CHAPTER II: A Review of the Literature, Historical Retail Meat Price Data, and Some Associated Concepts

2.1. A Review of the Literature

As a myriad of uses and applications of retail meat price data exist, the quantification of the shortcomings in the collection and reporting of the historical retail meat price data becomes an all-encompassing task. Detecting the shortcomings in the current retail price data and making suggestions for improvements begins with an examination of some of the applications of retail meat price data. To limit the scope of this study, only those applications of retail meat price data as they apply to the process of academic research and policy analysis were considered. Past and present research efforts will, therefore, provide the basis for a critical evaluation of the usability, efficiency, and accuracy of retail meat price data.

Over the last 30 years, problems within the beef industry have necessitated changing the focus of research efforts. As the research focus has changed, so have the data needed to conduct the research. Table 2.1 is a summary of the main policy issues that have received attention over the last three decades within the beef industry as well as the data needs associated with these issues.

During the 1980’s and into the early 1990’s, emphasis was placed on understanding the dramatic changes and shifts in the demand for beef. Much of the literature focused on modeling demand and developing econometric models of demand shifts to better identify and explain all the factors that effect demand. (Brester and Wohlgenant, 1991; Capps and Nayga, 1990; Lusk, Fox, Schroeder, Mintert and Koohmaraie, 1999; Purcell, 1998). Many of these research efforts examined demand shifts in terms of price changes, demand elasticities, and other measures of price. These research efforts served to focus
attention on the effect of retail demand changes on the farm-to-retail price spread for beef and the derived demand for beef cattle at the farm level. Wohlgenant and Mullen (1987) and Bessler and Akleman (1998) focused on issues of price spreads in an attempt to quantify the effects of various shifts in the demand and supply on, the retail-to-farm price ratio, derived demand elasticities, and ultimately, the farmers share of retail food expenditures.

Researchers also started examining the issues of simultaneity and structural change, particularly as the latter emerged as a driver of the U.S. demand for meat (Eales and Unnevehr, 1993). With this research, researchers tried to account for apparent shifts in demand due to structural changes in supply. An example of such changes in supply that shifted the supply curves for meat steadily outward are increased pork and broiler feed efficiency, higher beef carcass dressed weights, and the beef herd liquidation following feed price escalations in the early 1970’s. Such factors would have contributed to a false appearance of demand growth, when the converse was true in some meat industries, particularly in the beef sector.

Another prominent issue that came to light in the 1990’s is price asymmetry (Goodwin and Holt, 1999; Azzam, 1999; Paul, 1998). That farm level prices have not kept up with changing prices at the retail level led to research into this area as observers questioned the extent to which retail-level shocks are realized at the farm level. An overall concern in this area is whether pricing patterns in food markets are cost or demand driven. Since both prices and costs are involved, understanding both these aspects is critical.

In all aspects of the research topics and policy issues receiving prominence in the beef industry over the last couple of decades, meat price data are an important input in the research process (Table 2.1). The price data requirements may vary, but often the data needs include the price of beef at the farm, wholesale, or retail level, or the price of substitute meats at the retail level. Weekly beef prices – producer prices, wholesale prices for boxed beef cutouts, retail beef prices – are typically favored.
Table 2.1. The Major Research and Policy Issues of Interest within the Beef Industry over the Last Two Decades.

<table>
<thead>
<tr>
<th>Policy Issue</th>
<th>Parameters/Estimates</th>
<th>Data Needs</th>
<th>Possible Data Flaws</th>
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<tbody>
<tr>
<td>Price Determination</td>
<td>I. Supply of Beef (supply elasticities)</td>
<td>i) input prices</td>
<td>- Price is often not the important issue, but rather quality problems, inconsistent eating experiences, lack of convenience in preparation</td>
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<td></td>
<td>ii) technology</td>
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<td></td>
<td>iii) price of outputs produced from those inputs</td>
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<td>iv) imports</td>
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<td></td>
<td>II. Demand for beef (demand elasticities)</td>
<td>i) retail price of beef</td>
<td>- Disaggregated beef cut prices are not available&lt;sup&gt;a&lt;/sup&gt;</td>
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<td></td>
<td>ii) retail prices of competing meats</td>
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<td></td>
<td>ii) disposable income</td>
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<td></td>
<td>iv) consumer tastes and preferences</td>
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<td>- Preferences are difficult to measure numerically</td>
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<td>Price Asymmetry/ Unresponsive Retail Sector</td>
<td>I. Time Series Analysis</td>
<td>i) price data – farm level, wholesale and retail level</td>
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<td>ii) margins</td>
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<td></td>
<td>II. Error-Correction Modeling</td>
<td>i) weekly beef prices – producer prices, wholesale prices for boxed beef cutouts, retail beef prices (composite retail beef prices series)</td>
<td>- Lack of frequent (retail) prices</td>
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<tr>
<td>Developments and Reversing the Long-term Decline in Beef Demand/ Structural Changes in the Beef Industry</td>
<td>I. Demand for beef (demand elasticities)</td>
<td>i) price of beef</td>
<td>- Disaggregated beef cut prices are missing</td>
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<tr>
<td></td>
<td>ii) price of substitutes</td>
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<td>- More frequent prices are needed</td>
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<td></td>
<td>iii) disposable income</td>
<td></td>
<td>- Disaggregated beef cut prices are needed</td>
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<td></td>
<td>iv) consumer tastes and preferences – tenderness is the most important characteristic to beef consumers</td>
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<td>- Different cut prices are lacking</td>
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<td></td>
<td>v) demographic information like age, gender, household, size, etc.</td>
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<sup>a</sup>According to Eales and Unnevehr (1988) the disaggregation of composite meat groups into component subgroups makes possible the identification of sources of structural change in meat demand. The reasoning here is that the individual subgroup may be separate from the aggregate commodity and may therefore have a significantly different elasticity.
2.2. Retail Meat Price Data – An Overview of the last 30 Years

2.2.1. Beef Retail Price and Consumption Data

Figure 2.1 shows deflated retail beef prices and per capita consumption of beef from 1970 to 2001. From 1970 to 2001 there has been a strong downward trend in deflated retail beef prices with prices falling from $2.54/lb in 1970 to $1.91/lb in 2001. The past couple of years have seen a gradual reversal of this decline with prices starting to pick up again very gradually.

![Figure 2.1. Per Capita Consumption and Deflated Price (CPI, 1982-84 = 100) of Beef, 1970-2001.](Source: Economic Research Service)

Looking at the annual average per capita consumption of beef, a similar pattern emerges as that of the real retail beef prices. In the latter part of the 1970’s there was a spike in

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1In this section we will merely be examining the movements of retail meat prices over these three decades and will by no means be attempting to explain the reasons behind any movements and patterns as this is not the purpose of this section nor this study.

2 Retail Beef prices were deflated using the Consumer Price Index (CPI) with 1982-84 as the base year.
the consumption of beef, but from 1978 onwards, the consumption of beef has declined rather drastically from a high 94.5 pounds in 1976, to 68.2 pounds in 2001.

### 2.2.2. Pork Retail Price and Consumption Data

Figure 2.2 shows that deflated retail pork prices and per capita consumption followed a similar pattern to that of beef over the period 1970-2001. Deflated retail pork prices exhibit a downward trend over time. Although there has been a decline in the per capita consumption of pork, it would not appear to be a very drastic decline.

![Figure 2.2. Per Capita Consumption and Deflated Price (CPI, 1982-84=100) of Pork, 1970-2001.](Source: Economic Research Service)
2.2.3. Chicken Retail Price and Consumption Data

A review of the deflated broiler retail prices show that they exhibit the same downward trend evidenced in both the beef and pork sectors. After a sudden spike in prices in 1973 to $1.37/lb, retail broiler prices proceeded to fall, rather sharply at first, and then more gradually from the early 1980’s onwards to a price of $0.62/lb in the year 2001 (see Figure 2.3).

![Per Capita Consumption and Deflated Price (CPI, 1982-84 = 100) of Broilers, 1970-2001.](image)

(Source: Economic Research Service)

There has been a marked increase in the amount of poultry consumed from the 1980’s onwards and the consumption of poultry (ready-to-eat weights) now exceeds that of both beef and pork. The U.S. per capita consumption of broilers has increased from 0.7 pounds in 1935 to 89 pounds in 2001. In 1986 the consumption of broilers surpassed that of poultry consumption for the first time, and in 1993, the consumption of broilers exceeded...
the per capita consumption of beef, the leading meat product up to that time. (Martinez, 2000).

2.3. Elasticities and Related Concepts

2.3.1. Own-Price Elasticity of Demand

According to Mansfield (1994), the shape of the market demand curve for a good varies across goods and markets. For some goods, a small change in price will give rise to a large change in the quantity demanded of the good. For other goods, the opposite is true: a large change in price results in a small adjustment in the quantity demanded. The own-price elasticity determines whether a given change in price will decrease or increase the amount of money spent on a commodity. The own-price elasticity of demand is used to determine how sensitive the quantity demanded of a good is to changes in price. The own-price elasticity can, therefore, be defined as the percentage change in the quantity demanded of a good due to a one percent change in the price of that good.

\[
\varepsilon_1 = \frac{\partial Q_D}{\partial P} \cdot \frac{P}{Q_D}
\]

Where \(\varepsilon_1 = \) own-price elasticity of demand

\(\partial Q_D = \) change in the quantity demanded of a good

\(\partial P = \) change in the price of the good

\(P = \) price of the good

\(Q_D = \) quantity demanded of the good
Several factors affect the own-price elasticity for a good. These factors are

1. The number and closeness of substitutes available for a good. If many close substitutes exist for a good, its demand will most likely be price elastic. Generally, as the definition of a product becomes narrower and more specific, more close substitutes will exist for the product, and its demand will be more price elastic.

2. The importance of a good in a consumer’s budget. A rule of thumb is that the larger the proportion of the consumer’s budget that is spent on the good, the higher will be the own-price elasticity of that good (Mansfield, 1994).

3. The own-price elasticity depends on the length of time to which the market demand curve applies. Typically, demand tends to be more elastic over a long period of time than over a short period of time. The longer the period of time to which the market demand curve pertains, the easier it is for consumers and firms to substitute one good for another.

### 2.3.2. Income Elasticity of Demand

Price is not the only factor that affects the quantity demanded of a commodity in the market. Another very important factor is the income that the consumers have. If, for example, consumers have a lot of money to spend, the quantity of beef that they will demand is likely to be greater than if they are poverty-stricken. The Engel curve is a representation of the relationship between the equilibrium quantity purchased of a good (per period of time) and the income level (per period of time). At any point on the Engel curve, the income elasticity of demand gauges the sensitivity of the amount of a product consumed to changes in the consumer’s income. The income elasticity of demand is defined as follows:

\[
\eta_I = \frac{\partial Q_1}{\partial y} \frac{y}{Q_1}
\]
Where $\partial Q_1 = \text{the change in the quantity demanded of a good that results from a change in income;}$

$\partial y = \text{change in the consumer’s income;}$

$Q_1 = \text{the original quantity demanded; and}$

$y = \text{the original income of the consumer.}$

Large differences exist among goods as regards their income elasticities of demand. Some goods have positive income elasticities: increases in the consumer’s income give rise to increases in consumption of the good. Other goods have negative income elasticities: increases in the consumer’s income will result in decreases in the amount consumed of the good. It is generally assumed that luxury goods have high income elasticities of demand and necessities are characterized by low income elasticities of demand. The income elasticity of demand for food is usually quite low.\(^3\)

The low income elasticity of demand for food can be explained by the fact that consumers typically only spend about 12–16% of their income on food. Figure 2.4 shows that from 1970 on, the per capita total food expenditures as a percentage of income has actually decreased over time in the United States.\(^4\) At the same time, deflated per capita income\(^5\) (Figure 2.5) has increased – clear evidence that the income elasticity of demand for food is low.

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3 A phenomenon first discovered by Ernst Engel and forms part of Engel’s Law. Engel concluded from this result that the proportion of its income spent on food by a nation or a family is a good index of its welfare as better-off nations will tend to spend a smaller proportion of their income on food than poorer nations.

4 Source: ERS. http://www.ers.usda.gov

5 Source: Bureau of Economic Analysis.
Figure 2.4. Total Food Expenditures as a Percentage of Total Income, 1970-1996.
(Source: Economic Research Service)

Figure 2.5. Deflated (CPI, 1982-1984=100) Per Capita Income, 1970-1999.
(Source: Bureau of Economic Analysis)
Figure 2.6. Deflated (CPI, 1982-84=100) Per Capita Expenditures on Beef, Pork and Poultry, 1970-1999.
(Source: Economic Research Service)

Figure 2.6, shows deflated per capita expenditures on beef, pork and poultry. Clearly, the expenditure on pork has gone down over time, while expenditures on poultry and beef have increased over time. One reason why expenditures on beef were increasing in the early 1990’s is that per capita quantities were decreasing while price was increasing. The own-price elasticity of demand for beef is around – 0.67, and when demand is inelastic, expenditures will increase when the per capita quantity of food for sale decreases.

2.3.3. Cross-price Elasticity of Demand

The third important factor that determines the quantity of a commodity demanded in the market is the price of other commodities. By holding the own price of a good and the level of income constant while allowing the price of another good to vary, the cross-

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price elasticity of demand can be calculated and used to classify pairs of commodities as either substitutes or compliments.

Two goods X and good Y exist. The cross elasticity of demand is the relative change in the quantity of good X as a result of a one percent change in the price of good Y, with incomes and all prices except the price of good Y held constant. In mathematical terms, the cross-price elasticity can be defined as follows:

\[
\varepsilon_{xy} = \frac{\partial Q_x}{\partial P_y} \frac{P_y}{Q_x}
\]

Where \( \partial Q_x = \) the change in the quantity demanded of good x resulting from the change in the price of good y;

\( \partial P_y = \) the change in the price of good y;

\( P_y = \) price of good y; and

\( Q_x = \) original quantity demanded of good x.

To illustrate, an increase in the price of beef, when the price of chicken remains constant, will tend to give rise to an increase in the quantity of chicken demanded, an outcome that is associated with a positive cross-price elasticity. This positive value means that beef and chicken are substitutes. For complementary goods, on the other hand, the value cross-price elasticity is negative.

### 2.4. Elasticities and their Relation to Retail Meat Price Data

As retail meat prices are reported as simple averages and are not quantity-weighted to account for differences in the quantities of meat purchased at different price levels, we can conclude that the historically reported mean retail prices are too high. To illustrate this point, consider the following. If a simple average price, \( P_c \), is calculated using a series consisting of two prices \( P_a \) and \( P_b \), then \( P_a \) and \( P_b \) are each assigned an
equal weight of 0.5. When calculating a quantity-weighted price, on the other hand, each of the prices in the series are weighted by the quantity corresponding to that price. From the demand function shown in Figure 2.7, the quantity \((Q_k)\) associated with \(P_k\) is lower than \(Q_m\), the quantity associated with \(P_m\). The reason for this is that \(P_k\) is greater than \(P_m\). The weight assigned to \(P_k\) is the ratio of \(Q_k\) to the sum of \(Q_k\) and \(Q_m\) i.e. \(Q_k/(Q_k + Q_m)\). Similarly, the weight assigned to \(P_m\) is \(Q_m/(Q_k + Q_m)\). \(P_k\) and \(P_m\) do not, therefore, carry an equal weight: the higher the price, the smaller will be the weight and vice-versa.

The expectation is, therefore, that if the price collecting and reporting process moves to a system where quantity weighted averages are reported, these prices will be lower than with the current system of simple averaging. And lower prices will affect the values of the own-price, cross-price and income elasticities as price data are one of the key elements in calculating them.\(^{7}\)

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\(^{7}\) Other statistical and econometric measures will also be affected by changes in the mean price level, but this study seeks only to evaluate the influences on the elasticity parameters as they are such essential economic tools for gauging how changes in one good, sector or market impact on another good, sector or market.
2.4.1. The Impact on the Own-price Elasticity

At the mean levels for price and quantity, an own-price elasticity is calculated as follows:

\[ \varepsilon = \frac{\Delta Q}{\Delta P} \times \frac{\bar{P}}{\bar{Q}} \]

Where \( \Delta Q \) = change in quantity demanded due to a change in price
\( \Delta P \) = change in price of the good demanded
\( \bar{P} \) = average price
\( \bar{Q} \) = average quantity

This formula is similar to the formula used to calculate a point elasticity, but instead of using a specific price \( P \) and quantity \( Q \), the average price and quantity are used.

Consumers’ price/quantity response functions are based on the “true price” i.e. the actual price at which they purchase meat in the grocery store. The quantities of meat that they buy are, therefore, true and accurate and are recorded as such. The problem, however, arises when it comes to the price data as the true price is not necessarily reported. Instead, although the true prices are scanned, only simple average prices are reported. As a result, reported meat prices could be higher than the true prices on which consumers base their eating behavior and purchasing decisions.

Considered in the context of the calculation of an own-price elasticity, it can be said that consumers have observed the true price. The assumption is that the quantities of meat reported as purchased at the retail level are accurate since per capita consumption is a disappearance number and the manner in which prices are reported will not affect the quantities. \( \Delta Q \) and \( \bar{Q} \) will, therefore, remain unchanged when price collection procedures and calculations are changed. As a result, the main concern is what the impacts of a
lower price series (with a lower mean price) will be on $\Delta P$ and $\bar{P}$. While this might seem to be a simple enough task, in reality no simple inferences can be made about changes in $\Delta P$ and $\bar{P}$. The magnitude of the adjustments in $\Delta P$ and $\bar{P}$ will determine the degree of change in the own-price elasticity and, ultimately, in the cross-price and income elasticities.

Using a system of quantity weighted averages to report prices will lower all prices and also the average price. The response, \textit{a priori}, of switching to quantity weighting on the ratio $\Delta Q/\Delta P$ is not known. If it can be assumed that $\Delta P$ remains unchanged and, consequently, also the ratio of $\Delta Q$ over $\Delta P$ is unchanged, then it can be inferred that the own-price elasticity will be lower. In order to determine the direction (i.e. higher or lower in absolute terms) of the change in the own-price elasticity, it is necessary to compare the magnitude of the changes that would result in $\Delta P$ and $\bar{P}$.

2.5. Description of the Approaches to Analyzing the Data

Several changes need to be incorporated in a new (revised) retail meat price data series in order for it to be a more complete and reliable source of price data that can be used with greater accuracy in research efforts. To determine which changes need to be made to the current BLS retail meat price series and which data to incorporate in new retail meat price series, a two-pronged approach was used. Such an approach entailed using two separate, yet related, methods in establishing which changes to implement in a new retail price reporting system. The two methods used to determine and prioritize a recommended set of adjustments that will be used by the ERS are as follows:

1. A survey approach - the users of retail meat price data were given the opportunity to propose any changes to the current price reporting system and voice any concerns that they feel should be addressed in the development of a new price reporting system. The survey also aimed to establish how the users of retail meat
price data foresaw that proposed changes would affect the value of specific parameter estimators that are used in various research applications.

2. A data approach – used actual beef retail price data as an example to illustrate the impact of certain proposed changes to the current retail meat price data and the impact of these changes on important parameter estimators. In particular, the data approach is concerned with the issue of simple averages versus quantity-weighted averages.