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PRICE TRANSMISSION ACROSS MARKETING LEVELS IN A HEDONIC FRAMEWORK

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Abstract

A model combining hedonic pricing with an analysis of price transmission within the marketing chain is developed. Using data from a 1988 California peach study, the effects of quality and seasonal variations on producer and retailer prices are analyzed via hedonic price decomposition. Variations in the price decompositions by market level are analyzed through the marketing margin. It is shown that not considering different marketing levels produces misleading results.

PRICE TRANSMISSION ACROSS MARKETING LEVELS IN A HEDONIC FRAMEWORK

I. Introduction

The use of economics in the decomposition of prices by a commodity's quality characteristics provides important information to producers. Prior knowledge of the effects of shifts in seasonal timing, production techniques, and quality on output price can be especially important to agricultural producers. This information can also be used by regulators to increase an industry's stability and improve the public welfare.

Understanding the relationship between levels in a multi-level market is an integral part of such price decompositions. Price decomposition at the retail level may differ from that at the producer level due to the structure of wholesale markets. The study of price transmission across market levels provides for a complete price decomposition which permits producers to make optimal production decisions. Without knowledge of how the price is transmitted and how price signals change between market levels, producers are unable to accurately predict the market's response to production changes.

Many economic commodities pass through a multi-level marketing chain which delivers the product from the producer to the consumer. Differences in price decomposition between the producer and retail levels of these chains are explained by the marketing margin. Differences between levels of the marketing chain often result from the durability of the product. For durable products which are not damaged, spoiled, or otherwise changed in the marketing chain, price decompositions should not vary across market levels. Nondurable goods which may break, spoil, or change characteristics within the marketing chain will produce differing price decompositions. It is these types of goods with which this paper is concerned. The apparent lack of price transmission from the consumer to the producer for a perishable agricultural product will be explained as a function of the product's nondurability in the marketing chain.

The theory of consumer choice based upon product characteristics has been used in the study of agricultural products, housing, automobiles, and other durable goods (Phoebus J. Dhrymes, 1971; Lyle P. Fettig, 1963; George W. Ladd and Veraphol Suvannunt, 1976; and Raymond B. Palmquist, 1984). For some commodities, especially seasonal and perishable agricultural products, the set of substitute commodities changes over the season. Marketing nondurable commodities with different quality and seasonality characteristics may involve different actions or strategies at the producer, wholesaler, and retailer levels. At each level the desirability of certain quality characteristics may differ. Knowledge of the relationships between the marketing levels is necessary to understand why strategies differ.

The theory presented here assumes that producers and retailers operate independently. The link between these markets is represented as the marketing margin. A set of hedonic prices is derived for the producer and retailer levels of the marketing chain. A theory will be developed which examines the margin and how it transmits the different price signals between the separate markets. At each marketing level the model assesses the importance of the product's quality characteristics and compares them by way of the margin. Changes in the margin result from the relationship between price, quality, and the time of season. The time of season represents variations in the set of substitute goods from which a consumer may choose and shifts in the nearly vertical supply curve of the producer. The margin is modeled using a retailer production function which responds to retailer losses. and changes in consumer demand, changes in competition from substitutes, and changes in quality. The level of retail losses from damage and spoilage is controlled through a loss abatement expenditure function.

The empirical work for this paper results from a project for the California fresh peach industry. This paper assesses the relationship between price, date, and quality attributes for peaches. It examines price-quality relationships at different levels of distribution to ascertain if the market is optimally transmitting the most profitable price signals. By focusing on the behavior of the marketing margin, insight into the transmission of price signals is revealed.

II. The Hedonic Price Model

A. *Background*

Analysis of price based on product characteristics, known as the hedonic or implicit marginal price, dates to the early work of Frederick W. Waugh (1928). Without a formal theory, Waugh estimated hedonic prices for various characteristics of vegetables in the Boston wholesale market. Work by H. Theil (1952), H. S. Houthakker (1952), Kelvin J. Lancaster (1966), and Ladd and Suvannunt (1976) has produced a theoretical basis for the analysis of consumer demand for characteristics. A good review of this literature can be found in a paper by George W. Ladd (1982). Recent work has focused on the demand for and supply of characteristics, the existence of a market equilibrium for characteristics, and on the empirical problems of estimating characteristic demand and supply functions. For a good review of this literature, see Robert Mendelsohn (1987).

An analysis of fresh peach prices using the hedonic approach was performed for the Georgia area in 1984 (J. L. Jordan, R. L. Shewfelt, and S. E. Prussia, 1987). Hedonic prices were estimated for five fruit characteristics at the wholesale and retail levels. Size and damage characteristics were shown to be important price indicators at the wholesale level while size, damage, color, and firmness were important at the retail level. The differences between the two marketing levels were not analyzed. The data were collected in one day. Therefore no changes in the availability of substitute products were examined.

B. *The Model*

The theoretical basis of hedonic prices assumes that the consumer's utility function is based upon the consumption of characteristics and not the consumption of goods. Through a family production function, utility is derived from characteristics consumed. Following the work of Ladd and Suvannunt, let the set of quality characteristics for a product be defined by a vector $Z(Z_1, Z_{2,\ldots,} Z_n)$ where there are n characteristics. Each consumer measures the set of characteristics in the same manner while placing unique values on them.

The Ladd and Suvannunt approach assumes that the consumer's choice set of products is constant over the sample. Many agricultural products are seasonal and have seasonal substitutes. Allowing the consumer's choice set of goods to change over the season price can be modeled as a function of quality characteristics and time:

(1) $$P_i = P(Z_{i1}, Z_{i2}, \ldots, Z_{ij}, t;\ e_i),$$

where P_i is the price of the commodity, Z_{ij} is the quantity of characteristic j in product i, t is the time of the season, and e_i is the error term. This is similar to the price function shown in a paper by Robert E. B. Lucas (1975) except for the addition of the seasonality variable. For agriculture, the seasonal effect is adjusted for through the use of different fruit varieties, location of the grower (climate), chemicals, and the use of greenhouses.

The hedonic or marginal implicit prices are found by differentiating the price function with respect to the quality characteristics and time;

(2) $$H_{ij} = \frac{\partial P}{\partial Z_{ij}}$$

and

(3) $$H_{it} = \frac{\partial P}{\partial t},$$

where H_{ij} is the hedonic or implicit price of characteristic j for product i and H_{it} is the price effect of seasonal production and substitution for the commodity. Both H_{ij} and H_{it} are not necessarily linear. The function H_{ij} is often shown to be convex in the hedonic literature (Sherwin Rosen, 1974).

The hedonic prices, including the seasonal effect, may differ at each level of the marketing chain. The differences between the hedonic prices will affect the marketing margin as explained in the next section.

III. Theory of Changes in Hedonic Prices within the Marketing Chain

A. *Background*

William G. Tomek and Kenneth R. Robinson (1981) define the marketing margin as "(1) a difference between the price paid by consumers and that obtained by producers, or as (2) the price of a collection of marketing services which is the outcome of the demand for and the supply of such services."

Analysis of the marketing margin in agriculture often focuses on the constant rate and fixed percentage markup models. In a paper by P. S. George and G. A. King

(1971), a linear relationship between retail price and the margin is analyzed. They conclude that the margin is a combination of the constant rate and fixed percentage markup models. R. C. Buse and G. E. Brandow (1960) evaluate the margin as a function of retail price, volume, and other "trends". In their analysis the level of volume is unimportant in determining the margin. Michael K. Wohlgenant and J. A. Mullen (1987), using a model similar to Buse and Brandow's, find volume to be important for the beef industry. They conclude that, in an industry where there have been both demand and supply shifts during the sample time frame, volume is important. Gary D. Thompson and Charles C. Lyon (1984) show a good overview of different marketing margin models.

In a paper by Bruce L. Gardner (1975), the margin is derived from the supply of marketing services. Gardner presents a retail supply function where levels of output are dependant on farm and other inputs. The effects of shifts in consumer demand and inputs on the ratio of retail to farm level prices are examined. Gardner's model is a combination of the Buse and Brandow, George and King, and Wohlgenant and Mullen models. The retail production function to be presented here is similar to Gardner's model. Shifts in consumer demand and retailer inputs are incorporated in a more direct manner through changes in product quality, seasonal substitutes, and retailer losses. Changes in the input parameters to the model force endogenous changes elsewhere in the model.

B. *The Model*

Changes in the margin are driven by a product loss function. According to two separate U. S. Department of Agriculture studies, losses at the wholesale and retail levels for fresh peaches range from 6.8 percent to 18.1 percent (U. S. Department of Agriculture, 1973; U. S. Department of Agriculture, 1975). Losses to firms operating in the margin are significant, and methods to reduce these losses can have real effects on profits.

Assume that for perishable or fragile products there is some loss or damage function such as $L(Z, C)$. Define L as the percent of product lost or damaged between the producer and the consumer levels, Z as the vector representing the characteristics of the product (some of which will affect the level of losses), and C as the total marketing costs. Included in C are expenditures which help reduce losses. For California tree fruit, the Z's are quality characteristics which may affect losses due to damage and spoilage. The loss reducing expenditures in the scalar C are handling, transportation, and storage surcharges which reduce the level of losses.

The loss function is assumed to be continuous over both Z and C. It slopes downward and is convex with respect to loss abatement expenditures. The loss function is upward sloping with respect to characteristics.

At the retail level demand is a function of price, competition from substitutes, and quality. Following Tomek and Robinson, consumer demand is defined as the primary demand function. This demand function may be written $D^r = D^r(P_r, X(t), Z)$ where D^r is the retail demand function, P_r is retail price, $X(t)$ is competition, and Z is the vector of quality characteristics. Competition from other fruits is a function of time because the product's substitutes are seasonal. For the California fresh peach industry, competition is increasing at the beginning of the season (May through June), level through July and August, and decreasing in September.

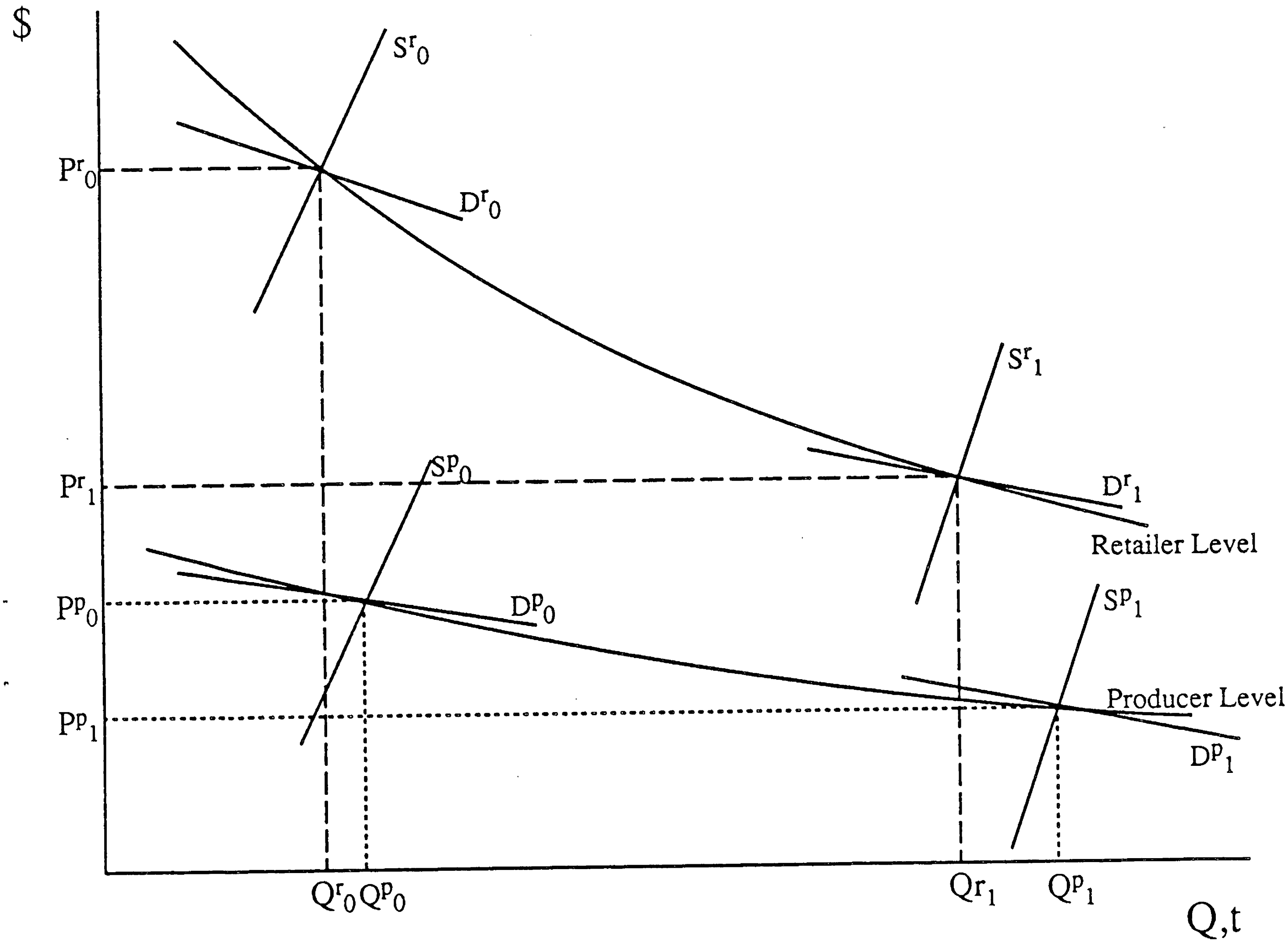
The producer level demand function is derived from the consumer's demand function. This can be written $D^p = g_D(D^r)$ where D^p is the producer demand function. Both demand functions are downward sloping, shift inward and become flatter as competition increases, and shift out with increases in quality.

Retail supply is derived from the retail production function which is dependant upon the producer level supply function, costs to the retailer, and losses. Costs include transportation and handling charges, expenditures to reduce losses, and other marketing charges. Losses due to damage and spoilage behave as in the previously defined damage function. The retail, or derived, supply function can be written $S^r = g_S(S^p, C, L(Z, C))$ where S^r is the retail supply function, S^p is the producer level supply function, C is the total costs to the retailer (which includes the expenditures to prevent losses), and $L(Z, C)$ is the percent of the product lost. The retail supply function shifts inward with increases in losses, costs, or producer prices.

The primary or producer supply function is based on producer price and costs. It is assumed that producer costs, PC, do not change over the season. Producer costs may increase with increases in quality characteristics. The producer supply function can be written $S^p = S^p(P_p, PC)$ where P_p is the producer level price. Producer supply slopes upward and shifts inward with increases in PC.

Assuming that the market is operating in equilibrium, the supply and demand equations are equated in both markets. Changing inputs into the supply or demand functions produces a set of equilibrium points which map out the producer and retailer level price response curves. In Figure 1, a series of small input changes, such as time, cause the producer and retailer demand and supply functions to shift. The resulting equilibria trace out their respective price response curves. Depending on what input variable changes, these price response curves may slope downward or upward. The specific variable will also determine whether the distance between the curves, the marketing margin, increases or decreases. The demand and supply curves are plotted against price and quantity while the resulting price response curves show the price response to change in that input variable, shown here as t. The change in the margin reveals the leverage of the middleman in this market.

Figure 1



$
$S^r{}_0$
$P^r{}_0$
$D^r{}_0$
$S^r{}_1$
$S^p{}_0$
$P^r{}_1$
$D^r{}_1$
Retailer Level
$P^p{}_0$
$D^p{}_0$
$S^p{}_1$
Producer Level
$P^p{}_1$
$D^p{}_1$
$Q^r{}_0$ $Q^p{}_0$
Qr_1
$Q^p{}_1$
Q,t

IV. The Retailer Production Function and the Margin

The retailer's profit function is maximized by choosing the optimal level of expenditure on loss abatement. Assuming a constant returns to scale retail production function, the profit maximization can be written

$$\max_{C} \pi = P_r(1 - L(Z, C)) - P_p - C. \tag{4}$$

The first-order condition is

$$\frac{\partial \pi}{\partial C} = -P_r \frac{\partial L}{\partial C} - 1 = 0. \tag{5}$$

The retailer will spend that amount on loss abatement for which the absolute value of the change in losses from a change in abatement costs is just equal to the inverse of the retail price, assuming a competitive market retail price will be such that revenues are equal to costs plus some competitive rate of return. Therefore the retail price may be written

$$P_r = \frac{P_p + C}{1 - L(Z, C)}. \tag{6}$$

The marketing margin, defined as the difference between the retail and producer price, can be written

$$M \equiv P_r - P_p = P_r L + C. \tag{7}$$

The change in the margin from changes in demand and supply parameters such as the quality of the product or the time of season can be written

$$\Delta M = M_1 - M_0 = (P_{r1} L_1 - P_{r0} L_0) + (C_1 - C_0). \tag{8}$$

Equation (8) shows that the change in the margin consists of revenue and cost components. Changes in revenues result from changes in losses and changes in price. The effects of changes in the demand and supply parameters on the margin will be shown.

A. *The Effects of Changes in Consumer Demand and Quantity Supplied on Price Transmission*

The case of a simultaneous shift in the demand for the product and supply of the product holding quality constant is analyzed first. Time of season may represent two important changes in the demand for seasonal, nondurable commodities. The first is unobservable changes in markets for substitute products. The other involves the novelty effect of early seasonal products. Consumers may initially differ in their assessment of a product when it is first available after some absence from the market. Later in the season this novelty wears off as the product's appearance in the marketplace becomes more common. Therefore the seasonal effect on demand is for it to shift inward and become flatter as the product's availability increases and as competition from substitute commodities increases. This leads to a reduction in the product's price.

A concurrent seasonal effect is for the quantity produced, supply, to increase. Quantity produced is exogenous in this short-run model where actual changes in quantity require several years. The seasonal quantity shift causes the nearly vertical supply curves to shift out. These changes cause producer and retailer level prices to decrease.

The reduction in price holding quality constant will affect the amount spent on loss abatement and therefore the margin in the following manner. Totally differentiating the retailer's first-order condition and holding characteristics constant, the change in expenditures in the loss function due to the change in retail price from a change in time of season can be represented as

$$\text{(9)} \qquad \frac{dC}{dt} = -\frac{\frac{\partial L}{\partial C}\frac{\partial P_r}{\partial t}}{P_r\frac{\partial^2 L}{\partial C^2}} < 0.$$

Since losses decrease with increased expenditures and retail price is falling over the season, the numerator of equation (9) is positive. The denominator is also positive since it is assumed that the loss abatement function is convex with respect to expenditures. Therefore as the season progresses, the direction of change in expenditures to reduce losses is negative. Note that increasing substitutes and quantity affect the price in the same manner. These two effects are therefore included in the one term representing the change in price over time. Because retail price is falling over the season, equation (9) implies that higher valued fruit, of equal quality, receive better treatment and incur fewer losses. Therefore as the season progresses and prices fall due to increased competition, the lessening of the novelty effect, and increased quantities available, the amount spent to reduce losses will fall. This causes an increase in the amount of fruit lost.

The change in the margin during the season can be represented as

$$\text{(10)} \qquad \frac{dM}{dt} = L\frac{\partial P_r}{\partial t} + P_r\frac{\partial L}{\partial C}\frac{\partial C}{\partial P_r}\frac{\partial P_r}{\partial t} + \frac{\partial C}{\partial P_r}\frac{\partial P_r}{\partial t} < 0.$$

The first term on the right-hand side of equation (10) represents the change in revenue lost from spoilage resulting from the change in retail price over time. Because prices are declining over the season, this term is negative. The second term is the change in revenue which results from the change in losses. The change in losses is, however, brought about by the change in the seasonal price. Because the change in expenditures to prevent losses over the season is negative (see equation (9)), the amount of losses will rise over the season. Therefore the change in revenue lost over the season is positive. The final term in equation (10) is the change in expenditures to avoid losses over the season. This was shown to be negative in equation (9). It seems reasonable to expect that the revenue lost due to increased losses will be approximately offset by the decrease in expenditures to avoid losses. Therefore the sign of equation (10) should be negative showing the marketing margin to decrease over the season.

B. *The Effects of Changes in Quality on the Margin*

As quality characteristics increase, consumer demand shifts outward. Furthermore, an increase in quality characteristics will cause the supply curve to shift inward due to an increase in losses and/or an increase in loss abatement expenditures. These combined affects will increase retail price.

Given the change in retail price resulting from a shift in demand when quality characteristics change, the change in the loss expenditure function can be seen as follows. By totally differentiating the retailer's first-order condition and holding time constant, the change in abatement costs due to a change in quality characteristics can be represented as

$$\text{(11)} \qquad \frac{dC}{dZ} = -\frac{\left[\frac{\partial P_r}{\partial Z}\frac{\partial L}{\partial C} + P_r\frac{\partial^2 L}{\partial C \partial Z}\right]}{P_r\frac{{}^2L}{\partial C^2}} > 0.$$

Because the loss function was assumed convex with respect to costs, the denominator in equation (11) is positive. The first term in the numerator is negative from prior assumptions. The sign of the second term in the numerator is therefore important in determining the sign of this equation or the expected change in loss abatement costs as quality characteristics change.

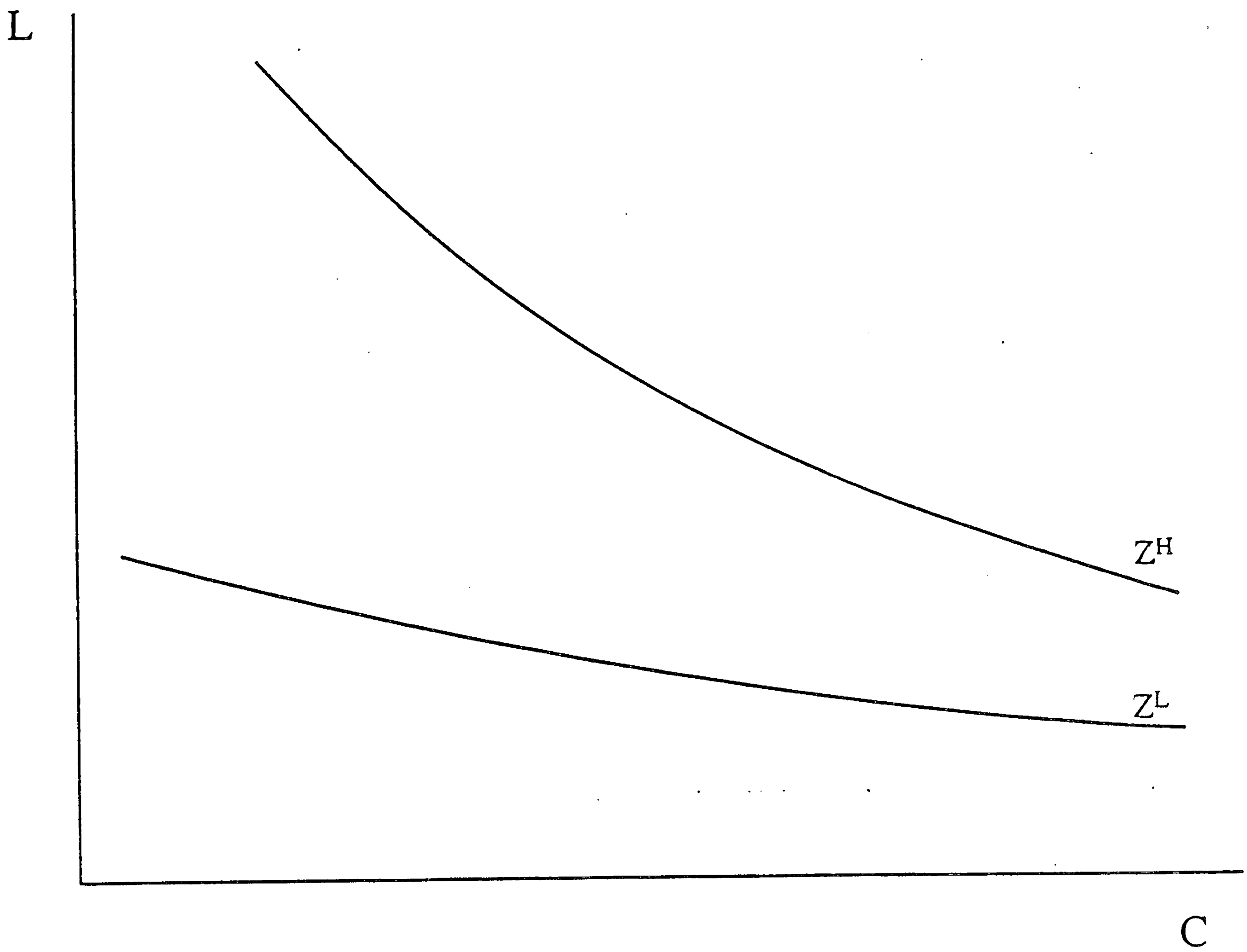
The derivative in the second term represents the change in the slope of the loss function as quality changes. The sign of this term can be shown to be negative. A negative sign would imply that as quality increases the change in the marginal dollar spent to reduce losses falls. This implies that money spent to reduce losses of high quality fruit is more effective than money to reduce losses of low quality fruit. This can be better understood by examining Figure 2. This figure reveals what two loss expenditure functions, the upper for high quality and the lower for low quality, would look like if the sign of this term is negative. Expenditures to reduce costs are more effective for high quality fruit. This is consistent with industry practices with respect to tree-ripened fruits. These combined affects show the sign of equation (11) to be positive. Therefore as quality increases the expenditures on loss abatement increase.

The change in the margin due to a change in quality can be written

$$\frac{dM}{dZ} = L\frac{\partial P_r}{\partial Z} + P_r\left[\frac{\partial L}{\partial Z} + \frac{\partial L}{\partial C}\frac{\partial C}{\partial Z}\right] + \frac{\partial C}{\partial Z} > 0. \tag{12}$$

The first term on the right-hand side represents the change in revenue lost from a change in retail price when quality characteristics change. Retail price increases as quality characteristics increase, therefore this term should be positive. The second term represents the change in revenue due to the total change in product losses. The change in loss is increasing due to higher quality and decreasing due to increased

Figure 2



expenditures on loss abatement (equation (11)). To be consistent with industry outcomes, total loss is expected to increase by a small amount. Therefore the second term should be positive. The last term was shown to be positive in equation (11). Equation (12) is therefore positive and the margin is increasing with increases in quality.

V. The Data

Producer level data were collected during the 1988 growing season from four packing sheds in California's San Joaquin Valley. Simultaneously, retail level data were collected from 20 retail stores in the San Francisco Bay area. Five quality characteristics were measured for each peach sampled. These are background color, fraction of fruit showing redness, firmness, weight, and soluble solids. The date of sale and price are also known. Due to the high degree of negative correlation between background color and firmness, only background color was used in the final analysis. Because a fruit's variety is known at the producer level, both buyers and sellers are able to ascertain some knowledge concerning the maturity of the fruit from its background color. The background color variable at this level is therefore adjusted for varietal differences by the regulated harvest color level imposed by the industry's marketing order. At the retail level no such meaningful adjustments can be made.

At the producer level two additional variables are added. To account for the limited shelf life of the fruit, the number of days between packing and shipping is included. Furthermore, since one of the producers, Packer A, possesses unique marketing advantages due to their size and variety of products sold, a dummy variable representing this producer is included.

The analysis at the retail level is complicated by the characteristics of the consumers themselves and by the varying marketing strategies of different stores.

Consequently three variables were added to the retail equation to offset the biases introduced by these differences. The mean value of household income for the area surrounding the store was added to account for differences between services offered at various locations, a variable representing field-packed fruit was added to account for this alternative production technique, and an advertising variable was included to account for the loss-leader tactics used by chain stores. Advertised prices do not reflect equilibrium prices for the product but, rather, a profit-maximizing strategy on the part of the store.

VI. Empirical Equations

There are no theoretical models which lead to the correct functional form for the price equations. Recent empirical tests have shown that the Box-Cox transformation provides good results (Maureen L. Cropper, Leland B. Deck, and Kenneth E. McConnell, 1988). The Box-Cox method requires a power transformation such as

$$(13) \qquad Y^{(\lambda)} = \begin{cases} \dfrac{Y^{(\lambda)} - 1}{\lambda}, & \lambda \neq 0 \\ \ln Y, & \lambda = 0 \end{cases},$$

of the random variable, Y. The price equations can be generalized to the form:

$$(14) \qquad P^{\lambda} = a + b_1 Z_1^{\mu} + b_2 Z_2^{\mu} + \ldots + b_n Z_n^{\mu} + \varepsilon.$$

The parameters, λ and μ, are the Box-Cox variables which determine the best fitting functional form for the equation. The Box-Cox method is often preferred for this type of analysis because it provides flexibility in the functional form. Some different functional forms which may be found in the Box-Cox framework are the linear ($\lambda = 1$,

$\mu = 1$); log ($\lambda = 0, \mu = 0$); log-linear ($\lambda = 0, \mu = 1$); and linear-inverse ($\lambda = 1, \mu = -1$) models. Through different combinations of the parameters, λ and μ, these and many other functional forms can be created.

The final empirical model to be estimated for the producer and retailer levels, respectively, can now be specified as

$$(15) \qquad P_{pi}^{\lambda} = a + b_{p1}\, Date_{pi}^{\mu} + b_{p2}\, Col_{pi}^{\mu} + b_{p3}\, Red_{pi}^{\mu} + b_{p4}\, Weight_{pi}^{\mu} + b_{p5}\, SolS_{pi}^{\mu} + b_{p6}\, Days\ H_{pi}^{\mu} + b_{p7}\, Pack\ 3_{pi}^{\mu} + \varepsilon,$$

$$(16) \qquad P_{ri}^{\lambda} = a + b_{r1}\, Date_{ri}^{\mu} + b_{r2}\, Col_{ri}^{\mu} + b_{r3}\, Red_{ri}^{\mu} + b_{r4}\, Weight_{ri}^{\mu} + b_{r5}\, SolS_{ri}^{\mu} + b_{r6}\, Adver_{ri}^{\mu} + b_{r7}\, Inc_{ri}^{\mu} + b_{r8}\, Def_{ri}^{\mu} + b_{r9}\, FP_{ri}^{\mu} + \varepsilon,$$

where the subscripts p stands for producer level and r for retailer level. The variables are defined in Table 1.

At the producer level the issue of fruit durability must be offset against taste. Higher quality fruits are more susceptible to damage and spoilage. Therefore the characteristics which imply better taste to the consumer may not lead to higher prices for the producer. The signs of the coefficients on background color, redness, weight, and soluble solids may not be positive at this level.

It is expected that consumer demand for quality should focus on taste characteristics. Visual characteristics which often imply better tasting fruit should show positive hedonic prices at the retail level. Less green levels of background color and larger fruits (weight) are all often associated with higher quality. Increases in the number of defects per fruit should lower prices, but it may also imply better taste as riper fruit are more susceptible to damage. The level of soluble solids is not

TABLE 1—DEFINITION OF VARIABLES FROM THE EMPIRICAL EQUATIONS

P_i	Price of the i^{th} Sample in Dollars Per Lug at the Packer Level and Cents Per Pound at the Retail Level
$Date_i$	Date the i^{th} Sample Was Recorded Measured in Days from April 30, 1988
Col_i	Background Color of the i^{th} Sample Using CTFA Color Chips (Adjusted for Maturity at the Producer Level)
Red_i	Fraction of the i^{th} Sample Showing Redness
$Weight_i$	Weight of the i^{th} Sample in Grams
$SolS_i$	Level of Soluble Solids of the i^{th} Sample in Degrees Brix
$Days\ H_i$	Number of Days from Packing Until Shipping of the i^{th} Sample (Packer Level Only)
$Packer\ A_i$	Dummy Variable Representing Packer A, 1 if the i^{th} Sample Is from Packer A, 0 otherwise (Packer Level Only)
$Adver_i$	Dummy Variable Showing if the Sample Is Advertised, 1 if the i^{th} Sample Is Advertised, 0 otherwise (Retail Level Only)
Inc_i	Level of Household Income for the Area Surrounding the Store from which the i^{th} Sample Was Taken in Dollars Per Year (Retail Level Only)
Def_i	Number of Defects on the i^{th} Sample (Retail Level Only)
FP_i	Dummy Variable Representing Field Packing, 1 if the i^{th} Sample Is Field Packed, 0 otherwise (Retail Level Only)
ε	Regression Error Term

response to soluble solids may represent nonmeasured visual or aromatic characteristics and consumer returns to previously tested locations.

The effect of date on price is expected to be negative in both equation. The change in availability of substitutes, quantity of peaches in the market, and a measure of the early season novelty effect should all lower price over the season. Price may level off after an initial drop as these changes occur.

VII. Results

The empirical equations (15) and (16) were estimated using an iterative procedure with the SHAZAM statistical computer program. The results for the two models are presented in Table 2. The Box-Cox parameters for both equations are near zero. This suggests that the best fitting functional forms are similar to the log-log model. The retail level model is close to the log-log model while the producer level model is between the log-log and linear specifications.

For the producer model, all of the coefficients are significant at the 99 percent level except for redness (70 percent), soluble solids (86 percent), and days held (86 percent). For background color and soluble solids, the signs of the coefficients were negative suggesting that buyers at this level are interested in more durable fruit which is less susceptible to damage and losses. The coefficient on weight is strongly positive suggesting that trade-offs are being made between durability and taste. The degree of redness is unimportant in the results. The coefficient on the Packer A variable is positive which reveals the value of the extra services that they are able to provide.

For the retail model, the date, weight, advertising, and income coefficients are significant at the 99 percent level (see Table 2). The soluble solids variable is significant at the 90 percent level, and the background color variable at the 88 percent

TABLE 2—RESULTS OF THE HEDONIC PRICE ESTIMATION*

Variables and Statistics	Estimated Coefficients		Price Elasticities	
	Producer	Retailer	Producer	Retailer
Constant	1.856 (8.26)	2.28 (14.8)	0.946	4.596
Date	-0.202 (-16.8)	-0.068 (-7.44)	-0.462	-0.293
Color	-0.056 (-3.28)	0.050 (1.58)	-0.054	0.156
Redness	0.086 (1.02)	-0.009 (-0.43)	0.039	-0.017
Weight	0.223 (19.5)	0.091 (6.37)	0.754	0.464
Soluble Solids	-0.069 (-1.47)	0.056 (1.61)	-0.085	0.173
Days Held	-0.017 (-1.46)		-0.014	
Packer A	0.319 (10.7)		1.31**	
Advertised		-0.139 (-9.32)		-20.2**
Income		0.038 (3.04)		0.149
Defects		0.008 (0.61)		0.019
Field Pack		0.022 (1.02)		9.8**
d.f.	303	297		
R^2	0.67	0.45		
λ	0.31	-0.16		
μ	0.36	0.18		

*Numbers in parentheses are t-statistics.

**Because these are 0, 1 dummy variables, these values represent absolute changes in price from mean values. Packer variable is in dollars per lug while retail is in cents per pound.

level. The coefficients on background color, weight, and soluble solids are positive. This supports the assertion that consumers value those characteristics which are perceived as indicators of good taste. The coefficient on redness is not significantly different from zero at this level of the marketing chain also. The industry's perception is that consumers prefer redder fruit but that redness does not actually affect fruit quality. This perception is not supported here. The coefficient on the field pack variable is also not significantly different from zero. This does not mean that field-packed fruits do not receive higher prices. It does mean that field packed fruit does not receive higher prices if there are no quality differences between these and other fruits.

The most interesting result relates to background color and soluble solids which have opposite effects at the two levels. These characteristics have a negative effect on price at the producer level. This signifies that durability and transportability are important at this level and overripe fruit are penalized. At the retail level background color and soluble solids have a positive effect on price. Here consumers desire more of these characteristics which correspond with taste. The difference is absorbed by the operations in the margin.

Using the coefficients in Table 2, the marketing margin may be analyzed. If all variables in the equations except one are held constant at their sample means, the effect of that changing variable on prices can be calculated. By changing this variable equally in both equations, the effect it has on the margin is found. In this way the seasonal and quality effects on the margin which were modeled in section IV can be tested.

A. *The Seasonal Effect on Price Transmission*

Holding all other variables to their sample means and allowing the date to vary over the season the marginal effect of date on prices is found. This is shown graphically in Figure 3. All prices are converted to dollars per 22.5 pound lug. The expected price per lug falls as the season progresses. The upper solid line shows the expected retail price for peaches during the season, while the lower dotted line shows the expected producer price over the season. Prices at both levels are high at the beginning of the season, drop quickly, and then level off for the remainder of the season. The data do not continue into September and October where prices rise as the season comes to a close. The shape of the curves supports the use of the Box-Cox methodology which does not impose linearity or other pre-set forms.

The difference between the price response curves is the marketing margin. This difference is shown in Figure 4. The marketing margin decreases as the season progresses. The margin falls sharply at the beginning of the season when prices are falling fastest at both levels. The reduction in the margin over the entire season is just slightly over one-half dollar per lug, approximately 5 percent. Therefore the margin is absorbing some of the reduction in price, supporting the hypothesis that the sign of equation (10) in section IV.A is negative. The model of price transmission correctly predicted the behavior of the margin given shifts in supply and demand based upon seasonality.

B. *The Effect of Product Quality on Price Transmission*

A common measure of quality is fruit weight. This is supported by the degree of significance assigned this variable in the results. Weight is correlated with many other quality characteristics such as soluble solids, maturity, and firmness. If all variables except weight are held at their sample means, the effect of peach weight as a proxy for quality can be shown. The date variable is set to the middle of the season. Predicted prices by weight are shown in Figure 5. Both retail and producer prices increase as weight increases. At the producer level the price for the larger fruits is

Figure 3
Predicted Price Over The Season

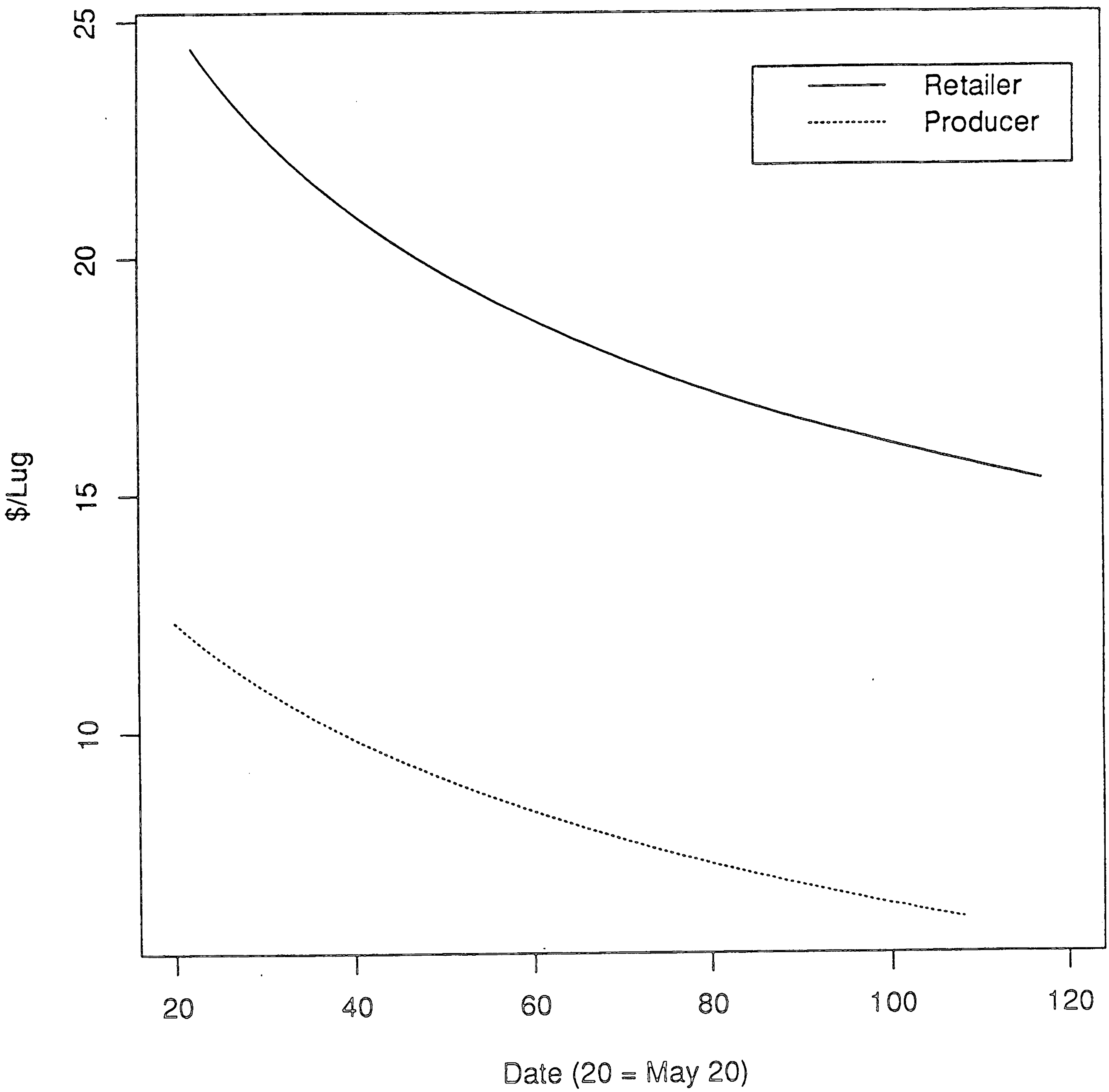


Figure 4
Predicted Marketing Margin Over The Season

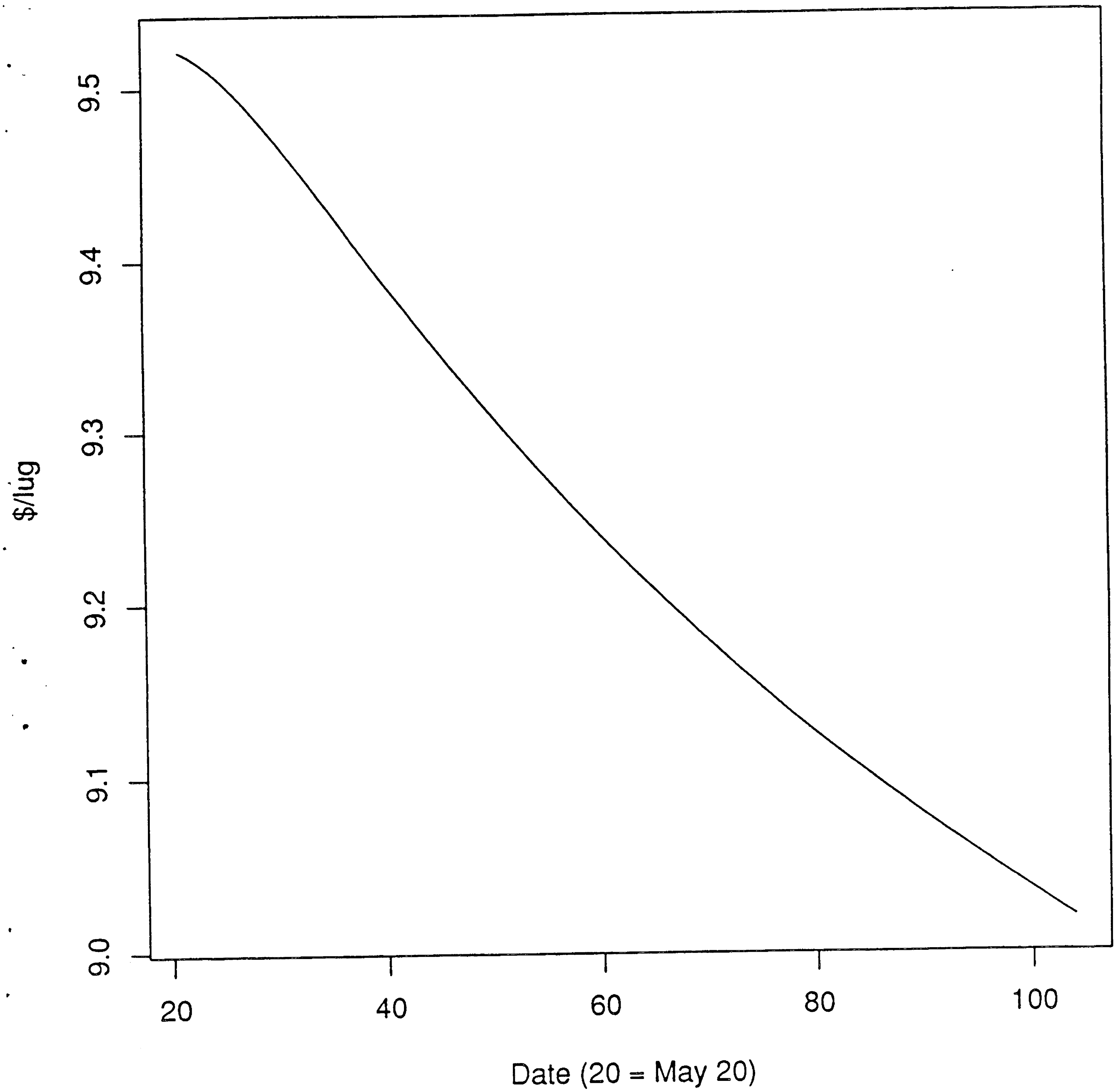
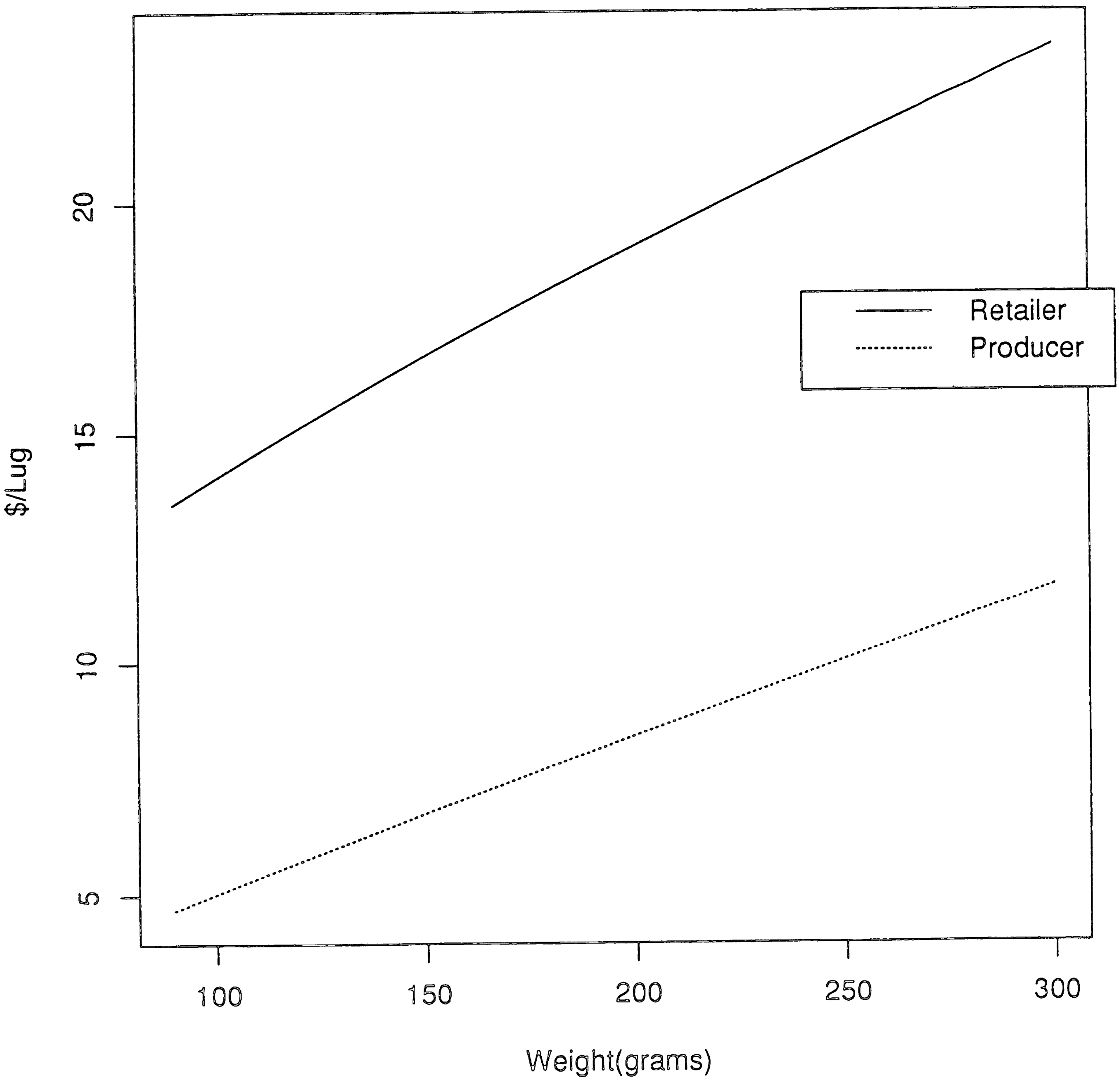


Figure 5
Predicted Price By Weight



approximately double that for smaller fruits. This points to the real gains to be made from pruning and other practices which increase fruit size.

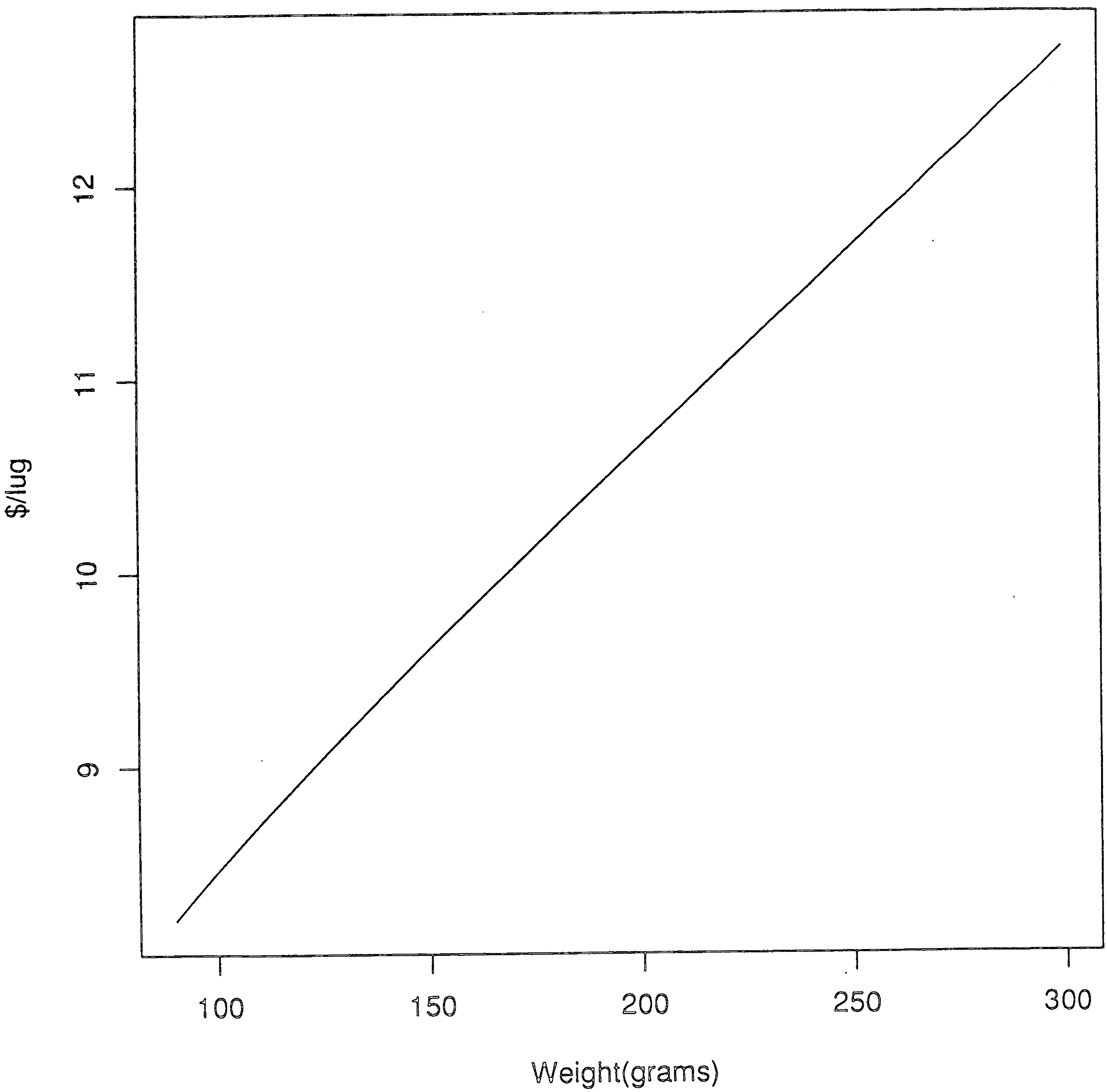
The difference between the price response curves is the marketing margin. This difference in response to changes in weight is show in Figure 6. The net effect of these price changes is that the marketing margin increases as the weight of the peach increases. The total increase in the margin over the sample weight range is over $4.00 per lug, an increase of almost 50 percent. This agrees with the hypothesis that the sign of equation (12) in section IV.B is positive. The increase in the retail price reveals the value that consumers place on large fruits. Over half of that price increase in transmitted to the producer while the rest is absorbed by the margin. Understanding where the retail price increase is realized is important if the various levels of the market are to respond optimally. Knowing that the margin will absorb nearly half of the retail price increase will prevent producers from overreacting to the predicted change in retail price.

VIII. Conclusions

The hedonic price framework was expanded to allow for changes in the set of goods from which the consumer may choose. It was further expanded to examine the value of quality characteristics throughout the food marketing chain. This is necessary to properly comprehend the differences between marketing levels brought about by price transmission.

A theory to examine the marketing margin based upon the addition of marketing services through a retailer production function was developed and tested. The effects on the marketing margin of simultaneous shifts in supply and demand and simultaneous shifts in inputs and demand were analyzed. In both cases the direction of change in the marketing margin was correctly predicted.

Figure 6
Predicted Marketing Margin By Weight



The importance of a multi-market level approach to hedonic pricing is seen in the case of a shift in quality characteristics. In this analysis quality increases affect producer and retailer prices to different degrees. Higher levels of quality increase retail price while the effect on producer price can be ambivalent. This reveals two points about the behavior of the market when quality increases. The first is that marketing services have increased to help offset increased losses. The second is that in equilibrium consumers show a willingness to pay for higher quality produce.

Recent industry innovations are attempting to capitalize on this. The increased use of field packing and marketing the product with the label "tree ripened" is an attempt to increase quality while keeping losses down. By reducing losses to the middleman, producers are able to more effectively capitalize on the production of high quality fruit.

The fact that much of the price transmission from the retail to producer levels is absorbed by the marketing margin is significant. It points out the need for multi-market level analysis as performed here. An analysis of consumer response to quality at the retail level only would have overestimated the level of quality producers should produce. Similarly, an analysis at the producer level only would underestimate consumer response to quality. In industries where there is some intermediate production response which affects output, a single market level analysis would lead to incorrect conclusions.

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