the money supply. It has also changed the yield on these securities and thus the credit conditions that exist in the money market. But the effect is not limited to the securities bought and sold by the Federal Reserve. Since the market price of government securities has fallen and the yield has increased, investors holding other types of securities such as corporate bonds, mortgages, etc., will sell some of these alternative forms of investments and buy government securities. As a result, the prices of other types of investments will fall and their yields will go up just as yields on government securities did. Thus, the effect of the Federal Reserve's actions to reduce the supply of money tends to spread throughout the money markets. It not only reduces the money supply, but it also changes the credit conditions that exist in the money markets and throughout the economic system. This is the initial effect of the Federal Reserve's actions. But there is also a secondary effect due to the fractional reserve banking system that exists in the United States, which has a greater impact on the economic system.

The Secondary Effect of Monetary Policy

The lower security prices and increased yields that have resulted from the Federal Reserve's actions will force more people to invest idle funds not previously invested. Most of these funds will come from the banking system and act to reduce demand deposits. As a result, there will be fewer dollars in the banking system to meet reserve requirements. This reduced amount of reserves will pyramid the secondary effects of the reduced money supply. Since commercial banks have been forced to reduce their holdings of required reserves, this encourages them to reduce the amount of loans they have outstanding. Therefore, the supply of loanable funds has been reduced which tends to force up the cost of credit. This is the secondary effect of the Federal Reserve's action to reduce the money supply. In so doing, it has also changed the credit conditions that exist in the economy.

A change in credit conditions does not simply mean an increased loan cost or interest rate. It also affects the banking system's psychology of loan making. If loanable funds are scarcer now than they were previously, a bank may not only increase its interest charge, but it may refuse to loan as many dollars as it has in the past, i.e., it will ration credit. The reasons for such actions by a bank may be quite varied, but most of it is attributable to the lack of loanable funds in the whole economic system. Therefore, there has been not only a change in the interest rate or cost of credit, but also a change in credit availability--all of which have previously been termed "credit conditions."

Thus, one can see how the Federal Reserve's administration of monetary policy has both an initial and a secondary effect on the supply of money and on credit conditions in the economic system. But how does this affect various sectors of the economic system?

How Monetary Policy Affects the Economic System

We have seen how monetary policy affects the supply of money and credit conditions. Now let us look at how these changes affect the rest of the economic system. The previous example used a decrease in the supply of money. Let us continue with this example to see its effects on various components of the economic system.

Investment

The change in credit conditions resulting from the Federal Reserve's actions decreases investment in the economy. This results for two reasons. First, the interest rate that firms must pay is higher. Therefore, as a firm looks at all alternative investments it has, fewer will be profitable at the higher interest rate. Hence, fewer investments will be undertaken by firms.

Secondly, in addition to a higher interest rate, there are fewer loanable funds in the economic system. Therefore, as firms apply for loans to finance the profitable investments that remain after considering the higher cost of financing, there are a greater number of loan refusals by banks due to external credit rationing. Loan applications may be viewed with greater skepticism, because there is greater risk at the higher interest rate, and loans are refused to firms. Therefore, this credit rationing acts to decrease investment as does the effect of an increased rate of interest. Thus, aggregate investment in the economic system has decreased, or it has failed to increase as fast as it would have in the absence of the restrictive actions of the Federal Reserve. This, in turn, affects other components of the economic system.

Employment, Gross National Product, Consumption and the Price Level

The reduced level of investment which results from the Federal Reserve's restrictive monetary policy is reflected through decreased plant and equipment expenditures. Firms planning expansions or thinking of starting new operations are forced to abandon these plans due to their inability to acquire sufficient capital or to acquire it at a cost that will make the investments profitable. This, therefore, results in a decreased need for people to work in the plants and operate the equipment. Thus the action of the Federal Reserve lowers the level of employment in the economy.

Due to the reduced expenditures for plant and equipment and the employment of fewer workers, the output of real goods and services is less. Therefore, gross national product fails to grow at the rate it would have with a less restrictive monetary policy.

The economy's rate of growth, as normally measured by economists, has been reduced.

Consumption is also reduced in the economic system for two reasons. First, the reduced supply of money and more restrictive credit conditions makes it more difficult for consumers to purchase what they desire. This is not only due to the fact that they may have fewer dollars to spend, but they have more difficulty obtaining loans for consumer goods. These loans also carry a higher rate of interest discouraging their use. Secondly, the reduced level of employment means more jobless consumers will reduce their consumption. For these two reasons, aggregate consumption in the economic system is reduced.

Thus far, we have shown that a restrictive monetary policy reduces investment, employment, gross national product, and consumption. These reductions are the result of decreased demands for various products and services. This reduced demand for various products tends to lower the prices of various products and services in the economic system. Hence, the level of prices in the economic system is reduced, or fails to increase at the rate they would have in the absence of the restrictive monetary policy. Therefore, restrictive monetary policies are shown to be a tool for controlling price levels.

This discussion of how monetary policy affects the economic system could just as easily be reversed to the case of an expansionary monetary policy. Results would simply be reversed. This type of theoretical reasoning has been used as the rationale for the use of monetary policy to aid the economic system in achieving the goals of full employment, price level stability and economic growth. As such, there is wide acceptance of this theoretical argument for using monetary policy to aid in achieving these three goals of economic policy. But there is much less agreement concerning the actual effectiveness of monetary policy.

In particular, there is a large amount of disagreement over the effect monetary policy has on investment. Some economists feel that monetary policy has no effect on investment while others feel it has. Therefore, some feel money "matters" and others feel money "does not matter."

While the effect of monetary policy on the whole economic system is not the focus of this study, its effect on investment certainly is. Therefore, if monetary policy is formulated to move the economic system toward these economic goals, we would like to know how this will affect investment in the economic system in general, and the beef producing industry in particular. To facilitate further investigation we can set forth the factors that theoretically act to determine the impact of monetary policy changes on investment by individual firms in the economic system.

Determinants of the Impact of Monetary Policy on Investments by Individual Firms

There are many factors that act to determine how individual firms react to changing monetary conditions. The most important factors have been set forth by Crockett, *et al.* [62] and Maisel [95]. These include:

1. Size of firm.
2. Ability and/or willingness of firm to absorb a higher cost of credit.
3. Proportion of investment made that requires credit.
4. Amount of credit required per unit of investment.
5. Institutional characteristics of credit market serving the firm.
6. Degree to which traditional lenders are influenced by monetary policy.

Given these major determinants, let us look at how each affects the impact of changes in monetary policy and credit conditions on investment by individual firms.

Size of Firm

The size of firm acts to determine the impact of changing credit conditions in at least two ways. First, larger firms will have more alternative sources of obtaining credit. A small firm may be limited to obtaining credit from one or two small banks whereas a much larger firm may be able to deal with a greater number of larger banks or even participate in the money markets on its own, something a small firm is unable to do. Secondly, a large firm may have much greater bargaining power when negotiating credit terms with traditional credit sources. A large firm may do a much bigger volume of business with a particular bank than does a small firm. The large firm can then use this as leverage in obtaining more favorable credit terms than a small firm could obtain.

Therefore, one would expect the impact of monetary policies to be greater on small firms than on large firms.

Ability of Firm to Absorb Higher Credit Cost

This relationship is very straight forward in nature. If a firm is planning an investment that has a relatively high expected rate of return considerably above the firm's cost of credit, an increase in the credit cost will not have a great impact. For example, if an investment has an expected rate of return of 40 percent, an increase in the cost of credit from seven to nine percent will have little effect on the decision to invest. But, if the expected rate of return is 10 percent, the increased cost of credit might cause the firm to at least reconsider its investment decision, and possibly force it to abandon the planned investment. Thus, we can see that firms considering investments with low rates of return or high risk will experience the impact of monetary policies to a greater degree than firms with projects offering much higher rates of return or lower risk.

Proportion of Investment that Requires Credit

The larger the proportion of an investment that requires credit, the greater the impact of monetary policy on the firm making the investment. If a firm is planning an investment that requires 80 percent of the cost to be financed by credit, a change in the cost and availability of that credit will have a large impact on the decision to make the investment. The amount of credit available may be insufficient to meet the needs of the firm or the increased financing cost for 80 percent of the investment may make the project unprofitable. But, an investment proposal that requires only 20 percent of the cost to be financed through credit will be affected to a much lesser extent.

Amount of Credit Required Per Unit of Investment

The impact of monetary policy on a given firm will also depend on the credit required per unit of investment. Assume we are looking at two similar firms that have plans to make investments in the near future. One firm plans to invest in a series of small projects, while the other firm is planning one large lump sum investment project. If a restrictive monetary policy creates a relative shortage of credit, the first firm may be able to undertake part of the projects in the proposed series of investments; but the reduced credit availability may force the second firm to abandon the one large proposed investment. Therefore, the larger the amount of credit required per unit of investment, the greater the likelihood that monetary policy will influence the investment decision.

Institutional Characteristics of Credit Market Serving the Firm

If the credit market serving an individual firm has institutional characteristics that prohibit the free flow of capital and credit, this will tend to amplify the effect of monetary policy changes on the firm. These institutional characteristics may manifest themselves in the form of rules and regulations or tradition.

But, regardless of reasons, they can cause an increased impact on the firm's decision to invest. For example, if certain rules prevent institutions in the money market from paying above a certain interest rate, these institutions will be unable to attract funds in the money market. In turn, the firms served by these institutions will experience a greater shortage of credit than other firms being served by institutions who do not have rules and regulations that deter the free flow of capital and credit.

Monetary Policy Influence on Traditional Lenders

This factor is much like the previous factor in its effect on the impact of monetary policy on a firm's investment decision. If traditional lenders with which the firm has done business in the past react a great deal to monetary policy changes, this can amplify the effect of changes in credit conditions. If traditional lenders are more inclined to serve certain firms under tight money conditions and other firms when conditions change, this can influence all firms to a great extent. For example, if a firm's traditional sources of credit tend to service other industries during tight credit periods, then this firm will face a limited supply of credit from its traditional source. This will force the firm to either reduce the amount of investment undertaken or to find alternative credit sources. This process of finding alternative sources of credit can be quite costly in terms of both time and money and may act to prohibit such searches for alternatives.

Total Impact of Monetary Policy

In review, we can see that, theoretically, the impact of changes in monetary policy and credit conditions depends on a number of factors. Some of the determinants are characteristics of the firm while others are related to the credit market serving the firm. Therefore, the firm may be able to alter some of the conditions, but it is unlikely that it can alter all of them to improve its position relative to changes in monetary policy. Therefore, monetary policy changes and changing credit conditions could have a large impact on some industries and firms while it has a much smaller impact on others. But, the discussion thus far has presented only the theoretical arguments. To substantiate or refute these arguments, let us look at some of the empirical evidence.

EMPIRICAL RESEARCH FINDINGS CONCERNING THE EFFECT OF CHANGING MONETARY AND CREDIT CONDITIONS ON INVESTMENT

As noted earlier, all economists do not accept the theoretical relationship between monetary policy and investment which has been set out here. One possible reason for this is the fact that investment did not respond to the low interest rates that were prevalent during the 1930's [23]. In addition, early empirical investigation tended to refute the idea that credit conditions have an effect on investment decisions. More recent work has found evidence to support the hypothesized relationship.

Results of Studies Using Business Attitude Surveys

A number of studies using business attitude surveys were conducted during the period from the late 1930's to the early 1950's.[2] In general these surveys found that business firms did not consider the interest rate or cost of capital funds when making investment decisions. If firms did consider these factors, they were usually of less importance than other factors affecting the decision.

A later survey conducted by Crockett, *et al*. in 1967 covering 8,876 firms found that financial market developments had greater influence on business investment than that found by similar surveys conducted in 1949 and 1955 [18]. They concluded that monetary conditions existing in 1966 had tended to reduce business fixed investment and inventories in 1966 and 1967. But the magnitude of the effect was quite small. The estimated reduction of investment was in the range of .67 percent to 1.33 percent of the investments that actually took place.

While these survey results seem to refute the hypothesized relationship between monetary policy and investment, they have been criticized by White [179, 180] on numerous counts. The major flaws in the survey studies included nonresponse, nonrepresentation of small firms in the surveys, method of asking questions that encouraged negative responses, and greatly biased samples in some cases. White therefore suggests that the results of the surveys may vastly underestimate the effect of monetary conditions on investment decisions.

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[2] For a review and critique of such studies see [179].

Thus, we seem to be left up in the air concerning the hypothesized relationship. Further evidence may help settle the question.

Results of Econometric Studies

There have been many econometric studies of investment behavior using various theories. Excellent surveys of such studies are contained in Jorgenson [79] and Mann [103]. A number of these studies have attempted to test the impact of monetary policy and credit conditions on investment behavior by firms in various industries. The investigations have attempted to relate measures of investment that are appropriate for an industry to factors that should theoretically influence it such as previous investment, profits, capacity utilization, internal funds, some measure of the cost of external finances, and other variables. The particular concern of this study is to look at the effect of changes in the cost of external finances, which reflect changing monetary policy and credit conditions, on the investment behavior of different industries.

Residential Construction

One of the industries for which the evidence overwhelmingly supports the hypothesized effect of monetary policy on investment is the housing industry. Studies by Liu [89], Maisel [95], and Muth [117] have found that the rate of interest (measured in various ways) does affect investment in residential construction. In addition, Maisel derived a number of measures of credit availability [95,

p. 494]. These measures included mortgage offerings by private holders to the Federal National Mortgage Association and savings available for mortgages. He also found that credit availability had an impact on housing starts. The magnitude of the effect of monetary policy on housing starts has been estimated by Maisel to account for about one-third of the changes in housing starts. This indicates that monetary policy is quite important in determining investment in the housing industry, much more so than the survey studies previously reviewed. Also, the relationship appears to be widely accepted by experts that have studied the situation. This wide acceptance has been reflected by the fact that some of the institutional rules concerning the capital markets serving the housing industry have recently been changed to remove some of the problems of credit availability [16].

Commercial Construction

Bischoff [5] and Hambor and Morgan [62] have found investment in nonresidential construction to be related to monetary conditions in a manner similar to the findings concerning the housing industry. The results were not as dramatic or conclusive as those for residential construction.

Both studies found that measures of the cost of capital significantly affected investment in such items as office buildings, stores, restaurants, and garages. Hambor and Morgan also found credit availability to be an important consideration, but Bischoff did not find capital rationing to be an important determinant affecting investment decisions. Thus, we again have some evidence that changes in monetary policy and credit conditions do influence investment decisions.

Business Investment

There have been a number of studies concerning the fixed business investment by both manufacturing and nonmanufacturing firms. The studies used various measures of the cost of capital and found evidence to support the hypothesized relationship between credit conditions and investment decisions.[3] None of the studies explicitly considered the effect of credit availability. The general findings support the relationship suggested here, but there were exceptions.

Liu found that the interest rate was not statistically related to the investment in durable equipment by manufacturing firms. Evans found similar results for the railroad industry, but the other five manufacturing industries studied proved to react in a manner consistent with a priori expectations. Thirteen manufacturing industries were studied by Evans and Resek. They found the majority of the industries responded in the manner expected. In the regression models used, only four or five industries appeared to react in an unexpected way, and none of these regression coefficients were found to be statistically significant.

Thus, we have again found considerable evidence to suggest that the hypothetical relationship between monetary conditions and

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[3]Examples of such studies include de Leeuw [23], Jorgenson [79], Evans [38], Resek [127], and Liu [89].

investment may be quite valid. Various studies have found the relationship to exist in numerous industries and types of investment. It appears the evidence is much stronger in the housing industry than in some manufacturing industries, which is in line with our discussion of the factors that determine the impact monetary policy may have on a firm. Residential construction fits the mold of an industry which monetary policy should have an extreme impact on; whereas firms in manufacturing industries do not.

IMPLICATIONS FOR THE BEEF INDUSTRY

If we look at the agricultural industry in general, and the beef industry in particular, in light of the theoretical and empirical findings concerning the relationship between monetary conditions and investment decisions, we may be able to provide further insights into the problem described in Chapter One. Comparing the characteristics of firms in the agricultural industry with the factors which influence the impact monetary policy has on a firm or an industry suggests that the farming sector may be influenced a great deal by monetary policy.

The Agricultural Industry

Agriculture has always been characterized as an industry composed of a large number of very small production units. Historically these small farms have been characterized as being very low profit operations. Therefore, the first two items in the list of factors that influence the impact monetary conditions have on a firm seem to apply to the agricultural industry.

In addition, the last two items appear to characterize the credit market serving agriculture. First, the locational nature of the farming industry dictates that firms be located in rural areas. The commercial banks that have developed to serve rural agriculture are generally quite small. Therefore, the farmer may not have access to a large commercial bank for the credit he desires and needs. The development of the Farm Credit System which provides credit to agriculture through Production Credit Associations and Federal Land Banks has aided the farmer in obtaining credit, but it has not been a panacea. Problems still exist in the credit markets serving agriculture. Evidence of this has been the recently adopted "seasonal borrowing privilege" by the Federal Reserve System [4, 112]. The idea behind the rule change is to allow banks that experience large seasonal movements in deposits and loans to borrow from the Federal Reserve System during periods of seasonal strain. Most of the banks which will qualify are rural banks serving agriculture. Hopefully this will improve the agricultural credit market.

Secondly, the traditional lenders in agriculture appear to be influenced by monetary conditions to a large extent. It has been observed that when the economy experiences a "tight money" situation some of the traditional agricultural lenders tend to desert agriculture for other sectors of the economy. Some commercial banks and life insurance companies seem to react in this manner. In addition, those small rural banks that do not desert agriculture encounter greater problems when attempting to obtain funds for their larger customers through correspondent banking relationships. Also, there is some feeling that rural bankers use credit rationing at high rates of interest. They simply do not wish to make loans when interest rates get "too high," whatever "too high" might be.[4] Thus, we again have conditions which suggest that the credit market serving agriculture may tend to amplify the effects of changes in monetary conditions.

The one area for which agriculture may not seem to fit the theoretical mold we have set forth involves the use of credit in the farming operation. Agriculture has long been thought of as an industry which financed its growth and expansion internally. Farmers have been characterized as great savers. They have historically used savings from current income to generate funds for future expansion and growth rather than use credit for such purposes. But indications are that this has changed over the past 20 years.

Brake [9], Melichar [111], and others have investigated agriculture's increased use of credit over time. One of the reasons

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[4]It has been observed that many rural banks make a practice of carrying excess reserves or pay less than the maximum rate on saving accounts and continue to make loans at less than the current rate of interest to established customers during tight money periods. Therefore, this credit rationing probably results in fewer loans being made to marginal farming operations and relatively more loans being made to local patrons for nonagricultural purposes.

for the increase has been the decrease in rate of saving by farmers. From the early 1950's to the late 1960's the farmers' savings rate fell from 37 percent to 32 percent. As a result of this and the fact that capital flow as a percent of cash flow has increased from 42 to 50 percent, the proportion of capital flow financed internally has decreased from 88 percent in the early 1950's to only 65 percent during the late 1960's. Thus, agriculture has come to depend on external financing to a much greater extent than it did in the past. All of which suggests that the idea "farmers operate on an all equity basis" is not nearly as valid as it might have once been. As farmers have been able to rid themselves of the "depression psychology" of the 1930's they have increased their use of credit. Thus, again we find the possibility that agriculture may be subject to the influence of changing monetary policy.

Research by Doll [30] and Nash [118] indicates that this may be the case. Both studies found monetary policy to have an effect on the income of the agricultural sector. Nash also found the money supply to be related to agricultural investment in the manner specified in the previous theoretical discussion. Further, Nash found the response of agriculture to monetary conditions to be greater in countries where government was involved to a lesser extent than it has been in the United States. This suggests that government involvement in agriculture may act as a buffer against the impact of monetary policy. If this is the case, the beef industry in the United States may be influenced more by monetary policy than the other sectors of the agricultural industry since there is little direct government involvement in the livestock industry.

The Beef Industry

The analysis of the potential effects which changing monetary policy and credit conditions may have on agriculture suggests that the beef industry may be influenced more by monetary conditions than agriculture in general. Also, the characteristics of each of the major sectors of the beef industry imply that there may be differential impacts on these sectors.

The Feeder Calf Industry

Chapter Two's descriptive analysis of the cow-calf operations in the United States suggests that changing monetary and credit conditions may have a relatively large impact on these operations. These firms are typically quite small. Normally they are located in rural areas with limited access to credit and capital markets. The operations also require relatively large amounts of capital in the production process. In addition, the operations have been noted for their low levels of profitability. All of these attributes imply that monetary policy may affect the cow-calf operator's investment decisions to a large extent. The same may not be true for beef feeding.

The Beef Feeding Industry

As described in Chapter Two, the beef feeding industry is quite different from the feeder calf industry. Typically, beef feeding firms are larger and more profitable than cow-calf operations. Beef feeding has tended to become more geographically concentrated than feeder calf production. All of these factors may have made credit and capital markets more readily accessible to beef feeding firms than they have been for cow-calf operations. In addition, many observers feel that lenders serving beef feeders do not exhibit credit rationing to the same extent that lenders serving cow-calf operations do. Thus, these differences between the beef feeding and the cow-calf industry suggest that the impact of monetary conditions on beef feeding may be less than on feeder calf production.

Chapter IV

MONETARY POLICY, CREDIT CONDITIONS AND THE BEEF COW INDUSTRY

INTRODUCTION

The previous discussion has set the stage for the analysis undertaken in this chapter. Chapter Two pointed out that the supply of feeder calves has been a critical link in the beef production process in the past and that its importance will likely increase in the future. The major source of feeder calves is the beef cow industry. Therefore, if monetary policy and credit conditions affect the beef cow industry, it also affects the supply of feeder calves and eventually the total supply of beef.

Chapter Three described the macroeconomic aspects of the theoretical relationship between monetary policy, credit conditions, and investment. It also explained how and why changing monetary policy and credit conditions would be expected to influence investment in the beef cow industry. The objective of this analysis is to investigate this relationship and attempt to answer the basic question and test the hypothesis set forth in the introductory remarks of this study.

At this point, it should be pointed out that this study is not an attempt to investigate the "cattle cycle." While it could have implications concerning the cattle cycle, this study does not consider the total number of cattle but attempts to separate the dairy industry and the beef industry and concentrates on the latter. The basic assumption underlying this analysis is that the major determinant of the long run supply of beef is the size of the beef breeding herd.

This relationship is shown in the flow chart presented in Figure IV-1. As demonstrated there, the solid lines represent the critical flow of beef through the production system. Thus, factors that affect the beef cow herd would 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.

The following analysis investigates the relationship between monetary policy, credit conditions, and the size of the beef cow herd. The analysis begins by looking at how changing monetary conditions should theoretically affect a firm's decision to invest in additional beef cows. Then an econometric model is formulated to

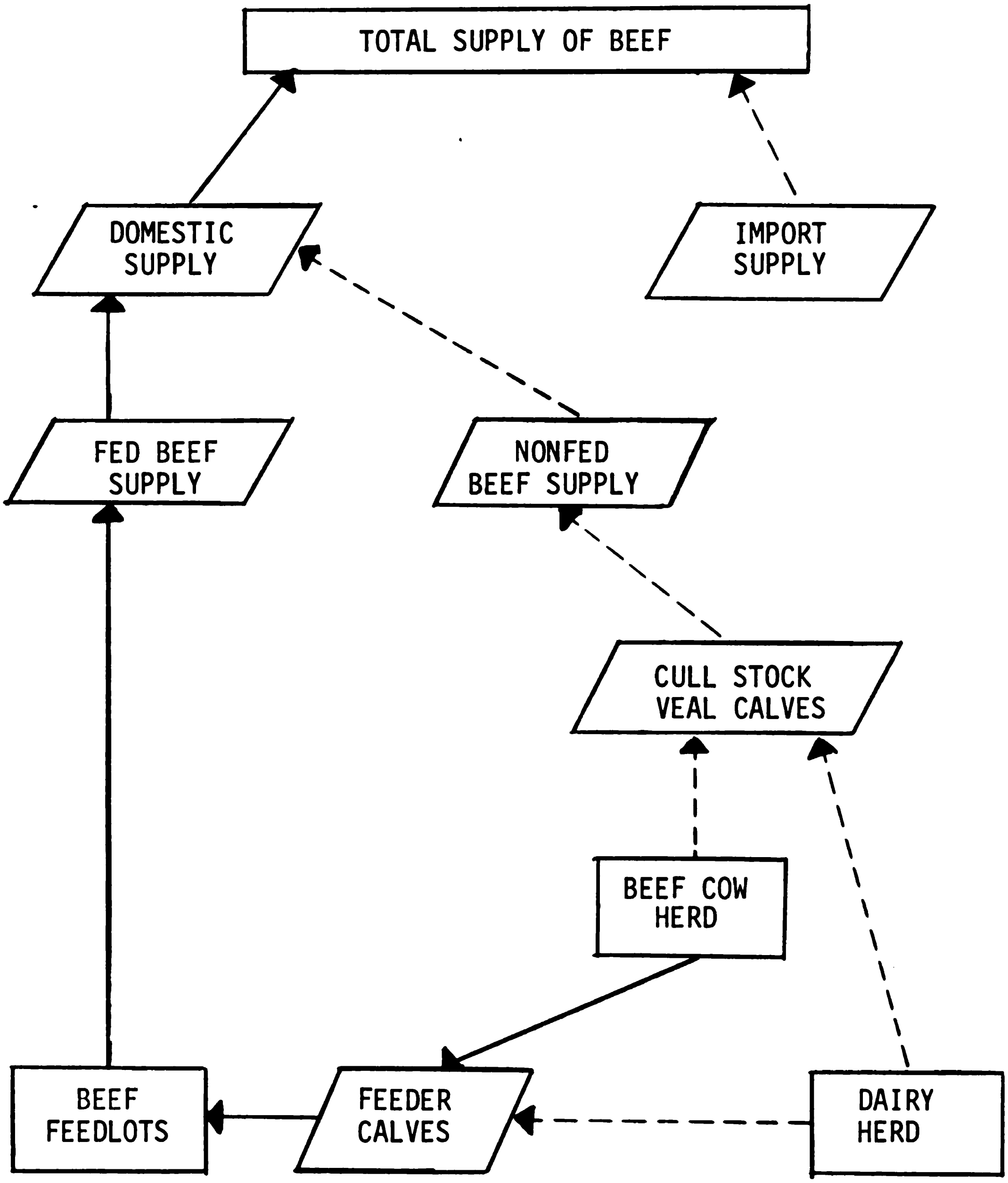

Figure IV-1. Flow chart of beef producing industry.

test the theoretical relationship. Finally, the empirical results are presented and discussed.

THEORETICAL ASPECTS OF AN INDIVIDUAL FIRM'S DECISION TO INVEST IN A BEEF COW

Theory of Investment

There have been various theories of investment set forth by a number of authors in economics and finance. Eisner [34], Jorgenson [78], Johnson [75], and Resek [128] present somewhat different theories of investment. However, they are quite complementary in the sense that they all point out what each believes to be the critical determinants of investment. For the most part, all of the theories consider the same determinants, but treat them in somewhat different ways. In general, the theoretical determinants of investment can be put into three general classes: 1) output variation (i.e., investment depends on changes in output), 2) price of capital (i.e., investment depends on cost of capital services), and 3) supply restraints (i.e., investment limited by capital goods available) [128, p. 325]. The theories set out by the various economists then cast measures of these determinants in some type of theoretical framework to explain changes in the stock of capital, or investment.

The one major exception of the above generalization is the investment-disinvestment theory advocated by Johnson [75]. This theory diverges from the others by relaxing the normal assumptions of perfect knowledge and foresight. This results in differing capital prices depending on whether the firm is investing or disinvesting in an asset. Therefore, the price the firm considers relevant depends on the marginal value product of the input. If the input's marginal value product is greater than its price (acquisition price), then the firm would invest in the asset. Should the marginal value product of an input fall below the price for which the firm could sell the input (salvage price), the firm should disinvest in the asset.

All of the previous investment theories are based on the same general idea. This idea has been expressed succinctly by Lindauer [88, p. 53].

> The purchase of a new capital asset occurs primarily because an investor expects returns over its life which will cover all the costs of purchasing and operating the asset while also yielding a net return at least equal to the interest he would have to pay if he borrowed the money to purchase it. The return anticipated must be that high or the potential investor would not want to borrow the money to purchase the asset.

Using this rationale, the various investment theories develop a framework that represents an individual firm's investment decision. At this point, the theories of investment begin to differ. The acceleration and capacity models developed by Eisner[1] and others consider investment as simply an attempt by the firm to achieve the desired amount of capital stock. Therefore, investment is considered to be primarily dependent on the level of output or the desired level of output.

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[1]See Resek [128] for a discussion of these models.

Jorgenson's theory of investment is based on the assumptions of classical production theory. Thus, the firm's demand for capital goods depends on the marginal value product and its price. The theoretical model developed by Resek is a compromise of the Eisner and Jorgenson theories. We can use this previous work in investment theory to develop a theoretical model of an individual firm's decision to invest in additional beef cows.

Theoretical Considerations of a Beef Cow Investment Decision

The firm's investment decision has been investigated and discussed in both the fields of finance and economics. There are numerous methods by which a firm can judge the merits of a proposed investment. These methods include: 1) urgency, 2) payback, 3) accounting rate of return, 4) net present value, and 5) internal rate of return.[2] The extent to which such criteria are used by firms in making investment decisions is unknown. The general observations are that the first two criteria are used quite extensively since they are relatively easy to use. The last two are theoretically more correct because they consider the time value of money, but are explicitly used to a much lesser extent by business firms due to the relatively complicated nature of the required computations. However, it is apparent that a theoretical model of a firm's beef cow investment decision should consider the time value of money. Thus, this suggests that one should use either

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[2]For a discussion of these and other such criteria see Mao [104], Quirin [127], and Van Horne [173].

the net present value criterion or the internal rate of return criterion.

Due to its relative simplicity, the net present value concept will be used to develop the theoretical model. It is not only easier to use than internal rate of return but the results of both with respect to the accept-reject criteria are the same for simple investments. This type of theoretical model has been specified by Jorgenson [78].

The Theoretical Investment Model

If we assume that a beef cow operator desires to maximize his net worth, he will invest in additional beef cow units if and only if the investment will increase his net worth. We can further define the operator's net worth as being the sum of all discounted net revenues of all investments undertaken. Let R(t) be gross revenues at time t, C(t) costs at time t, and r the discount rate. Then the net worth, NW, would be: $NW = \int_{o}^{\infty} e^{-rt} [R(t) - C(t)]\, dt$. The firm would then desire to maximize the function "NW."

Using this assumption, we can look at the decision to invest in a beef cow. The definition of net present value (NPV) is: $\sum_{t=o}^{n} \frac{[R(t) - C(t)]}{(1+r)^t}$ where R(t), C(t), and r are as previously defined. Here we are considering one single investment and taking revenues and costs to occur within a discrete time period rather than being continuous as in the case of NW. Thus, there is no conceptual definitional difference between NPV and NW as defined previously.

Therefore, as a firm attempts to maximize net worth, it will choose only those investments for which the NPV$\geq$0. If the NPV<0, the project will decrease the firm's net worth. Hence, when making an investment decision, the firm considers those factors that determine the NPV of an investment.

To look at the factors that affect the NPV of an investment in a beef cow for a particular firm we can write out the definition of NPV more explicitly.

$$\text{NPV} = -\text{initial investment} + \sum_{t=o}^{n} \frac{\text{expected revenues}}{(1+r)^t}$$

$$- \sum_{t=o}^{n} \frac{\text{expected costs}}{(1+r)^t} + \frac{\text{expected salvage value}}{(1+r)^t}$$

In the case of an investment in a beef cow unit, the initial investment is the cost of the cow. The revenues the cow generates occur from the annual sale of feeder calves which the cow produces. The costs associated with the investment are the costs of maintaining the cow over her useful life. The salvage value of the cow is the amount she will bring when sold for slaughter at the end of her useful life. The discount rate, r, is the firm's cost of capital which may or may not be adjusted for risk associated with the investment.[3] Thus, the investment demand for cows to be added to the existing breeding herd should depend on each of these factors.

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[3]This is only a partial analysis which considers the variable costs associated with putting an additional cow in the breeding herd. The rationale for this treatment will be pointed out later when a specific budget is presented.

The relationship between investment and revenues and costs is fairly obvious. But, the relationship between the discount rate and investment may not be. As the discount rate (r) increases, the net revenues in future periods are discounted at a higher rate. Therefore, the discounted value of future returns is less. Hence, the beef cow operator cannot afford to pay as much for the initial investment with a high discount rate as he can with a low discount rate if all other things are the same. Thus, anything that acts to change a firm's cost of capital or discount rate should affect the firm's investment demand. This is the theoretical basis for the question raised and the hypothesis set out to be tested in Chapter One.

The theoretical link between monetary policy, credit conditions, and investment in beef cows should be fairly obvious. Changing monetary and credit conditions change the interest rates that exist in the economy and the availability of credit. This change in both the cost and availability of credit in turn affects the beef cow operator's investment decision in at least two ways.

First, changes in the rate of interest affect the firm's cost of capital. Tight money policies that increase the rate of interest and the firm's cost of capital discourage investment in beef cows. Easy money policies have the opposite effect. Secondly, the availability of credit should also affect investment decisions. If the beef cow operation depended on credit to finance investment for expansion, then changes in credit availability could affect the firm's ability to invest irrespective of the cost of capital. Tight money policies that raise interest rates and reduce the amount of credit available could make it impossible for the firm to invest in a very profitable venture. If the beef cow operator cannot obtain the credit required to expand a profitable operation, then he must forgo such expansion.

A simple analytical example of an investment in a beef cow might serve to clarify the effect a changing cost of capital or discount rate has on the NPV of the investment. The effect of reduced availability of credit should be self-evident.

Beef Cow Investment Analysis: An Example

Table IV-1 presents a simplified budget for a beef cow operation. The cost and returns are approximately those experienced by a Michigan farmer with a 50-cow beef herd in 1970. The budget includes both variable and fixed costs for purposes of exposition. We can analyze the investment in a single beef cow as either an initial investment where all costs are considered or as an addition to an existing herd where only variable costs are of concern to the operator. In this budget, neither fixed nor variable costs contain any capital costs or finance charges. These will be considered explicitly in the net present value analysis.

The analysis assumes that a bred heifer is purchased and held for six productive seasons and sold at the end of the sixth year. It also assumes that all costs (except,initial investment) and returns occur at the end of each period. Using the costs presented in Table IV-1, the net present value of an initial investment

Table IV-1. Budget of investment in a beef cow.[a]

I. Required Investment	
A. Cow	$350.00
B. Buildings and Equipment	60.00
C. Land (pasture and hay)	390.00
D. Total Investment in cow, buildings and equipment, and land	$800.00
II. Source of Returns and Costs	
A. Returns	
1. Annual returns from sale of calves: 90% (calf crop) X 420 lb. (sale weight) X $38/c.w.t. (sale price)	$143.64
2. Salvage value of cow at end of six years: 1000 lb. (sale weight) X $22/c.w.t. (sale price)	220.00
3. Salvage value of land and buildings and equipment at end of six years[b]	450.00
B. Costs[c]	
1. Variable costs	
a. Roughage as hay equivalent: 2 tons X $20	40.00
b. Protein, salt and mineral	5.00
c. Breeding charge, bull cost	7.00
d. Veterinary and drugs	3.00
e. Marketing: 3% of total returns	4.50
f. Taxes and insurance	5.19
g. Miscellaneous	1.31
h. Total variable costs	$ 66.00
2. Fixed costs	
a. Buildings and equipment: Insurance, depreciation, repairs, and taxes	$ 6.00
b. Labor: 7 hours X $2.00/hr	14.00
c. Total fixed costs	$ 20.00
3. Total costs (variable and fixed)	$ 86.00
III. Returns above Total Cost without Capital Charges (annual returns - total costs)	$ 57.64
IV. Returns above Variable Cost without Capital Charges (annual returns - total variable costs)	$ 77.64

[a]Source [150].

[b]This assumes that the land and buildings can be sold at the end of the six years for the purchase price.

[c]These cost estimates do not provide for any replacement stock. Finance charges are excluded since they will be considered in the discussion of net present value analysis of the investment.

in a bred heifer where both variable and fixed costs and a cost of capital or discount rate of six percent are considered would be:

$$NPV_{(\text{initial investment})} = -(\text{initial investment in bred heifer and all supporting facilities})$$

$$+ \sum_{t=1}^{6} \frac{(\text{total annual returns} - \text{total annual costs})}{(1 + \text{discount rate})^t}$$

$$+ \frac{(\text{salvage value of cow at end of six years})}{(1 + \text{discount rate})^6}$$

$$+ \frac{(\text{salvage value of supporting facilities at end of six years})}{(1 + \text{discount rate})^6}.$$ [4]

Therefore:

$$NPV_{(\text{initial investment})} = -\$800 + \sum_{t=1}^{6} \frac{(143.64 - \$86)}{(1 + .06)^t}$$

$$+ \frac{\$220}{(1 + .06)^6} + \frac{\$450}{(1 + .06)^6}$$

$$= -\$800 + \$283.43 + \$155.09 + \$317.23$$

$$NPV_{(\text{initial investment})} = -\$44.25.$$

Thus, the investment in the single beef cow unit, considering both fixed and variable costs, would not be undertaken. The returns are not sufficient to cover all costs and earn a return of six percent on the invested capital.

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[4]The salvage value of land, buildings, etc., is considered to be the same as the purchase price for purposes of exposition.

We can also look at the decision to add one additional cow to an existing beef cow herd. In this instance, we assume that the operation has sufficient fixed resources to handle the additional cow. Therefore, the only costs that are relevant are those that will change as a direct result of the addition of the cow (i.e., variable costs). The net present value of the investment in an additional cow would be:

$$NPV_{(\text{additional cow})} = -(\text{initial investment in bred heifer}) + \sum_{t=1}^{6} \frac{(\text{total annual returns - annual variable costs})}{(1 + \text{discount rate})^t} + \frac{(\text{salvage value of cow at end of six years})}{(1 + \text{discount rate})^6}$$

Therefore:

$$NPV_{(\text{additional cow})} = -\$350 + \sum_{t=1}^{6} \frac{(\$143.64 - \$66)}{(1 + .06)^t} + \frac{\$220}{(1 + .06)^6}$$

$$= -\$350 + \$381.78 + \$155.09$$

$$NPV_{(\text{additional cow})} = \$186.87.$$

Considering the NPV of $186.87 that would result from the investment in an additional beef cow, the firm should undertake the herd expansion. The project will generate returns sufficient to cover all variable costs and earn a return of six percent on the capital invested in the beef cow. The excess of $186.87 can then be considered as returns that can contribute to meeting the fixed costs that were not considered in this analysis.

Tables IV-2 and IV-3 present the net present value of beef cow investments under various assumptions concerning the price of

Table IV-2. Net present value of investment in a beef cow: initial investment considering both fixed and variable costs.

Cost of Capital	Feeder Calf Price in $1 per Hundredweight					
	$30.00	$34.00	$38.00	$42.00	$46.00	$50.00
	Net Present Value of Investment					
4%	-$126.86	-$47.60	$31.66	$110.93	$190.19	$269.45
6	-192.95	-118.60	-44.25	30.10	140.45	178.80
8	-251.12	-181.22	-111.33	-41.43	28.47	98.37
10	-302.47	-236.62	-170.77	-104.92	-39.07	26.79
12	-347.91	-285.74	-223.58	-161.41	-99.25	-37.09

Table IV-3. Net present value of investment in a beef cow: as an addition to existing herd considering only variable costs.

Cost of Capital	Feeder Calf Price in $1 per Hundredweight					
	$30.00	$34.00	$38.00	$42.00	$46.00	$50.00
	Net Present Value of Investment					
4%	$72.34	$151.60	$230.86	$310.12	$389.38	$468.64
6	38.17	112.52	186.87	261.22	335.57	409.92
8	7.77	77.66	147.56	217.46	287.36	357.26
10	-19.38	46.47	112.33	178.18	244.03	309.88
12	-43.66	18.50	80.67	142.83	205.00	267.16

feeder calves and the firm's cost of capital. These data serve to point out the apparent unprofitability of a beef cow operation. An investment in a beef cow, when all costs are considered, will generate revenues sufficient to cover these costs and provide a return on invested capital equal to the firm's cost of capital only at relatively high calf prices and low costs of capital. Whereas, an investment in an additional cow will cover variable costs and provide a return on invested capital with relatively lower calf prices and higher costs of capital.

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. This result is completely consistent with the findings of previous studies of costs and returns of beef cow operations. Almost without exception, the studies reviewed found beef cow operations to be quite unprofitable.[5] Realizing that all costs (both variable and fixed) must be covered in the long run, this raises questions as to why a farmer would enter into a beef cow operation and why expansion of beef cow operations would occur.

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[5]This is the general type of conclusion reached by almost all, if not all, of the studies of costs and returns of beef cow operations reviewed by the author. Numerous studies of this nature are listed in the bibliography.

As pointed out in Chapter Two, one of the main reasons for the existence of many beef cow operations is the lack of any alternate use for the owners' resources. This is especially true in the western United States, but it does not explain the expansion of beef cow herds in other areas. Various studies have looked at this question of why beef cow operators continue in operation and even expand when they apparently fail to cover all costs in the long run. Studies by Martin and Jefferies [105], Smith and Martin [143], and Morgan and Huffman [114] suggest that factors in addition to the economic factors normally considered may influence the farmer's decision to undertake a beef cow operation. These studies found various noneconomic factors that may affect the decision. These include: 1) land fundamentalism, 2) rural fundamentalism, 3) conspicuous consumption, 4) joys of working with beef cows, 5) beef cow operation works well with off-farm employment, and other such socioeconomic reasons.

This may explain why farmers continue to raise beef cows even though they appear to be quite unprofitable. Farmers simply consider the opportunities for the use of their fixed factors and choose to invest in a beef cow operation even though it may not cover all costs in the long run. They disregard the opportunity costs of their fixed resources and consider only the variable costs when making investment decisions. Hence, this consideration of the socioeconomic aspects of the beef cow operators' investment decision would help explain the increase in the size of the aggregate beef cow herd even though such operations appear to be unprofitable when all costs are considered.

Therefore, when one is considering the beef cow operator's investment decision, it appears that only the variable costs are relevant. If fixed resources such as land, buildings, and family labor are taken as given by the beef cow operator, as the budgets in this analysis and the findings of previous studies indicate, then these fixed costs are not considered. Thus, the decision concerning investment in beef cows would consider the net present value of the investment using variable costs only. This is the rationale for using the partial analysis in the previous explanation of net present value analysis.

A Consideration of Disinvestment

The previous discussion looked at the beef cow operator's investment decision. But, as pointed out by Johnson [75], there is another aspect of the decision, disinvestment. A beef cow has a limited life span. At some point in time she will either be sold for slaughter or die. The farmer would prefer to sell her before she dies, but how does he reach this decision?

Using net present value analysis we can present a framework the beef cow operator may use in making the disinvestment decision. If the discounted net returns of the sale of both the cow and calf next year are not equal to or greater than what the cow would bring if sold for slaughter this year, then the firm should disinvest (i.e., sell the cow). By increasing the variable costs to reflect increased maintenance costs for the cow (such as greater expense for drugs and veterinary, opportunity cost for labor that could be spent tending to other cows, etc.) and increasing the discount rate (to reflect the much greater death risk and the higher probability that the cow will not be capable of bearing and raising a calf), we can see how the decision is reached.

For example, if we use the previous investment example and increase costs by $20.00, increase the discount rate to 30 percent, and consider a one year time horizon, the NPV would be:

$$NPV = -\$200 + \frac{(\$143.64 - \$86)}{(1 + .30)^1} + \frac{\$200}{(1 + .30)^1}$$

$$= -\$200 + \$44.34 + \$153.85$$

$$NPV = -\$1.81.$$

Therefore, the NPV of -$1.81 would indicate that the firm should sell this cow this year rather than keep her for another year. There are undoubtedly other factors that may affect the disinvestment decision, but this type of framework indicates the important variables that influence the decision.

Summary

This discussion of the theoretical aspects of the beef cow investment decision has presented a framework that seems to be appropriate to the decision process. It has also set out the types of economic information that would likely be used by the beef cow operator. But the appropriateness and usefulness of this type of analysis is unknown until it is tested empirically.

SPECIFICATION OF ECONOMIC MODEL

The basic assumption that underlies the analysis undertaken in this study is that the major determinant of the long run supply of beef is the size of the beef cow breeding herd. Given that assumption, the factors that determine the size of the beef cow breeding herd are the rates of investment and disinvestment. The number of cows in the herd at any point in time (t), is determined by the number of cows in the herd at time (t-1), plus the number of heifers added to the herd during the period (t-1) to (t), less those cows which were culled or died during the same period. Therefore, the economic factors that affect the size of the beef cow breeding herd should manifest themselves through their effects on the number of heifers placed in the herd and the number of mature cows culled from the herd.

The previous theoretical discussion of a beef cow owner's decision to invest or disinvest suggested the factors that affect these decisions. We can use this theoretical basis to formulate two economic relationships that represent the decisions made by the beef cow farmer. One relationship represents the investment decision, the other the disinvestment decision.

The Investment Decision

The theoretical model of the farmer's decision to invest in additional beef cows used net present value analysis as a method of evaluating the investment. We can relate the amount of investment in beef cows undertaken by a beef cow operator to those factors that theoretically should influence the decision in a single equation. The general form of the equation would be:

Amount of Investment = F(returns, costs, cost of capital or discount rate).

In a world of certainty, this general equation should represent the major factors that determine a farmer's decision to invest in a beef cow. But, the farmer does not live in a world of certainty. Hence, he does not know with certainty what the various returns and costs will be in the future. Therefore, the decision maker would undoubtedly use some type of expected returns and costs in determining the investment he should make. This would then change the economic relationship and the general equation to the following:

Amount of Investment = F(expected returns, expected costs, cost of capital).

As it stands, this equation represents the demand for heifers to be placed in the breeding herd. If the farmer is depending on credit to finance the investment, then the availability of credit may act to limit investment demand. Therefore, consideration of credit availability should be introduced into the equation. The resulting economic relationship would be:

Amount of Investment = F(expected returns, expected costs, cost of capital, credit availability).

But, the actual number of heifers that can enter the herd at any particular point in time is limited by the supply of heifers that are available to enter the breeding herd. Therefore, we must incorporate this supply constraint into the economic relationship. The resulting general equation would be:

Amount of Investment = F(supply of heifers, expected returns, expected costs, cost of capital, credit availability).

This equation should now be complete. It contains both the supply of investment goods available and the demand for investment goods. Their interaction should then determine the amount of investment made by the beef cow operator. We can use this single equation to test the theoretical model of investment previously set out. In the process we will be able to assess the impact that changing monetary and credit conditions has on the investment in beef cows.

The Disinvestment Decision

The decision to disinvest in a beef cow is much like the investment decision. The farmer that owns a herd of beef cows knows that each cow has a limited productive life, and it is to his benefit to sell the aged cow before she dies. Therefore, as specified earlier, he would make his disinvestment decision based on the cow's value if sold for slaughter versus the expected net returns she would provide if held one more year. Again we can represent this economic relationship in a single equation.

Amount of Disinvestment = F(supply of heifers for replacement, salvage value, expected returns, expected costs, cost of capital).

This equation represents the disinvestment decision and is quite similar to the investment equation. Salvage value is included as well as expected returns to reflect the opportunity to sell the cull cow during the current period (i.e., disinvest). In addition, the credit availability factor does not appear in this equation since it should not influence the disinvestment decision. The other factors are the same as those appearing in the economic relationship representing the beef cow operator's investment decision.

The Full Effect of Investment and Disinvestment

To see the full effect of both investment and disinvestment on the beef cow herd one can use the identity:

Beef cows in herd$_{(t)}$ ≡ Beef cows in herd$_{(t-1)}$ + Heifers added to herd$_{(t-1) \text{ to } (t)}$ (investment) - Beef cows culled from herd$_{(t-1) \text{ to } (t)}$ (disinvestment) - Beef cows that died$_{(t-1) \text{ to } (t)}$.

This incorporates both the effects of investment and disinvestment in determining the size of the beef cow herd. While this is a simple physical identity, the economic factors that act to determine the size of the beef herd are introduced via investment and disinvestment. As such, this explicitly considers the beef cow operator's decisions that do, in fact, determine the size of the herd.

Now that we have specified the general form of the economic model, we can proceed to specify the relationship more specifically and test the model empirically.

TESTING THE ECONOMIC MODEL

To test the economic model we will look at the United States beef cow industry during the period 1952 to 1971. We will use the two equations, which should represent a farmer's investment and disinvestment decisions, to attempt to explain the amount of investment and disinvestment that has occurred in the beef cow herd during the 20-year period. In so doing, we will attempt to isolate the economic effect of each of the factors hypothesized to influence the decision process. This should allow us to analyze the impact of changing monetary policy and credit conditions on the beef cow industry. Thereby, we should be able to answer the basic question and test the hypothesis set out in the introduction to this study.

Definition of Variables

Testing of the economic model requires quantitative measurement of investment, disinvestment, and the factors that we have set out as influencing the respective decisions. The following variables, as herein defined, will be used as these quantitative measures. They will be functionally related in the form of the two single equations to explain the annual investment and disinvestment in the beef cow herd during the 20-year period under analysis.

$BCOFAM_t$ = Other[6] cows, 2 years old and older, in January 1 farm inventory that were not on feed (in 1,000 head).[7]

$BKNOFD_t$ = Other calves in January 1 farm inventory that were not on feed (in 1,000 head).[7]

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[6]Other than dairy.

[7]Data for these variables were not directly available from secondary sources, but were derived using data that were available. See Appendix A for specific method of derivation, data sources, and data used in analysis.

$RBHEFK_t$ = Other heifers, 1 to 2 years old, in January 1 farm inventory that were not on feed (in 1,000 head).[7]

$BCNDEA_t$ = Other cows, 2 years old and older, not on feed which died during year t (in 1,000 head).[7]

$NBECCUL_t$ = $(BCOFAM_t + RBHEFK_t - BCNDEA_t - BCOFAM_{(t+1)})$, an estimate of the number of other cows culled during year t (in 1,000 head).

$NCULRAT_t = \frac{NBECCUL_t}{BCOFAM_t}$, a measure of the annual cull rate.

$PRIKAF_t$ = Feeder calf price: Annual average price in dollars per 100 pounds for good and choice steer calves at Kansas City. Source: [155 and 156, Table 155].

$CULCOP_t$ = Cull cow price: Annual average price in dollars per 100 pounds for commercial grade slaughter cows at Chicago.[8] Source: [155 and 156, Table 161-3].

$PRIHAY_t$ = Annual average price in dollars per ton received by farmers for all hay, baled. Source: [161].

$KHPRAT_t$ = Calf-hay price ratio; $\frac{PRIKAF_t}{PRIHAY_t}$.

$RANCON_t$ = Annual average range feed conditions in 17 western states as a percent of normal. Source: [155 and 156, Table 85].

$FICBLR_t$ = Annual average interest rates in percentage points charged by the Federal Intermediate Credit Banks. Source: [169 and 168].

$CBTDIF_t$ = (Annual average market yield in percentage points on Baa corporate bond - Annual average market yield in percentage points on 3-month treasury bills), a measure of credit availability. Source: [6].

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[8]The Chicago market closed during 1971, therefore adjusted Omaha prices were used for 1971.

We can use these variables to specify the equations to be estimated. Here it should be pointed out that the variables defined and used in this model are not ideal. The variables that measure the various animal numbers are particularly inadequate. The inventory numbers suffer from lack of clear definition and specification as reported by the U.S.D.A. There is no published data concerning the number of cull beef cows removed from the herd or sold for slaughter. Therefore, this data series must be derived by means that leaves much to be desired. But, these difficulties have been pointed out by Ives [72], and will not be dwelled upon here.

Equations to be Tested

Investment

Substituting the specific variables into the general investment equation set out earlier, we have the following relationship to be tested:

$$RBHEFK_t = F(BKNOFD_{(t-1)}, PRIKAF_{(t-1)}, PRIHAY_{(t-1)}, RANCON_{(t-1)}, FICBLR_{(t-1)}, CBTDIF_{(t-1)}).$$

Using this equation let us look at how we expect each of the independent variables (those on the right hand side) to influence the dependent variable ($RBHEFK_t$).

Beef Calves Not on Feed (BKNOFD)

$BKNOFD_{(t-1)}$ represents the source of supply of heifer calves that can be saved for addition to the national beef herd. This variable was specified to exclude those calves on feed since they would not likely be taken off feed to be placed in the breeding herd.[9]

The relationship between $RBHEFK_{(t)}$ and $BKNOFD_{(t-1)}$ is expected to be positive. A large supply of calves in (t-1) would make a large supply of heifer calves available to be saved for replacement stock or herd expansion in t. A small supply of calves would act to limit the supply of heifers and reduce the number of heifers being put in the herd.

Price of Feeder Calves (PRIKAF)

The feeder calf price is the source of returns to the beef cow investment. Therefore, expectations concerning the future price of calves should influence the investment decision. As specified here, the expectation model assumes future prices will be those that are experienced at the time the decision is made. Since the number of replacement heifers that are held in the January 1, t inventory is determined by decisions made during the (t-1) period, the prices that are relevant to the decision process are those that existed during (t-1).

Calf prices should influence the decision process such that a higher price of calves will encourage beef cow operators to place more heifers in the breeding herd. Hence, we would expect a positive relationship between $RBHEFK_{(t)}$ and $PRIKAF_{(t-1)}$.

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[9]According to the survey questionnaire used by the U.S.D.A. to collect cattle and calves on feed data, an animal is considered to be on feed if and only if it is being fattened for market [165, p. 87-121 and appendix].

Price of Hay (PRIHAY)

The price of hay is a variable used to measure the cost of keeping a beef cow and producing a calf. As the budget in Table IV-1 indicates, there are numerous variable costs in producing a feeder calf. But, the cost of hay is by far the largest. Thus it should influence the investment decision.

The price of hay should affect the decision in a manner just the opposite of the feeder calf price. As the cost of production increases, we would expect the number of heifers going into the herd to be reduced. Thus, a negative relationship between $RBHEFK_t$ and $PRIHAY_{(t-1)}$ would be expected.

Range Conditions (RANCON)

In addition to the price of hay as a cost of production, the range conditions that prevail during the period when the investment decision is made may influence it. Although it is not an explicit cost, it does act to determine the number of animals that can be grazed. This being the case, we would expect better range conditions to be associated with the retention of more heifers for addition to the beef herd. Hence, we would expect $RBHEFK_t$ to be positively associated with $RANCON_{(t-1)}$.

Federal Intermediate Credit Banks' Loan Rate (FICBLR)

The rate of interest charged on loans to individual Production Credit Associations by the 12 Federal Intermediate Credit Banks is used as a measure of the interest rates that existed in the agricultural sector during the period of analysis. As such, it is being used to represent the cost of capital or discount rate that would be used by beef cow operators as they evaluate their possible investments in beef heifers. While this interest rate may not be the actual discount rate used, it does represent the monetary and credit conditions that face the farmer as he makes the decision.

For example, if the farmer was using credit to finance his investment in beef heifers, this rate of interest, as it reflects changing monetary and credit conditions, should be directly related to the discount rate the farmer would apply to the investment. If he was using credit to finance part of the investment, then a more appropriate discount rate would be the firm's weighted average cost of capital, which is again directly related to this rate of interest. The weighted average cost of capital would then incorporate both the cost of credit and the cost of equity capital, measured as an opportunity cost of investing in the next best alternative investment.[10] Thus, as the rate of interest in the agricultural sector changes, it will affect both the cost of credit and the opportunity cost of using equity capital to finance the beef cow investment.

As demonstrated earlier, the net present value of an investment decreases as the discount rate increases. Therefore, we would expect the investment in heifers to be reduced as the

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[10]For a more extensive discussion of this point see Mao [104, chapter 10], Quirin [127, chapter 11], and Van Horne [173, chapters 4 and 6].

interest rate increases. As a result, we would expect $RBHEFK_t$ to be negatively related to $FICBLR_{(t-1)}$.

Credit Availability (CBTDIF)

The difference between the market yield on Baa corporate bonds and 3-month treasury bills is incorporated as a general measure of credit availability. This measure has been suggested by Evans [37, pp. 188-194] and used empirically by Hambor and Morgan [62]. The theoretical validity of this spread as a measure of credit availability is based on the term structure of interest rates which results from investor expectations about capital gains. The nature of the relationship between this spread, as a measure of credit availability, and monetary and credit conditions can be summarized by a statement made by Evans [37, p. 192]: "Thus easy money through its effects on expectations about capital gains will lead to a large spread between the interest rates, and tight money to a small spread."

Utilizing the nature of this relationship we can see how this measure of credit availability would be expected to influence the investment decision. If there is a limited amount of credit available, irregardless of the cost of credit, then this would be expected to limit the investment in beef heifers. Thus, using CBTDIF as a measure of credit availability we would expect more credit to be available when the spread is large than when it is small. Hence, we would expect $RBHEFK_t$ to be positively related to $CBTDIF_{(t-1)}$.

Using this rather extensive explanation of the specific nature of the investment in beef heifers as a reference, we can proceed to the disinvestment decision. By realizing that the nature of the decision to disinvest is quite similar to the investment decision we should be able to limit our discussion to a great extent.

Disinvestment

Using the general disinvestment relationship developed earlier and substituting the specific variables for the general terms we have the following relationship to be tested:

$$NBECCUL_t = F(RBHEFK_t, PRIKAF_t, CULCOP_t, FICBLR_t, RANCON_t, PRIHAY_t).$$

The rationale used to explain the investment relationship is equally applicable here. As returns ($PRIKAF_t$) increase or costs ($PRIHAY_t$) decrease we would expect the number of cows culled from the herd ($NBECCUL_t$) during the same period to decrease. Better range conditions ($RANCON_t$) will support more cows, therefore we would expect $NBECCUL_t$ to be negatively related to $RANCON_t$. A higher discount rate will result in a lower net present value of the continued investment in the aged beef cow, hence we would expect a positive relationship between $NBECCUL_t$ and $FICBLR_t$.

The relationship between $RBHEFK_t$ and $NBECCUL_t$ appears to be simultaneous in nature in this equation, and it probably is also true in the day-to-day operation of a beef herd. However, as specified here, it is not simultaneous but recursive. As the variables are defined (which is the only form in which the data are available), $RBHEFK_t$ is the January 1 inventory of heifers that are available for use as replacement stock and $NBECCUL_t$ is the number of cows culled during the whole year t. Thus, while $RBHEFK_t$ can, and as set out here does, influence the number of cows culled during the year t; the number of cows culled during the year t cannot influence the number of heifers held in inventory at the beginning of period t. As a result, the relationship is recursive rather than simultaneous as it might appear initially.

There is another difference between the investment and the disinvestment equation. Cull cow price ($CULCOP_t$) is included in the disinvestment relationship to represent beef cow salvage value, which affects the decision. A relatively high salvage value of cows should tend to encourage disinvestment. Therefore, we would expect $NBECCUL_t$ to be positively related to $CULCOP_t$.

We now have both of the equations specified such that they should explain investment and disinvestment in the beef cow herd. We can now proceed to test the relationships to determine the empirical verification of the theoretical relationships.

As the above economic model has been specified, it is not totally unlike previous models which have been developed.[11] In general, the previously developed models used similar measures of returns and costs to explain the number of animals held in farm inventories or the number of cows slaughtered. But, the models did

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[11]See Crom [19], Maki [100], Reutlinger [129], and Walters [176].

not explicitly treat farm inventory as investment in productive assets. Therefore, none of the studies considered capital and credit costs to be of importance. This is the major point of departure in this study from previous investigations.

Method of Testing

To test the economic model we can transform the structural model into a statistical model that can be estimated using ordinary least squares regression analysis. The general form of the statistical equations to be estimated would then be:

$$RBHEFK_t = \alpha + \beta_1\ BKNOFD_{(t-1)} + \beta_2\ PRIKAF_{(t-1)} + \beta_3\ PRIHAY_{(t-1)} + \beta_4\ RANCON_{(t-1)} + \beta_5\ FICBLR_{(t-1)} + \beta_6\ CBTDIF_{(t-1)} + e_t.$$

$$NBECCUL_t = \alpha + \beta_1\ RBHEFK_t + \beta_2\ PRIKAF_t + \beta_3\ CULCOP_t + \beta_4\ FICBLR_t + \beta_5\ RANCON_t + \beta_6\ PRIHAY_t + e_t.$$

These are the type of general equations to be tested, but the specific independent variables that are included in any particular equation will depend on the statistical problem of multicollinearity. The nature of the independent variables included suggests that collinearity may be a definite problem.

EMPIRICAL RESULTS

The following section presents and discusses the investment and disinvestment relationships which were estimated using ordinary least squares regression analysis. In conjunction with each estimated equation a number of statistics are presented which are useful for evaluating the fitted relationships. These statistics include the t-values, coefficients of determination (R^2's), and Durbin-Watson statistics.

<u>The Relationship Used to Explain Investment in the Beef Cow Herd</u>

Table IV-4 presents a summary of the results of the regression analysis used to estimate the investment relationship. Equation one is the estimated relationship using the variables as initially specified, except that the measure of credit availability is not included. The results are consistent with a priori expectations except for the PRIHAY. This measure of the costs of production had a statistically significant relationship with the wrong sign. There are at least three possible reasons for this result. First, a lack of variation in the price of hay could result in this type of relationship. Second, the price of hay as measured here may not actually represent the cost of production as a producer looks at it. Third, the relationship between costs and returns could have been such that an increase in the price of feeder calves more than offset the increase in the cost of hay.

Equation two is presented as a test of the last rationale for the incorrect relationship between $RBHEFK_t$ and $PRIHAY_{(t-1)}$. This equation substitutes a ratio of calf prices to hay cost (KHPRAT) for PRIKAF and PRIHAY. The resulting estimated relationship is consistent with a priori expectations, except that the measure of range

Table IV-4. Estimated relationships between investment in beef cows ($RBHEFK_t$) and selected explanatory variables, 1952-1971.

Equation Number	Explanatory Variables[a]			
	$BKNOFD_{(t-1)}$	$PRIKAF_{(t-1)}$	$FICBLR_{(t-1)}$	$RANCON_{(t-1)}$
1	.185* (3.27)	22.27 (.74)	-258.71*** (-1.91)	58.85 (1.32)
2	.246* (3.51)		-241.68 (-1.37)	-10.83 (-.19)
3	.271* (5.23)	72.27* (2.79)	-364.74** (-2.47)	-19.45 (-.53)
4	.270* (5.32)	64.93* (3.03)	-364.32** (-2.52)	
5	.276* (5.25)	62.42* (2.81)	-369.47** (-2.50)	

[a]Numbers in parenthesis are t-values. One, two and three asterisks denote statistical significance at .01, .05, and .10 levels respectively.

[b]All Durbin-Watson statistics fall in inconclusive region at 5% level of statistical significance except equation two for which the D-W statistic falls in inconclusive region at 1% level.

Explanatory Variables[a]					
$PRIHAY_{(t-1)}$	$KHPRAT_{(t-1)}$	$CBTDIF_{(t-1)}$	Constant	R^2	D-W[b]
189.69** (2.50)			-6103.89	.879	1.35
	937.98 (1.07)		1763.27	.763	.70
			1606.06	.829	1.09
			334.37	.826	1.07
		97.23 (.61)	135.37	.830	1.04

conditions has an incorrect sign. Again, a hypothesized measure of production cost has an incorrect relationship. Hence, it appears that feeder calf producers do not react to the costs of production, as measured here, in a manner consistent with theoretical expectations. For this reason, costs of production were dropped from the estimated relationship in equation four.

The reformulated relationship in equation four is completely consistent with a priori expectations. This equation explains 83 percent of the variation in investment in heifers to be put into the beef cow herd. The three included explanatory variables are statistically significant at the 5 percent level. The importance of lagged inventory and price variables (such as BKNOFD and PRIKAF) has been emphasized in previous studies (see footnote 11), and will not be dwelled on here. It is sufficient to say that the importance of each of these variables has been previously recognized. The same cannot be said for the interest rate variable included in this equation.

The estimated relationship in equation four indicates that a one percentage point increase in the interest rate charged by Federal Intermediate Credit Banks in one year will decrease the number of heifers being placed in the beef cow herd the following year by 364,000 head. This represents about six percent of the annual average number of heifers placed in the beef cow herd over the 20-year period studied. By comparison, it would require more than a $5.00 decline in the price of feeder calves to reduce the investment in heifers by a similar amount. This suggests that the interest rate has substantial influence on the investment decisions made by feeder calf producers.

Another aspect of monetary and credit conditions is included in equation five. Here, CBTDIF (a measure of credit availability) was added to equation four. The resulting relationship is essentially the same as that estimated for equation four. The relationship between RBHEFK and CBTDIF is consistent with a priori expectations, but it is not statistically significant. It does indicate that the investment in beef heifers increases as the supply of credit increases (i.e., the spread between long and short term interest rates increases). But, the size of the t-value associated with the coefficient of CBTDIF indicates that we should not be too confident of the estimated relationship.

In summary, this analysis of investment in the beef cow herd suggests that monetary and credit conditions do influence feeder calf producer investment decisions. The interest rate variable appears to be more reliable than the credit availability variable. Thus, we have shed some light on the basic question concerning monetary policy and the supply of beef. Now let us turn to the disinvestment decision.

The Relationship Used to Explain Beef Cow Herd Disinvestment

Table IV-5 presents a summary of the results of the regression analysis used to estimate the disinvestment relationship. Equation one presents the estimated relationship as initially specified in the theoretical model. The results are consistent with

Table IV-5. Estimated relationships between beef cow disinvestment ($NBECCUL_t$) and selected explanatory variables, 1952-1971.

Equation Number	Explanatory Variables[a]				
	$RBHEFK_t$	$PRIKAF_t$	$CULCOP_t$	$FICBLR_t$	$RANCON_t$
1	.697 (1.30)	-172.16 (-1.58)	130.89 (.87)	473.37* (2.86)	-104.85 (-.98)
2	.164 (.45)		-59.51 (-.65)	368.76** (2.36)	-9.58 (-.10)
3	.393 (1.56)	-184.16*** (-1.75)	94.20 (.69)	471.22* (2.90)	-48.21 (-.80)
4	.435*** (1.78)	-202.99*** (-2.00)	102.34 (.76)	454.98* (2.85)	
5	.376 (1.46)	-248.68*** (-1.79)	161.74 (.97)	535.67* (2.86)	-40.44 (-.65)
6	.408 (1.65)	-274.00** (-2.09)	178.83 (1.11)	532.43* (2.90)	

[a]Numbers in parenthesis are t-values. One, two, and three asterisks denote statistical significance at .01, .05, and .10 levels respectively.

[b]All Durbin-Watson statistics fall in inconclusive region at 5 percent level of statistical significance.

Explanatory Variables[a]			Constant	R^2	D-W[b]
$PRIHAY_t$	$KHPRAT_t$	$CBTDIF_t$			
-153.87 (-.64)			12,160.60	.766	1.21
	-2,085.78 (-.92)		5,914.94	.728	1.14
			7,025.84	.759	1.23
			3,529.41	.750	1.12
		188.61 (.73)	6,499.92	.768	1.31
		217.82 (.87)	3,572.46	.761	1.28

a priori expectations for all variables except the cost of production variable, PRIHAY. The same problems that were encountered in the investment relationship appear to be present here. Again, KHPRAT was substituted for PRIKAF and PRIHAY, and the resulting relationship again suggests that producers do react as expected. But, the use of the price ratio introduced a great deal of multicollinearity into the relationship. Therefore, the price of hay was dropped from the relationship in equations three through six.

The estimated relationships in equations three and four are completely consistent with theoretical expectations. Again, let us point out, as have other studies, the importance of the lagged inventory supply and calf price variables. However, few previous studies have considered the price of cull cows sold for slaughter to be an important factor affecting the culling decision.[12] The results contained in Table IV-5 indicate that the cull cow price does affect the number of cull cows sold. While the coefficient of CULCOP was not statistically significant in any estimated equation (believed to be due to a high degree of collinearity between PRIKAF and CULCOP), the relative size and rather consistent sign of the regression coefficient suggests that it might be of economic importance in determining the disinvestment decision of feeder calf producers. Recognizing the importance of the price and lagged inventory variable, let us move on to the considerations that are of major interest in this analysis.

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[12]For example see Reutlinger [129, p. 912] where he states that "While for cow slaughter it may be assumed that 'available' supplies do not depend appreciably on price, ..."

Equation four indicates that an increase of one percentage point in the rate of interest will result in an additional 455,000 cows being culled from the existing beef herd. This represents approximately 14 percent of the annual average number of cows culled during the 20-year period of the analysis. Thus, the interest rate appears to have an even larger relative impact on beef cow herd disinvestment than it did on investment. Again, we see that the interest rate appears to have an economically significant impact on the beef cow industry.

Although it was not included in the theoretical model, the credit availability variable was added in equations five and six. These estimated relationships indicate that larger supplies of credit are associated with increased beef cow culling. This could be due to producers' use of credit to add new heifers to the herd to replace cull cows and thereby reduce the risk associated with carrying aged cows.

Thus, again we have more empirical support for our theoretical argument concerning the relationship between monetary and credit conditions and the beef cow herd. At least one criticism might be leveled against this model of beef cow disinvestment. This involves the idea that the number of cows culled from the herd does not depend on the number of heifers kept for replacement, but rather on the number of cows in the herd. As such, this relationship would be more physical and less economic in nature than the previously specified equation.

Table IV-6 presents a summary of the results of the regression analysis of the disinvestment decision, where BCOFAM has been substituted for RBHEFK in each of the equations. In general, the results are quite consistent with the results presented in Table IV-5. The proportion of variation explained has increased somewhat, and the economic and statistical significance of the interest rate variable has been reduced. This suggests that the impact of monetary and credit conditions may not be as great as the analysis of Table IV-5 might indicate.

A final method of looking at the disinvestment decision would be to simply consider the cull rate (number culled as proportion of total herd) rather than the number culled. The resulting estimated relationship is:

$$NCULRAT_t = .46373593 - \underset{(-1.14)}{.00000851RBHEFK_t} - \underset{(-2.00)}{.00623556\overset{***}{PRIKAF}_t}$$

$$+ \underset{(.78)}{.00315350CULCOP_t} + \underset{(1.99)}{.00956866\overset{***}{FICBLR}_t} - \underset{(-1.39)}{.00246943RANCON_t}$$

R^2 = .652

D-W = 1.17

Here the statistical significance of the interest rate variable indicates it to be an important determinant of the culling rate. Thus, it appears that the monetary and credit conditions do influence the disinvestment decision. But the magnitude of the impact is uncertain. The analysis of equation four (Table IV-5) indicates a 455,000 change in the number of cows culled for an interest rate change of one percent, whereas equation four (Table IV-6) indicates only a 108,000 change. But, even the smaller change represents over three percent

Table IV-6. Alternative estimated relationships between beef cow disinvestment ($NBECCUL_t$) and selected explanatory variables, 1952-1971.

Equation Number	Explanatory Variables[a]				
	$BCOFAM_t$	$PRIKAF_t$	$CULCOP_t$	$FICBLR_t$	$RANCON_t$
1	.226* (3.36)	-203.07** (-2.37)	231.20*** (1.88)	55.48 (.29)	-112.90 (-1.60)
2	.125*** (1.98)		-56.29 (-.78)	28.67 (.13)	-26.91 (-.35)
3	.155* (3.16)	-207.53** (-2.33)	162.31 (1.38)	130.11 (.68)	-37.35 (-.74)
4	.162* (3.41)	-223.26** (-2.62)	171.09 (1.48)	108.26 (.58)	
5	.151* (2.98)	-248.71** (-2.12)	204.21 (1.44)	181.25 (.84)	-32.62 (-.63)
6	.156* (3.18)	-269.72** (-2.44)	219.46 (1.60)	172.20 (.82)	

[a]Numbers in parenthesis are t-values. One, two, and three asterisks denote statistical significance at .01, .05, and .10 levels respectively.

[b]All Durbin-Watson statistics fall in inconclusive region at 5 percent level of statistical significance.

Explanatory Variables[a]			Constant	R^2	D-W[b]
$PRIHAY_t$	$KHPRAT_t$	$CBTDIF_t$			
-191.92 (-1.48)			12,266.31	.852	1.36
	-1197.85 (-.70)		5,033.19	.779	.83
			5,055.82	.829	1.01
			2,370.89	.824	.93
		122.23 (.55)	4,769.58	.833	1.09
		144.96 (.68)	2,434.81	.829	1.08

of the annual average number of cows culled during the 20-year period.

Thus, again we have reason to believe that monetary and credit conditions do influence the decisions made by the feeder calf producer. To see the full impact of monetary and credit conditions let us combine the investment and disinvestment decisions.

The Impact of Monetary and Credit Conditions on the Beef Cow Herd

We can combine the effects of the interest rate on both the investment and disinvestment decisions to see how it affected the size of the beef cow herd over the 20-year period. From Table IV-4, equation four, we see that a change in the interest rate of one percentage point, holding all other variables constant, results in a change of 364,000 head in the annual average number of heifers placed in the breeding herd. The estimated relationships in Tables IV-5 and IV-6, equation four, indicate that the same change in the rate of interest will change the average number of cows culled from the breeding herd by either 108,000 or 455,000 head. And the relationships are such that they are cumulative rather than offsetting.

For example, let's assume that during the year (t-1), the FICBLR was on the average one percentage point higher than it was during the year (t-2) and all other variables are held constant. This higher rate of interest in (t-1) will result in from 108,000 (equation 4, Table IV-6) to 455,000 (equation 4, Table IV-5) additional cows being culled from the beef herd during (t-1). It will also result in 364,000 fewer heifers being held back as replacement stock during (t-1) to be held in inventory, as measured in this model by RBHEFK, at the beginning of year t. Therefore, the cumulative effect of the increased rate of interest will result in a breeding herd in year t that is from 472,000 (364,000 + 108,000) to 819,000 (364,000 + 455,000) head smaller than it would have been in the absence of the increased interest rate, assuming the interest rate has no effect on the other independent variables.

The magnitude of this change represents from 1.7 to 2.9 percent of the average number of breeding cows in the beef herd for a change of one percentage point in the rate of interest during the 20-year study period. When we consider that the FICBLR has ranged from a low of 2.22 percent to a high of 8.50 percent during the period, this suggests that the interest rate could have had a significant impact on the size of the beef cow breeding herd through its influence on feeder calf producer investment and disinvestment decisions.

There are also indications that credit availability acts to influence investment decisions in addition to the rate of interest. This again reinforces the idea that monetary and credit conditions do affect the size of the beef cow breeding herd through the influence they have on producer investment decisions.

Thus, the results of this model of investment and disinvestment in the beef cow industry are consistent with the findings of previous studies concerning the effect of monetary and credit conditions on industrial and other types of investment.[13] Also, the results with respect to the relationship between investment and disinvestment in the beef cow herd and prices and costs are generally consistent with the findings of previous studies.[14] All of these results tend to confirm the general thrust of the findings of this analysis of the beef cow industry.

In summary, this analysis of the investment and disinvestment decisions of feeder calf producers provides evidence that monetary policy, as it determines monetary and credit conditions, does affect the beef cow industry. The findings generally indicate that a tight money policy during one year will result in a beef cow breeding herd that is smaller in the following year than it would have been in the absence of the tight money policy. This smaller breeding herd would result in a smaller supply of beef reaching the slaughter market two or three years in the future. This reduced beef supply then acts to increase the price of beef during subsequent time periods.

Thus we have provided some insight into the basic question set out in Chapter One. But, to ascertain quantitative estimates of the magnitude of the effect monetary policy has on the beef industry, we must look at the effect on beef supplies and prices.

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[13]See Chapter Three for a short summary of such investigations.

[14]See footnote 11.

THE ECONOMIC IMPACT OF MONETARY AND CREDIT CONDITIONS ON THE SUPPLY AND PRICE OF BEEF

First Order Impact on Supply of Beef

To look at the possible impact monetary and credit conditions have had on the supply and price of beef, let us look at the current situation. For the past year beef prices have been high relative to historical levels. It is generally believed that this is due primarily to a demand phenomenon. But, the relatively high interest rates that existed during 1969 and 1970 suggest, in light of the present analysis, that a reduced beef supply as a result of the relatively high interest rate during this period may have acted to accentuate the high beef prices.

The interest rates in existence during 1969 and 1970 were about 1.7 percentage points higher than they were in 1967 and 1968. Using equation four in Tables IV-4, IV-5, IV-6, we can see that this increase of 1.7 percentage points in the general level of the interest rate would result in a beef cow breeding herd that was from 802,400 to 1,392,300 head smaller in 1970-1971 than it would have been if the interest rate had remained at the level of 1967-1968.[15] This reduction in the potential size of the breeding herd that existed in 1970-1971 would then tend to reduce the number of steers and heifers going to slaughter in 1972-1973.

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[15]This results from the combined effect of the 1.7 percentage points higher interest rate on RBHEFK and NBECCUL. Using equation four in Tables IV-4 and IV-6 the reduction is 1.7 X 472,000 = 802,400, and equation four in Tables IV-4 and IV-5 the reduction is 1.7 x 819,000 = 1,392,300.

To see the impact of this reduction in the potential size of the breeding herd, we can estimate the amount of beef that would have been produced if there had been no increase in the rate of interest. Applying the 90 percent calving rate that was achieved during the 1969-1970 period, the 802,400 to 1,392,300 cows would have produced 721,800 to 1,253,070 calves. Assuming the 3.8 percent death rate that was experienced during the period to be applicable, 694,372 to 1,205,453 of the calves that were born would have survived to be potential slaughter animals. Assuming 50 percent of the animals to be steers and 50 percent to be heifers, there would have been 347,186 to 602,767 of each, steers and heifers, that could potentially have gone to slaughter.

Applying the average slaughter weight of steers and heifers (1137.37 and 964.17 lbs. respectively)[16] slaughtered during 1972, we find that from 729,437,786 to 1,266,412,503 pounds of steer and heifer could have potentially been added to the total supply of steer and heifer beef. Considering that 31,503,107,968 pounds of steer and heifer beef were produced in 1972,[17] we can see that this potential supply would have amounted to between 2.32 and 4.02 percent of the total supply of steer and heifer beef in 1972.

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[16] Derived from [157] using average dressed weight for steers and heifers (682.42 lbs. and 578.50 lbs. respectively) and an assumed 60 percent dressing yield.

[17] Derived from [157] using number of steers and heifers slaughtered under federal inspection, the average slaughter weight and adjusting by 1.109271 to get commercial steer and heifer slaughter.

In summary, we see that the change in monetary and credit conditions from 1967-1968 to 1969-1970, as reflected by the interest rate charged by Federal Intermediate Credit Banks, could have resulted in a 2 to 4 percent smaller supply of beef going to slaughter in 1972-1973. This indicates the magnitude of the effect monetary policy could have had on the supply of beef. To determine the economic significance of this impact, we must look at the effect such a reduction in the beef supply would have had on beef prices.

First Order Impact on Beef Prices

To determine the effect of a 2.32 to 4.02 percent reduction in the potential supply of steer and heifer beef on the price of steers and heifers, we can employ the concept of price flexibility. A price flexibility coefficient indicates the effect of a one percent change in the quantity marketed upon the price of the product [10, p. 26]. Brandow has estimated the farm level price flexibility[18] for cattle to be -1.5862 [10, Table 13].

Using this price flexibility coefficient, we see that the 2.32 to 4.02 percent reduction in supply would have resulted in a 3.68 to 6.38 percent increase in the farm price of steers and heifers. The average price received by farmers for steers and heifers in 1972 was $35.58 per c.w.t. [157]. If the rate of interest during the 1969-1970 period had been at the level it was in the

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[18]This is a "quasi" price flexibility measure which Brandow suggests to be superior to a true price flexibility for applications of this type.

1967-1968 period, the price farmers received for steers and heifers would have been $33.45 to $34.31 per c.w.t. Thus, changing monetary and credit conditions may have been responsible for an increase of $1.27 to $2.17 per hundredweight in the farm level price of beef.

As this higher farm level price has been reflected through the whole marketing system, it could certainly account for some of the increase in beef prices that has occurred during the past year. Thus, we have some estimate of the economic impact monetary policy may have had on the supply and price of beef. But, this analysis has considered the first order effects only. Second order effects of the impact of monetary and credit conditions could serve to accentuate or ameliorate the initial effects.

Consideration of Second Order Impacts on Beef Supply and Price

The impact of changes in the size of the beef cow herd in one year will have a continuing effect for a number of years in the future. If there are a large number of cows culled and a small number of heifers saved for replacement this year, the size of the reproductive herd is smaller next year. Therefore, there are fewer animals available for reproduction and the capacity for expansion of the herd in subsequent years is reduced. As this protracted size of the beef cow herd is carried forward into the future, the effects would tend to grow until economic conditions lead to their correction. These are the second order impacts of changing monetary and credit conditions on the beef industry.

Attempts were made to identify the magnitude of these second order impacts. Using the identity:

$$\widehat{BCOFAM}_t \equiv \widehat{BCOFAM}_{(t-1)} + \widehat{RBHEFK}_{(t-1)} - \widehat{NBECCUL}_{(t-1)} - BCNDEA_{(t-1)},$$

and an assumed interest rate ceiling of six percent, which would have been in effect during the years 1968 through 1971, the $BCOFAM_t$ was estimated for each of the 20 years under analysis. A comparison of estimated BCOFAM and observed BCOFAM indicated a biased, nonrandom pattern of under and over estimation of the number of beef cows on farms during the period. This biased estimate of BCOFAM was believed to result from serial correlation of the errors of each of the independent estimates (RBHEFK and NBECCUL) used in the identity and the method of calculating BCNDEA.

Recognizing this bias and the fact that little confidence can be placed in the results, the effect of the lower rate of interest was traced through the production process in the same manner used in the analysis of the first order impacts. The results indicate that the average effect of the lower rate of interest on the supply of beef in 1972 and 1973 was from 1.94 to 4.78 percent. This is quite comparable to the range of 2.32 to 4.02 percent estimated in the analysis of the first order impact, which suggests that the second order impacts on supply and therefore prices may not be too large. But, these results do tend to confirm the findings of the previous analysis. Thus, the high interest rate experienced during 1969 and 1970 could have resulted in a beef price in 1972 and 1973 that was from \$1 to \$2 per c.w.t.

greater than it would have been if the interest rate had remained at its 1967-1968 level.

This is not to imply that monetary policy has been fully responsible for the higher beef prices that have been experienced recently. It has not. But, the tight money policies employed by the Federal Reserve during 1969-1970 would seem to have contributed to the higher beef prices we have recently experienced.

Summary

This example of the impact of monetary policy on the beef cow industry and the resulting supply and price of beef suggests that monetary policy does affect the beef industry. Specifically, the results of this analysis indicate that monetary policy, used to control inflation, does have an adverse effect on the supply of beef in subsequent time periods. Based on these results, we would reject the null hypothesis that monetary policy does not affect the supply of beef, and accept the alternative that monetary policy does affect the supply of beef.

Chapter V

MONETARY POLICY, CREDIT CONDITIONS AND THE BEEF FEEDING INDUSTRY

INTRODUCTION

The analysis of Chapter Four explained how monetary policy affects the supply of beef through its influence on the beef cow industry and the production of feeder calves. But, as pointed out in Chapter Two, beef feeding has contributed to the increased productivity of the beef industry. Thus, the logical question arises: How does monetary policy affect the beef feeding industry and thereby the supply of beef? This is the question to which the following analysis addresses itself.

IMPORTANCE OF THE BEEF FEEDING INDUSTRY

Function of Beef Feeding Industry

The beef feeding industry, as viewed in this analysis, performs the functions of obtaining, maintaining, and feeding feeder calves on concentrate rations until they reach slaughter weight and are sold as grain fed steers and heifers. The place of the beef feeding industry in the production process was shown in Figure 1. Thus, the beef feeding function involves the addition of weight to the feeder calf. The beef feeder obtains a 300-500 pound feeder calf and feeds it to a weight of 1000-1100 pounds and sells it for slaughter. But, how can the beef feeding industry change the supply of beef if they perform only the simple but important processing functions just outlined?

Influence of Beef Feeding Industry on Beef Supply

Short Run Considerations

The most obvious method by which the beef feeding industry can change the supply of beef is by changing the weight to which animals are fed. They can feed to different weights depending on the cost of feeding and the price of the finished product. However, the economics of feeding to heavier weights makes this method of increasing the supply of beef economically infeasible. The historical variation in average slaughter weights indicates that this is not subject to a great deal of change over time. Therefore, increasing the finished weight of fed cattle does not seem to be an economical method of increasing the supply of beef.[1]

A second possible method of changing the supply of beef is through variation of the time required for an animal to reach slaughter weight. Beef feeders may vary the speed with which they finish an animal. But, this does not change the actual supply of

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[1]This does not consider the possibility of changing the type of animal put on feed through cross breeding. It may be feasible to feed such animals to heavier weights, but these changes must occur in the beef cow industry as a result of economic incentives provided by the beef feeding industry.

beef. It simply changes the pattern of marketing of fed animals. Thus, animals that are not slaughtered this month will go to slaughter next month, but this will not change the supply of beef that will eventually reach the market.

Therefore, it appears that the beef feeding industry cannot change the supply of beef in the short run to any great extent. Beef feeders can marginally adjust the finished slaughter weight and the time of marketing and thereby influence the total supply of beef in the short run to meet changing economic conditions. But, they cannot exert a significant effect on the short run supply of beef.

Long Run Considerations

The beef feeding industry can change the supply of beef by changing the number of animals that are fed. Therefore, in the longer run, beef feeders can increase the supply of beef by feeding more animals. As pointed out in Chapter Two, they have done this in the past and have increased the productivity of the beef industry a great deal in the process. However, the supply of feeder calves limits the number of animals that can be placed on feed. Beef feeders have progressively drawn calves off pasture and away from veal slaughter to the extent that nearly all, if not all, of the animals that are available and suitable for feeding are being fed. Therefore, beef feeders have apparently exhausted much of the potential for increasing supply which they have enjoyed in the past.

Greater Efficiency in Beef Feeding Industry

Given the fact that beef feeders are feeding all of the potential feeder calves that are available, how can they increase the number of calves they feed? The only way of bringing about this increase is to encourage the beef cow industry to produce more feeder calves. They can do this by offering a higher price for feeder calves. But, how can the beef feeding industry increase the price it is willing to pay for feeder calves?

The demand for beef at the level of the beef cow industry is derived from the demand for beef at retail. This derived demand for beef is carried through the beef producing industry via the price of intermediate products. Therefore, if the beef feeding industry could increase the price it was willing and able to pay for feeder animals it would encourage the beef cow industry to increase the production of feeder calves. A beef feeder will continue to buy feeder calves and feed them as long as he can cover all variable costs in the short run. Hence, he could increase the price he is willing to pay for feeder calves if he could reduce the variable costs of feeding the animal to slaughter weight. Given any retail demand situation, the beef feeding industry could increase the feeder calf price it was willing to pay by lowering the variable costs of production and becoming a more efficient operation. This general increase in the level of feeder calf prices would then encourage the beef cow industry to increase the supply of feeder calves. These added calves would then be available for feeding and thereby act to increase the supply of beef in the long run. In this indirect manner, the beef feeding industry could affect the supply of beef.

Economies of Size in Beef Feeding

How does a beef feeding operation become more efficient? There have been numerous studies on the economics of beef feeding that have looked at this question.[2] In general, these studies have found substantial economies of size to exist in a beef feeding operation. A larger beef feeding operation can produce a pound of fed beef at a lower average total cost than a smaller feedlot.[3] Such findings have been used to explain the movement to much larger units in the beef feeding industry. Thus, a larger feedlot is more efficient than a smaller operation. But, this movement to a larger operation requires substantial capital investment in fixed feedlot facilities by the beef feeder. Therefore, monetary and credit conditions may have an effect on the beef feeder's decision to invest in additional fixed facilities to expand his operation and obtain the economies of size as a result.

Various studies of the microeconomic aspects of beef feeding operations have looked at the importance of financial considerations such as the amount of capital required to finance different

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[2]Numerous such studies are listed in the bibliography. In particular see [25], [71], and [70].

[3]This is true over the relevant range of the respective cost curves, but may not hold for an infinitely large operation due to diseconomies of size that may exist.

sizes of large feedlots and how the costs of capital should theoretically affect the operation of the firm.[4] But, very little has been done along the lines of determining how monetary and credit conditions actually influence the investment in large feedlots.[5] This is the purpose of the following analysis. If the investment in large feedlot facilities is influenced by monetary and credit conditions, this would, in turn, influence the ability of the beef feeding industry to change the supply of beef in the long run in the manner previously specified.

THEORETICAL CONSIDERATION OF THE BEEF FEEDLOT INVESTMENT DECISION

The theoretical aspects of the decision to invest in feedlot facilities are the same as those discussed in conjunction with the beef cow investment analysis of Chapter Four. The beef feeder bases his investment decision on expected returns, expected costs, and the cost and availability of capital to finance the intended expansion. If the net present value (NPV) of the intended

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[4]See [2], [27], [126], and [136].

[5]This type of investment is not viewed as being required to add needed capacity to the beef feeding industry, but to gain efficiency. In fact, the industry appears to have excess total feedlot capacity. However, much of this capacity may be or may quickly become technologically or locationally obsolete. In addition, this and future references to large feedlot facilities do not imply an infinitely large firm, but feedlots of sufficient size to be able to economically employ the more efficient technology. Should firms become "too large" they could experience diseconomies of size or resort to collusion, either of which would negate the beneficial aspects of larger size implied here.

investment is greater than or equal to zero, the beef feeder would invest in the additional facilities.

However, there is one difference between the beef cow investment and the beef feedlot decision that should be noted. The analysis of the beef cow industry explicitly considered the disinvestment decision as well as the investment decision. This cannot be done in the analysis of the beef feeding industry for at least two reasons. First, there is no measure of disinvestment that can be used. Second, there is no way of placing a salvage value on fixed feedlot facilities. Therefore, it is impossible to investigate the effect the salvage value would have on the disinvestment decision. But, this is not to say that the theoretical argument does not hold.

For example, we can ask the question: What would the beef feeder consider as an appropriate expected salvage value for the specialized investment in fixed feedlot facilities? There are two types of situations which can occur. First, the feeder can expect to use the facilities until they are completely worn out. In this case, the expected salvage value would be zero. Second, the expected useful life of the facilities could be until they are technologically or locationally obsolete, in which case the salvage value could be zero or negative. In either case the maximum expected salvage value would be zero and would not increase the NPV of the investment. Hence, an assumed expected salvage value of zero for fixed feedlot facilities may be quite appropriate for an empirical analysis of the beef feedlot investment decision.

As for the actual disinvestment decision, it may not take place in reality. Rather, the decision may be whether to abandon the used fixed feedlot facilities or to continue to use them. If the marginal value product of using the existing facilities is less than the marginal value product of the new facility (considering the net cost of establishing the new facility), then the beef feeder would abandon the old facilities and invest in the larger, or at least more efficient, feedlot. This decision to abandon the fixed facilities and take advantage of the opportunities offered by the new facilities is the result of the technological obsolescence of the existing facilities.

Using these theoretical similarities and differences between the investment in the beef cow and the beef feeding industry, we can proceed to analyze the beef feeding industry's investment in larger, more efficient feedlot facilities.

SPECIFICATION OF ECONOMIC MODEL

Using the theoretical considerations discussed previously, we can relate the amount of investment in large feedlot facilities undertaken by the beef feeding industry to those factors that should theoretically affect the decision in a single equation. As in the beef cow industry, the general form of the equation would be:

Amount of investment = F (supply of feeder calves, expected returns, expected costs, cost of capital, credit availability).

Now we can use this general economic model and proceed to specify the relationship closely and test the model empirically.

TESTING THE ECONOMIC MODEL

To test the economic model we will look at the beef feeding industry during the period 1962 to 1972. This is a relatively short period. A longer time period would be desirable, but no data were available prior to 1962. The data concerning the number and size of beef feedlots that is available does not specify the actual amount of feedlot investment. But one can use the number of large feedlots, the estimated amount of feedlot capacity of large lots, and the actual number of cattle marketed per large feedlot as indications of investment undertaken during the period.

We will attempt to relate these measures of feedlot investment to various factors that should theoretically influence the decision and thereby isolate the economic effect of each factor. This should allow us to analyze the impact monetary policy and credit conditions have had on investment in the beef feeding industry and thereby provide further insights into the basic question concerning the supply and price of beef posed in the introduction of this study.

Definition of Variables

The following variables will be used in the process of testing the economic model. They will be functionally related in the form of a single equation to explain the annual investment in large feedlot facilities by the beef feeding industry during the 10-year period under analysis.

$BFLNO_t$ = Total number of cattle feedlots operating during year t in 22 major cattle feeding states with feedlot capacity of 1,000 head or more (i.e., large feedlots).[6,7] Source: [164] and [163].

$CMPLBL_t$ = Number of cattle marketed per feedlot by large feedlots in 22 major cattle feeding states during year t. Source: [164] and [163].

$CAPBFL_t$ = Total cattle feedlot capacity of large feedlots in 22 major cattle feeding states that existed during year t (in 1,000 head).[8] Source: [164] and [163].

$BCOFAM_t$ = Other cows, 2 years old and older, in January 1 farm inventory that were not on feed (in 1,000 head). Source: See Chapter Four.

$CSSTP_t$ = Choice slaughter steer price: Annual average price in dollars per 100 pounds live weight at Omaha. Source: [156, Table 156-159I] and [157].

$PRIKAF_t$ = Feeder calf price: Annual average price in dollars per 100 pounds for good and choice steer calves at Kansas City. Source: [156, Table 155] and [157].

$CORNP_t$ = Corn price: Annual average price in dollars per bushel for No. 3 yellow corn in Chicago. Source: [160].

$BCRAT_t$ = Beef-corn ratio: $CSSTP_t/CORNP_t$.

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[6]Twenty-two states were the largest number of states for which the U.S.D.A. consistently reported data on the number and size of cattle feedlots over the period of analysis.

[7]Data for all variables defined and used in this analysis are presented in Appendix B.

[8]Calculated by multiplying the number of cattle feedlots reported in each size category by the midpoint of the respective size range for all size categories except the largest, for which the minimum capacity of 32,000 head was used.

$PRMAR_t$ = Price margin: $CSSTP_t$ - $PRIKAF_t$.

$FICBLR_t$ = Annual average interest rates in percentage points charged by the Federal Intermediate Credit Banks. Source: [169] and [168].

$CBTDIF_t$ = (Annual average market yield in percentage points on Baa corporate bond - Annual average market yield in percentage points on 3-month treasury bills), a measure of credit availability. Source: [6].

$FWAGR_t$ = Annual average farm wage rate, without board or room, in dollars per hour. Source: [169] and [168].

These variables will be used to specify the equations to be estimated. While the following analysis will look at only the feedlot investment relationship, data limitations necessitated analysis of more than one measure of feedlot investment. If a specific measure of investment, such as dollars invested, had been reported, it would have been the preferred measure. But no such data are reported. Therefore, number of large feedlots, feedlot capacity, and the actual number of cattle marketed per large feedlot were used to represent investment in large feedlot facilities. Thus, we will use a single equation to analyze each of these measures of investment. In each equation, the same explanatory variables will be used to explain each of the measures of investment: $BFLNO_t$, $CMPLBL_t$, and $CAPBFL_t$.

Equations to be Tested

Substituting the specific variables into the general investment equation set out earlier, we have the following relationships to be tested:

$$BFLNO_t \text{ or } CMPLBL_t \text{ or } CAPBFL_t = F\ (BCOFAM_t, BCRAT_t, PRMAR_t, FICBLR_t, CBTDIF_t).$$

Given this equation, consider how each of the independent variables (those on the right hand side) is expected to influence the dependent variable (the three alternative measures of investment: $BFLNO_t$, $CMPLBL_t$, and $CAPBFL_t$).

Beef Cows on Farms (BCOFAM)

The decision to invest in additional feedlot facilities should depend on the supply of feeder calves and the beef feeders expectations concerning future supplies.[9] A large supply of feeder calves should encourage investment in the beef feeding industry to expand facilities and take advantage of technological innovations in beef feeding. Therefore, the relationship between BCOFAM (a measure of feeder calf supply) and investment in large feedlots is expected to be positive.

Beef-Corn Ratio (BCRAT)

The beef-corn ratio is a commonly used measure of the relative profitability of beef feeding. It reflects both the price of

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[9]The measures of feedlot investment used in this analysis are enumerated as of the last of year t, while the $BCOFAM_t$ is a January 1, t inventory and the other independent variables are annual averages. Therefore, the expectation model employed throughout this analysis assumes that future conditions will be the same as those experienced in the current period. Other expectation models (such as a one-period lag of the independent variables or a three-year moving average centered on year (t-1)) were tested, but did not provide an estimated relationship superior to the naive expectation model finally employed.

the final product (CSSTP) and the cost of one of the major inputs in the production process (CORNP). Therefore, as CSSTP increases relative to CORNP the profitability of beef feeding should increase. This should encourage beef feeders to invest in new facilities. Thus, BCRAT is expected to be positively related to feedlot investment.

Price Margin (PRMAR)

The price margin is another measure of the profitability of beef feeding. It compares the cost of a feeder calf to the price of a choice slaughter steer. If the price margin is positive, the feeder can sell the pounds of beef he bought as a feeder calf at a higher price as a slaughter animal. Thus, this is another potential source of profits to the feeder in addition to the feeding margin measured via BCRAT. The PRMAR is normally negative; therefore, the feeder does not normally consider this a potential source of profit, but a potential source of decreased returns to the feeding operation.

The relationship between feedlot investment and PRMAR is expected to be positive. As the PRMAR becomes more positive, this should reflect greater profitability of beef feeding and encourage investment in the industry.

Federal Intermediate Credit Bank Loan Rate (FICBLR) and Credit Availability (CBTDIF)

The expected relationship between the investment in large feedlot facilities and monetary and credit conditions is similar to the relationship specified in the analysis of investment in the beef cow industry. As the FICBLR increases, this is reflected through the discount rate the beef feeder uses as he analyzes a potential investment. A higher discount rate decreases the present value of net returns in future periods. Therefore, we would expect a negative relationship between FICBLR and feedlot investment.

The relationship between credit availability (CBTDIF) and investment is expected to be positive. Greater credit availability (as measured by relatively larger values of CBTDIF) at any rate of interest should allow beef feeders to increase the industry's investment. Credit shortages should act to limit the amount of investment undertaken.

We have specified the economic model to be tested. We can now proceed to test the equation to determine the empirical verification of the theoretical relationship.

Method of Testing

Statistical testing of the specified economic model requires transformation of the structural model into a statistical model. Ordinary least squares regression analysis was used to estimate the following statistical relationship:

$$BFLNO_t \text{ or } CMPLBL_t \text{ or } CAPBFL_t = \alpha + \beta_1\, BCOFAM_t + \beta_2\, BCRAT_t + \beta_3\, PRMAR_t + \beta_4\, FICBLR_t + \beta_5\, CBTDIF_t + e_t.$$

This is the general equation to be tested, but the specific independent variables included in any particular estimated equation will depend on the statistical problem of multicollinearity.

EMPIRICAL RESULTS

The following section presents and discusses the investment relationships which were estimated using ordinary least squares regression analysis. The format of the presentation of results is similar to that used in Chapter Four. The one exception involves the Durbin-Watson statistic. The number of observations over the period of analysis was not sufficient to allow statistical tests using the Durbin-Watson statistic.

The Estimated Large Feedlot Investment Relationship Using the Number of Large Feedlots (BFLNO) as a Measure of Investment

Table V-1 presents the estimated investment relationship using BFLNO as a measure of investment in large feedlots. In general, the estimated relationships are consistent with a priori expectations. The one major exception involves the relationship between investment and FICBLR. The estimated relationship was statistically significant with the wrong sign.

This estimated relationship implies that increases in the rate of interest cause beef feeders to invest more in feedlot facilities. Thus, it does not conform to theory. This could be the result of an illogical, spurious relationship or it might be due to the cyclical nature of the beef feeding industry or the

Table V-1. Estimated relationships between number of large feedlots (BFLNO) and selected explanatory variables, 1962-1972.

Equation Number	Explanatory Variables[a]						Constant	R^2	D-W
	$BCOFAM_t$	$BCRAT_t$	$FICBLR_t$	$PRMAR_t$	$CBTDIF_t$	$FWAGR_t$			
1	.078* (8.04)						-854.84	.878	.86
2	.074* (6.47)	9.21 (.72)					-916.97	.885	.98
3	.047* (4.59)	10.76 (1.34)	86.11* (3.65)				-524.97	.960	2.43
4	.050* (4.35)	13.43 (1.44)	87.09** (3.53)	5.97 (.65)			-656.86	.963	2.28
5	.045** (3.84)	9.97 (1.07)	99.73** (3.87)	12.75 (1.24)	36.67 (1.24)		-534.57	.972	2.12
6	.043** (3.59)	7.70 (.81)	91.56** (3.53)		17.34 (.66)		-396.34	.963	2.35
7	.021 (.84)	-3.11 (-.22)	69.74** (2.60)			448.14 (1.18)	178.94	.968	2.15

[a]Numbers in parenthesis are t-value. One, two and three asterisks denote statistical significance at .01, .05, and .10 levels, respectively.

relationship between the feeder calf industry and the beef feeding industry.

If beef feeders invest in a counter-cyclical manner this could account for the wrong relationship when we consider the time lags for decision making and bringing facilities into operation. Beef feeders may "read" the cycles and realize that when conditions appear to be the most inappropriate for expansion is actually the opportune time to invest. If they decide to invest and expand capacity during such times, their facilities will be on line and producing when the cycle peaks in the future. Therefore, such investors could profit from their investment during what appeared to be an illogical period for expansion of facilities. Thus, this could account for the wrong estimated relationship between investment in feedlot facilities and the rate of interest.

Another explanation of the wrong relationship involves the relationship between the feeder calf and beef feeding industries. As discussed in Chapter Four, higher rates of interest resulted in fewer heifers being kept for replacement stock by beef cow operators. Thus, more feeder calves are made available to the beef feeding industry during periods of high interest rates. This increased supply of feeder calves could encourage beef feeders to expand their operations. This would result in continued investment by beef feeders during periods of high interest rates.

Thus, increases in the rate of interest do not appear to discourage investment in large feedlot facilities. Beef feeders appear to be willing to pay the higher financial costs. However, they may not be able to obtain the credit they desire during tight money periods. The coefficient of CBTDIF indicates that the availability of credit does influence the investment decision. Beef feeders appear to be willing to use credit and invest in large feedlot facilities even though interest rates might be quite high. But, they may be limited in their use of credit by its availability.

Monetary policy and credit conditions appear to have a mixed impact on the investment in large feedlot facilities, as measured by BFLNO. Beef feeding is apparently profitable enough to allow firms to underwrite high costs of credit, but the availability of credit appears to limit the industry's investment. Using these results concerning the number of large feedlots as a measure of the beef feeding industry's investment in large feedlot facilities, let us look briefly at other alternative measures of investment.

The Estimated Large Feedlot Investment Relationship Using the Capacity of Large Feedlots (CAPBFL) as a Measure of Investment

Table V-2 presents the estimated investment relationship where CAPBFL was used as a measure of investment in large feedlot facilities. BCOFAM, FICBLR, and PRMAR had the same relationship to investment as in the previous analysis. However, BCRAT changes sign from what was expected in equations two, three, and six as it did when FWAGR was introduced into the relationship used to explain BFLNO. Again this would indicate the possibility that when the beef-corn ratio increases, the profitability of beef feeding is

Table V-2. Estimated Relationships between capacity of large feedlots (CAPBFL) and selected explanatory variables, 1962-1972.

Equation Number	Explanatory Variables[a]						Constant	R^2	D-W
	$BCOFAM_t$	$BCRAT_t$	$FICBLR_t$	$FRMAR_t$	$CBTDIF_t$	$FWAGR_t$			
1	1.86* (8.73)						-47,436.71	.894	1.23
2	1.98* (8.11)	-275.38 (-1.01)					-45,579.01	.906	1.47
3	1.59* (5.09)	-253.19 (-1.03)	1,231.70 (1.71)				-39,971.78	.934	2.12
4	1.84* (8.54)	.180 (.001)	1,325.55** (2.84)	567.80** (3.29)			-52,510.81	.976	2.73
5	1.87* (7.59)	24.59 (.12)	1,236.13*** (2.26)	519.86*** (2.37)	-259.41 (-.41)		-53,375.89	.977	2.87
6	1.82* (5.56)	-68.22 (-.26)	902.66 (1.28)		-1,047.46 (-1.48)		-47,740.25	.952	2.83
7	2.70* (4.04)	327.04 (.85)	1,916.34** (2.62)			-18,747.18 (-1.81)	-69,418.61	.957	2.80

[a]Numbers in parenthesis are t-value. One, two and three asterisks denote statistical significance at .01, .05, and .10 levels, respectively.

such that firms do not feel it necessary to invest in new technology to become more efficient through the use of larger feedlot facilities.

When the wage rate was introduced into equation seven to test the capital-labor substitution argument, the coefficient of FWAGR was the opposite of that found in the BFLNO relationship (Table V-1, equation 7). This suggests that the increasing cost of hired labor discourages the addition of feedlot capacity that uses labor, but encourages the addition of feedlot capacity that utilizes capital inputs (reflected through FICBLR's positive coefficient). The substitution of capital for labor may explain the positive relationship between investment, as measured by CAPBFL, and the rate of interest (FICBLR).

The coefficient of the measure of credit availability (CBTDIF) had a negative sign in equations five and six. This indicates that credit availability does not present a problem for feedlots as they attempt to increase capacity. This relationship in conjunction with the previous findings concerning the rate of interest suggest that monetary and credit conditions do not have the expected effect on the beef industry's investment in additional large feedlot capacity.

The Estimated Large Feedlot Investment Relationship Using the Cattle Marketed per Feedlot by Large Feedlots (CMPLBL) as a Measure of Investment

Table V-3 presents the estimated relationship where CMPLBL was used as a measure of investment in large feedlot facilities. All the estimated relationships are consistent with a priori

Table V-3. Estimated relationships between cattle marketed per feedlot by large feedlots (CMPLBL) and selected explanatory variables, 1962-1972.

Equation Number	Explanatory Variables[a]						Constant	R^2	D-W
	$BCOFAM_t$	$BCRAT_t$	$FICBLR_t$	$PRMAR_t$	$CBTDIF_t$	$FWAGR_t$			
1	.375* (8.79)						-7,724.93	.896	.71
2	.318* (10.12)	130.78* (3.72)					-8,607.16	.962	1.51
3	.328* (6.84)	130.24* (3.48)	-29.92 (-.27)				-8,743.36	.962	1.61
4	.287* (10.82)	87.96* (4.05)	-45.58 (-.79)	-94.74* (-4.45)			-6,651.08	.991	2.16
5	.274* (10.64)	78.75** (3.80)	-11.84 (-.21)	-76.65** (-3.35)	97.88 (1.49)		-6,324.66	.994	2.57
6	.282* (6.68)	92.44** (2.77)	37.33 (.41)		214.08*** (2.34)		-7,155.63	.980	2.53
7	.117 (1.38)	19.69 (.40)	-160.36 (-1.72)			3,571.84** (2.71)	-3,132.95	.983	2.34

[a]Numbers in parenthesis are t-value. One, two and three asterisks denote statistical significance at .01, .05, and .10 levels, respectively.

expectations except the relationship between PRMAR and investment in equations four and five. In these equations, an increase in the price margin is associated with a decrease in the number of cattle marketed per feedlot by large feedlots. This can be explained when one realizes that there are a large number of small feedlot operations that are capable of profitably feeding cattle during periods of generally high profits in the beef feeding industry. During such periods, smaller, less efficient feedlots would, therefore, feed cattle that would otherwise be available for feeding by large feedlots. Therefore, as the smaller feedlots feed more of the available feeder calves, there are fewer cattle to be fed by large lots and the cattle marketed per lot by large lots necessarily decreases. Hence, when we hold constant the other measure of beef feeding profitability (BCRAT), this could explain this estimated relationship between CMPLBL and PRMAR.

The coefficients of FICBLR and CBTDIF indicate that monetary and credit conditions may have the expected effect on CMPLBL. The coefficient of FICBLR is never statistically significant and has the wrong sign in equation six, which indicates that this is not a very reliable relationship. However, the coefficient of CBTDIF consistently has the correct sign and is statistically significant in equation six, which would suggest that this relationship is more reliable than the interest rate relationship.

Summary of Estimated Investment Relationships

The first general conclusion that can be drawn about the three estimated relationships is that the results were quite mixed and inconsistent. While each of the equations was quite successful in explaining the variation in the dependent variable, the inconsistency of the sign of various independent variables among equations suggests that there may be serious problems in the estimated relationships. These problems may be the result of the characteristics of the investment measures employed in each of the three equations estimated.

As explained previously, much of the problem may be the result of the relationship between small and large feedlots in the cattle feeding industry. This appears to be particularly true with respect to the inconsistency of the estimated relationships between investment and the measures of profitability (BCRAT and PRMAR). Theoretically we expected increased profits or expectations of greater profit to encourage investment in large feedlot facilities. But the empirical analysis did not consistently verify the theoretical expectations.

This is believed to result from actions of smaller beef feedlot operations. During high profit periods in the beef feeding industry, the cost advantages of new technology may not be great enough to encourage investment in larger feedlot facilities. But, decreases in beef feeding profit margins may necessitate the investment in larger feedlot facilities by small feedlots. The feedlots either become more efficient or go out of business. This could explain the theoretically incorrect relationship between profitability and feedlot investment in some of the estimated relationships.

Monetary policy and credit conditions appear to have a mixed impact on investment in large feedlot facilities. The general indications are that beef feeders do not react to the rate of interest as expected. But the availability of credit does appear to limit the amount of investment undertaken by beef feeders. This result indicates that beef feeding is sufficiently profitable to allow firms to invest even though the interest rate might be quite high. Beef feeders would also use more credit to finance investment in large feedlot facilities if it was available.

SUMMARY

This analysis of the impact monetary policy and credit conditions has on investment in large feedlot facilities and thereby the ability of the beef feeding industry to increase the supply of beef fails to show that restrictive monetary policy has an adverse effect on the beef feeding industry. Although no quantitative estimates of the impact on beef supply were made due to data limitations, this analysis indicates that the cost of credit does not discourage greater investment in large feedlot facilities. However, the availability of credit does act to limit feedlot investment. Therefore, restrictive monetary policy appears to have a mixed impact on the investment in large feedlot facilities by the beef

feeding industry and the resultant effect on the supply of beef over time is at best uncertain. Thus, we cannot provide a very meaningful answer to the basic question set out in Chapter One, with respect to the beef feeding industry. The most that can be said is that this analysis found no evidence that monetary policy and credit conditions have a significant effect on the beef feeding industry.

Chapter VI

SUMMARY, CONCLUSIONS AND IMPLICATIONS

SUMMARY AND CONCLUSIONS

Objectives of the Study

The basic objective of this study was to answer the question: "Do the monetary and credit actions of the Federal Reserve System as it attempts to control rising prices in the general economy have an adverse effect on the supply of beef in subsequent time periods?" In conjunction with this basic research objective there were a number of more specific objectives. These objectives were to: (1) investigate the beef producing industry to determine what major changes have taken place in the past 20 years and the critical links in the production process both historically and in the future, (2) set forth the theoretical relationship between monetary policy and the supply of beef, and (3) construct one or more econometric models to test the theoretical relationship and describe the effects of monetary policy on subsequent supplies and prices of beef.

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.

The Beef Industry

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. Various factors have contributed to the beef industry's ability to increase productivity in the past. Many of these factors have been fully exploited.

Increased beef feeding is an example of this type of change. During the past 15 years, fed beef as a proportion of total beef slaughter has increased from 27 percent to 68 percent. The beef feeding industry has diverted animals from veal slaughter and grass fattening to such an extent that there is no potential feeder calf supply remaining to be diverted to beef feeding. Future increases in the number of animals fed will require the production of more feeder calves rather than diversion of animals from alternative uses. Other factors that have contributed to increased productivity in the past (such as calving percentage and death losses) have been utilized in a similar manner.

Therefore, 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.

The production of beef can be divided into two major functions that have become somewhat separate and distinct over time. The production of feeder calves by the feeder calf industry and the feeding of these calves to slaughter weight by the beef feeding industry are the two major functions performed by the beef industry. Changes have occurred in each sector, but at different rates.

The Feeder Calf Industry

Feeder calves are produced by a relatively large number of relatively small producers. Farms or ranches that keep beef cows to produce feeder calves as a major enterprise often have very few or no alternative uses for their resources. Other farms use beef cows as a supplementary operation to use resources that are available at very little cost. In general, the profitability of producing feeder calves has not been sufficient to encourage significant enterprise and resource use changes where viable alternative uses for the resources exist.

Therefore, the structure of the feeder calf industry and the method of producing feeder calves have not undergone major changes over time. The average size of beef cow herds in the United States has very slowly been increasing but they are still quite small. There has also been some enterprise shifting from dairy to beef and some geographical dispersion of feeder calf production, particularly into the southeastern United States. But, these are the major changes that have taken place in feeder

calf production. No major technological changes have taken place in the industry. Thus, the feeder calf industry has maintained its traditional structure and method of production to a large extent.

The Beef Feeding Industry

In contrast with the feeder calf industry, the beef feeding industry has undergone a great deal of change during the past 15 years. There has been a movement to a much smaller number of larger, more efficient feedlot operations. During the past ten years, the proportion of all cattle fed that were fed by feedlots with a capacity of 1,000 head or more has increased from 37 to 62 percent. This trend to larger beef feeding units has been accompanied by some changes in production methods.

The larger feedlot operations have allowed producers to improve the feeding efficiency of the beef feeding operation. They have also allowed improvement of the rate of gain of feeder steers and heifers. Thus, the beef feeding industry has been able to shorten the time that an animal must remain on feed and to produce beef at a lower cost per pound of gain.

Thus, the beef feeding industry has adopted technological changes to become more efficient in the production process. But, the feeder calf industry has not. The beef feeding industry has gradually increased the number of animals fed to the point that any further increase is dependent on increased feeder calf production. All of which suggests that future increases in the supply of beef will be dependent on or limited by the changes that occur or fail to take place in the feeder calf industry.

Using this descriptive analysis of the beef industry and recognizing where the critical links have been in the past and where they are likely to be in the future, we then turned to the basic questions under consideration in this study: Does monetary policy affect the beef industry? If so, how and to what extent?

Monetary Policy, Credit Conditions and the Supply and Price of Beef: Theoretical Considerations

Theoretically, monetary policy should affect the supply and price of beef through its influence on producers' decisions concerning investment in productive assets. As the Federal Reserve System administers monetary policy, it changes the supply of money in the economic system. In turn, this affects the credit conditions that exist in the economy. These changes in the cost and availability of credit influence producer investment decisions. Investment in productive assets determines the amount of output in subsequent time periods. Changes in output or supply in turn influence the price of output.

It is fairly easy to see how changes in credit availability could influence investment in the beef industry. It, in fact, simply acts to limit the amount of investment by beef producers regardless of the cost of credit. If producers require credit to finance an investment and it is not available, the investment cannot be made.

The effect of changes in the cost of credit or interest rate on investment are somewhat less straight forward in nature. As the rate of interest increases (decreases) the net present value of an investment decreases (increases). Therefore, as beef producers analyze the possibility of investing in additional productive assets, changes in the discount rate they use (which is directly related to the rate of interest) in evaluating proposed investments should affect the profitability and, therefore, the amount of investment undertaken.

In this manner, monetary policy should affect the investment in the beef industry and thereby the supply and price of beef in subsequent time periods. Specifically, restrictive monetary policy designed to control inflation which raises the rate of interest and reduces credit availability should act to reduce investment in the beef industry. This would reduce the supply and raise the price of beef in subsequent time periods.

Empirical Analysis and Findings

To investigate the effect monetary policy has on the beef industry, the industry was separated into its two major functional parts, the feeder calf industry and the beef feeding industry. The effect of changing credit costs and availability on each industry was analyzed separately.

The Feeder Calf Industry

This analysis of the effect monetary policy has on the feeder calf industry looked at investment in the beef cow herd in the United States during the period, 1952 to 1971. The basic assumption behind the approach was that the size of the beef cow herd is the major determinant of the number of feeder calves that are made available to the feeding industry. The number of heifers added to the breeding herd (investment) and the number of aged cows culled from the herd (disinvestment) determine changes in the size of the beef cow herd over time. Therefore, any factors that act to influence investment in the beef cow herd will change the size of the herd, the number of feeder calves produced, and finally the supply and price of beef in subsequent time periods.

Ordinary least squares regression analysis was used to estimate the investment and disinvestment relationships in the feeder calf industry. Using this technique one is able to estimate the economic relationship between the cost and availability of credit and investment in the beef cow herd. The two estimated relationships indicated that a one percentage point increase in the annual average rate of interest would result in a six percent decrease in the number of heifers added to the beef herd in the following year. This increase in the rate of interest would also result in an increase in the number of cows culled from the herd by three to 14 percent[1] in the same time period. Thus, the increased cost of credit in one

[1]This range is based on two different estimated disinvestment relationships.

year results in a smaller breeding cow herd in the following year due to decreased investment and increased disinvestment.

In addition to the effect the cost of credit had on investment, the relationship between credit availability and investment was found to be consistent with a priori expectations. While the relationship did not prove to be statistically significant, it did indicate that investment in the beef cow herd was somewhat limited by the availability of credit. This would tend to reinforce the conclusions concerning the effect of monetary policy on investment in the feeder calf industry.

To see how restrictive monetary policies on the part of the Federal Reserve System might have contributed to the high beef prices currently being experienced, the effect on investment and disinvestment were traced through the beef production process. The interest rate during 1969 and 1970 was about 1.7 percentage points higher than it was in 1967 and 1968. This higher rate of interest would result in a beef cow breeding herd that was from 802,400 to 1,392,300 head smaller in 1970-1971 than it would have been if the interest rate had remained at the 1967-1968 level.

Allowing for calving rates, death losses, and a two to three year production period for the calves to be born, raised, and fed by the beef feeding industry; this reduction in the potential size of the breeding herd could reduce the total supply of steer and heifer beef in 1972 and 1973 by two to four percent. This reduction in the supply of beef could have resulted in a 3.7 to 6.4 percent increase in the farm price of steers and heifers.

Thus, restrictive monetary policies during 1969 and 1970 could have resulted in a farm price of fed beef that was one to two dollars per hundred pounds greater than it would have been in the absence of such tight money policies.

Based on the empirical results of the analysis of the feeder calf industry restrictive monetary policy does have an adverse effect on the supply of beef in subsequent time periods. Thus, we would reject the null hypothesis as set out in Chapter One and accept the alternative.

The Beef Feeding Industry

As viewed in this study, the beef feeding industry simply takes what feeder calves are available at any point in time and feeds them to slaughter weight. Therefore, its ability to change the supply of beef is quite limited. Beef feeders can adjust the weights at which they market animals and the timing of marketings in the short run, but they cannot directly change the long-run supply of beef.

The beef feeding industry could indirectly increase the supply of beef by becoming a more efficient industry. If the industry could lower the cost of feeding an animal to slaughter weight, it could pay higher feeder calf prices. This would encourage the feeder calf industry to increase the supply of feeder calves and in this manner the beef feeding industry does affect the supply of beef in the long run.

One of the principle ways by which a beef feeding operation can become more efficient in the feeding process is by becoming larger and utilizing the economies of size that exist in beef feeding. But, the adoption of new technology and the change to a larger operation requires additional capital investment. Thus, monetary policy and credit conditions could affect the beef feeding industry's investment in larger feedlot facilities and thereby its ability to increase the supply of beef.

To empirically analyze this type of relationship, the investment in large feedlot facilities in the United States during the period 1962 to 1972 was investigated. As in the analysis of investment in the feeder calf industry, regression analysis was used to estimate the economic relationship between investment and the cost and availability of credit. The major problem encountered in this analysis was that there were no published data concerning the investment in large feedlot facilities. Therefore, three different possible measures of investment were investigated. As a result, the three estimated investment relationships had quite mixed and inconsistent results.

The general indications were that the cost of credit did not reduce investment in large feedlot facilities. But, the availability of credit did act to limit investment. Such results were believed to be related to the profitability of beef feeding. If beef feeding was sufficiently profitable, increases in the rate of interest (over the range of observations) may not have been sufficient to make investment in large feedlot facilities unprofitable.

Therefore, beef feeders would have continued to invest even though the rate of interest might have been relatively high. But, if credit to finance the investment in larger feedlot facilities was not available, the investment could not be undertaken.

Hence, this analysis failed to show any significant effect of monetary and credit conditions on investment in large feedlot facilities by the beef feeding industry. Restrictive monetary policies do not appear to have an adverse effect on the beef feeding industry and its ability to indirectly increase the long-run supply of beef.

The Beef Industry

The results of this analysis show that the beef industry is primarily influenced by monetary policy through its effect on investment in the feeder calf industry. The effect of restrictive monetary policies on the feeder calf industry and the resulting supply and price of beef in subsequent time periods shows that monetary policy did have an impact on the beef industry.

Based on this analysis we would reject the null hypothesis: "Monetary policy does not affect the supply of beef" and accept the alternative: "Monetary policy to control inflation in the general economy through its effect on consumer demand has resulted in reduced beef supplies in subsequent time periods." In addition, future prospects indicate that the importance of monetary policy's effect on the supply and price of beef in the future may be even greater.

Given that the beef industry has exploited many of its potential sources of productivity increases and is unable to increase productivity in the future by some of the means it has in the past, future increases in the supply of beef will be much more dependent on increases in the size of the breeding herd than in the past. This will require greater future investment by the feeder calf industry.

In addition, past trends in agriculture have been toward greater use of credit by farmers to finance their operations. As this trend continues, feeder calf producers could become even more sensitive to changes in monetary and credit conditions. Thus, considering the possible need for increased investment by feeder calf producers and a greater use of credit to finance this investment, the effect of changes in the cost and availability of credit on the feeder calf industry could be more important in the future than they have been in the past. As a result, the effect of monetary policy on the supply and price of beef may be greater in the future than it has been historically.

IMPLICATIONS OF THE STUDY

Policy Implications

This study has implications for at least two major policy making bodies in the United States, the Federal Reserve System and the United States Department of Agriculture (USDA). The Federal Reserve administers monetary policy. Therefore, when restrictive monetary policies are designed and implemented to control inflation in the general economy, the Federal Reserve should be aware of the reduced supply of beef and increased beef prices that could occur in the future as a result. If the Federal Reserve has any desire to keep beef prices low, then it should recognize that tight money policies, as administered in the past, may not be consistent with the goal of cheap beef.

There are changes that the Federal Reserve could make that might alleviate this situation. The most radical proposal involves the implementation of a differential interest rate policy by the Federal Reserve. It could be very specific in nature such that there was a specific ceiling on the interest rate charged on loans for investment in beef cows. Or, it could be quite general in nature such that the basis for differentiation was the loan purpose. Loans for production purposes would carry a lower rate of interest than loans for consumption. This should tend to limit consumer demand without limiting production.

A less radical and likely less effective proposal involves credit availability. The Federal Reserve apparently does not favor the use of differential interest rate policies [103]. But, it could institute policy changes to assure that credit is available irregardless of the cost of credit. This would involve removing money market constraints or changing regulations to make credit more readily available than it has been in the past. An example of such a change is the recently instituted "seasonal borrowing privilege."

Similar changes could tend to remove credit unavailability as a limiting factor on investment in the beef industry.

The findings of this study also suggest that there may be a need for the USDA to undertake a more concerted effort to increase the supply of beef in the future. The feeder calf industry should be of particular concern. The analysis of the productivity of the beef industry suggests that sources of productivity that were enjoyed in the past have been fully exploited. Therefore, the USDA should undertake research efforts or intensify ongoing efforts to find methods of improving cattle herd productivity and bring about their adoption. Two examples of such methods of improving productivity could involve the improvement and increased use of crossbreeding and the introduction of multiple births.

If sufficient productivity increases are not forth coming, the USDA and Congress should consider the possibility of subsidizing the cost of producing feeder calves or other methods of encouraging feeder calf production. If the USDA desires to keep the price of beef low in the future, such actions may be necessary.

In addition, the findings of this study suggest that the USDA should be aware of monetary policies being followed by the Federal Reserve System as it attempts to increase the supply of beef. Restrictive monetary policies that increase the cost of credit and reduce the availability of credit could offset USDA efforts to increase the beef supply.

An example of such a situation involves the recent USDA policy change to allow farmers to graze diverted acres that were not previously available for grazing. During the same period, the rate of interest has gone up. Therefore, the increase in the supply of beef in future periods will likely be less than it otherwise might be, due to the increased cost of investing in additional cows to graze the diverted acres. To offset this, the USDA and other institutions could undertake programs to educate owners of diverted acres or land that is not currently being used for productive agricultural purposes concerning the potential of putting beef cows on the otherwise unproductive land.

In a similar manner, the USDA could design and implement policies to offset the effect of tight money policies on the beef industry. Such policies could provide for the subsidization of the interest cost of investing in beef cows by the feeder calf industry. Provisions might be made such that cost of interest above a certain rate would be paid by the USDA with funds authorized by Congress. This would in effect place a ceiling on the rate of interest paid by feeder calf producers and tend to offset the effect of restrictive monetary policies on the beef industry.

Implications for Further Research

This analysis of the beef industry showed that monetary policy does have a significant effect on the supply and price of beef. Does monetary policy have similar effects on other agricultural industries? If so, this could have significant implications concerning the price of food in general. Further research is needed to determine if restrictive monetary policies do affect the supply of other agricultural products as it does the supply of beef. If it does, this would suggest that there is a definite need for the Federal Reserve System to reevaluate its use of restrictive monetary policy to fight inflation. The Federal Reserve could actually be defeating its purpose if tight money policies to fight inflation result in higher food prices in subsequent time periods. This further suggests that there may be a need for further research to reevaluate the whole theory of the use of monetary policy to control inflation. If restrictive monetary policy has a greater impact on supply than it does on demand; then supply may be reduced more than demand. This would result in price increases rather than decreases. Therefore, restrictive monetary policy has acted to create inflation rather than control it.

This investigation of the beef industry also found the production of feeder calves to generally be a very low profit enterprise. The logical question arises: Why do farmers produce feeder calves if it is unprofitable? If, as suggested in this study, beef cows are kept by producers that have no alternative uses for their resources, what type of incentive will be required to encourage increased feeder calf production in the future? What level of feeder calf prices will be required to encourage farmers to shift additional resources, that were previously used for other purposes, into feeder calf production? Where will this enterprise shifting occur? When and to what extent will such shifting be required in the future?

Questions of this type imply that there is a need for in-depth, firm level, analysis of the economics of feeder calf production. A great deal of research has been carried out concerning the beef feeding industry. But, increased feeder calf production appears to be the critical determinant of future increases in the supply of beef. Therefore, there is a definite need for research into the economics of producing feeder calves.

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APPENDICES

APPENDIX A

METHOD OF DERIVATION, SOURCES OF DATA, AND DATA USED IN ANALYSIS CONTAINED IN CHAPTER FOUR

APPENDIX A

METHOD OF DERIVATION, SOURCES OF DATA, AND DATA USED IN ANALYSIS CONTAINED IN CHAPTER FOUR

The following is a description of the methods used to derive the values for the variables defined in Chapter Four for which data were not directly available from secondary sources. The description begins by defining variables for which data were available from secondary sources, and then presents the mathematical transformations used to obtain the data series for the variables used in the analysis. Following this listing and description are tables that contain both the data that were directly available from secondary sources and the derived data series used in the analysis of the beef cow industry.

Appendix Table A-1. Definition of variables for which data were available from secondary source.

Variable Name	Definition and Source
$TCAF39_t$	Total number of cattle and calves on feed (in 1,000 head), in January 1 inventory for largest number of states reported by the USDA. Source: [155] and [156].
$TCAF23_t$	Total number of cattle and calves on feed (in 1,000 head), in January 1 inventory, for largest number of states for which USDA provided breakdown by class and type of animal on feed. Source: [163], [161], and [154].

Table A-1. Continued.

Variable Name	Definition and Source
$BECF23_t$	Total number of cows on feed (in 1,000 head) in January 1 inventory, for largest number of states for which USDA provided breakdown by class and type of animal on feed. Source: [163], [161], and [154].
$BEKF23_t$	Total number of calves on feed (in 1,000 head) in January 1 inventory, for largest number of states for which USDA provided breakdown by class and type of animal on feed. Source: [163], [161], and [154].
$BEHF23_t$	Total number of heifers on feed (in 1,000 head) in January 1 inventory that weighed over 500 pounds,[1] for largest number of states for which USDA provided breakdown by class and type of animal on feed. Source: [163], [161], and [154].
$BEECOW_t$	Total number of other[2] cows 2 years and older in January 1 inventory (in 1,000 head).[3] Source: [155] and [156].
$BEEHEF_t$	Total number of other[2] heifers 1 to 2 years old in January 1 inventory (in 1,000 head). Source: [155] and [156].
$BEESTR_t$	Total number of other[2] steers 1 year and older in January 1 inventory (in 1,000 head). Source: [155] and [156].
$BEEMAL_t$	Total number of other[2] bulls 1 year and older in January 1 inventory (in 1,000 head). Source: [155] and [156].
$BEEKAF_t$	Total number of other[2] calves in January 1 inventory (in 1,000 head). Source: [155] and [156].
$DARCOW_t$	Total number of cows 2 years and older, kept for milk, in January 1 inventory (in 1,000 head). Source: [155] and [156].
$TCADEA_t$	Total cattle deaths (in 1,000 head). Source: [155] and [156].

[1]This classification was 600 pounds for 1950 through 1954.

[2]Other than dairy.

[3]The method of reporting the inventory variables was changed in 1971. Therefore, adjustment of reported inventory numbers was necessary in 1971 and 1972 to provide a consistent series.

Using the variables defined in Appendix Table A-1, the following mathematical transformations were used to derive the values for variables used in the analysis of Chapter Four.

$BCFEED_t$ = $(TCAF39_t/TCAF23_t)$ X $BECF23_t$, an estimate of the total number of cows on feed.

$BKFEED_t$ = $(TCAF39_t/TCAF23_t)$ X $BECF23_t$, an estimate of the total number of calves on feed.

$BHFEED_t$ = $(TCAF39_t/TCAF23_t)$ X $BEHF23_t$, an estimate of the total number of heifers weighing more than 500 pounds on feed.

$BCOFAM_t = BEECOW_t - BCFEED_t$

$BKNOFD_t = BEEKAF_t - BKFEED_t$

$RBHEFK_t = BEEHEF_t - BHFEED_t$

$$BCNDEA = [(BEECOW_t - BCFEED_t)/(DARCOW_t + DARHEF_t + BEECOW_t + BEEHEF_t + BEESTR_t + BEEMAL_t)] \text{ X } TCADEA.$$

These last four variables are those which were defined and used in Chapter Four. Appendix Tables A-2 and A-3 contain both the data obtained from secondary sources and the derived estimates used in the analysis.

Appendix Table A-2. Data taken directly from secondary sources.

Year	TCAF39	TCAF23	BECF23	BEKF23	BEHF23	BEECOW	BEEHEF	BEESTR	BEEMAL	BEEKAF	DARCOW	DARHEF	TCADEA
						(in 1,000 head)							
1950	4,390	1,864	31	532	205	16,743	4,754	6,805	1,690	12,516	23,853	5,394	1,445
1951	4,534	1,894	29	583	197	18,526	5,122	7,029	1,689	14,319	23,568	5,493	1,537
1952	4,961	2,114	36	487	260	20,863	5,971	8,400	1,774	15,829	23,060	5,694	1,603
1953	5,762	3,042	51	811	400	23,291	6,535	9,147	1,907	17,440	23,549	5,893	1,573
1954	5,370	2,781	58	808	333	25,050	6,365	8,229	1,896	17,978	23,896	5,873	1,574
1955	5,795	4,934	89	1,323	902	25,659	6,514	8,444	1,829	18,804	23,462	5,786	1,590
1956	5,929	4,971	47	1,056	1,047	25,371	6,206	9,483	1,762	18,869	22,912	5,407	1,487
1957	6,122	5,161	69	1,185	1,088	24,534	5,926	8,991	1,713	18,405	22,325	5,267	1,446
1958	5,898	5,005	48	1,226	1,041	24,165	5,903	9,252	1,619	18,275	21,265	5,126	1,512
1959	6,627	6,324	91	1,259	1,216	25,112	6,557	9,931	1,607	19,407	20,132	5,050	1,501
1960	7,535	7,173	108	1,310	1,496	26,344	7,036	10,574	1,676	20,425	19,527	5,079	1,567
1961	8,007	7,645	82	1,310	1,625	27,327	7,115	10,997	1,714	20,814	19,271	5,016	1,532
1962	8,319	7,993	99	1,577	1,530	28,691	7,446	11,103	1.715	22,300	18,963	4,887	1,583
1963	9,337	8,989	83	1,755	1,737	30,589	8,108	12,251	1,771	23,747	18,379	4,708	1,560
1964	9,433	9,104	59	1,643	1,758	32,794	8,612	12,669	1,851	25,243	17,647	4,395	1,595
1965	9,979	9,844	65	1,881	1,962	34,238	8,989	12,134	1,908	26,181	16,981	4,149	1,641
1966	10,582	10,436	62	1,836	2,327	34,433	8,925	12,749	1,878	26,879	15,987	3,860	1,612
1967	11,268	11,125	61	1,865	2,419	34,685	9,121	12,752	1,870	27,294	15,198	3,636	1,525
1968	11,417	11,263	52	1,858	2,508	35,405	9,328	12,712	1,897	27,559	14,644	3,579	1,507
1969	12,534	11,965	49	1,850	2,640	36,227	9,313	12,784	1,911	28,034	14,152	3,525	1,541
1970	13,190	12,644	49	2,008	2,927	37,422	9,675	13,018	1,956	29,058	13,838	3,469	1,594
1971	12,770	12,209	56	1,887	2,593	38,531	10,080	13,257	2,010	29,501	13,675	3,420	1,655
1972	13,796	13,250	61	2,145	3,017	39,743	10,645	13,543	2,062	30,798	13,523	3,420	NA

Appendix Table A-3. Data used in analysis contained in Chapter Four.

Year	BCOFAM	BKNOFD	RBHEFK	BCNDEA	NBECCUL	PRIKAF	CULCOP	PRIHAY	KHPRAT	RANCON	NCULRAT	FICBLR	CBTDIF
	-----------in 1,000 head				-------------	--in $/cwt.	---	$/ton		-------in percent			---------
1950	16,670	11,263	4,271	407	2,078	29.99	21.48	21.10	1.42	81	12.5	2.00	2.04
1951	18,457	12,923	4,650	462	1,867	37.86	27.76	22.30	1.70	78	10.1	2.36	1.89
1952	20,779	14,686	5,361	507	2,439	31.58	21.74	24.60	1.28	75	11.7	2.72	1.80
1953	23,194	15,904	5,777	519	3,515	20.55	13.92	22.60	.91	74	15.2	2.82	1.84
1954	24,938	16,418	5,722	551	4,555	20.21	13.28	21.90	.92	73	18.3	2.22	2.57
1955	25,555	17,250	5,455	567	5,127	21.04	12.98	22.50	.94	73	20.1	2.27	1.80
1956	25,315	17,610	4,957	529	5,291	19.57	12.72	22.40	.87	69	20.9	3.36	1.26
1957	24,452	16,999	4,635	514	4,465	23.36	14.83	19.40	1.20	77	18.3	4.33	1.48
1958	24,108	16,830	4,676	550	3,227	31.68	19.76	18.80	1.69	83	13.4	3.56	2.95
1959	25,017	18,088	5,283	549	3,520	32.65	19.11	22.10	1.48	78	14.1	4.64	1.68
1960	26,231	19,049	5,465	585	3,869	27.88	16.21	21.70	1.28	78	14.7	5.05	2.32
1961	27,241	19,442	5,413	584	3,482	27.77	16.07	20.70	1.34	77	12.8	4.00	2.72
1962	28,588	20,659	5,854	622	3,317	27.69	15.89	21.80	1.27	79	11.6	4.05	2.25
1963	30,503	21,924	6,304	628	3,446	27.02	15.11	24.60	1.10	76	11.3	4.26	1.70
1964	32,733	23,541	6,791	670	4,682	22.57	13.57	23.90	.94	75	14.3	4.70	1.29
1965	34,172	24,274	7,000	715	6,087	23.70	14.58	23.20	1.02	79	17.8	4.94	.92
1966	34,370	25,017	6,565	712	5,601	28.38	18.31	25.00	1.14	77	16.3	5.82	.82
1967	34,623	25,405	6,671	683	5,258	28.00	16.96	24.50	1.14	77	15.2	5.88	1.93
1968	35,352	25,676	6,786	687	5,276	29.10	17.50	23.60	1.23	80	14.9	6.41	1.61
1969	36,176	26,096	6,548	716	4,637	32.89	20.07	24.70	1.33	79	12.8	7.23	1.17
1970	37,371	26,963	6,622	751	4,770	36.73	21.17	26.10	1.41	78	12.8	8.50	2.69
1971	38,472	27,527	7,368	786	5,375	36.84	21.56	28.20	1.31	76	14.0	6.37	4.23
1972	39,680	28,565	7,504	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

APPENDIX B

DATA USED IN ANALYSIS CONTAINED IN CHAPTER FIVE

Appendix Table B-1. Data used in analysis contained in Chapter Five.

Year	BFLNO	CMPLBL	CAPBFL	CORNP	CSSTP	BCRAT	PRIKAF	PRMAR	FICBLR	CBTDIF	FWAGR	BCOFAM
	(actual number)		(1,000 head)	($/bu)	($/cwt)		--($/cwt.)----		-(in percent)-		($/hr)	(1,000 head)
1962	1,432	3,684	4,940	1.11	26.45	23.83	27.69	-1.24	4.05	2.25	1.01	28,588
1963	1,488	3,909	5,426	1.21	23.21	19.19	27.02	-3.81	4.26	1.70	1.05	30,503
1964	1,553	4,313	14,950	1.22	22.21	18.20	22.57	-.36	4.70	1.29	1.08	32,733
1965	1,677	4,507	16,229	1.27	25.12	19.78	23.70	1.42	4.94	.92	1.14	34,172
1966	1,810	4,776	17,453	1.34	25.69	19.17	28.38	-2.69	5.82	.82	1.23	34,370
1967	1,893	5,002	18,625	1.27	25.27	19.90	28.00	-2.73	5.88	1.93	1.33	34,623
1968	1,972	5,305	20,084	1.11	26.83	24.17	29.10	-2.27	6.41	1.61	1.44	35,352
1969	2,066	5,966	21,437	1.21	29.66	24.51	32.89	-3.23	7.23	1.17	1.55	36,176
1970	2,141	6,360	22,714	1.35	29.33	21.73	36.73	-7.40	8.50	2.69	1.64	37,371
1971	2,187	6,743	23,154	1.39	32.42	23.32	36.84	-4.42	6.37	4.23	1.73	38,472
1972	2,089	7,915	22,420	1.30	35.77	27.52	46.92	-11.15	6.01	4.08	1.84	39,679