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Formulation of a carcass cutout value: an alternative wholesale beef pricing method

Eric (Eric L.) Grundmeier
Iowa State University

Formulation of a carcass cutout value:

An alternative wholesale beef pricing method

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Eric L. Grundmeier

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CHAPTER I. INTRODUCTION

The reporting of agricultural prices by public and private reporting services has taken place for many years. Periodically, the methods used to measure various prices have required adjustments. Recently, the methods of valuing the wholesale price of beef have come under intense scrutiny. The need for change has been due in large part to structural adjustments occurring within the wholesale beef sector. Changes in consumption patterns and technological growth have also contributed. In this study many of these factors are discussed and recommendations for improving the reporting of the wholesale price of beef are presented.

Industry Overview

The wholesale beef industry has undergone a rapid transition in recent years. During the past 20 years, dramatic changes have occurred in the movement of beef and beef products from the meatpacker to retail stores and food service outlets. Packers have switched from selling carcasses to selling boxed beef, more value-added products are being marketed, and away-from-home food consumption has increased in importance (USDA 1988).

Boxed beef, packaged in vacuum sealed plastic packages, was first introduced during the late 1950s and commercially produced in 1968 (Havrilla 1981). Packaging wholesale beef in this form gained universal acceptance during the early 1970s (Ward 1988), and by 1982, 83 percent of all federally inspected fed steer and heifer slaughter was marketed in boxed form. A study conducted by the Cryovac Division, W. R. Grace and Company found that during 1986 retail foodstores made less than 5 percent of their beef purchases in carcass form (USDA 1988).

With the trend toward more value-added products and the increase in away-from-home consumption, a greater proportion of the fabrication process has been assumed by meatpackers. Leaner beef, boneless cuts, and greater fat trim on all cuts have changed the product marketed by wholesalers. Another finding by the Cryovac study indicated that boneless cuts accounted for 23 percent of all beef cut sales at foodstores in 1979. By 1986, boneless cuts had risen to 45 percent of sales and were projected to rise to 62 percent by 1989. Also, in the past few years the importance of branded products has grown. Branded products are especially gaining importance in the hotel, restaurant, and institutional (HRI) market.

The wholesale beef industry has also experienced dramatic structural changes in recent years. There has been a trend toward fewer and larger meatpacking plants and companies. Ward (1988) reported that the Packers and Stockyards Administration (P&SA) estimated that the four largest beefpackers accounted for over 82 percent of total U.S. boxed beef production during 1988. This is substantially greater than the four-firm concentration of 64 percent just three years earlier during 1985. Part of this increase in concentration has come at the expense of the retail food industry. Several large food retailers have decreased their breaking operations in recent years (Duewer 1984).

Vertical integration has also had an impact on the structure of the beef industry. Several large meatpackers have expanded by purchasing commercial feedlots, and thus, control a larger portion of their cattle inputs. Vertical integration has also expanded through the increased use of forward contracts for cattle procurement (Ward 1988). Ward states that "significantly more" forward contracting of beef occurred during 1986-87 than during 1977-78.

Wholesale Beef Pricing Issues

One of the results of the change in the structure of the beef industry has been a change in the way beef is marketed. Vertical integration has reduced the demand for beef carcasses since meatpackers have combined the slaughter and fabrication processes. As a result, the carcass beef market has become thinly traded. Thus, there has been much speculation that the carcass price of beef does not adequately reflect wholesale market information.

An alternative method of representing wholesale beef prices is through the use of a composite index of boxed beef prices. The Agricultural Marketing Service (AMS) of the U.S. Department of Agriculture (USDA) presently reports a Carcass Cutout Value (CCV) based upon daily boxed beef prices.

Proposed Solution

Given the recent changes within the beef industry, the methods used to value beef at the wholesale level need to be further revised. Numerous suggestions have been proposed but most are only partial or temporary solutions. The most meritous solution involves the adoption of a boxed beef composite index. This approach has been suggested as a possible solution when product composition shifts in a market (Hayenga 1980).

The use of a boxed beef composite is the solution evaluated in this study. One obvious choice for a boxed beef composite index is the CCV which the AMS began reporting in 1979. However, there are several real or potential problems with the CCV reported by the AMS. Selected improvements are proposed in this study. These include: incorporating more of the boxed beef subprimal cuts presently traded and including the value of boxed beef sold as an entire carcass unit.

By including a larger set of the boxed beef cuts traded it is hypothesized that the composite index will better represent the wholesale beef market. This is a desirable outcome since a wholesale price series is required for measuring price spreads and also is widely used as a basis for the forward pricing of beef carcasses and boxed beef products.

Objectives

The primary objective is to develop a boxed beef composite index which better reflects actual wholesale market conditions than either the carcass price or the CCV presently reported by the AMS. This study derives a carcass cutout value using an expanded information base as compared with the AMSs CCV. Conceptually, expanding the information set used to create the index should be viewed as an improvement over what is presently available. This may, however, be more difficult to establish statistically. A second objective is to test the derived series to determine whether it is more representative of wholesale market conditions. Through ARIMA (autoregressive integrated moving average) modeling procedures and residual cross-correlation analysis the causal relationship between various wholesale price variables and live cattle prices can be tested.

The specific objectives are the following:

- Develop a boxed beef composite index which more accurately reflects wholesale market conditions.

- Apply residual cross-correlation analysis to test the intertemporal relationship among beef prices.

Organization

The structure of this study is as follows. In Chapter Two problems encountered in accurately valuing prices in the wholesale beef sector are discussed. Evidence concerning the thinly traded carcass beef market is presented. Alternative solutions are discussed. Chapter Three contains a brief overview of the relevant literature. Price reporting issues and previous analyses are reviewed. In Chapter Four the boxed beef composite indexes are derived. The derivation process is outlined, and the price and yield information required for the analysis is described. In Chapter Five causal relationships between the price series are determined. The ARIMA modeling and residual cross-correlation procedures are explained. The results of the analysis are reviewed. A summary of the study is provided in Chapter Six. Conclusions are presented.

CHAPTER II. WHOLESALE BEEF PRICING

Live cattle are sold at terminal markets, auctions, or directly to a packer. Price may be determined through negotiation or by forward contract. Until recently a majority of cattle slaughter was sold as carcasses to retail outlets where the carcasses were broken into the desired retail cuts for consumers. Beef going to the hotel, restaurant, and institutional (HRI) market was sold by the packer to a processor for final fabrication. In recent years structural changes in the beef industry have occurred. Packers have expanded their operations to include much of the fabrication into primal, subprimal, and more recently, retail-ready beef cuts.

These structural changes have had direct implications on the need for new price information. In particular, the type of price information required and the source of that information have changed over time. The change from the selling of beef carcasses to the trading of boxed beef products created a need for price reporting of the various boxed beef cuts. The price reporting services responded rapidly to meet this informational need. However, the United States Department of Agriculture (USDA) has been slow to adjust the wholesale beef price series. Until very recently, the USDA had not taken appropriate measures to reflect the changes in the wholesale beef market. This slowness to adjust is an area of substantial concern as the wholesale price of beef is important to industry participants at all levels as well as researchers and policymakers.

This chapter contains four sections. First, the causes and concerns of the thinly traded carcass beef market are detailed. Second, the development of the Carcass Cutout Value (CCV) reported by the Agricultural Marketing Service (AMS) is detailed. Problems with this price series and possible improvements are discussed. Third, a brief history of beef price spreads reported by the USDA is presented. Fourth, a summary and implications section is included.

Thin Market

The lack of data availability for carcass prices is a direct reflection of the thinness of the market for beef carcasses. In recent years the majority of beef purchased by retailers has been in the form of primal and subprimal cuts packaged in vacuum sealed boxes. This development in the industry was one of the primary factors leading to the switch by the USDA to basing the wholesale price on boxed beef rather than a beef carcass price.

Prior to the advent of boxed beef, packers slaughtered live cattle and sold beef carcasses to retailers or to processors. The processors then broke the carcasses into smaller cuts for distribution to the HRI market. The decline in the trade of beef carcasses has led to concerns of insufficient data availability and possible price manipulation. Price reporting by the three main reporting services includes only a small fraction of the trades completed. It is very possible then that beef carcass transactions do not adequately reflect actual economic conditions in the market and that the carcass price reported does not accurately reflect actual market price movements of beef carcasses.

Several suggested improvements for wholesale beef price reporting have been presented in the literature. These include mandatory price reporting, prohibition of formula trading, and use of electronic trading. The main problem with these suggestions is that they do not target the primary problem. Specifically, the central cause of the thin wholesale beef market is due to the shift from selling carcasses to marketing boxed beef products. Solutions or improvements in price reporting procedures would be better represented by providing alternatives to pricing wholesale beef as a reported carcass value.

The first step in identifying a solution to a problem, in this case the valuation of wholesale beef prices, is to define the direct cause of the problem. Then, an acceptable solution may be more readily identified. The reporting of a carcass or wholesale beef price serves three main functions: a transfer price for carcasses moving from slaughter to fabrication for each individual packer, a base for pricing boxed carcass units (BCU), and as an indicator of the value of beef at this stage relative to the live price of cattle (Lawrence 1988).

Packers have been able to set the transfer price on their own, although a more accurate wholesale price series may improve this process. Providing an accurate determinant base price for pricing BCUs is very important, especially for smaller buyers who have limited resources. As stated by Hayenga (1978), the use of formula pricing "protects against disproportionate pricing" in the wholesale beef market. The second function takes on added significance as formula pricing of boxed carcass units increases. A BCU is a set of beef cuts into which a carcass composed of all four primal cuts (chuck, loin, rib, and round) can be processed. The BCU is sold as a single unit, although it has already been broken into subprimal units. The third function has implications for the beef price spreads reported by the USDA.

From the wholesale beef pricing concerns outlined, it is apparent that an alternative method of pricing beef at the wholesale level is required. The need for an alternative method of price valuation has also been recognized in the literature. The best solution appears to be a move to base the wholesale price of beef on boxed beef cuts. As denoted by Hayenga (1980), a composite value index may prove useful when product composition shifts (e.g., boxed beef products) in a market.

Carcass Cutout Value

The AMS of USDA recognized the need for an alternative method of valuing beef carcasses. The AMS developed a fabricated cut composite index of subprimal beef cuts. Since 1979 the AMS has published this estimated CCV for the central U.S. region. Although the CCV reported by the AMS has been viewed an improvement, it was decided not to include the CCV as a component of USDA price spread calculations when price spread procedures were revised in 1978. Primarily, this decision was based on the problems of obtaining accurate data and potential complications that may arise from changing the beef price spread series (Parham and Duewer 1980). However, based upon recommendations by an Economic Research Service task force (USDA 1988), the USDA has decided to include the Choice, 550-700 pound boxed beef cutout value in its Choice beef price spread series (Duewer 1988). Previously, the carcass beef price series had been used.

During the ten years that the AMS has reported boxed beef prices several improvements have been made. Also, at various points in time, the AMS has updated the yield relationships used in deriving the CCV. The AMS publishes the boxed beef composite daily in its National Carlot Meat Report. A weekly average of the boxed composite is published in the weekly Livestock, Meat, and Wool Market News report.

Although the CCV reported by the AMS has gained universal acceptance, there exist several real or potential problems with the series. First, the set of eight cuts presently used by the AMS is too small to adequately reconstruct a carcass value.[1] Approximately 25 different cuts of beef are presently traded in the market. Price information for these cuts is collected daily by the AMS. Second, the CCV includes only boxed beef sold as an individual cut. Boxed beef that is sold as a carcass unit is not included. The price of an individual cut, not sold as part of a BCU, may depend greatly upon the inventory position of the buyer or seller. Third, the small sample of cuts used to estimate the CCV may result in valuation distortions. Thus, a small traded quantity of any one particular cut may influence the resultant CCV. These concerns were outlined by the Safeway Fresh Meat Procurement

Office (Lawrence 1988).

By targeting the problem areas of the present CCV, a more representative proxy for the wholesale price of beef can be derived. This can be accomplished by incorporating a greater number of boxed beef cuts in the valuation process. Including more information in the boxed beef carcass composite index will help to alleviate the first and third problems (listed in the previous paragraph) denoted by Safeway Foods (Lawrence 1988). Expanding the number of subprimal cuts included in determining the CCV will reduce the potential for distortions in the price series. Since data is not presently available, incorporating prices of boxed carcass units, the second proposed change by Safeway Foods, cannot be used in the valuation of a boxed beef composite. Collection of BCU price quotes may, however, merit future consideration by the USDA.

Reporting of Wholesale Beef Prices and Price Spreads

Price spreads for beef have been reported by USDA for over fifty years. The structural changes in the beef industry have affected the point of origin for different cost components of the farm-retail price spread/margin. The changes have had an even greater impact on the division of the farm-retail price spread into the farm-wholesale and wholesale-retail components. With the changes taking place in the beef industry, the Economic Research Service (ERS) of the USDA organized a task force to assess some of the issues regarding present methods of calculating and reporting beef price spreads (USDA 1988). The task force also presented several options for adapting current procedures to reflect recent changes in the beef industry.

Historically, the wholesale price of beef has been reported as the "carcass price" of beef. From 1978 through 1988, the wholesale beef price reported by USDA has been a composite of five market areas.[2] The prices collected in the five market areas are for 600-700 pound, Choice, Yield Grade 3, steer carcasses. The aggregate carcass price of beef was constructed by using a weighted average of the five markets based upon population and consumption criteria. One of the problems with this procedure was that the AMS discontinued publication of the data from three of the five markets. Estimates for these three markets were made by using a transportation differential from the central Midwest market price (USDA 1988). This pricing scheme provided a less than ideal method of valuing beef at the wholesale level.

During the past year the USDA, ERS recognized the need to provide more accurate price information for analyzing the beef industry. Beginning January 1, 1989 the USDA began to base the wholesale value in the Choice beef price spread series on the Choice, Yield Grade 1-3, 550-700 pound boxed beef cutout value published by the AMS. This decision was based, in part, on the recommendations made by the ERS-CED Task Force Report completed earlier in the year (Duewer 1988). The use of this boxed beef composite value is expected to provide a more representative middle value for estimating price spreads.

For use as the middle value in the USDA Choice beef price spread series, the cutout value must be transformed into a retail weight equivalent. Thus, it is necessary to adjust the boxed beef composite reported by the AMS. First, the Choice, Yield Grade 1-3, 550-700 pound boxed beef cutout value, minus the value of fat and bone, is collected on a daily basis using the AMSs daily National Carlot Meat Report. Fat and bone are excluded because they are not sold on the retail market. The daily cutout value is averaged on a weekly basis, and the weeks are averaged to a monthly value. A transportation differential is added to the monthly average. This monthly value (adjusted for transportation costs) is multiplied by a boxed beef retail conversion factor to obtain the Choice boxed beef wholesale value on a retail basis (Duewer 1988).

Summary and Implications

Considering the problems of the thinly traded carcass beef market, it is clear that an alternative method of valuing the wholesale price of beef is required. A viable solution appears to be the use of boxed beef prices as the basis for pricing beef at the wholesale level. Following this reasoning, the AMS has been reporting a boxed beef composite value index for more than ten years. However, there are several potential problems with the methods employed in deriving the series. A limited number of boxed beef cuts included in the valuation process restrict the ability of the wholesale price series to capture movements in demand for the various boxed beef cuts.

These problems may be, in part, alleviated through the inclusion of an expanded set of boxed beef cuts. The ability to accurately measure the price movements in the wholesale beef market has gained importance since the USDA is now using the AMSs CCV as the middle value in its beef price spread series. Thus, the approach taken in this study will to be create an composite wholesale value index based upon boxed beef prices. This composite value index will incorporate a larger information set than presently used in the CCV reported by AMS. The goal being to more accurately measure changes in the wholesale beef market.

End Notes

[1]The eight cuts (during 1988) are as follows: lip-on ribeye, 2-piece boneless chuck, brisket, knuckle, top inside round, bottom gooseneck round, 2 x 3 strip, and boneless top butt sirloin.

[2]The five market areas include: the East Coast, Colorado, the Midwest, the Amarillo area, and Los Angeles.

CHAPTER III. LITERATURE REVIEW

Considerable literature exists on wholesale beef prices and farm-retail margins and price spreads. However, little research has been conducted with direct relation to boxed beef prices and pricing methods. Most of the present literature concerning wholesale beef prices uses a reported carcass value. The widescale adoption of selling beef in vacuum sealed packages is relatively new, and prior to recent years reporting of boxed beef prices has been limited. Nevertheless, the methodology and results from previous works are important sources of information and comparison. An exhaustive study of previous works is beyond the scope of this analysis, but an overview of relevant literature is presented.

This chapter is divided into two sections. The first section focuses on price reporting and market efficiency of the wholesale beef market. The second section reviews methods of determining causality and relevant empirical studies.

Price Reporting and Market Efficiency

The number of carcasses traded in recent years has declined sharply, reducing the data available for collection and price reporting. There is general agreement by industry analysts (Hayenga 1979, 1980; Faminow and Sarhan 1980; Ward

1980; Marsh and Brester 1985; Menkhaus and Carver 1986) and industry participants (Lawrence 1988) that the trading of beef carcasses can be considered a "thin market". A thin market can be defined as "markets with little trading volume and liquidity in which individual firms or offers to buy or sell can sometimes exert 'undue' influence on price or other terms of trade" (Hayenga et al. 1979, p. 7).

Thin markets may result as actual levels of trading diminish, as a result of insufficient price reporting of actual trades, or if a large proportion of trades are conducted on a formula pricing basis. All of the above factors have occurred in the carcass beef market.

First, the percentage of carcasses sold and fabricated as boxed beef has risen during the 1980s to an estimated 85 percent. Thus, there are fewer carcass transactions available for price reporting (Ward 1987). And as noted previously, less than 5 percent of all beef purchased at the retail level was in carcass form (USDA 1988).

Second, only a small percentage of actual carcass transactions are reported by price reporting services. Ward (1980, 1987) cites a 1978 Packers and Stockyards Administration (P&SA) report that found that each of the three price reporting services reported carcass beef prices on a basis of less than 5 percent of total federally inspected steer and heifer slaughter. The reported carcass prices as reported by the P&SA were estimated to be 1.7, 1.6, and 4.6 percent of total federally inspected steer and heifer slaughter for the two private and one public reporting services, respectively (Faminow and Sarhan 1980; Ward 1980).[1]

Third, the concerns of increased use of formula pricing primarily involve a limited number of negotiated prices on which to base price reports and that price manipulation may arise as a result of the small number of trades (Menkhaus and Carver 1986; Williams 1979). Menkhaus and Carver (1986, p. 2) define formula priced trades as "those where delivery, quality and quantity are agreed on at the time of sale with price to be established at a later date".

Several concerns arise when the issue of a thinly traded market is raised. Tomek (1980, p. 434) states that "a small volume of trading at a central market place can result in price behavior not warranted by economic conditions". It has also been speculated that price manipulation may occur in markets which may be considered thinly traded. Several lawsuits have been filed against meatpacking companies, retail food chains, and other market participants. However, none of these cases have been won in court. Examples of price manipulation allegations against meatpackers center on three hypothetical cases of manipulation by packers: packer to packer highball, high-low split, and savings on the sly (Faminow and Sarhan 1980).

Packer to packer highball constitutes the purchase of a small quantity of beef by one packer from another packer at a price above the prevailing market price. The transaction is then reported near the end of the business day. Assuming that the packer has a formula based sales contract based on the closing price quote of that day, the result is that the packer has successfully manipulated the contract price upward. The second hypothetical case of price manipulation, the high-low split, occurs when a packer has completed a transaction below the current price but does not wish to lower the closing market price. This is done in order to protect a forward sale based upon the closing market price. Thus, the packer splits the transaction into two prices and selectively reports only the higher of the two prices. The final method, savings on the sly, involves selling meat at a price below the prevailing market price on the condition that the price is not reported.

Very little empirical research has been conducted with respect to the identification or measurement of a thin market. In one such study, Ward (1980) conducted a weak form test of the efficient markets model for the carcass beef market. An efficient market is defined as "a market in which prices always 'fully reflect' available information" (Fama 1970).

Ward found that the random walk hypothesis was rejected for carcass beef prices, indicating that there was serial correlation in carcass beef price changes. The results indicated that there was some evidence of market inefficiency, but the market could not be shown to be inefficient (Ward 1980). Marsh and Brester (1985) attempted to measure whether movements in the carcass price could be explained by systematic economic behavior. They concluded that over 85 percent of the variation in carcass prices was explainable. However, they could not statistically disprove the possibility of influence from non-economic factors.

Numerous suggestions have been forwarded as solutions to the problems of a thin carcass beef market. Three possible alternatives have received the most consideration: mandatory price reporting (Henderson 1979; Williams 1979; Faminow and Sarhan 1980), electronic trading (Williams 1979; Faminow and Sarhan 1980; Menkhaus and Carver 1986), and prohibition of formula trading (Raikes 1979; Williams 1979; Menkhaus and Carver 1986). Other suggestions have included: expanding reporting of non-price information (Henderson 1979), not reporting prices for thinly traded markets (Henderson 1979; Raikes 1979), using a standard trading format (Henderson 1979), and setting prices through a central committee (Raikes 1979). Very little if any change has occurred as a result of these suggestions.

A different approach to the thin carcass beef market problem involves using boxed beef prices as the source for pricing beef at the wholesale level. The value of a composite value index has previously been recognized in the literature (Hayenga 1980). Also, the use of a beef carcass cutout value has been accepted by the USDA (Duewer 1988) and by the wholesale beef industry (Lawrence 1988). The development of a wholesale beef price series based on boxed beef prices is the approach taken in this paper. The goal being to improve upon the information presently available.

Lead-Lag Relationships and Causality

Having provided an alternative method of valuing wholesale beef, it becomes necessary to determine whether the resulting price series is an improvement over previous methods. One way in which this type of determination can be conducted is through correlation analysis. This type of analysis can be extended to provide some evidence of the direction of price determination or causality. Thus, the properties of the wholesale beef price series created in this study can be compared with previous studies which used other pricing methods. The following section reviews previous studies of price relationships involving wholesale beef pricing.

Testing of price relationships between different market stages of a particular commodity have been conducted through statistical tests of causality. The identification of a causal relationship between two price series results in the determination of a lead-lag relationship between the two sets of price series. Most empirical studies use the notion of Granger Causality as the basis for the determination of causal directions. Granger (1969, p. 428) defined causality by stating that "we say that Y_t is causing X_t if we are better able to predict X_t using all available information than if the information apart from Y_t had been used".

Several statistical techniques have been used to identify the causal relationship between wholesale and live cattle prices. Univariate cross-correlation analysis (Miller 1979; Boyd and Brorsen 1985; Schroeder and Hayenga 1987), cross-spectral analysis (Barksdale et al. 1975), and harmonious analysis (Franzmann and Walker 1972) are among the methods employed in the literature. Cross-correlation analysis is the technique most widely used. Cross-correlation analysis has also been applied to live cattle prices (Spreen and Shonkwiler 1981), wholesale beef prices (Faminow 1981), pork prices (Miller 1980; Boyd and Brorsen 1985; Schroeder and Hayenga 1987), turkey prices (Bessler and Schrader 1980a), and egg prices (Bessler and Schrader 1980b). Numerous studies testing causal flows in futures prices have also been conducted.

Most studies of lead-lag relationships in beef prices have found that farm level prices lead wholesale prices by as much as 5 weeks, and wholesale prices lead retail prices by as many as 6 weeks. However, Barksdale et al. (1975) and Schroeder and Hayenga (1987) determined that farm and wholesale prices were determined simultaneously. Franzmann and Walker (1972) found that wholesale prices led slaughter steer prices by 12.8 months. It should be noted that Franzmann and Walker qualify their results by making reference to the poor statistical quality of their wholesale price function. Also, Barksdale et al. (1975, p. 311) note that "it is not mathematically possible to distinguish between a lead and a lag" when using harmonic analysis. The results of selected studies are summarized in Table 1.

Only one study was found which used the boxed beef price series in the context of lead-lag/causality testing. Hudson (1987) cites a study completed by Hudson, Purcell, and Koontz in which boxed beef, cash slaughter cattle, and live cattle futures were compared. The study used algebraic models in an information mapping process. In the study boxed beef prices were found to interact simultaneously with cash slaughter cattle and live cattle futures on a daily basis. Also, lagged

Table 1. Beef farm-wholesale lead/lag relationships from selected studies[a]

Study	Sample Period	Frequency	Estimation Method	Lead/Lag F -> W
NCFM (1966)	1962-65	Weekly	Regression	2
Franzmann and Walker (1972)	1949-69	Monthly	Harmonic	-55
Barksdale et al. (1975)	1949-72	Monthly	Spectral	0
King (1976)	1973-75	Weekly	Distributed Lag	0
Miller (1979)	1974-78	Weekly	Cross-Correlation	1
Boyd and Brorsen (1985)	1974-78	Weekly	Regression	5
	1978-81	Weekly	Regression	4
Schroeder and Hayenga (1987)	1983-85	Weekly	Transfer Function	0
			Regression	4

[a]Lead/lag relationship given as the number of weeks.

feedback flows (within three days) in both directions were found to exist between the price series.

It is often necessary in empirical studies of industry behavior for forecasting purposes or policy analysis to determine a priori the direction of price determination. Determination of causal direction must be implicitly assumed prior to model estimation. For example, Marsh (1983) estimated distributed lag equations of quarterly live cattle prices. In his analysis he assumed the maintained hypothesis "that fed cattle and feeder cattle prices are based on the wholesale market" (Marsh 1983, p. 541). Marsh estimated the price of fed cattle as a function of the contemporaneous steer carcass price. His conclusion was that fed cattle prices fully adjust within one quarter to the carcass price. This is not a surprising conclusion considering that one quarter is a fairly long time period for adjustment.

Studies concerning the relationship between wholesale and retail prices have also been completed. Heien (1980) determined that wholesale prices led retail prices for most commodities. Heien used distributed lag regression analysis to test the notion that changes in wholesale price are transmitted to the retail level by markup pricing behavior. In estimating a dynamic econometric model using rational distributed lags Brester and Marsh (1983) found that the carcass price was highly correlated with formula and boxed beef prices. Thus, they hypothesized that price was determined at the retail level and that all other price relations were derived from retail demand. These results contrast directly with the findings of Heien (1980).

End Notes

[1]The three reporting services are The National Provisioner (Yellow Sheet), Fairchild Publications (Meat Sheet), and the United States Department of Agriculture, Agricultural Marketing Service (Blue Sheet), respectively.

CHAPTER IV. DERIVATION OF THE CARCASS CUTOUT VALUE

In this chapter the derivation process is described, and the cutout values for choice and select carcass qualities are derived. First, an overview of the data collected and sources is presented. Second, the general procedure for deriving the cutout value is discussed. Boxed beef prices and yield relationships are combined through linear algebraic procedures.

Third, a brief overview of the cutting process is provided for each of the four primal cuts and for the fat, bone, and trim categories common to each of the four primals. Within each of these five categories price assumptions are also described.

Data Overview

The construction of a composite value index of boxed beef products, termed the carcass cutout value, can be created through simple manipulation of boxed beef prices and the corresponding yield relationships. More specifically, the price of each boxed beef cut times the yield percentage of the cut provides a value measure for each component of the carcass. The yield percentage is measured for each boxed cut as a percent of the total carcass weight. Then, assuming that the subprimal and byproduct cuts used compose a complete carcass, summing the derived component values provides an aggregate carcass measure.

A beef carcass can be split into four distinct component parts which are called the primals. These four parts are from anterior to posterior: the chuck, the rib, the loin, and the round (see Figure 1). For purposes of this study the chuck primal will be defined to include the chuck, foreshank, and brisket. The rib will also include the plate, and the loin will include the flank. Since these four primals are completely distinct with respect to the fabrication process, a value index can be determined for each of the four primals. Thus, the sum of these four primal values will determine the carcass cutout value.

Prior to the analysis it was necessary to obtain time series data of boxed beef prices and subprimal yield relationships from controlled cutting tests. Price information was obtained from the Agricultural Marketing Service (AMS) of the United States Department of Agriculture's (USDA) Wholesale Meat Quotations publication. The price series, from the week ending January 3, 1986 to the week ending September 9, 1988, contains 141 observations. Most of the prices are published daily in the National Carlot Meat Report of the USDA, AMS. The daily publication is also

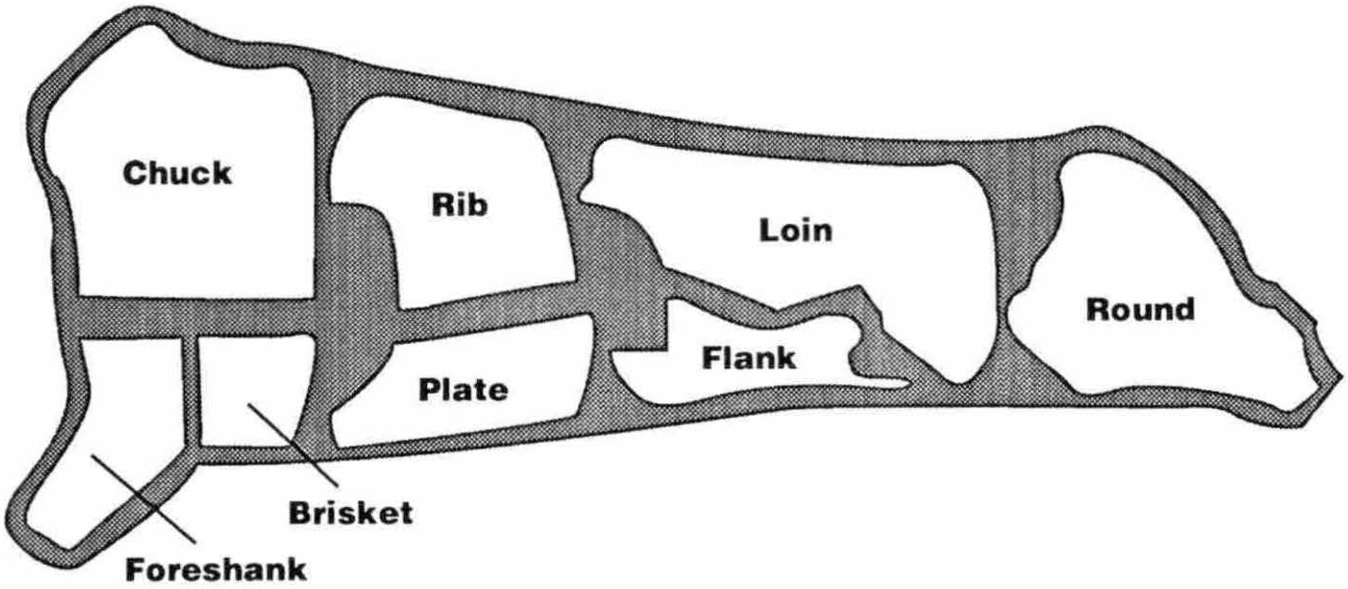

Figure 1. Primal cuts of the beef carcass

commonly called the "blue sheet". Weekly averages are published in the Livestock, Meat, and Wool Market News report from the AMS. Subprimal and byproduct yield relationships were obtained from industry sources under the condition that the source would be held confidential.

For this analysis both a Tuesday price quote and the weekly average of all prices quoted during the week were collected. Prices were collected on a weekly basis because a longer time period (i.e. monthly) would not allow an accurate measure of price movements. Collection of daily price quotes was not undertaken for two reasons: first, the collection process would have been too tedious and second, the number of transactions reported on Mondays and Fridays are minimal.

It was determined a priori that a weekly price was an adequate time frame to allow for measurement of price movement. The weekly average price was selected as an indicator of all reported transactions during the week. The Tuesday price was chosen as being representative of the origination of the weekly price discovery process. Tuesday is generally the first day of each week in which a substantial number of trades are completed and reported. Also, using price quotes from early in the week will allow for the examination of the weekly price discovery process. More specifically, does information from the previous week help to determine prices in the following week?

The price series collected were for Choice, Yield Grade 2-3 and Select, Yield Grade 2-3 Central U.S. boxed beef cuts valued FOB Omaha. The yield curves, sets of yield relationships for a complete carcass, for both the Choice and Select carcasses are based upon a standard carcass weighing 650 pounds. Four carcass cutout value index series were derived: two for Choice, Yield Grade 2-3, 550-700 pound carcasses and two representing Select, Yield Grade 2-3, 550-up pound carcasses. For each carcass quality one series was derived based upon a weekly average price, and a second series was derived based upon a Tuesday price quote.

One problem encountered with the boxed beef price series collected was missing observations. The number of missing price quotes was especially prevalent for the Tuesday price quotes and in the early portion of the sample period. On Tuesdays in which a price was not reported for a particular cut, the weekly average price was used. During weeks in which Tuesday occurred on a holiday the Wednesday price quotes were used in place of the Tuesday price for that week. However, weeks in which no negotiated trades were reported for a particular cut was a greater concern. It was decided not to include price quotes for 1985 specifically due to the large number of missing price observations for some cuts during that year. Price series were not used if greater than half of the observations were missing for a particular year. This is the reason that the choice boxed beef series is not based upon exactly the same cuts as the select series.

Missing data points were replaced through a simple method of using the midpoint between the preceding price quote and the following price quote. For the few cases in which two or more consecutive observations were missing, the same midpoint price was used for each of the missing observations. A second problem was the unavailability of price information for a few necessary subprimal or byproduct items. For each of these cuts a price series was created based upon related price information. The assumptions and techniques used are discussed individually in the later sections of this chapter which are specific to each primal. All of the boxed beef cuts used in this analysis are shown in Tables 2-4. Each cut is described using three different naming conventions.

Derivation Process

Each of the four primal cuts can be fabricated in several different ways or cutting styles. Several carcass cutting styles are included in the carcass valuation process for each primal cut. This is the primary advantage of the

Table 2. Naming conventions used for choice boxed beef cuts

Primal	NAMP Code	USDA, AMS	Common Name
Chuck	113	Chuck, 2 pc	2-piece bone-in chuck
	114	Shoulder clod	Chuck clod
	115	Chuck, 2 pc, bnls	2-piece boneless chuck
	116	Chuck roll	Chuck roll
	120	Brisket	Brisket
	126	Armbone chuck	3-piece boneless armbone chuck
	---	Chuck, sq cut (neck off)	Bone-in neck-off chuck[a]
	---	Chuck, semi-bnls (neck off)	Semi-boneless neck-off chuck[a]
	---		Chuck tender[b]
Rib	107	Rib, 3-4	3 x 4 rib
	112A	Ribeye (2" lip-on)	Lip-on ribeye
	---	Ribeye (2" lip-on) bn-in	2 x 2 bone-in lip-on ribeye[a]
Loin	172	Loin, dia cut	1-piece loin
	174	Short loin 2-3	2 x 3 short loin
	175	Strip loin 4-6	4 x 6 strip loin
	180	Strip loin	2 x 3 strip
	184	Top butt	Top butt sirloin, boneless
	189	Full tenderloin	Tenderloin
	189A	Ful tender, mus'l on	Peeled tenderloin
	191		Butt tenderloin[b]
	---	3 pc loin	3-piece loin
	---	Top butt bone-in	Bone-in top butt sirloin
Round	160	Round, shank-off	2-piece semi-boneless round
	161	Round, bnls	2-piece boneless round
	167	Knuckle	Knuckle
	167A	Knuckle trmd	Peeled knuckle
	168	Top inside round	Inside round
	170	Btm gooseneck round	Gooseneck round, boneless

[a]Price reported during 1988 only.

[b]Price not reported by the USDA, AMS.

Table 3. Naming conventions used for select boxed beef cuts

Primal	NAMP Code	USDA, AMS	Common Name
Chuck	113	Chuck, 2 pc	2-piece bone-in chuck
	114	Shoulder clod	Chuck clod
	115	Chuck, 2 pc, bnls	2-piece boneless chuck
	116	Chuck roll	Chuck roll
	120	Brisket	Brisket
	126	Armbone chuck	3-piece boneless armbone chuck
	---	Chuck, sq cut (neck off)	Bone-in neck-off chuck[a]
	---		Chuck tender[b]
Rib	107	Rib, 3-4	3 x 4 rib
	112A	Ribeye (2" lip-on)	Lip-on ribeye
Loin	172	Loin, dia cut	1-piece loin
	174	Short loin 2-3	2 x 3 short loin
	180	Strip loin	2 x 3 strip
	184	Top butt	Top butt sirloin, boneless
	189	Full tenderloin	Tenderloin
	189A	Ful tender, mus'l on	Peeled tenderloin
	191		Butt tenderloin[b]
	---	3 pc loin	3-piece loin
	---	Top butt bone-in	Bone-in top butt sirloin
Round	160	Round, shank-off	2-piece semi-boneless round
	161	Round, bnls	2-piece boneless round
	167	Knuckle	Knuckle
	167A	Knuckle trmd	Peeled knuckle
	168	Top inside round	Inside round
	170	Btm gooseneck round	Gooseneck round, boneless

[a]Price reported during 1988 only.

[b]Price not reported by the USDA, AMS.

Table 4. Naming conventions used for credit items

Primal	NAMP Code	USDA, AMS	Common Name
Chuck	---		Boneless chuck short ribs[b]
	---		Neck meat[b]
	117	Shank meat	Foreshank
Rib	123A	Short rib	Plate short ribs
	---	Inside skirt	Inside skirt
	---	Outside skirt	Outside skirt
	---	Back ribs, fr. vac. pk.	Back ribs
	---	Cap & wedge meat	Lifter meat
	---	Pastrami	Pastrami
	---		Plate trim[b]
Loin	185A	Bottom sirloin, flap	Flap meat
	185B	Bottom sirloin, b ti	Ball
	185C	Bottom sirloin tri	Tri-tips
	193	Flank steak	Flank
	---	Kidney	Kidney
	---	Steak tails	Steak tails
	---		Flank trim[b]
Round	117	Shank meat	Shank
Other	134	Bone	Bone
	137	Sp trimmings	Sp trim[a]
	---	Beef trmgs 50% fresh	50/50 trim
	---		80/20 trim
	---	Coarse ground fresh 80%	80% coarse ground
	---	Fat	Fat

[a]Price reported during 1988 only.

[b]Price not reported by the USDA, AMS.

value index derived here as opposed to the Carcass Cutout Value (CCV) reported by the USDA, AMS. The use of more than one cutting style allows for more information to be incorporated into the value index. This may be important since a shift in demand for a specific cut by food retailers or the hotel, restaurant, and institutional (HRI) buyers may not be incorporated as information if a limited set of boxed beef cuts are included in the cutout value. Also, the inventory position of packers and processors is important in the price determination process. Hence, a packer may lower the offered price for a specific cut due to an inventory surplus for that cut.

Several carcass cutting styles are included for each particular primal. A primal value is obtained by creating a (m x n) matrix of the form

$$\begin{bmatrix} Z_{11} & Z_{12} & \cdots & Z_{1n} \\ Z_{21} & Z_{22} & \cdots & Z_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ Z_{m1} & Z_{m2} & \cdots & Z_{mn} \end{bmatrix} . \tag{4.1}$$

Each of the N columns of the matrix (4.1) denotes a different carcass cutting style. The M rows are each comprised of a different subprimal cut from the primal. The fat, bone, and trim categories are also included. Not all cutting styles will require all cuts, but each of the M cuts will be included in at least one cutting style. Each element (Z) of the matrix (4.1) contains the corresponding yield percentage for each cut corresponding to the appropriate cutting style.

The above matrix of yield percentages (4.1) is then transposed and given by,

$$\begin{bmatrix} Z_{11} & Z_{21} & \cdots & Z_{m1} \\ Z_{12} & Z_{22} & \cdots & Z_{m2} \\ \cdots & \cdots & \cdots & \cdots \\ Z_{1n} & Z_{2n} & \cdots & Z_{mn} \end{bmatrix} \qquad (4.2)$$

creating a (n x m) matrix of yield percentages. A (m x 1) matrix of boxed beef prices of the form

$$\begin{bmatrix} P_1 & P_1 & \cdots & P_1 \\ P_2 & P_2 & \cdots & P_2 \\ \cdots & \cdots & \cdots & \cdots \\ P_m & P_m & \cdots & P_m \end{bmatrix} \qquad (4.3)$$

is also created.

The prices are the same for cuts common to two or more different cutting styles (e.g., fat and bone). The only variation between the elements in the columns of matrix (4.3) occurs as null values are placed in matrix elements for which the cutting style does not contain a particular cut. The zero values are used primarily for ease of observation. The obtained solution is invariant of the these null price values since the zero values correspond directly to zero values from the matrix of yield percentages (4.2).

Multiplying the matrix of yield percentages (4.2) times the matrix of prices (4.3) yields a (n x n) matrix of boxed beef primal values. The matrix is of the general form

$$\begin{bmatrix} V_{11} & V_{12} & \cdots & V_{1n} \\ V_{21} & V_{22} & \cdots & V_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ V_{n1} & V_{n2} & \cdots & V_{nn} \end{bmatrix} . \qquad (4.4)$$

Each element of the principal diagonal of the above value matrix (4.4) contains a primal value based on a different carcass style. The final primal value, based on the M subprimal prices, was derived through a simple averaging of the N estimated primal values (V_{11}, V_{22}, ... V_{nn}). Thus, each primal value is created as a simple average type index. The solution is given by,

$$\frac{(V_{11} + V_{22} + \ldots + V_{nn})}{N} = V^{*} \qquad (4.5)$$

where N is the number of carcass cutting styles used. The average primal value is denoted as V^{*}.

The same solution would be obtained by replacing the price matrix (4.3) with a column vector of boxed beef prices. Then, multiplying the yield percentage matrix (4.2) times the (m x 1) column vector of prices would result in a (n x 1) column vector of primal values. Each of the elements in this column vector would be identical to the values of the principal diagonal of the value matrix (4.4). Averaging the values from the column vector of primal values would result in the solution V^{*} derived previously.

The above process was completed four times for each period in time, once for each of the four carcass primals. Thus, a value was obtained for each of the four primal cuts from the beef carcass. The derivation of the wholesale value index is then completed by the summation of the four primal values.

It is implied by the construction method of the composite index that all cutting styles recieve an equal weight in the valuation process. It would be an improvement if an appropriate weighting scheme based upon relative quantities traded of each cut could be incorporated. However, this information is not presently available. Assigning a weighted average for the subprimal cuts would be purely guesswork, and thus, a naive approach of assigning equal weights was used.

Description of Carcass Cutting Styles

Various fabrication techniques are used by packers and processors in the boxed beef industry. The type of cuts demanded may differ among buyers, depending on the intended use. These differences include varying levels of fat trim and deboning. Also, certain cuts may be packaged together or sold separately. These types of marketing differences entail different pricing schemes by the packer.

Each of the four primal components of the carcass are discussed separately and a fifth category is included which includes those fat, bone, and trim products which are not specific to a particular primal. The cutting styles are only briefly described. A more rigorous technical description of the cutting process can be obtained from the Meat Buyer's Guide to Standardized Meat Cuts (1970) published by the National Association of Meat Purveyors (NAMP). The primal definitions forwarded for the purposes of this paper differ from those described in NAMP (1970). This difference is due to a need within this analysis to be able to compose an entire carcass from the four primal cuts.

For each of the five boxed beef categories the various boxed cuts are listed using common names. The cutting process is described, although briefly, from the primal level to the smallest cut marketed on an individual basis from the respective primal. Only cuts incorporated into the yield relationships used for this analysis are included. Unless otherwise stated, the cutting methods described are included in both the choice and select quality carcass valuation. Pricing assumptions for the boxed beef products are explained as well.

Chuck Primal

The chuck primal (see Figure 1) is the portion of the forequarter[1] remaining after the removal of the short plate and rib. The separation from the rib occurs between the 5th and 6th ribs (see Figure 2). Six cutting methods are included in creating the chuck primal cutout value for choice carcasses, and five cutting methods are used for select carcasses (see Table 5).

The removal of the brisket and foreshank from the chuck

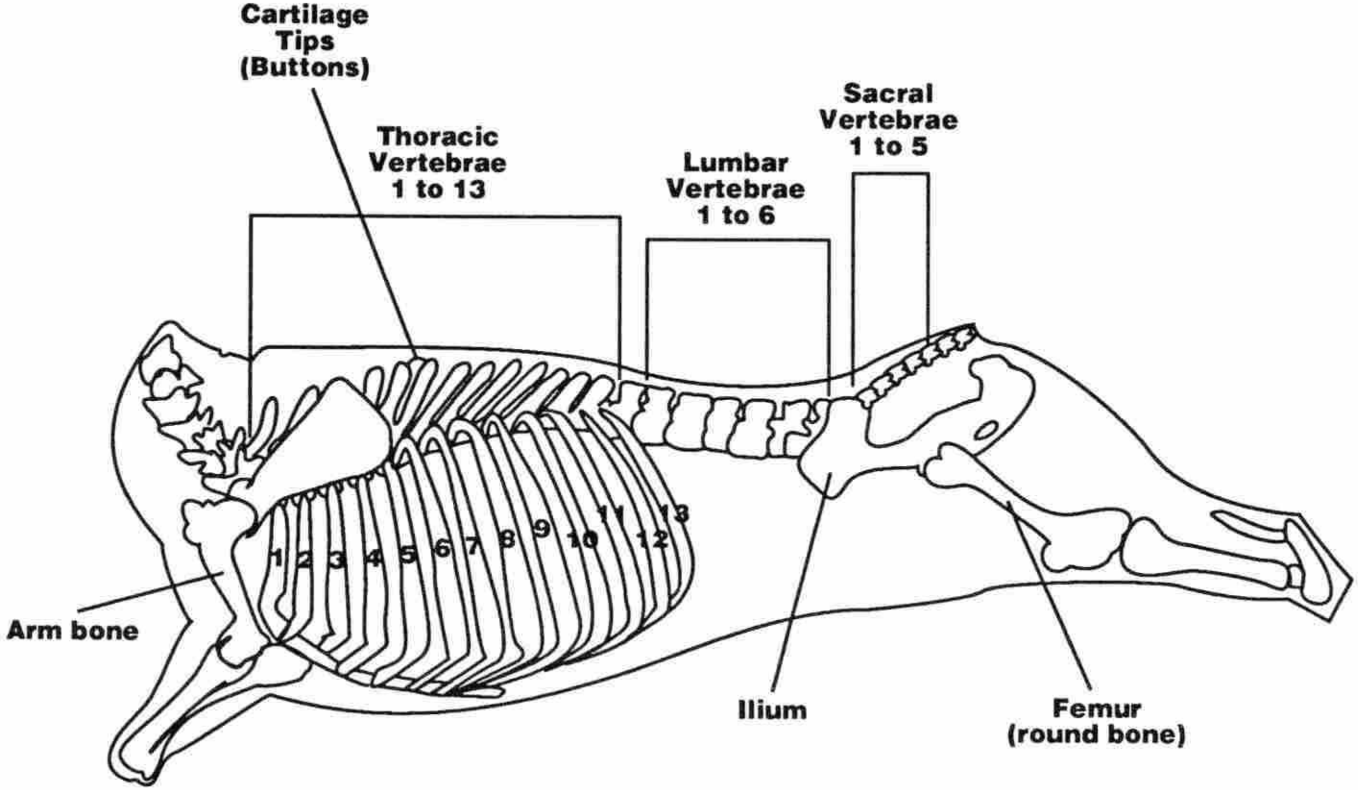

Figure 2. Skeletal structure of the beef carcass

Table 5. Chuck primal yield percentages by cutting style[a]

Boxed Cut	1[b]	2[c]	3	4	5	6
CHXSBNO	14.11	---	---	---	---	---
CHXSQCNO	---	20.84	---	---	---	---
CHXROLL	---	---	7.51	---	---	---
CHXCLOD	---	---	5.69	---	---	---
CHX126	---	---	---	24.63	---	---
CHX113A	---	---	---	---	23.88	---
CHX2BLS	---	---	---	---	---	17.97
CHXTDR	---	---	0.78	---	---	---
NECK	1.41	1.41	---	---	---	---
SPTRIM	0.52	---	0.54	---	---	0.54
SHANK	1.48	1.48	1.48	---	1.48	1.48
CHXSR	0.49	---	0.49	---	---	0.49
BFTM50	---	---	0.50	0.21	---	---
FRESH80	5.30	2.11	4.15	---	2.11	2.41
FAT	0.63	0.46	0.96	0.30	0.19	0.76
BONE	5.71	3.35	7.55	4.51	1.99	6.00
TOTAL	29.65	29.65	29.65	29.65	29.65	29.65

[a]Yields are given as a percent of carcass weight.

[b]Cutting style used only for 1988 choice boxed beef composites.

[c]Cutting style used only for 1988 boxed beef composites.

primal creates the 2-piece bone-in chuck (CHX113A) also commonly referred to as a square-cut chuck. Deboning the 2-piece bone-in chuck allows the chuck to be sold as a 2-piece boneless chuck (CHX2BLS). To facilitate the boning procedure, the 2-piece bone-in chuck is broken into two smaller cuts: the chuck clod (CHXCLOD) and the chuck roll (CHXROLL). The clod is the large outside muscle which lies at the lower end of the arm bone. The roll is the remaining portion of the chuck and must be boned and trimmed prior to marketing. The 2-piece boneless chuck and foreshank are often marketed as a single unit and are referred to as a 3-piece boneless armbone chuck (CHX126).

In recent years demand has increased for chucks sold with all of the neck meat removed. Cuts such as the 2-piece boneless chuck have only a portion of the neck region removed, that which has a dark blood discoloration. The two cuts used for which all of the neck meat (NECK) is removed are the bone-in neck-off chuck (CHXSQCNO) and the semi-boneless neck-off chuck (CHXSBNO). These cuts are used only for the 1988 primal value since prices for these boxed cuts were not reported by the AMS prior to that year. For the select quality cutout value only the square-cut neck-off chuck is used.

The other boxed cuts which originate from the chuck primal portion of the beef carcass are the chuck tender (CHXTDR) and the boneless chuck short ribs (CHXSR). The chuck tender is removed and marketed separately when the chuck roll and clod are separated and sold individually. The boneless chuck short ribs are removed and sold when the chuck is at least partially deboned and the cuts are not sold as combined unit.

Prices for the boxed cuts from the chuck primal are generally used as reported by the AMS. However, for the chuck tender, boneless chuck short ribs, and neck meat no prices are reported. Thus, a separate pricing method was determined. The chuck tender was valued at a constant markup value of forty percent over the chuck roll. This markup percentage only provides a rough approximation. Boneless chuck short ribs were valued at the same price as the plate short ribs. Neck meat, considered to be approximately equivalent in value to 80/20 trim (FRESH80), was valued as 80 percent coarse ground beef less six cents/pound grinding cost. Prices for the square-cut and semi-boneless neck-off chucks were not reported prior to 1988, so these two cuts are only included in the valuation process during 1988.

Rib Primal

The rib primal (see Figure 1) is the portion of the carcass forequarter remaining after the removal of the chuck primal (includes the 2-piece bone-in chuck, brisket, and foreshank). Included in the rib primal are the rib and short plate. The separation of the rib primal and chuck primal occurs between the 5th and 6th ribs of the carcass (see Figure 2). Three cutting methods are incorporated into the valuation of the choice rib primal value, and two are included in the valuation of the select quality rib primal (see Table 6).

The short plate and rib are separated by making a straight cut across the ribs at a point not more than ten inches from the inside protruding edge of the thoracic vertebrae. From the rib portion of the rib primal three cutting styles are included. First, a 3 x 4 rib (RIB107) can be made by a straight cut beginning three inches from the extreme outer-tip of the rib-eye muscle at the 12th rib and continuing to a point four inches from the extreme outer-tip of the rib-eye muscle at the 6th rib. The bodies of the thoracic vertebrae (chine bones) must be entirely removed, exposing the lean meat but leaving the feather bones attached.

The 2 x 2 bone-in lip-on ribeye (RIBBILO) is the eye

Table 6. Rib primal yield percentages by cutting style[a]

Boxed Cut	1[b]	2	3
RIBBILO	4.14	---	---
RIB107	---	7.29	---
RIB112	---	---	3.33
SR123A	0.87	0.87	0.87
INSKT	0.50	0.50	0.50
OUTSKT	0.52	0.52	0.52
BRISKET	2.46	2.46	2.46
BKRIB	---	---	1.04
SPTRIM	0.55	0.37	0.55
PASTRAMI	1.27	1.27	1.27
PLATE TRIM	3.43	3.43	3.43
BFTM50	3.54	1.51	2.35
FAT	1.71	0.26	2.11
BONE	2.33	2.84	2.89
TOTAL	21.32	21.32	21.32

[a]Yields are given as a percent of carcass weight.

[b]Cutting style used only for choice 1988 boxed beef composite.

muscle of the rib. All other muscles and bones, except for the back ribs, are removed from the rib. This cut is included only for the choice quality rib primal valued during 1988. It is not included in the select rib primal valuation. The 2 x 2 bone-in lip-on ribeye is only used in the 1988 rib cutout value because prices were not reported prior to 1988. Removal of the back ribs (BKRIB) from the 2 x 2 bone-in lip-on ribeye leaves a lip-on ribeye (RIB112). The rib lifter meat is muscle removed from the rib when the eye muscle is separated.

The short plate is fabricated into several component parts. The inside (INSKT) and outside (OUTSKT) skirts (diaphragm) are removed from the short plate. Also cut from the short plate are the plate short ribs (SR123A). The short ribs are removed from the short plate by making a straight cut parallel to the cut made separating the short plate from the rib portion of the rib primal. Only the 6th through 10th ribs may be sold as plate short ribs.

The prices used for the above cuts obtained from the rib primal are all included as reported by the AMS. However, as noted previously, the 2 x 2 bone-in lip-on ribeye is included only for 1988 as prices were not reported by the AMS prior to that year.

Loin Primal

The loin primal (see Figure 1) is the portion of the hindquarter[2] remaining after the removal of the round. It includes both the loin and the shank. The loin and shank are removed from the hindquarter by making a straight cut perpendicular to the outside surface of the hindquarter. The cut begins at a point on the backbone between the last sacral vertebra and the first tail vertebra and continues through a point immediately anterior to the femur bone, exposing the ball of the femur bone (see Figure 2). Six cutting methods are included for the choice loin primal and five cutting methods are included for the select loin primal as shown in Table 7.

The 1-piece loin (LOIN172) is obtained after removing the flank, kidney, and excess fat from the loin primal. One method of fabricating the loin involves splitting the 1-piece loin into two parts. Either a regular short loin or a 2 x 3 short loin (LOIN174) can be fabricated from the anterior portion of the 1-piece loin and are obtained by making a straight cut perpendicular to the outside surface of the loin and through the ilium (pelvic bone). The 2 x 3 short loin is often referred to as diamond cut loin and is used for the value index. The regular short loin is not included in the loin cutout value. A small portion of the hip bone is left

Table 7. Loin primal yield percentages by cutting style[a]

Boxed Cut	1	2	3	4[b]	5	6
LOIN3PC	10.95	---	---	---	---	---
LOIN180	---	3.97	3.97	---	---	---
LOIN184	---	3.32	3.32	3.32	---	---
LOIN189	---	2.05	---	2.05	---	---
LOIN189A	---	---	1.37	---	---	---
LOIN175	---	---	---	5.58	---	---
LOIN174	---	---	---	---	6.57	---
LOINBITB	---	---	---	---	4.43	---
LOINBTDR	---	---	---	---	1.06	---
LOIN172	---	---	---	---	---	13.89
BALL	0.42	0.42	0.42	0.42	0.42	0.42
TRI	0.69	0.69	0.69	0.69	0.69	0.69
FLAP	0.45	0.45	0.45	0.45	0.45	0.45
FLANK	0.49	0.49	0.49	0.49	0.49	0.49
KIDNEY	0.25	0.25	0.25	0.25	0.25	0.25
FLANK TRIM	2.17	2.17	2.17	2.17	2.17	2.17
BFTM50	2.48	3.97	3.57	3.20	2.28	0.64
FAT	4.68	4.36	5.27	3.74	4.84	4.64
BONE	1.12	1.56	1.73	1.34	0.05	0.06
TOTAL	23.70	23.70	23.70	23.70	23.70	23.70

[a]Yields are given as a percent of carcass weight.

[b]Cutting style used only for choice boxed beef composites.

attached to the 2 x 3 short loin. This is the primary difference between the 2 x 3 short loin and the regular short loin. The posterior portion of the loin obtained from this cut is the sirloin.

The regular short loin can be further broken into a 4 x 6 strip loin (LOIN175). This is accomplished by removing the tenderloin (LOIN189), the protruding edge of the chine bone, and the edge of the flank. The 4 x 6 strip loin is included in the choice loin primal value but not the select value. The tenderloin is removed by first cutting along the inside of the chine bone and then cutting along the lateral processes of the lumbar vertebrae. The tenderloin can also be further processed, resulting in a peeled tenderloin (LOIN189A). A second method of cutting the regular short loin involves the same fabrication method as the 4 x 6 strip loin, except that the flank edge must be cut off in a straight line starting at a point on the rib end which is not more than 3 inches from the outer tip of the loin eye muscle. The cut is continued in a straight line perpendicular to the outer surface of the loin. The resulting cut is the 2 x 3 strip (LOIN180).

The bone-in top butt sirloin (LOINBITB) is obtained by removing the butt tenderloin (LOINBTDR) from the sirloin. The bone-in top butt can be made boneless and after removing the bottom sirloin, the remaining cut is the boneless top sirloin butt (LOIN184). Since both the short loin and sirloin can be cut in several different ways, there are several combinations into which the loin primal can be fabricated. Marketing the boneless top sirloin butt, 2 x 3 short loin, and the butt tenderloin together as a single unit is referred to as a 3-piece loin (LOIN3PC).

Other cuts obtained from the loin primal include: the ball (BALL), the tri-tips (TRI), and the flap meat (FLAP). These three cuts are all fabricated from the bottom sirloin butt. The bottom sirloin butt is that portion of the boneless sirloin remaining after the removal of the boneless top sirloin butt.

Prices for most of the boxed cuts from the loin primal are used as reported by the AMS. However, prices for the butt tenderloin are not reported by the AMS. The butt tenderloin was valued as equal to the price of a tenderloin less 50 cents/pound. The 50 cent price differential was chosen in a ad hoc method and provides only a rough approximation of the actual butt tenderloin value.

<u>Round Primal</u>

The round primal (see Figure 1) is the posterior portion of the hindquarter obtained after the removal of the loin and flank. The cutting method is as described for the loin primal. Four cutting methods are included for the choice and select primal valuations (see Table 8).

The 2-piece semi-boneless round (RD160) is the portion of the round primal remaining after the removal of the rump bone, tail bones, shank meat, and shank bone. The 2-piece boneless round (RD161) is identical to the 2-piece semi-boneless round except that the cut must be made entirely boneless. The round bone (femur) must be removed to make the 2-piece round completely boneless.

A second cutting style involves splitting the round primal into three smaller subprimal cuts. The knuckle (RD167KN) is removed by making a straight cut perpendicular to the surface of the round and between the knuckle and inside round. The cut begins at the kneecap and continues down to the round bone. Another cut is made between the knuckle and outside round. The inside (RD168IN) and outside rounds are separated by a cut along the natural seam between these two subprimals and continues to the inside edge of the "eye" muscle on the face of the round. The heel, shank meat, and rump remain attached to the outside round. The boneless gooseneck round (RD170GS) is obtained from the outside round after removing the shank meat. (The heel and rump remain attached.) The knuckle can also be trimmed and sold as a

Table 8. Round primal yield percentages by cutting style[a]

Boxed Cut	1	2	3	4
RD160	17.96	---	---	---
RD161	---	16.38	---	---
RD167KN	---	---	2.98	---
RD167AKN	---	---	---	2.72
RD168IN	---	---	5.96	5.96
RD170GS	---	---	7.33	7.33
SHANK	1.25	1.25	1.25	1.25
BFTM50	0.39	0.42	1.01	1.06
FAT	0.78	0.74	0.84	1.05
BONE	3.27	4.86	4.28	4.28
TOTAL	23.65	23.65	23.65	23.65

[a]Yields are given as a percent of carcass weight.

peeled knuckle (RD167AKN).

Prices for the cuts obtained from the round primal are all valued as reported by the AMS. No price adjustments were necessary for the round subprimal cuts.

Fat, Bone, and Trim

Fat and bone are obtained from all four of the primal cuts. Different types and qualities of beef trim can be obtained from different locations on the carcass. The amount of trim and the trim quality are also dependent on the cutting method used since the different cutting styles require different levels of trim (Table 7). The types of beef trim used in the choice and select yield curves include: 50/50 trim (BFTM50), 80/20 trim (FRESH80), plate trim, flank trim, and SP trim (SPTRIM). The 50/50 trim is 50 percent lean, and the 80/20 trim is 80 percent lean. The plate and flank trim are approximately 60 percent lean. The SP trim is a higher quality byproduct similar in nature to lifter meat.

The prices for fat and bone are used as reported by the AMS. The price of 50/50 trim is also used as reported by the AMS. However, the price of 80/20 trim is derived since prices for this item are thinly reported by the AMS. The price of 80/20 trim is priced by the same method as the neck meat removed from the chuck primal. It is valued as 80 percent coarse ground beef less 6 cents/pound grinding cost. Plate and flank trim are valued at a 12 cent/pound premium over 50/50 trim.

SP trim prices were not reported by the AMS prior to 1988. The price of SP trim for 1986 and 1987 is derived as a function of lifter meat. The regression equation was estimated using ordinary least squares (OLS). The sample period for the regression analysis was the 35 observations reported in 1988. The OLS equation estimate was

$$\text{SP TRIM}_t = \underset{(0.033)}{0.0414} + \underset{(0.047)}{0.9927} * \text{LIFTER MEAT}_t, \qquad (4.6)$$

$$R^2 = 0.93$$

where the standard errors of the parameter estimates are shown in parentheses, and R^2 is the coefficient of determination.

End Notes

[1]The forequarter is the anterior portion of each side of the carcass, divided between the 12th and 13th ribs.

[2]The hindquarter is the posterior portion of each side of the carcass, divided between the 12th and 13th ribs.

CHAPTER V. CAUSAL RELATIONSHIPS IN THE BEEF SECTOR

This chapter examines the lead/lag relationship between boxed cutout, carcass, and live cattle prices for beef. In the first section a description of the data and data sources used in the analysis is provided. The second section contains an overview of the ARIMA modeling process. In the third section the results of the ARIMA models are presented. In the fourth section the causal direction between the price variables is examined. The final section provides a brief summary of the results.

Data and Data Sources

The price series used for this analysis are weekly data. Weekly average prices were collected for beef of both choice and select quality grades. For live, 900-1100 pound slaughter steers an Omaha price was used.[1] The live steer price series collected were Choice, Yield Grade 2-4 steers and Select, Yield Grade 2-3 steers. The carcass steer prices used are central U. S. prices for 600-700 pound steer carcasses valued FOB Omaha. The series collected were Choice, Yield Grade 3 carcass steers and Select, Yield Grade 1-3 carcass steers.[2] Each of these four price series were obtained from the weekly Livestock, Meat, and Wool Market News report published by the

USDA, AMS.

A third price series used in the analysis is the boxed beef composite or CCV reported by the AMS. The CCVs collected include the Choice, 550-700 pound boxed beef cutout value and the Select, 550-up pound boxed beef cutout value. These two price series were also collected from the AMS, and the weekly averages are reported in Livestock, Meat, and Wool Market News. Graphs of the data are provided for the choice and select beef price series in Figures 3 and 4, respectively.

The other price series used for the modeling procedure were the carcass cutout values derived in Chapter Four. The boxed beef composites are based upon Choice, Yield Grade 2-3 and Select, Yield Grade 2-3 boxed beef cuts. The boxed cut prices are for the central United States and are valued FOB Omaha. Two price series (choice and select) were collected as the Tuesday price quotes; a second set of price series was based on the weekly average price for each individual boxed cut.

The boxed beef price data were obtained from the Livestock Market News office in Des Moines, Iowa as reported in the Wholesale Meat Quotations reports. Most of the daily prices are published in the National Carlot Meat Report of the USDA, AMS. Weekly averages are published in the Livestock, Meat, and Wool Market News report.

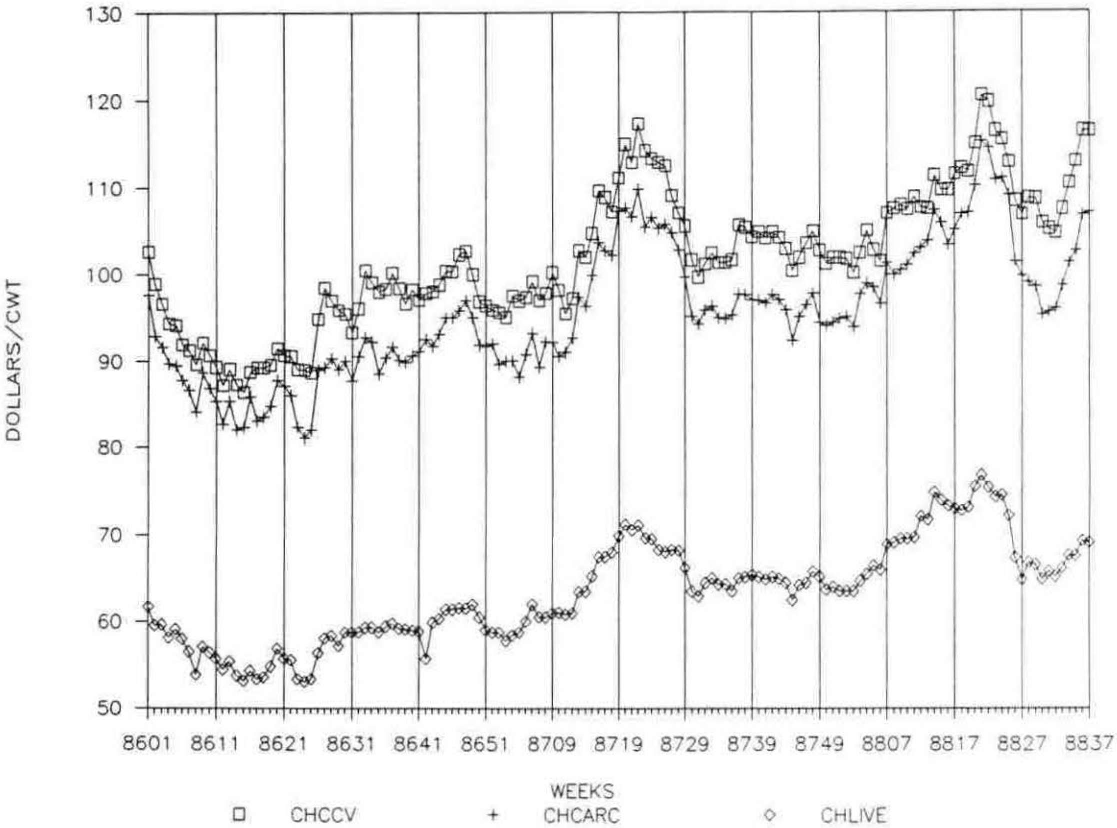

Figure 3. Choice beef price series

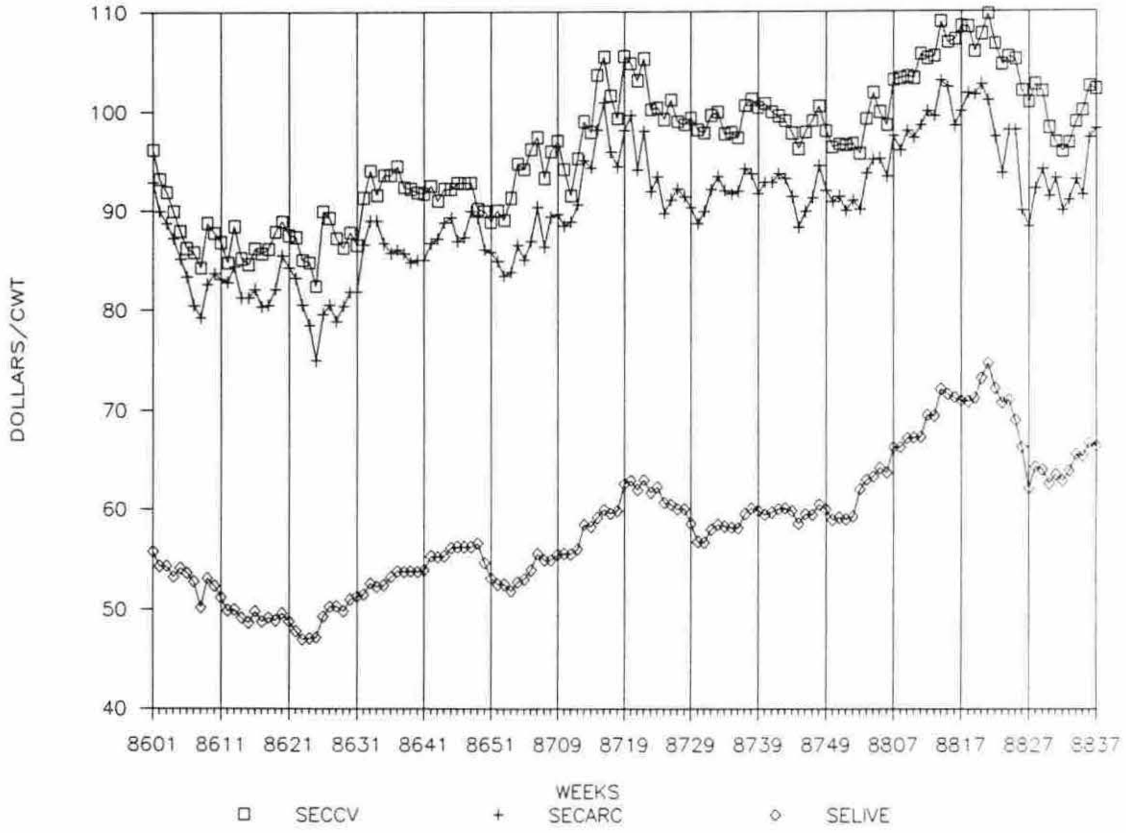

Figure 4. Select beef price series

As outlined previously, one of the objectives of this study was to create an improved wholesale beef price series. One method by which the two series can be compared is by examining differences between the two series. Using this simple approach, it appears that the AMSs CCV and the boxed beef composites derived in Chapter Four move together closely. However, by viewing a plot of the differences between the series, it is apparent that there is a noticeable difference (see Figures 5 and 6). This does not prove superiority of one series over the other, but it does provide some indication of differing movements.

ARIMA Modeling Procedure

The goal of this chapter is to identify the relationship between autocorrelated time series. The independence of two time series may be tested and from this test the presence of a leading indicator between variables may be inferred. The method employed involves computing the residual cross-correlation function between two time series. However, a difficulty in interpretation arises when the time series of interest are autocorrelated.

A simple solution to this dilemma was proposed by Haugh (1976) and others. Haugh suggested the use of a two-stage procedure for identifying the independence of two covariance-

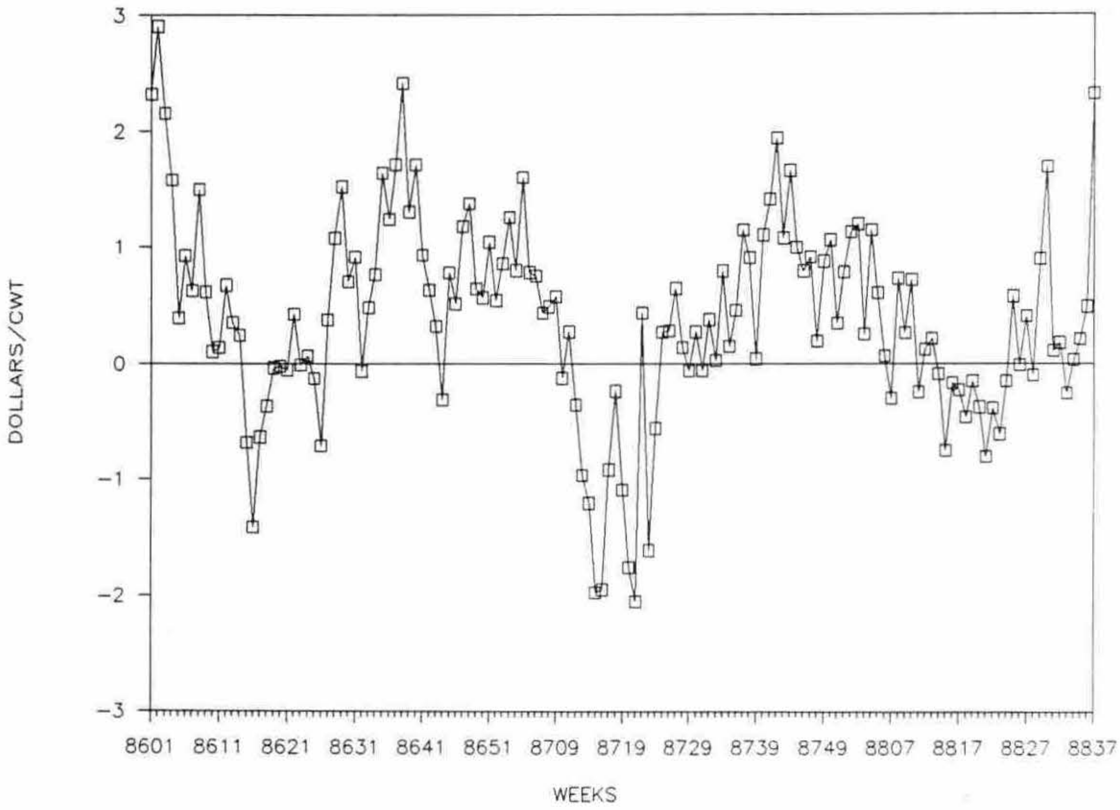

Figure 5. Difference between choice CCV and choice weekly boxed beef composite (CHCCV - CHWBBC)

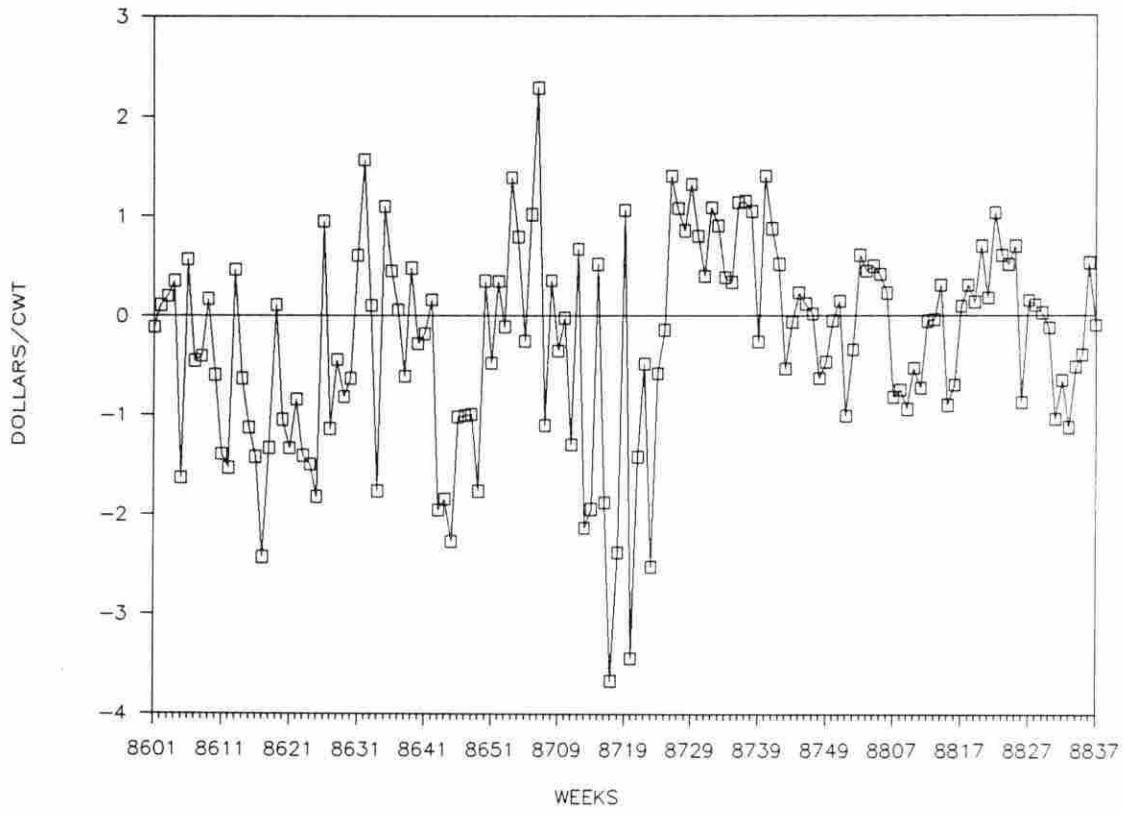

Figure 6. Difference between select CCV and select weekly boxed beef composite (SECCV - SEWBBC)

stationary time series. The two stages include fitting an appropriate univariate model for each time series and then cross-correlating the series of white-noise residuals obtained from the models. The use of two white-noise series allows for visual and statistical interpretation of the cross-correlation functions. This two-stage procedure has been subsequently applied to beef prices by Miller (1979) and Faminow (1981).

The fitting of autoregressive integrated moving average (ARIMA) models provides white-noise residuals from each time series. The modeling approach used is the three-stage procedure introduced by Box and Jenkins (1976) and repeated in time-series texts such as Pankratz (1983) and Vandaele (1983). The three stages include: identification, estimation, and diagnostic checking.

In the first stage, identification, the estimated autocorrelation functions (ACF) and partial autocorrelation functions (PACF) are computed for stationary series. The estimated ACFs and PACFs are compared to the known patterns exhibited by theoretical models. Tentative models can then be chosen. Features of a good ARIMA model include parsimony and stationarity (constant mean and variance). Time series are stationarized by differencing the observations and/or through the use of various transformations.

The second stage involves the estimation of possible

ARIMA models of order p and q, where p represents the autoregressive parameters and q represents the moving average terms. These parameters can be obtained by using maximum likelihood estimates of the parameters or by using nonlinear regression techniques.

In the third stage residuals are computed from the predicted values obtained from the univariate models. These residuals are then used in diagnostic checking procedures to determine whether or not the residuals approximate white-noise series. The diagnostic procedure includes the examination of the ACF of the residuals. If the residuals do not represent a white-noise series, then the model has been misidentified and adjustments in the assumed model must be made. A test of whether the set of residual cross correlations are statistically different from zero can be made by using the Ljung-Box Q-statistic. This procedure is often referred to as the Portmanteau test. The Q-statistic is approximately chi-square distributed with n-p-q-P-Q degrees of freedom where n is the number of observations after differencing and p, q, P, and Q are the model parameters. The formula for the Ljung-Box Q-statistic is

$$Q(K) = n(n+2)[\sum_{j=1}^{k} (1/n-j)r_j^2] \qquad (5.1)$$

where K is the number of autocorrelations and r is the estimated autocorrelation value. Other diagnostic checks include fitting additional variables or omitting variables and then comparing the different models. Also, the forecasting ability of the model may provide a useful comparison between model specifications.

ARIMA Models

ARIMA models were estimated for each of the ten beef price series described previously. These ten variables include five series each for choice quality and select quality beef. Upon first examination of the plotted data for each variable the mean of the observations appears to be increasing over time. The variance also appears to be nonconstant. Examination of the ACFs and PACFs for each series confirmed that the series were nonstationary. To correct for this nonstationarity, first differences were taken. The first differenced series appeared to be stationary, and no further transformations were required.

Numerous model specifications were attempted for each variable based upon the ACF and PACF for the differenced series. The software used in estimating the ARIMA models was RATS (Doan 1988). RATS uses the Gauss-Newton algorithm to minimize the sum of squares to estimate the model parameters.

The most parsimonious model which provided uncorrelated residuals was selected. The final models are shown in Tables 9 and 10. The model specifications are given using standard backshift notation. The asymptotic t-ratios, standard error of the estimated equation, and the Ljung-Box Q-statistic are provided for each equation. Using these and other diagnostic checks indicate that the selected models adequately represent the data.

Causal Relationship

The ARIMA models described in the previous section were used to create series of white-noise residuals. Cross-correlation functions between each series of residuals were computed for both the choice and select price series. The estimated cross-correlation function at lag k is given by

$$r(k) = \frac{\Sigma\ u_{t-k}\ v_t}{(\Sigma\ u_t^2\ \Sigma\ v_t^2)^{1/2}}, \qquad (5.2)$$

where u and v represent white-noise residual series. The standard error of individual estimated cross correlations is approximated by

$$SE = 1/\sqrt{n} \qquad (5.3)$$

for large sample series where n is the sample size. Using

Table 9. Estimated ARIMA models for choice beef price series[a]

Choice slaughter steers (900-1100 lbs., yield grade 2-4), Omaha

$$(1-B)\ CHLIVE_t = \underset{(0.45)^c}{0.052} + \epsilon_t^{\,b}$$

$Q(33)^d = 23.24$ $\qquad SE^e = 1.35$ (5.4)

Choice carcass steers (600-700 lbs., yield grade 3), Omaha

$$(1 - \underset{(-5.99)}{0.266}B + \underset{(-24.90)}{0.856}B^2 - \underset{(3.62)}{0.248}B^3)(1 - B)\ CHCARC_t =$$

$$\underset{(0.69)}{0.132} + (1 + \underset{(3.13)}{0.348}B + \underset{(12.54)}{0.997}B^2 - \underset{(-2.07)}{0.237}B^3)\ \epsilon_t$$

$Q(33) = 20.61$ $\qquad SE = 2.07$ (5.5)

AMS choice CCV (550-700 lbs.)

$$(1 - \underset{(2.15)}{0.130}B + \underset{(-4.14)}{0.254}B^2 - \underset{(9.82)}{0.702}B^3)(1 - B)\ CHCCV_t =$$

$$\underset{(2.19)}{0.094} + (1 - \underset{(-9.68)}{0.775}B)\ \epsilon_t$$

$Q(29) = 23.08$ $\qquad SE = 1.99$ (5.6)

---

[a]The lag operator B is defined such that $B^k x_t = x_{t-k}$.

[b]The variable ϵ_t denotes a white-noise error process.

[c]Asymptotic t-ratios are reported in parentheses.

[d]The Ljung-Box Q-statistic is calculated from the residual autocorrelation with the number in parentheses reflecting the degree of freedom. The 0.05 critical value for the chi-square distributed Q-statistic is 42.6 for 29 degrees of freedom and 47.4 for 33 degrees of freedom.

[e]SE is the standard error of the estimate.

Table 9. Continued

Weekly choice boxed beef composite (550-700 lbs.)

$$(1 - \underset{(2.46)}{0.145B} + \underset{(-4.32)}{0.261B^2} - \underset{(10.62)}{0.708B^3})(1 - B)\ CHWBBC_t =$$

$$\underset{(2.30)}{0.089} + (1 - \underset{(-12.13)}{0.812B})\ \epsilon_t$$

$Q(29) = 17.65$ $\quad$ $SE = 2.08$ $\quad$ (5.7)

Tuesday choice boxed beef composite (550-700 lbs.)

$$(1 - \underset{(1.31)}{0.081B} + \underset{(-3.94)}{0.244B^2} - \underset{(7.59)}{0.684B^3})(1 - B)\ CHTBBC_t =$$

$$\underset{(1.85)}{0.116} + (1 - \underset{(-7.15)}{0.714B})\ \epsilon_t$$

$Q(29) = 18.47$ $\quad$ $SE = 2.34$ $\quad$ (5.8)

Table 10. Estimated ARIMA models for select beef price series[a]

Select slaughter steers (900-1100 lbs., yield grade 2-3), Omaha

$$(1-B)\ SELIVE_t = \underset{(0.79)^c}{0.076} + \epsilon_t^{\,b}$$

$$Q(33)^d = 24.82 \qquad SE^e = 1.14 \qquad (5.9)$$

Select carcass steers (600-700 lbs., yield grade 1-3), Omaha

$$(1 - \underset{(1.52)}{0.091B} + \underset{(-6.08)}{0.339B^2} - \underset{(15.86)}{0.802B^3})(1 - B)\ SECARC_t =$$

$$\underset{(1.60)}{0.167} + (1 - \underset{(-3.23)}{0.285B} + \underset{(1.07)}{0.092B^2} - \underset{(-11.64)}{1.000B^3})\ \epsilon_t$$

$$Q(33) = 28.95 \qquad SE = 2.15 \qquad (5.10)$$

AMS select CCV (550-up lbs.)

$$(1 + \underset{(-2.81)}{0.476B^5})(1 - B)\ SECCV_t = \underset{(0.48)}{0.110} + (1 - \underset{(-1.96)}{0.164B^2} +$$

$$\underset{(1.81)}{0.330B^5} + \underset{(2.02)}{0.200B^7})\ \epsilon_t$$

$$Q(29) = 26.06 \qquad SE = 2.01 \qquad (5.11)$$

---

[a]The lag operator B is defined such that $B^k x_t = x_{t-k}$.

[b]The variable ϵ_t denotes a white-noise error process.

[c]Asymptotic t-ratios are reported in parentheses.

[d]The Ljung-Box Q-statistic is calculated from the residual autocorrelation with the number in parentheses reflecting the degree of freedom. The 0.05 critical value for the chi-square distributed Q-statistic is 42.6 for 29 degrees of freedom and 47.4 for 33 degrees of freedom.

[e]SE is the standard error of the estimate.

Table 10. Continued

Weekly select boxed beef composite (550-up lbs.)

$$(1 + \underset{(-2.81)}{0.178B^2} + \underset{(-1.35)}{0.163B^4} + \underset{(-4.24)}{0.517B^5})(1 - B)\ SEWBBC_t =$$

$$\underset{(0.55)}{0.148} + (1 + \underset{(3.03)}{0.398B^4} + \underset{(2.60)}{0.347B^5})\ \epsilon_t$$

$Q(28) = 20.64$ $\qquad$ $SE = 1.83$ $\qquad$ (5.12)

Tuesday select boxed beef composite (550-up lbs.)

$$(1 + \underset{(-2.95)}{0.199B^2} + \underset{(-1.57)}{0.165B^4} + \underset{(-5.16)}{0.559B^5})(1 - B)\ SETBBC_t =$$

$$\underset{(0.52)}{0.146} + (1 + \underset{(2.91)}{0.351B^4} + \underset{(3.30)}{0.410B^5})\ \epsilon_t$$

$Q(28) = 20.71$ $\qquad$ $SE = 1.91$ $\qquad$ (5.13) this formula the estimated standard error is approximately 0.086 (n=135) for the computed cross correlations at low lags.

Residual cross correlations can be used to infer causal direction by extending the idea of Granger causality. Granger (1969) forwarded a method of determining causal flows between time series. Given two time series, X_t and Y_t, Granger proposed that Y_t can be said to cause X_t if X_t can be better predicted using all available information than if Y_t had not been used. Granger applied his notion of causality through regression analysis. However, Pierce and Haugh (1977) note that sample cross correlations of white-noise residuals will be closely related to parameters estimated using ordinary least squares techniques. Thus, the Granger notion of causality is directly applicable to residual cross-correlation procedures.

The estimated cross-correlation functions are provided for lags of -5 through 5 in the Appendix. However, for ease of observation, the implied lead/lag relationships are presented for the choice beef series (Table 11) and the select beef series (Table 13). All of the cross-correlation functions indicate strong evidence of instantaneous causality (see Tables 12 and 14). Instantaneous causality implies that the time series are simultaneously determined. This result is as expected, especially for the various wholesale price

Table 11. Causal relationships between choice beef variables[a]

Variable Name	CHCARC	CHCCV	CHWBBC	CHTBBC
CHLIVE				
Lead	0	2[b]	2[b]	1,2[b],4
Lag	1[b]	1,5	1	5
CHCARC				
Lead		1,2[b]	2[b]	1[c],2
Lag		0	0	4
CHCCV				
Lead			0	1[c]
Lag			1	2
CHWBBC				
Lead				1[c]
Lag				0

[a]Minimum level of significance is 0.10.

[b]Significant at the 0.05 level.

[c]Significant at the 0.01 level.

Table 12. Instantaneous cross correlations between choice beef variables[a]

Variable Name	CHCARC	CHCCV	CHWBBC	CHTBBC
CHLIVE	0.65	0.63	0.63	0.60
CHCARC		0.71	0.70	0.62
CHCCV			0.94	0.88
CHWBBC				0.85

[a]All cross correlations significant at the 0.01 level.

Table 13. Causal relationships between select beef variables[a]

Variable Name	SECARC	SECCV	SEWBBC	SETBBC
SELIVE				
Lead	5[b]	1	0	0
Lag	2[b]	0	4	3,4
SECARC				
Lead		1[b]	0	0
Lag		3	0	1[b]
SECCV				
Lead			1	1[c]
Lag			4	1[b],4
SEWBBC				
Lead				0
Lag				0

[a]Minimum level of significance is 0.10.

[b]Significant at the 0.05 level.

[c]Significant at the 0.01 level.

Table 14. Instantaneous cross correlations between select beef variables[a]

Variable Name	SECARC	SECCV	SEWBBC	SETBBC
SELIVE	0.59	0.57	0.61	0.60
SECARC		0.64	0.66	0.62
SECCV			0.79	0.72
SEWBBC				0.95

[a]All cross correlations significant at the 0.01 level.

variables.

Examining the results of the correlation tests provides some interesting conclusions. First, looking at the choice beef variables in Table 11, a strong lead relationship appears between live slaughter steers and the three estimated cutout values (AMSs CCV and the two boxed beef composites derived in this study). The causal flow appears to adjust within two weeks. There is also some evidence of a feedback relationship as the live price lags these three variables by one or five weeks, however, the lags are only significant at the 0.10 level. Feedback is defined as X_t causes Y_t and Y_t causes X_t. There is also statistically significant evidence of a lag relationship between the live and carcass prices.

The carcass price shows a statistically significant lead relationship for the three estimated cutout values. There is no evidence of a feedback relationship. A curious result occurred between the AMSs CCV and the two boxed composites created in this analysis. There is no significant relationship between CHCCV and CHWBBC, however there is a strong lead relationship between the AMSs CCV and the boxed composite based on Tuesday price quotes (CHTBBC). A similar relationship is apparent between CHWBBC and CHTBBC. This strong correlation indicates that boxed beef prices from a Tuesday are determined, at least in part, by the prices of the previous week.

The select beef variable causal relationships are presented in Table 13. The results for these relationships are substantially different from the relationships identified among the choice price series. Select quality slaughter steers show evidence of leading carcass prices. The lead period is significant at five weeks. The only significant relationship between live cattle prices and boxed beef prices appears to be instantaneous causality (see Table 14). However, there is some evidence that live steer prices lag SEWBBC and SETBBC by up to four weeks but only at a level of significance of 0.10. The only significant relationships between the carcass price and the boxed composites are a one-week lag with the SECCV and a one-week lag with the SETBBC.

The correlations between the AMSs CCV and the two derived boxed composites show a lead relationship of one week. The SECCV also appears to lag the SETBBC by one week. No other significant relationships are apparent. However, there is some indication of a feedback relationship between the SECCV and SEWBBC. The instantaneous causal flow is the most significant between the SEWBBC and the SETBBC (see Table 14).

A more formal statistical test of the independence or causal relationship of the correlation between two time series is provided by using the U-statistic. The test, proposed by

Pierce and Haugh (1977) and subsequently applied to beef prices by Miller (1979) and Faminow (1981), provides a procedure to test the significance of causal relationships. The three relevant U-statistics are given by

$$U_m = n \sum_{k=1}^{m} [r_{uv}(k)]^2, \tag{5.14}$$

$$U_{-m} = n \sum_{k=-1}^{-m} [r_{uv}(k)]^2, \tag{5.15}$$

and

$$U_{2m+1} = n \sum_{k=-m}^{m} [r_{uv}(k)]^2 \tag{5.16}$$

where n is the number of observations and k is the number of lags. The estimated residual cross correlations are denoted by r. The first equation (5.14) provides a test of the null hypothesis that X_t does not lead Y_t where X_t and Y_t are the two series being tested for causal ordering. The second equation (5.15) tests the null hypothesis that Y_t does not lead X_t, and the third equation (5.16) provides a test of overall independence.

In order to complete the tests it is necessary to a priori determine the lag period to be tested. For this analysis the lag period chosen is two time periods. Two weeks was selected as the lag period for a couple of reasons:

first, most of the statistically significant correlations occur within two weeks and second, the same test was applied to each set of correlations for comparative reasons. The estimated U-statistics are provided with the estimated correlation functions in the Appendix. The results are not discussed here as the tests, for the most part, only confirm the intuitive explanations provided earlier.

The results of this analysis can be directly related to previous studies. The two-week lead by farm level (live slaughter steer) prices and wholesale prices is similar to the results of the National Commission on Food Marketing (NCFM) study completed in 1966 and to Miller's (1979) findings. Their results indicated that farm prices led wholesale prices by two weeks and one week, respectively (see Table 1). The live-to-carcass lead of five weeks for select quality beef is similar to the findings of Boyd and Brorsen (1985) and Schroeder and Hayenga (1987), both of whom used Akaike's Information Criterion (AIC) to select the lag structure for a bivariate autoregression model. The results of this analysis strongly refute the findings of Franzmann and Walker (1972) as do most other studies.

It is more difficult to compare results of the causal relationships between the different wholesale price series. Faminow (1981) compared weekly wholesale price series from two different price reporting services. He found evidence that one of the reporting services' wholesale price series led the other by as many as two days, as well as evidence of instantaneous causality. Faminow's results cannot be compared directly due to the different time periods used (i.e., daily and weekly).

Changes in Causal Relationships

It is possible and perhaps even likely that the relationship between the various wholesale beef and live cattle prices have changed over time. Another possibility is that the correlation may differ depending upon the time during the year during which the correlation is measured (i.e., location in the cycle). To test these propositions the sample was divided into smaller ranges using two different criterion.

First, the sample was divided into three ranges by year. Thus, cross correlations for each year in the sample can be estimated and then compared to see if changes in the causal flow have changed over time. The data appear to move in an annual cyclical pattern with peaks occurring during the early summer and troughs occurring later in the summer. It was hypothesized that the strength of the lead/lag relationship among beef prices may differ during an uptrend versus a downtrend. To test this hypothesis two ranges were selected from the sample.

Second, the two trough-to-peak ranges were identified in the sample and tested to examine whether the correlation differed from the sample as a whole. The downtrends were not treated likewise because the subgroup sample size would be too small.

The first test involved breaking the sample period into three parts by year. Residual cross correlations for each subgroup were computed, and the results used to infer whether or not causal relationships between the different variables have changed over the three years of the sample period.

The correlation results are summarized in Tables 15-26. There are very few significant correlations at non-zero lags due, in part, to the small sample periods and hence large standard errors for the estimates. The cross correlations for the choice variables during 1986 (Table 15) show evidence that the live price leads wholesale prices by three weeks. The cross correlations for 1987 and 1988 provide little evidence that live prices lead wholesale prices (Tables 19 and 23).

All three time periods indicate that the CHCARC leads the CHTBBC from one to three weeks. The 1986 and 1988 samples also show a lead relationship between the CHCARC and and the two weekly average boxed composites. A feedback relationship is also evident during 1986. An interesting relationship

Table 15. Causal relationships between choice beef variables for 1986[a]

Variable Name	CHCARC	CHCCV	CHWBBC	CHTBBC
CHLIVE				
Lead	3	3	3^b	3^b
Lag	0	0	0	0
CHCARC				
Lead		3	3^b	3^b
Lag		3^b	3^b	3
CHCCV				
Lead			0	0
Lag			0	0
CHWBBC				
Lead				0
Lag				1

[a]Minimum level of significance is 0.10.

[b]Significant at the 0.05 level.

[c]Significant at the 0.01 level.

Table 16. Instantaneous cross correlations between choice beef variables for 1986[a]

Variable Name	CHCARC	CHCCV	CHWBBC	CHTBBC
CHLIVE	0.52	0.45	0.45	0.44
CHCARC		0.65	0.72	0.66
CHCCV			0.94	0.90
CHWBBC				0.88

[a]All cross correlations significant at the 0.01 level.

Table 17. Causal relationships between select beef variables for 1986[a]

Variable Name	SECARC	SECCV	SEWBBC	SETBBC
SELIVE				
Lead	0	0	0	0
Lag	2[c]	0	5	5
SECARC				
Lead		1	0	0
Lag		0	0	0
SECCV				
Lead			0	0
Lag			1	1[b]
SEWBBC				
Lead				0
Lag				0

[a]Minimum level of significance is 0.10.

[b]Significant at the 0.05 level.

[c]Significant at the 0.01 level.

Table 18. Instantaneous cross correlations between select beef variables for 1986[a]

Variable Name	SECARC	SECCV	SEWBBC	SETBBC
SELIVE	0.45	0.51	0.61	0.61
SECARC		0.53	0.73	0.68
SECCV			0.75	0.65
SEWBBC				0.95

[a]All cross correlations significant at the 0.01 level.

Table 19. Causal relationships between choice beef variables for 1987[a]

Variable Name	CHCARC	CHCCV	CHWBBC	CHTBBC
CHLIVE				
Lead	0	0	2,5	0
Lag	0	0	0	0
CHCARC				
Lead		0	0	1,3
Lag		0	0	5
CHCCV				
Lead			3	1,3[b]
Lag			3[b]	2
CHWBBC				
Lead				1[b],3
Lag				3

[a]Minimum level of significance is 0.10.

[b]Significant at the 0.05 level.

Table 20. Instantaneous cross correlations between choice beef variables for 1987[a]

Variable Name	CHCARC	CHCCV	CHWBBC	CHTBBC
CHLIVE	0.79	0.76	0.77	0.67
CHCARC		0.75	0.71	0.57
CHCCV			0.93	0.85
CHWBBC				0.82

[a]All cross correlations significant at the 0.01 level.

Table 21. Causal relationships between select beef variables for 1987[a]

Variable Name	SECARC	SECCV	SEWBBC	SETBBC
SELIVE				
Lead	0	1	0	0
Lag	0	0	5	5
SECARC				
Lead		1[b]	0	0
Lag		0	0	1
SECCV				
Lead			1[b]	1[c]
Lag			0	0
SEWBBC				
Lead				0
Lag				0

[a]Minimum level of significance is 0.10.

[b]Significant at the 0.05 level.

[c]Significant at the 0.01 level.

Table 22. Instantaneous cross correlations between select beef variables for 1987[a]

Variable Name	SECARC	SECCV	SEWBBC	SETBBC
SELIVE	0.72	0.67	0.64	0.64
SECARC		0.74	0.70	0.67
SECCV			0.75	0.67
SEWBBC				0.95

[a]All cross correlations significant at the 0.01 level.

Table 23. Causal relationships between choice beef variables for 1988[a]

Variable Name	CHCARC	CHCCV	CHWBBC	CHTBBC
CHLIVE				
Lead	0	0	0	0
Lag	0	0	0	0
CHCARC				
Lead		1,2[b]	2[b]	1,2[b]
Lag		0	0	0
CHCCV				
Lead			0	1
Lag			0	0
CHWBBC				
Lead				0
Lag				0

[a]Minimum level of significance is 0.10.

[b]Significant at the 0.05 level.

Table 24. Instantaneous cross correlations between choice beef variables for 1988[a]

Variable Name	CHCARC	CHCCV	CHWBBC	CHTBBC
CHLIVE	0.68	0.72	0.70	0.70
CHCARC		0.73	0.67	0.65
CHCCV			0.94	0.90
CHWBBC				0.88

[a]All cross correlations significant at the 0.01 level.

Table 25. Causal relationships between select beef variables for 1988[a]

Variable Name	SECARC	SECCV	SEWBBC	SETBBC
SELIVE				
Lead	5[b]	4,5[b]	5[b]	5[b]
Lag	0	0	0	0
SECARC				
Lead		0	0	0
Lag		3	3	3[b]
SECCV				
Lead			0	0
Lag			0	0
SEWBBC				
Lead				0
Lag				0

[a]Minimum level of significance is 0.10.

[b]Significant at the 0.05 level.

Table 26. Instantaneous cross correlations between select beef variables for 1988[a]

Variable Name	SECARC	SECCV	SEWBBC	SETBBC
SELIVE	0.58	0.59	0.63	0.62
SECARC		0.63	0.55	0.51
SECCV			0.92	0.89
SEWBBC				0.97

[a]All cross correlations significant at the 0.01 level.

appears in 1987 indicating that the CHCCV leads the CHTBBC but lags the CHWBBC (at the 0.05 level of significance). Years 1986 and 1988 do not show statistically significant evidence of a lead or lag relationship between the CHCCV and the two derived boxed composites. There is a one-week lead relationship present in 1987 between the CHWBBC and CHTBBC.

The select variables show even fewer significant causal relationships. For example, in 1986 only two statistically significant relationships occur and in 1987 only three significant relationships occur (Tables 17 and 21). The correlations for 1987 show a strong lead of one week between the SECCV and the SETBBC which is the same as the lead relationship over the entire sample period (Table 21). The 1988 correlations show a significant lead relationship between the select live cattle price and the four select wholesale prices (see Table 25).

The second set of subdivided cross correlations include the two cyclical uptrends from the sample. Very few significant relationships are identifiable from these correlations as shown in Tables 27-33. From the first uptrend the only significant relationship evident from the choice prices is a lead of the CHWBBC with the CHTBBC. The choice variables from the second uptrend indicate a three-week lead between carcass prices and the boxed composites.

Table 27. Causal relationships between choice beef variables during first (1986-87) uptrend[a]

Variable Name	CHCARC	CHCCV	CHWBBC	CHTBBC
CHLIVE				
Lead	0	0	0	0
Lag	0	0	1	0
CHCARC				
Lead		0	0	0
Lag		0	0	0
CHCCV				
Lead			0	0
Lag			0	0
CHWBBC				
Lead				1[b]
Lag				0

[a]Minimum level of significance is 0.10.

[b]Significant at the 0.05 level.

Table 28. Instantaneous cross correlations between choice beef variables during first (1986-87) uptrend[a]

Variable Name	CHCARC	CHCCV	CHWBBC	CHTBBC
CHLIVE	0.58	0.53	0.53	0.53
CHCARC		0.68	0.73	0.61
CHCCV			0.93	0.87
CHWBBC				0.82

[a]All cross correlations significant at the 0.01 level.

Table 29. Causal relationships between select beef variables during first (1986-87) uptrend[a]

Variable Name	SECARC	SECCV	SEWBBC	SETBBC
SELIVE				
Lead	2,3	0	5	5
Lag	2[b]	1,2	4	0
SECARC				
Lead		0	0	0
Lag		0	0	0
SECCV				
Lead			2,4	1[b],2
Lag			0	1
SEWBBC				
Lead				0
Lag				0

[a]Minimum level of significance is 0.10.

[b]Significant at the 0.05 level.

Table 30. Instantaneous cross correlations between select beef variables for during first (1986-87) uptrend[a]

Variable Name	SECARC	SECCV	SEWBBC	SETBBC
SELIVE	0.57	0.50	0.53	0.56
SECARC		0.60	0.75	0.73
SECCV			0.69	0.61
SEWBBC				0.94

[a]All cross correlations significant at the 0.01 level.

Table 31. Causal relationships between choice beef variables during second (1987-88) uptrend[a]

Variable Name	CHCARC	CHCCV	CHWBBC	CHTBBC
CHLIVE				
Lead	3	0	0	3
Lag	0	0	0	0
CHCARC				
Lead		3[b],5	3[b]	3[b]
Lag		0	0	0
CHCCV				
Lead			0	0
Lag			0	0
CHWBBC				
Lead				0
Lag				0

[a]Minimum level of significance is 0.10.

[b]Significant at the 0.05 level.

Table 32. Instantaneous cross correlations between choice beef variables during second (1987-88) uptrend[a]

Variable Name	CHCARC	CHCCV	CHWBBC	CHTBBC
CHLIVE	0.65	0.67	0.66	0.68
CHCARC		0.59	0.59	0.55
CHCCV			0.95	0.91
CHWBBC				0.91

[a]All cross correlations significant at the 0.01 level.

Table 33. Causal relationships between select beef variables during second (1987-88) uptrend[a]

Variable Name	SECARC	SECCV	SEWBBC	SETBBC
SELIVE				
Lead	5[b]	3	2[b],3[b]	2[b],3,5
Lag	0	0	0	0
SECARC				
Lead		0	0	0
Lag		0	0	0
SECCV				
Lead			0	0
Lag			0	0
SEWBBC				
Lead				0
Lag				0

[a]Minimum level of significance is 0.10.

[b]Significant at the 0.05 level.

Table 34. Instantaneous cross correlations between select beef variables during second (1987-88) uptrend[a]

Variable Name	SECARC	SECCV	SEWBBC	SETBBC
SELIVE	0.55	0.54	0.54	0.54
SECARC		0.66	0.63	0.56
SECCV			0.91	0.86
SEWBBC				0.95

[a]All cross correlations significant at the 0.01 level.

The select uptrends show a lag relationship between the live and carcass price with some evidence of a feedback relationship. This feedback corresponds to the result for the entire sample period. In the second uptrend period there is a significant lead correlation between the live price and the wholesale prices (see Table 33). As for the previously discussed correlation there is statistically significant evidence of instantaneous causality among all variables (see Tables 28, 30, 32, and 34).

Summary and Implications

The estimated cross correlations from the beef price variables show mixed results. Some of the correlations imply statistically significant relationships, however, the results are not totally consistent. Inconsistencies are particularly evident when comparing the choice price variable correlations with the results of the select variables. A portion of these differences is undoubtedly due to the estimation techniques and the dependence of the results on obtaining white-noise residuals. It is also very possible that identical causal relationships do not exist for choice and select quality beef.

There are a few obvious identifiable relationships, most of which have already been mentioned. First, there is strong evidence that live cattle prices lead wholesale beef prices.

There is also evidence of a feedback relationship between live and wholesale prices. A second significant result is that choice carcass prices lead choice boxed beef prices. This does not, however, appear to be true for select wholesale beef. Very strong evidence is shown for the relationship between Tuesday boxed beef prices and the weekly average price from the previous week. This suggests that packers and beef buyers begin the weekly price discovery process based upon prices of the previous week. This result is not altogether surprising.

There is some evidence that the boxed beef composites derived in Chapter Four lead the AMSs CCV to a greater extent than they lag the CHCCV and the SECCV. For the choice boxed series the correlations indicate a unidirectional causal flow from the CHWBBC to the CHCCV (although only statistically significant at the 0.10 level). A feedback relationship is evident between the CHCCV and CHTBBC, but the lead is one week longer for the CHTBBC. The select boxed composites show a similar relationship. There is a feedback relationship from the SEWBBC and SETBBC to the SECCV; however, the lead is only one week for the SECCV as compared with a four week lead for the SEWBBC and SETBBC (see Table 13). Thus, there is support for the claim that the boxed beef composite developed in this analysis more accurately reflects wholesale beef price changes.

Results from the two sample subdivisions are even less clear. The significant lead relationship between the CHLIVE and the two choice derived boxed composites during 1986 is not evident in 1987 or 1988. Another interesting result for the yearly correlations is that during 1986 the select live prices appear to unidirectionally lag wholesale prices but in 1988 the opposite is true. The live cattle price shows a significant five-week lead over wholesale prices. A similar occurrence took place between the two uptrend ranges. For these and other results there may be some indication of intertemporal change, but the evidence is not very definitive.

End Notes

[1]Beginning the week ended January 9, 1988 the series were changed to a steer weight range of 1000-1100 pounds.

[2]Prior to the week ended January 25, 1986 the select series was reported for a yield grade range of 2-3.

CHAPTER VI. SUMMARY AND CONCLUSIONS

The purpose of this study was to present evidence indicating the need for an alternative method of valuing beef at the wholesale level. Historically, the carcass price has been used as the wholesale beef price; however, in recent years beef carcasses have become thinly traded and do not adequately reflect the wholesale beef market. This is due, in part, to recent structural changes in the meatpacking industry.

The alternative wholesale pricing method proposed in this study involves the use of a boxed beef composite index or carcass cutout value composed of subprimal boxed beef cuts. The benefits of basing the wholesale price of beef on boxed beef cuts have also been recognized by the USDA. Beginning January 1, 1989 the Economic Research Service (ERS) of the USDA began using the CCV reported by the AMS as the middle value in their farm-retail price spread, replacing the carcass price. This acceptance of the CCV by the USDA, ERS provides additional credence to this proposed change.

The use of the CCV reported by the AMS leads to another question. Does the CCV adequately represent the boxed beef market and all available information, and if not, how can the methods used to derive the CCV be improved? Suggestions for improvement presented in this study include: incorporating additional price information (i.e., expanding the set of boxed cuts) into the valuation process and including the prices of boxed beef sold as a complete carcass unit.

The first of the two proposed improvements is incorporated into this study. The latter suggested improvement requires the use of information not presently available. Thus, it is suggested that it would be beneficial to begin collection of boxed carcass units traded within the wholesale beef sector. This may be accomplished through the same methods presently being used by the AMS and other reporting services to collect boxed beef prices on a daily basis.

In this study weekly boxed beef prices were used to create a composite value index of boxed beef products. The process involved multiplying a matrix of boxed beef prices times the corresponding matrix of subprimal yield relationships. The advantage to the development of this composite index is that it allows for the incorporation of additional price information over the CCV reported by the AMS. There are, however, several improvements which, although beyond the constraints of this study, merit future consideration. These improvements include: incorporating prices of boxed carcass units, assigning a weight for each cutting style based upon its relative importance, and allowing for changes in the yield curve over time. The first two of these suggested improvements involve the addition of information not presently available. Thus, the implication is that the future collection of this information would be of some merit.

A test of the created series was undertaken using the notion of Granger causality. The procedure involved estimating ARIMA models in order to create series of white-noise residuals. Cross correlations of these residual series were then computed to allow for the determination of leads and lags between the price series.

The first general conclusions concern the method used to value wholesale beef prices. Considering the thinly traded carcass beef market and the recent changes in the wholesale beef industry, it is apparent that using a boxed beef composite value index to value the wholesale beef market is a viable alternative. With the inclusion of all available information, a carcass cutout value may be the best available solution.

Several conclusions are made from the results of the residual cross-correlation tests. First, the results compare favorably with previous studies concerning the relationship between live cattle prices and wholesale beef prices. There is a strong indication that live and wholesale beef prices move interactively during the week. The strongest interactive correlation for choice beef occurs between the CCV reported by the AMS and the weekly boxed composite derived in this study. The most significant interactive relationship for select quality beef occurs between the weekly and Tuesday based boxed composites derived in this study. Also, there is statistically significant evidence that, for the most part, live cattle prices lead wholesale level prices.

The indication from the results of this study is that choice carcass beef prices lead the boxed composite indexes by one or two weeks. The select carcass series does not show a similar lead relationship. There is a clear indication that the Tuesday boxed composite lags by one week the two composites which are based on a weekly average price. Thus, it is inferred that market participants begin the weekly price discovery process based upon the previous week's price pattern.

A more difficult comparison involves the relationship between the CCV reported by the AMS and the boxed composites developed in this study. The indication, although only significant at the 0.10 level, is that the CCV lags the boxed composites created in this study. If this is true, the implication is that the boxed beef composites derived in this study more quickly reflect available market information. However, the evidence is not strong enough to make a definitive statement from these results. In theory the incorporation of additional information in the boxed composited derived in this study should indicate an improvement.

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APPENDIX: ESTIMATED RESIDUAL CROSS CORRELATIONS

Table A.1. Estimated residual cross correlations

Variables	1	2	3	4	5
CHLIVE-CHCARC					
Negative lags	0.038	0.133	-0.085	0.067	0.066
Positive lags	0.193	0.120	-0.044	0.012	-0.039
		$U_{-2} = 2.57$	$U_{+2} = 6.94^a$	$U_5 = 67.31^b$	
CHLIVE-CHCCV					
Negative lags	0.063	0.189	-0.028	0.094	0.037
Positive lags	0.146	-0.004	0.036	0.017	-0.144
		$U_{-2} = 5.33$	$U_{+2} = 2.88$	$U_5 = 61.52^b$	
CHLIVE-CHWBBC					
Negative lags	0.023	0.181	-0.022	0.103	0.034
Positive lags	0.163	-0.003	0.047	0.019	-0.098
		$U_{-2} = 4.51$	$U_{+2} = 3.60$	$U_5 = 61.56^b$	
CHLIVE-CHTBBC					
Negative lags	0.159	0.170	-0.036	0.146	-0.007
Positive lags	0.030	0.023	0.064	0.021	-0.144
		$U_{-2} = 7.34^a$	$U_{+2} = 0.20$	$U_5 = 55.36^b$	
CHCARC-CHCCV					
Negative lags	0.169	0.193	0.019	-0.022	0.065
Positive lags	0.030	0.072	-0.066	0.086	-0.055
		$U_{-2} = 8.87^a$	$U_{+2} = 0.83$	$U_5 = 77.71^b$	

[a]Significant at the 0.05 level.

[b]Significant at the 0.01 level.

Table A.1. (Continued)

Variables	1	2	3	4	5
CHCARC-CHWBBC					
Negative lags	0.112	0.223	-0.037	0.038	0.030
Positive lags	0.076	0.052	-0.033	0.078	-0.030
	$U_{-2} = 8.42^{a}$		$U_{+2} = 1.15$	$U_{5} = 75.13^{b}$	
CHCARC-CHTBBC					
Negative lags	0.279	0.169	0.007	0.048	0.021
Positive lags	-0.052	0.102	-0.070	0.148	-0.118
	$U_{-2} = 14.40^{b}$		$U_{+2} = 1.78$	$U_{5} = 68.37^{b}$	
CHCCV-CHWBBC					
Negative lags	0.037	0.099	0.071	0.037	-0.037
Positive lags	0.150	0.099	0.132	-0.005	0.020
	$U_{-2} = 1.51$		$U_{+2} = 4.37$	$U_{5} = 123.93^{b}$	
CHCCV-CHTBBC					
Negative lags	0.211	0.033	0.078	0.037	-0.013
Positive lags	-0.037	0.164	0.079	0.030	-0.039
	$U_{-2} = 6.18^{a}$		$U_{+2} = 3.81$	$U_{5} = 113.52^{b}$	
CHWBBC-CHTBBC					
Negative lags	0.252	0.072	0.066	0.052	0.006
Positive lags	-0.062	0.136	0.091	0.042	-0.054
	$U_{-2} = 9.24^{b}$		$U_{+2} = 3.03$	$U_{5} = 110.36^{b}$	

Table A.1. (Continued)

Variables	1	2	3	4	5
SELIVE-SECARC					
Negative lags	-0.022	0.057	0.088	0.034	0.175
Positive lags	-0.018	-0.176	-0.105	0.110	-0.019
	U_{-2} = 0.50	U_{+2} = 4.21	U_5 = 51.24[b]		
SELIVE-SECCV					
Negative lags	-0.063	0.150	-0.051	0.081	0.058
Positive lags	0.122	-0.093	0.115	0.085	0.040
	U_{-2} = 3.58	U_{+2} = 3.19	U_5 = 50.22[b]		
SELIVE-SEWBBC					
Negative lags	0.008	0.129	-0.005	-0.030	0.049
Positive lags	-0.020	-0.021	0.115	0.158	0.055
	U_{-2} = 2.27	U_{+2} = 0.12	U_5 = 52.01[b]		
SELIVE-SETBBC					
Negative lags	0.051	0.097	0.038	-0.049	0.054
Positive lags	-0.076	-0.009	0.148	0.147	0.017
	U_{-2} = 1.62	U_{+2} = 0.79	U_5 = 51.60[b]		
SECARC-SECCV					
Negative lags	-0.217	-0.053	-0.090	0.089	-0.050
Positive lags	0.020	-0.028	0.164	-0.054	0.005
	U_{-2} = 6.75[a]	U_{+2} = 0.16	U_5 = 61.64[b]		

Table A.1. (Continued)

Variables	1	2	3	4	5
SECARC-SEWBBC					
Negative lags	-0.052	-0.097	-0.099	-0.025	-0.043
Positive lags	-0.106	0.017	0.099	0.067	0.017
	U_{-2} = 1.63	U_{+2} = 1.55	U_5 = 61.49[b]		
SECARC-SETBBC					
Negative lags	0.038	-0.114	-0.075	-0.020	-0.034
Positive lags	-0.178	0.064	0.083	0.067	-0.021
	U_{-2} = 1.96	U_{+2} = 4.83	U_5 = 58.17[b]		
SECCV-SEWBBC					
Negative lags	0.158	-0.112	0.059	-0.108	-0.010
Positive lags	-0.104	0.016	0.032	0.157	-0.034
	U_{-2} = 5.05	U_{+2} = 1.50	U_5 = 90.22[b]		
SECCV-SETBBC					
Negative lags	0.277	-0.134	0.090	-0.092	0.000
Positive lags	-0.176	0.054	0.034	0.152	-0.075
	U_{-2} = 12.80[b]	U_{+2} = 4.57	U_5 = 86.85[b]		
SEWBBC-SETBBC					
Negative lags	0.113	-0.042	0.050	-0.037	0.018
Positive lags	-0.115	0.015	-0.021	-0.013	-0.035
	U_{-2} = 1.96	U_{+2} = 1.82	U_5 = 126.60[b]		