

MEASUREMENT COSTS AND PRICING METHODS IN
THE RETAIL PRODUCE MARKET

by

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ABSTRACT

A persistent practice in the retail produce market is the mixed use of per unit and per pound pricing for bulk produce commodities. While per pound pricing explicitly prices the size dimension of the produce, per unit pricing (known in the industry as "by the each" pricing) is a form of average pricing whereby units differing in size and value are sold for the same price.

When goods are average priced, opportunities exist for buyers to find units of exceptional value at the going price. Exploiting these opportunities requires buyers to measure and compare the values of individual units. Measurement of this kind often results in costly wealth transfers among buyers and between buyers and sellers. Profit maximization implies that sellers will avoid average pricing and its associated measurement costs whenever alternative pricing methods can be implemented at lower cost.

This study examines the implications of measurement costs in the retail produce market, and develops predictions concerning the seller's decision to set an average price (price per each) or a price per pound. Logistic regression analysis is used to test the predictions on retail price data from major retailers in Bozeman, Montana. The results suggest that sellers choose between the two pricing methods in a manner that is consistent with the minimization of pre-sale measurement costs.

CHAPTER 1

INTRODUCTION

Goods of differing value often sell for the same price. Common examples of this phenomenon include general admission seating and bins of fresh produce where the individual units vary in size and quality. In both of these examples, valued attributes of the good are left in the public domain, and opportunities for costly wealth transfer are present. Theater goers may benefit by arriving early or waiting in line for the show, and grocery shoppers may spend time sorting through the produce bin for the best buys. As Barzel (1982) has noted, such instances of non-price allocation abound because it is often too costly to price all of the valued margins of a commodity.

At a minimum, pricing requires measurement. In order to charge buyers for higher levels of valued attributes, those attributes must be quantified, and the terms of the exchange must be enforceable. If sellers choose not to price these attributes, buyers might find it beneficial to incur the costs of measurement themselves, thereby finding a bargain at the going price. Measurement of this kind is often distributional in nature, and hence sellers may have an incentive to constrain buyer measurement by pre-sorting the good or by adopting terms of exchange that reduce the buyer's benefits from measurement. Under the assumption of profit maximization, we would expect sellers to adopt such measures

whenever they are less costly than the distributional measurement of buyers (Barzel, 1982).

Despite its intuitive appeal, empirical tests of the importance of measurement cost have been limited. Part of the problem, no doubt, is the difficulty of quantifying variables such as the level of buyer measurement and the degree of variability in product attributes. In this study, I offer a measurement cost explanation for a persistent but odd institution of the retail produce market: the mixed use of per unit and per pound pricing for bulk produce. Major retail sellers typically sell as much as half of their produce on a per unit basis, while the rest is sold by the pound. Comparison of these two methods reveals a classic distinction between priced and unpriced product attributes. While per-pound pricing explicitly prices the size dimension of the produce, per unit pricing (known in the industry as each pricing) is a form of average pricing in which units of differing size and value are sold at a common price. With average pricing, buyers can sort through the offering and pick out the “underpriced” units. Sellers can eliminate this activity by posting a price per-pound, an alternative that presumably is not costless.

Overview of the Problem

A casual glance through any retail produce market reveals that sellers employ numerous methods of sale: radishes and asparagus are sold in bunches; berries are offered in volumes of a pint or quart; some apples are offered in bags of 5 to 10 pounds while others are sold from bulk; cucumbers are sold by count while zucchini are sold by weight. This mixture of pricing schemes appears peculiar within the standard price theory context

of one dimensional, homogeneous, and unalterable commodities. Indeed, the distinction between pricing by count and by weight is only meaningful if commodities vary in size.

The basic problem facing the produce retailer—and the focus of this study—is that of how to offer a heterogeneous product for sale. In particular, given that individual units of produce vary in size, how should the units be priced? One option is to post an average price for the entire offering. There are two potential problems with this. First, depending on the value and variability of the good, buyers may search for the larger, higher valued units, leaving behind only the units that are “too small” at the going price. Second, sellers will eventually have to count the items selected by buyers in order to charge them for their purchases. While counting items may not be a great burden for small purchases of 1 to 4 items, it will quickly become one as the size of the purchase increases. For items like cherries or grapes, the burden is clearly prohibitive.¹

Perhaps the most expedient alternative to average pricing is to sell the goods at a price per pound. This eliminates the problem of buyer sorting over the size dimension, because buyers are now charged for marginal increases in the size of individual units. In essence, the size dimension is explicitly priced. The counting problem is also eliminated with a price per pound, because it is now the weight of the items, not the number, that is needed to calculate the total price of a purchase.

But while pound pricing effectively neutralizes the problems associated with average pricing, it is not a costless alternative. Goods must now be weighed at least once

¹ Presumably it is prohibitive for buyers as well, who will want to have a reasonable idea of how much their purchase will cost them.

prior to sale, and buyers may need to weigh items in order to determine the approximate unit price of the commodity. Hence, measurement of the variable attribute has not been eliminated, but has merely taken a different form. The basic premise of this study is that sellers face a choice between these different sets of measurement costs.

The empirical objective of this research is to determine the extent to which buyer measurement influences the seller's method of pricing. My explanation for the mixture of pricing will combine some standard results from the theory of optimal search with Barzel's (1982) analysis of measurement cost and market institutions. After a brief overview of the literature on search and measurement cost, I develop a framework for predicting changes in the level of buyer measurement and in the relative use of by the each and by the pound pricing. The predictions are tested using produce price data from retail grocers.

CHAPTER 2

LITERATURE REVIEW

Although there is no lineage of work on the subject of produce pricing specifically, the theoretical concepts of optimal search over price and pre-sale measurement of goods have both spawned substantial literatures. Despite their apparent similarities, the concepts of search and measurement have significantly different meanings and implications for behavior. The basic model of search, first developed by Stigler (1961), concerns the search behavior of buyers over a distribution of prices for a perfectly homogeneous good. In contrast, pre-sale measurement refers to the efforts of exchange parties to determine the true qualities of goods that are heterogeneous in quality but equal in price.

The difference turns out to be substantial. Price search is typically understood as a productive activity involving the joint maximization of buyers and sellers. Given positive information costs, there is some optimal level of buyer search and dispersion of prices. In contrast, pre-sale measurement of commodities is often a purely distributive activity, involving the attempts of exchange parties to appropriate a larger share of a fixed quantity of gains from trade. Because resources are used merely to transfer wealth between parties, unconstrained measurement is often associated with the wasteful use of resources. This distributive component of measurement leads to implications about how parties will

organize exchange such that wasteful measurement is minimized. In this chapter, I compare the basic model of search over price with Barzel's model of measurement cost.

Searching Over Price

The theory of buyer search evolved out of Stigler's (1961) insight that information about the market—such as knowledge of asking prices and the identities of buyers and sellers—was a costly and valuable resource. Stigler began with the question of why substantial price distributions seem to persist in competitive markets for homogeneous products. His basic answer was that there are costs in identifying the lower priced sellers, and that these costs prevent buyers from possessing perfect information about the market. At some point, seeking additional price information simply does not earn a large enough return to warrant the investment.

To illustrate this last point, Stigler developed a simple model of optimal search over a distribution of prices for a homogeneous product. Buyers, having prior knowledge of the price distribution, collect a sample of asking prices from which they will choose the minimum. The more sellers a buyer surveys, the lower the expected minimum price. The cost of surveying another seller is constant, and can be thought of either as an opportunity cost or the disutility of engaging in search. At the margin, the value of search is the difference between the minimum price with n surveys and the expected minimum with one more survey. In deciding whether or not to collect an additional observation, the buyer compares the expected additional reduction in price (or expenditures) with the cost of obtaining an additional observation. Using a distribution of minimum order statistics

derived from the standard uniform distribution, Stigler demonstrated that the marginal benefits of search are decreasing in the number of searches, and that an increase in the dispersion of prices increases the marginal benefits of search for any given level of search.²

These two results are clearly illustrated in table 1, which shows an approximation of expected minimum prices and the marginal benefits of search from a normal distribution. The marginal benefits of search are simply the difference between the expected minimum prices for any two levels of search. Between 1 and 2 searches, the marginal benefits of search are $\mu - (\mu - .564\sigma)$, or $.564\sigma$. Notice that an increase in the dispersion of prices (σ) increases the marginal benefits of search for all levels of search.

Stigler recognized that in many cases a sequential search rule would be superior to the fixed sample rule just described, although he left it to others to develop the rule formally. With a sequential search rule, buyers decide whether or not to continue searching after each observation. If the observed price is less than or equal to some reservation price, search ends. This search rule can be written as

$$c \equiv \int_{\xi}^{\infty} (p - \xi) dF(p)$$

where $F(p)$ is the distribution of prices, ξ is the reservation price, and c is the per-unit cost of search (Lippman and McCall, 1976). The right hand side of this identity is simply the expected benefit of inspecting one more unit of produce, and c is the marginal cost of

²Gastwirth (1971) and Rothschild (1974) both provide a more formal discussion of Stigler's results. Telser (1973) conducted simulations which indicate that, for a given cost of search, the net benefits from search increase with the range of the distribution. Telser also provides a proof of the intuitive proposition that a simple shift in the distribution, holding constant the range, has no effect on the optimal search policy.

search. The reservation price is chosen such that the expected benefits of one more observation (given that the reservation price is already in hand) is equal to the cost of one more observation. Hence, the only difference is that in the fixed sample model the buyer is assumed to continue collecting additional observations with no regard for the prices already observed. While for some problems the distinction could be useful, Rothschild (1974) has confirmed that the comparative statics of the two models are essentially the same.³ All else equal, an increase in the dispersion of prices reduces the optimal reservation price and results in increased search.

Just as important as Stigler's discussion of buyer search was his assertion that the level of price dispersion in the market is itself a function of the amount of buyer search. The more search there is in the market, the less likely a high priced seller is to find a willing buyer. To remain competitive, higher priced sellers will have to adjust their prices downward, thus reducing the level of price dispersion. In his paper on information and labor markets, Stigler provided some simple tests of this proposition. Given the consistent empirical relationship between the mean and standard deviation of a random variable, Stigler suggested that the coefficient of variation for wage offers should be lower for groups that have greater benefits of search. Younger engineers, for example, will have a greater incentive to search than older engineers because they will receive the realized wage for a longer period of time. Stigler found that the coefficient of variation was consistently

³Stigler (1986) has commented on the distinction: "A popular strategy, at least with economists, is to continue to search until the expected gain from another search is less than the cost."

less for groups with greater benefits of search, and he interpreted this as an indication of more intensive search by these groups.

Stigler's main predictions, then, are that an increase in the value of a good leads to greater search over price, and that greater search in turn reduces the level of price dispersion. The prediction relating to the value of a good follows from Stigler's assumption that the good is homogeneous. Under this assumption, an increase in the mean price of the good, holding constant the level of search, will tend to result in a proportionate increase in the dispersion of prices; that is, the mean and standard deviation from table 1 will increase proportionately. Given the increase in dispersion, however, the level of search will also increase because a more disperse distribution yields greater benefits from search. Because the realized level of price dispersion is partly determined by the level of search, changes in average price are a better empirical measure of the marginal benefits of search than changes in price dispersion. The simplest test of Stigler's hypothesis would be a regression of the level of search (or some proxy of search) on price.

Measurement With Heterogeneous Goods

As Stigler (1986) has carefully noted, in most cases the quality of the good will be an important consideration, perhaps much more important than price. Quality heterogeneity marks the starting point for Barzel's (1982) analysis of measurement cost. In contrast to the model of search over a distribution of prices, Barzel begins with a single good that varies in some dimension of quality but not in price. Units of differing value sell at a common price, and hence the relevant dispersion is now in the good itself rather than

the asking prices of sellers. Measurement becomes a problem because buyers will have an incentive to measure more units than they intend to purchase in an effort to find units that are "underpriced".

Although Barzel did not discuss formal search rules, his predictions regarding pre-sale measurement seem to follow directly from the basic fixed sample search model. Barzel suggests that a buyer will evaluate the price and variance of an offering and then determine the fraction of the distribution from which he will choose. For example, at a given value variance the buyer may decide to purchase only from the top half of the distribution, implying that on average two units will be inspected for every unit purchased. If the variance were to increase, Barzel suggests that the buyer would choose from a smaller fraction of the distribution, and a higher expected level of per-unit search would result.

Barzel's major proposition, however, was not about measurement behavior per se, but rather the implications of measurement for the organization of transactions. In particular, Barzel argues that when measurement is primarily distributive in nature, it will often be in the seller's interest to impose constraints on (or reduce the incentives for) buyer measurement. The emphasis on distributional measurement is critical. Measurement is distributional when it serves no valuable allocative function, but rather reallocates pre-existing wealth. Because this reallocation uses resources, distributional measurement is typically associated with waste.

As Kenny and Klein (1983) have noted, measurement is only distributional when buyers have equal valuations of the variable attribute. If buyers have different preferences

for the variable attribute, then measurement is necessary to match particular units with the buyers that value them the most. Kenny and Klein provide an example of this distinction from the diamond market. For standard sized, uncut diamonds, wholesale buyers typically have close to equal valuations of individual stones because the cost of processing the stones is roughly equal across buyers. In this case, search will be wasteful because it results purely in a transfer of wealth between the buyer and the seller. In contrast, for abnormally large stones, certain buyers will be better equipped to do the cutting and marketing, and hence some measurement is required to match the stone to the highest bidder. Even though multiple buyers will measure the same stones, this measurement may increase the value of the diamonds by allocating them to the highest valuing users.

A key question posed by Barzel is that of who will do the pre-sale measurement, the buyer or the seller. By way of answering, he used a simple sorting model involving a bin of oranges where the quantity of juice in each orange varies and is subject to measurement error. Barzel argued that if the unit search costs of buyers and sellers were equal and constant, sellers would sort the distributions just finely enough to dissuade any buyer measurement.⁴ The reasoning is simple: when sellers sort, each orange is measured exactly once; when buyers sort, each orange is measured at least once. Each buyer will on average examine more units than he intends to purchase, and hence individual oranges will be measured repetitively. The total cost of measurement will be lowest when sellers do all of the sorting. This suggests that the seller's level of sorting is determined by the buyer's

⁴ If the marginal costs of search are increasing, then it will be optimal for both buyers and seller to do some sorting.

incentive to measure. If the buyer's cost of measurement falls, or if the benefits of measurement increase, sellers will sort their distributions more finely.

The main assumption behind these results is that the buyer's unit cost of measurement is not lower than the seller's. Because buyer search is duplicative, this ensures that the seller's total cost of sorting will always be lowest when he does the sorting. While this assumption is reasonable for single attribute goods, it is less likely to hold for commodities that vary across several dimensions. For example, consider a good that varies in two attributes. If the per-unit levels of these attributes are not highly correlated, sorting the commodity into relatively homogeneous grades is likely to be prohibitively costly.⁵ If instead they are sorted by only one of the attributes, then buyers can still benefit from searching over the unmeasured attribute, and again sorting will be duplicative. In these cases, or in the analogous case where buyers have highly heterogeneous preferences concerning the desired combination of the two attributes, it may be optimal for buyers to do all of the sorting.

To summarize, the standard search model suggests that the marginal benefits of search are a function of the dispersion of prices. This makes good intuitive sense, because at the margin it is the reduction in price resulting from additional search that counts. Although the search model is based on the stringent assumption of homogeneous quality, the logic of search over a heterogeneous but commonly priced good is essentially the same. Barzel, beginning with some basic assumptions about search behavior, examined

⁵ In the extreme case, each unit would constitute a separate grade.

the consequences of measurement over such heterogeneous goods, arguing that under certain conditions sellers would have an incentive to constrain measurement.

In the remainder of this paper, I use the search and measurement frameworks to relate the level of pre-sale measurement to the seller's method of pricing. The process is twofold: first, I employ a variant of the basic search model to develop predictions for changes in the optimal level of search over a heterogeneous but commonly priced good; then, I discuss how the costs of buyer measurement inform the seller's decision to price by the pound or by the each.

CHAPTER 3

MEASUREMENT COSTS AND CONSTRAINTS

In his analysis of measurement cost, Barzel (1982) reaches two fundamental conclusions. First, measurement will tend to be done by the party with the lowest cost. For example, because the true value of a new car is most easily determined after being driven for some time, car sellers can benefit if the buyer of the car is responsible for conducting quality measurement *ex post*. However, if car sellers are to realize these benefits, they will need to insure buyers from unexpected losses due to choosing a below average car. In the absence of such a guarantee, buyers would have an incentive to engage in costly *ex ante* measurement of the seller's offering. Sellers would have to lower their price to account for the buyer's cost of pre-sale inspection and the expected cost of future repairs. Barzel's second point, then, is that the terms of the exchange will be arranged in a manner that minimizes the costs of pre-sale distributional measurement. In this example, the seller incurs the added cost of providing a guarantee in order to eliminate the more costly alternative of excessive *ex ante* measurement.⁶

⁶ Kenny and Klein's analysis of DeBeers' diamond marketing is similar. They argue that DeBeers' buyers are offered a stream of rents in exchange for their agreement to select diamond sights with large variances in value at random.

A crucial component of Barzel's argument is that the seller bears a portion of the costs of buyer measurement. These costs generally provide the seller with an incentive to constrain the measurement activity of buyers. Because constraints cannot be costlessly imposed, the seller faces a tradeoff between the costs of various forms of constraint. In this section, I first examine the nature of distributional measurement over size in the sale of bulk produce. I then examine the nature of the seller's pricing problem and discuss the various measurement constraints available to him. Finally, I develop predictions concerning the seller's decision to post an average price (and bear the costs of buyer measurement) or to constrain buyer measurement by posting a price per pound.⁷

Determinants of Buyer Measurement

Although Stigler (1961) dealt explicitly with search over price for a homogeneous product, his basic approach can be extended to the analysis of optimal search over heterogeneous but equally priced goods. Consider Barzel's bin of oranges again, but now suppose that oranges only vary in the size of individual units. The quality of juice and the amount of juice per unit of weight is constant, and hence larger (and heavier) oranges are valued more than smaller oranges. Assume further that large and small units, when adjusted for price, are perfect substitutes (that is, buyers do not have an intrinsic preference for larger or smaller units). We want to identify the characteristics of the orange distribution that determine the buyer's optimal search behavior. Let the price per-

⁷ Pricing by the pound eliminates the *incentive* for buyers to search over size. Throughout the paper I refer to this as "constraining measurement."

pound of oranges be \$1.00, the mean weight of an orange be 1 pound, and the standard deviation of the orange weights be .25 pounds. The expected price of a randomly drawn orange is \$1.00, and the standard deviation of prices drawn is 25 cents. Note that under these assumptions the oranges are equivalent to a perfectly homogeneous good, and buyers will select at random from the offering.

Suppose now that the seller posts an average price (a price per each) that is based on the weight of the average orange (i.e., $P_{ea} = P_{lb} \cdot \mu$, where P_{ea} is the each price, P_{lb} is the price per pound, and μ is the weight of the average orange). Now the price of *any* orange drawn will be \$1.00. At a dollar per orange, however, some oranges are better deals than others, because size is now a partially unpriced attribute.⁸ The 25 cent standard deviation from above is analogous to the dispersion of prices in Stigler's model; that is, it represents the degree to which buyers can benefit by searching as opposed to drawing randomly. Define this as the value dispersion. If the commodity becomes more expensive, the value dispersion will be greater; if the commodity becomes more variable in size, the value dispersion will be greater.

As in Stigler's model, the buyer's search decision is made at the margin. The buyer compares the marginal benefit of inspecting one more orange with the cost of another inspection. Unlike in Stigler's model, the good here is heterogeneous, and the marginal benefits of search will depend on two factors: 1) the dispersion of the variable

⁸Size is partially unpriced in the sense that, while on average the units are priced according to their size, the variability in size is unpriced.

attribute (the sizes of the oranges); and 2) the value of the variable attribute (the price per pound). The marginal benefit of search can be defined as

$$MB_{\text{search}} = P_{\text{lb}} \cdot E[w'(n)]$$

where $E[w'(n)]$ is the change in the expected maximum weight that results from inspecting one more orange (and $E[w''] < 0$).⁹ This expression can be thought of simply as the marginal value product of search: additional search increases the expected size (weight) of a unit (at a decreasing rate), and the value of an added pound of size is P_{lb} .

Two predictions for the level of buyer measurement follow from this discussion. The first is simple enough: an increase in the price per pound increases the marginal benefits of search and the per-unit intensity of search. The second prediction concerns the behavior of $E[w'(n)]$ given a change in the size dispersion of the good. Recall from the discussion in Chapter 2 that if the standard deviation of a random variable is increased, the difference between any two order statistics will increase for all levels of search. Hence, an increase in the size dispersion of the good increases $E[w'(n)]$ in equation 1, and the buyer's per-unit level of search will be more intense.

Rothschild (1976) has examined the effect of an increase in dispersion on search intensity in a more general context. Nevertheless, he notes that the more common practice is to demonstrate this effect for particular parametric families of distributions. Consider, for example, a rectangular distribution of the form $f(w) = 1/(a-b)$ where b is fixed at 0.

⁹ This marginal benefit expression results from the objective function, $\text{Max } NB_s = [P_{\text{lb}} \cdot E[w(n)] - P_{\text{ea}}] - c \cdot n$, where P_{ea} is the posted average price, c is the constant unit cost of search, and $P_{\text{lb}} \cdot E[w(n)]$ is a measure of the value to the buyer of the unit selected.

The distribution of expected maximum weights for this density function is $[1 - 1/(n+1)]a$, and the change in the expected maximum with respect to n is $a/(n+1)^2$, which is clearly decreasing in n but increasing in the parameter a . Hence, for any level of n , an increase in the variance of the underlying distribution (that is, an increase in a) results in an increase $E[w'(n)]$.

Distributional Measurement

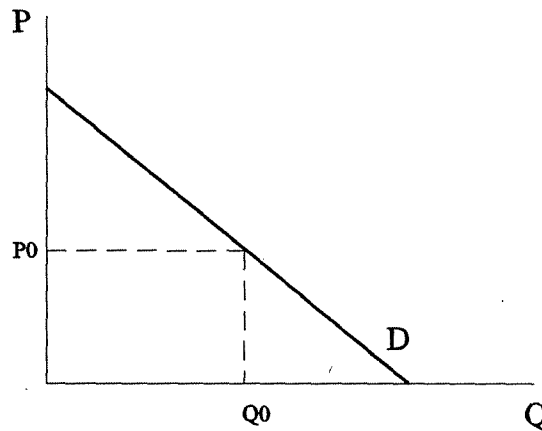
The previous discussion has demonstrated how buyers may benefit from measurement when heterogeneous goods are average priced. The next question to address is, who bears the cost of this measurement? The question is of course central to the basic prediction that sellers have an incentive to constrain buyer measurement. It is not enough simply to demonstrate that buyers measure for their own gain; it must also be demonstrated that sellers bear a portion of these measurement costs.

In this section, I will suggest three ways that sellers bear the costs of buyer measurement. First, assuming that buyers place equal value on increases in size, sorting efforts will merely redistribute wealth between buyers. Second, given a sufficiently heterogeneous good, average cost pricing will result in an adverse selection problem for the seller. Buyers will tend to skim off the underpriced units, leaving the seller with only the units that could not sell at the average price (Kenny and Klein, 1983). Because produce is highly perishable, adverse selection may be a problem even when consumers have substantially heterogeneous search costs. Smaller units that are repeatedly passed over are likely to deteriorate and become waste. Finally, intensive buyer measurement

increases the rate of product decay and damages the produce. All produce is subject to natural decay from water loss and ripening, but excessive handling exacerbates the problem, and sellers generally attempt to minimize the number of times the goods are handled prior to purchase.¹⁰

A simple supply and demand example illustrates the essence of the distributional measurement problem. Consider the demand for oranges in Figure 1. Assume that all buyers have the same demand for oranges and let D be the summation of the individual demand curves. Furthermore, assume that buyers have equal valuations on quality constant increases in size. Under the simple case where the oranges are perfectly homogeneous, the total value of the oranges is the area underneath D from 0 to Q_0 .

Figure 1. Demand for Oranges



¹⁰ Obviously, the degree to which this deterioration (known as “shrink” in the industry) is important varies across commodities. It is of greatest concern with the soft fruits (e.g., peaches, berries), but most items are at least somewhat susceptible to damage from handling.

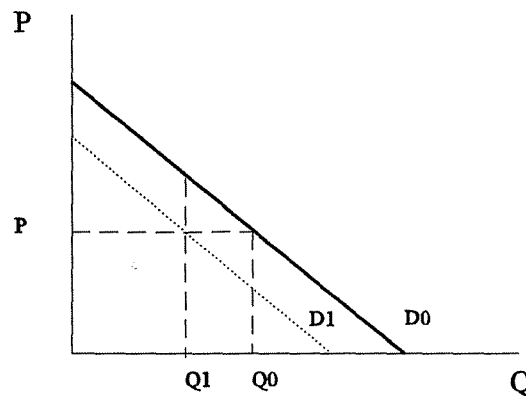
Now, let the oranges vary in size such that the average orange is the same size, but some are smaller and some are larger. Furthermore, assume that buyers are not allowed to search; instead, they pay for the desired number of oranges and then draw them randomly out of the bin. The expected size of an orange is unchanged, and if buyers are risk neutral, then nothing in Figure 1 will have changed. Relative to the case where oranges were homogeneous, some buyers get a good deal and others get a bad deal. But the total value of the oranges has not changed because their value is independent of the allocation between buyers.

If instead buyers are allowed to search through the bin for the larger oranges, the total value of the oranges will be diminished. Suppose that the search costs of individual buyers range from low to prohibitively high, so that given enough time all of the oranges in the bin will sell. Again, some buyers get good deals while others do not. The only difference is that now some buyers are expending resources to acquire the good deals. Because the value of the oranges is no different than when the allocation was purely random, the net effect is a dissipation. Measurement simply redistributes the value represented by the triangle of consumer surplus.

Finally, suppose that some of the oranges in the bin are small enough that no buyer would wilfully purchase them. That is, purchase of these smaller oranges would actually yield negative surplus at the going price per each. Also, allow the oranges to be prone to normal deterioration. In this case, the oranges that are repeatedly passed over for the larger ones will be more prone to become waste. Both of these scenarios are equivalent to the adverse selection problem discussed in Kenny and Klein (1983). In figure 2 this is

represented by the inward shift of the demand curve. The seller's revenues are lower by the amount of the rectangle formed between Q_1 and Q_0 . From the seller's perspective, damage to the produce due to excessive buyer measurement would have the same effect.

Figure 2. Change in Demand with Adverse Selection



To summarize, measurement over size alters the distribution of wealth among buyers and between buyers and sellers. Because the resources employed in measurement do nothing to increase the value of the goods, sellers generally have an incentive to constrain this measurement provided that imposing the constraint is not too costly.

Costs Of Search When Other Attributes Are Variable

The discussion has progressed so far under the assumption that size is the only attribute that varies across units. Of course, the quality of individual produce units may also vary a great deal. Bins of avocados, for example, although rather homogeneous in size, can be quite diverse in the degree of ripeness of individual avocados. How does this

extra degree of heterogeneity affect the seller's incentive to constrain measurement over the size dimension?¹¹

Barzel (1982) suggested that when products vary in several dimensions of quality, sellers will be more likely to allow buyers to do all of the sorting. His reasoning was that when goods vary in a number of dimensions, the seller will tend to find it prohibitively costly to sort the good exhaustively (i.e., to the point where buyers derive no benefit from sorting). If the seller sorts over only some of the dimensions, buyers will still find it beneficial to choose units according to the unsorted (and unpriced) dimensions. Sorting will then be duplicative both across buyers and between buyer and seller.

A key assumption of Barzel's argument is that if a buyer inspects a unit for a particular attribute, other attributes can also be examined at no (or very little) additional cost (the buyer's average cost of inspecting attributes is decreasing in the number of attributes inspected). For example, imagine a good with two attributes, A and B. Suppose that the seller sorts A into various classes such that buyers derive no benefit from sorting over A, but leaves B unsorted. The good is now priced explicitly according to attribute A, but average priced with respect to attribute B. Buyers choose from the various classes of A, but they still benefit from sorting over attribute B. The total sorting costs will be the seller's costs of sorting over A, plus the sum of individual buyer search costs over B. Supposing that buyers could have sorted over both A and B at the same

¹¹ I continue to assume that buyers have uniform preferences for quality. As noted earlier, if buyers have sufficiently heterogenous preferences, or if they employ different proxies for quality, some search will be necessary to match units with the highest valuing buyers.

cost of sorting over only B, then total sorting costs will be minimized if buyers do all of the sorting.

So, the greater the number of quality dimensions, the less likely the seller is to constrain measurement over any one dimension. But what about the effect of a change in the dispersion of a quality dimension? In particular, suppose that a good varies in both size and quality, and that we want to know the effect of an increase in quality dispersion on the seller's incentive to constrain measurement over size. The preceding discussion seems to suggest that as the intensity of search over quality increases relative to the intensity of search over size, sellers will have less incentive to constrain search over the size dimension. However, we do not generally know how *changes* in quality dispersion will interact with the optimal level of search over size. Because search over various dimensions is jointly produced, we cannot really think about simple increases in search over quality holding constant search over size. The basic search predictions discussed in Chapter 2 pertain only to search over one variable, and it is not immediately clear how the addition of a second variable dimension will affect the optimal search behavior.

The Seller's Problem

When goods are heterogeneous, the seller's maximization problem is no longer simply one of choosing the optimal level of output, because any single posted price will differ from the market clearing prices of individual units (Kenny and Klein). The seller faces a choice between selling goods at an average price (and bearing the subsequent costs of buyer measurement), or employing an alternative sales arrangement that constrains (or

reduces the incentives for) buyer measurement of the variable attribute. In this section, I examine 3 possible alternatives to average pricing of produce commodities that are heterogeneous in size. These are: 1) sorting the produce into size grades; 2) bunching or pre bagging produce; 3) pricing the size dimension explicitly by posting a price per pound. The sum of the discussion is that, in today's supermarket, the first 2 alternatives are used primarily for reasons other than reducing buyer search over size. Hence, it appears that the seller's problem can be characterized as a simple choice between average pricing and pricing by the pound.

Sorting and Grading By Size

As in Barzel's simple sorting model, one solution to the measurement problem is for sellers to sort their commodities into various grades such that buyers will not benefit from measurement. Although retailers today do not directly sort over size, commodities are graded to various degrees at the grower and distributional levels. Some commodities are graded quite precisely. For example, top grade apples and bell peppers are packed and sold to retailers by count; units are so homogeneous that, for a particular size grade, boxes containing the same number of units will be virtually identical in weight.¹² In contrast, melons typically contain enough variation in size after grading that they are sold from growers to distributors by weight.¹³ Other items, such as cucumbers or zucchini, are sold

¹² USDA grading standards for apples specify that when quantity is designated by the numerical count for a container, not more than 5 percent of the apples in the lot may vary more than 1/4 inch in diameter from the specified size.

¹³ At the wholesale distributor that I visited in Los Angeles, melons were re-packed in boxes by count for sale to the retail level.

explicitly by weight but with an approximate count per box (e.g., 20 lbs., 50-60 units).

Hence, the level of size grading differs substantially across commodities. To some degree, the characteristics of the produce will determine the degree of grading that is economical.

All else equal, larger items will naturally be more resistant to precise size grading.

Despite this often extensive size grading, grading does not appear to be a complete solution to the seller's problem.¹⁴ Apples are sold by the pound even after extensive size grading. Other commodities that tend to be well graded, such as red, yellow, and orange bell peppers, are sold by the pound almost as often as they are by the each. Indeed, size grading may primarily be a response to packing and shipping needs. Well graded items can easily be shipped in protective trays designed to hold a particular size grade.

Additionally, size grading allows for greater contractual specificity and is likely to reduce the costs of measuring the quantities actually exchanged.

¹⁴ An interesting question is whether more valuable items tend to be graded more precisely. A simple regression of the observed weight standard deviation at the retail level on mean weight and price per-pound suggests that for items with the same mean weight, higher priced items are slightly more homogeneous (p values are in parentheses):

$$\ln(\text{WEIGHT DEVIATION}) = -2.14 + 0.85 \ln(\text{MEAN WEIGHT}) - 0.13 \ln(\text{PRICE})$$

(0.02) (0.03)

(The data used for this regression are discussed in Chapter 5). If sellers did not have access to low cost weighing technology, it might be expected that the negative effect of PRICE on WEIGHT DEVIATION would be greater.

Bundling: Bunching and Pre Bagging

Bundling has frequently been advanced as a means of constraining pre-sale measurement opportunities.¹⁵ In this sense, bundling is viewed as an alternative to sorting and grading of individual units of a product. Rather than allowing buyers to pick from an unsorted offering, sellers offer units of the good in all or nothing bunches. Barzel (1977, 1982), and later Kenny and Klein (1983), have argued that this was the primary purpose of the DeBeer's diamond marketing arrangement. Kenny and Klein also argued that the practice of block booking films was a form of bundling that alleviated ex post opportunism and adverse selection.¹⁶

Although the great majority of produce is sold from bulk today, bundling does exist in 2 primary forms: first, items such as radishes, green onions, and beets are sold in bunches; second, a number of goods (e.g., apples, onions, potatoes, oranges, etc.) are offered in pre-weighed bags *in addition to the bulk offerings*. Although these forms of bundling appear to serve the dual purpose of constraining search over *quality* and eliminating the need for pre sale weighing, they do not provide the best solution to the problem of size variability. I will address these two forms of bundling in turn.

The practice of bundling certain commodities into "bunches" has existed since at least the late 1800s. At that time, scales were crude and quite costly to employ. It is

¹⁵ Bundling can also be a form of price discrimination. Sellers may bundle goods in order to exploit differences in buyers' willingness to pay for different goods.

¹⁶ For an alternative view on the purpose of block booking, see Hanssen (1999).

conceivable that bunching some commodities was a convenient way to avoid the costs of selling by weight. Items that were purchased in quantities large enough to make counting individual units infeasible — such as radishes or green onions — could simply be sold by the bunch.¹⁷ To avoid excessive sorting over the average sized bunches, sellers could presumably control the size variability of the bunches.

Bundling also serves as a means of protecting commodities from excessive handling and other kinds of damage. For example, bunching of commodities such as asparagus and green onions reduces potential damage to the fragile stems. Berries, a particularly fragile type of commodity, are typically sold pre packaged by the quart or pint. Although strawberries are occasionally sold from bulk at the peak of summer, it is far more common for them to be offered pre packed in dry measures. Other berries, such as blueberries and raspberries, are always sold pre packaged in closed containers.¹⁸

The second type of bundling involves pre weighing and bagging of bulky dry commodities such as apples. There are a number of explanations for the existence of this practice. Perhaps most obviously, bagged items provide an easy way for buyers to purchase in quantity.¹⁹ In some cases these large purchases will be accompanied by a bulk

¹⁷ Bunching of leafy commodities (e.g., radishes, green-top carrots) also reduces mess.

¹⁸ Tomatoes are another commodity often packaged in trays or boxes of 4 or more. Given the higher price and fragility of hot-house and hydroponically grown tomatoes, it is not surprising that these tend to be pre-wrapped more often than vine ripened tomatoes.

¹⁹ To purchase 10 pounds of potatoes, a buyer would have to fill at least 3 separate bags full of potatoes. Clearly, a sturdy pre weighed bag of potatoes saves the buyer a non trivial amount of time.

discount. For example, Albertson's offers a "grab bag" of apples where buyers get a dollar off the price of the bag. The bags, which are not pre weighed, typically contain around 6 or 8 pounds of the *same apples* that are sold from bulk.²⁰ Albertson's brand name is apparently enough to convince buyers that they are receiving a random selection of apples.

With the exception of the Albertson's grab bag, however, most pre bagged commodities do not appear to be from the same distribution as the goods being sold from bulk. This suggests a second explanation for pre bagging: by purchasing a bagged selection, buyers forgo the opportunity to inspect individual units for quality. Given that buyers are not able to "cherry pick" the higher quality units, it might be expected that the produce offered in bags will on average be of a higher quality variance than produce offered from bulk. Casual inspection suggests that this tends to be the case. Although both bagged and bulk items are typically of the same USDA quality grade, these grade categories are broad enough to allow for substantial variation in the quality variance of distinct offerings of the same grade.

Pricing By the Pound

The sum of the discussion so far suggests that sorting and bundling, at least in current practice, are primarily employed for purposes of product protection and easy sale

²⁰ Note that if the bags were all the same price, Albertson's would have a potential problem with buyers adding apples to the open-topped bags. On the east coast, where heads of broccoli have typically been bunched with rubber bands and sold by the bunch, buyers have been caught adding additional heads to their bunch. A manager from a store in Maryland suggested that the persistence of this problem has led many sellers on the east coast to begin pricing broccoli by the pound.

of large quantities rather than as alternatives to average pricing of bulk produce. The fact that bunched and bagged commodities continue to exist side by side with the sale of bulk goods is perhaps the strongest indication that bundling is not directed at this end. Hence, the seller's problem can be framed as a simple choice between selling bulk goods at an average price and allowing buyers to sort over size, or pricing the size dimension with a price per pound.

Given the expediency of modern weighing and check-stand equipment, it is not surprising that pricing by the pound provides the primary alternative to average pricing. Indeed, given the low marginal cost of weighing and the fixed nature of the investments in weighing technology, it is perhaps surprising that sellers continue to offer any produce at a price per each. But pricing by the pound is not, of course, a costless alternative to average pricing, because commodities must be weighed at least once prior to sale. Produce managers generally contend that by the each pricing is preferred from a marketing perspective because it allows consumers to know the unit price of the good without having to weigh it. This view is consistent with the notions that a price per-pound does not always convey instantaneous price information, and that the buyer's cost of weighing produce is not trivial.²¹

Consider again the fundamental differences between each and pound pricing. First, while each pricing leaves a portion of the commodity's size dimension unpriced, pound pricing explicitly prices the size dimension, thereby eliminating distributional measurement

²¹ This argument is less satisfying for frequently purchased commodities with relatively stable prices, because buyers may not need to weigh the produce to form a reasonable estimate of the unit price.

over size. Hence, as the incentive for buyers to search over size increases, by the each pricing will become more costly relative to pound pricing due to the increase in measurement costs. Second, pricing by the each requires that items be counted prior to sale, and the cost of measuring the transaction at the check stand increases with the number of units purchased by the average buyer (because counting takes longer and is more prone to error). In contrast, the cost of weighing commodities will not vary with the number of units purchased over the relevant range of purchase sizes.²²

These differences suggest two clear predictions for changes in the relative costs of each pricing and pound pricing. First, as buyer measurement over size increases, each pricing becomes more costly relative to pound pricing. Second, as the number of units purchased by the average buyer increases, each pricing becomes more costly relative to pound pricing.

Predictions

The main purpose of the empirical analysis presented in Chapter 6 is to determine whether the level of buyer measurement over size can be used to explain the seller's decision to post a price per each or a price per pound. This requires making a connection between the parameters that determine the level of buyer measurement — the price per pound and the weight dispersion of the commodity — and the seller's method of pricing.

²² Weighing costs, however, may vary with the average weight of the item being purchased. For example, it is easier to weigh an eggplant than a watermelon.

The foregoing discussion yields 5 predictions concerning changes in the level of buyer measurement:

i. An increase in the value (price per-pound) of a produce commodity, all else equal, increases the optimal level of buyer measurement and the likelihood that the seller will constrain measurement by posting a price per-pound.

ii. An increase in the size dispersion of a produce commodity, all else equal, increases the optimal level of buyer measurement and the likelihood that the seller will constrain measurement by posting a price per-pound.

iii. Items that can be dismembered prior to purchase (e.g., leaf lettuce, artichokes) are more likely to be priced by the each, all else equal. Pricing by the each eliminates any gain from dismembering inedible or undesirable parts of the commodity before purchase.²³

iv. Decorative and inedible items (e.g., gourds, ornamental pumpkins) are more likely to be priced by the each, all else constant. Because the items are decorative, buyers are expected to have heterogenous valuations on size, and hence buyer measurement will not be distributional. To the extent that size is not valued per se, it is even possible that pricing by the pound could result in a kind of adverse selection where the smaller (but equally attractive) units are skimmed off first.

vi. Commodities with a higher average purchase size, holding constant the level of measurement, are less likely to be priced by the each due to the increased cost of counting the good before sale.

²³ There are clearly other alternatives, such as wrapping or bundling the item and selling it by the pound.

CHAPTER 4

THE EVOLUTION OF PRICING PRACTICES

A basic premise of this study is that the seller faces a tradeoff between the costs of weighing produce prior to sale and the costs of allowing consumers to choose from an offering that is average priced. As indicated earlier, current scale and check-stand technology have rendered the physical costs of weighing largely trivial. In the past, however, weighing technologies could not be employed at such low cost. Hence, it is of interest to this study to examine some of the alternative methods of sale employed by produce sellers over time. A general prediction is that the higher costs of weighing in the past would have resulted in less use of pound pricing relative to today.

Early Pricing and the Dry Measure

At the turn of the 19th century, the employment of scales for weighing produce was a cumbersome and costly ordeal, so much so that they do not appear to have been regularly employed by sellers until the early 1900s. Before that, sellers typically employed volumetric dry measures to measure the quantities of bulky produce commodities.²⁴ By

²⁴ The system of dry measures is based on the bushel unit, which breaks down into half bushels, pecks, half pecks, quarts and pints. The bushel unit was first defined in England as a means of linking volume and weight. (Report of the 19th National Conference on Weights and Measures, pg. 61)

the early 1920s, dry measures were still being used as an alternative to sale by weight for some commodities.²⁵ For example, it was common practice to sell potatoes, apples, onions, and other similarly bulky commodities by the peck, half peck, and quart measures. Interestingly, this was not true in the Rocky Mountain or Pacific Coast States, where most commodities had always been sold either by net weight or by count.²⁶

Dry measures were certainly a convenient way to sell bulky dry goods. In the 18th and 19th centuries, dry measures were used almost exclusively as an alternative to employing costly and inconvenient scales.²⁷ In the early 1900s, most states attempted to standardize the use of dry measures by enacting standard bushel basket specifications and statutory “bushel weights” for individual commodities. For example, in Illinois the statutory weight for a peck of apples was 11 and 3/4 pounds. This seemed to work for a while, but the system of bushel weights was complex and confusing, and it was difficult to set an accurate statutory weight for each type of produce. The weight of a bushel for a specific commodity could vary greatly depending on factors such as the time of harvest, the time elapsed since packing, or transportation conditions. Hence, it is not surprising that the statutory weights often differed from what was actually being traded. Inspectors in Chicago found that the average weight of a peck of potatoes was 12.5 pounds, while

²⁵ Department of Commerce, Bureau of Standards, “Buying Commodities By Weight Or Measure,” Miscellaneous publication No. 45, 1920, pg. 23.

²⁶ *Ibid.*, pg. 24. Even today, there seems to be a split between western and eastern markets — pricing by the each is slightly more prevalent in mid-western, southern, and east coast states. I spoke with some managers who referred to the West as a “per-pound market”, and the East as a “by the each market.”

²⁷ Report of the 19th National Conference on Weights and Measures, pg. 61.

the statutory weight was 15 pounds.²⁸ They tended to view these discrepancies as an indication of widespread fraud, a view that ignores the role of repeat dealings and the possibility that the market determined “price per peck” was simply based on 12.5 rather than 15 pounds.

This is not to say that dry measures did not offer numerous possibilities for fraud. Since the inception of the National Conferences on Weights and Measures in 1905, Weights and Measures (W&M) officials had been concerned with these potential problems, and in 1920 the Conference published a handbook titled “Buying Commodities by Weight or Measure.”²⁹ Its purpose was to inform consumers of the legal standards in

²⁸ The variance of peck weights would seem to be of relevance here, but regulators made no mention of it.

²⁹ The National Conferences are organized by the Bureau of Standards. These yearly meetings bring state level Weights and Measures officials and industry representatives together to discuss the standardization of sales practices relating to weights and measures. Although the Conference can only adopt guidelines for standardization at the state level, it often seeks the implementation of federally mandated standards through Congressional legislation.

use, and to alert them to some of the more prevalent methods of fraud by sellers.³⁰

Nevertheless, despite the perception of extensive fraud, much of the evidence suggests that it was largely contained to street peddlers and other kinds of transient sellers.³¹

Despite their piecemeal efforts to standardize the dry measure system, W&M officials had never looked favorably on the use of dry measures for bulky items because of the inconsistent measurements that could result. An official from Illinois summed up the standard complaint: “No two pecks of potatoes or apples are of the same shapes or are heaped in the same manner, nor do they weigh alike.” Indeed, the quantities held by dry measures are particularly sensitive to the method of packing as well as the shape of the container.³² By the 1920s, movements had developed within some states to pass

³⁰ At the national conference in 1922, an official from Illinois highlighted some of the more common means of fraud:

“We cited instances of dry measures found in use where the bottoms had been taken out and cut off around the circumference, shortening the diameter, and the sides of the measure lapped, making them 2 quarts short in capacity. We cited cases where measures had been cut off at the top, making them too shallow; other cases where extra bottoms had been put in the insides of the measures; other measures that had two inches of mud packed down on the bottom; also that we had found peddlers with one row of potatoes wedged tightly in the bottom so that they remained there after each sale. We also demonstrated with the peck measure and potatoes how a measure could be stacked by laying potatoes crosswise in the inside of the measure and putting an honest heap on the top; a shake of the measure would cause the potatoes to fall down to the level of the top of the measure.”

Another popular scam was to employ a seemingly standard sized basket with a smaller basket woven inside.

³¹ In paper after paper at the National Conferences, W&M officials provide examples of fraud by street peddlers. I did not find one instance of a store owner accused of using fraudulent measures.

³² This is because proper packing of dry measure containers involves “heaping” the commodity in a mound above the brim of the container. Containers with smaller

mandatory sale by weight laws, thus eliminating the dry measure as a legal method of sale for bulky dry goods.³³ Illinois was one of the first states to pass such a measure. The “Instructions to Merchants” issued by the state W&M department noted that the dry measure was no longer a legal method of sale; only sales by weight or count were permissible. In a peculiar distinction, the instructions provided an exemption for items such as cabbage, celery, beets, carrots, and vegetable roots, “which by common custom have been sold by head or bunch and may still be sold in this manner.”³⁴

The emergence of sale by weight laws in New Jersey provides an interesting case. As early as 1918, the state had passed a kind of de facto sale by weight law which specified that when dry measure units were used, sellers had to represent the specific weight for each commodity in quantities of the bushel and its subdivisions.³⁵ Upon adoption of the law, a number of the chain-store merchants switched to selling by weight outright, perhaps anticipating the ultimate elimination of the dry measure. More interesting, however, was the fact that most consumers and smaller merchants simply

diameters allow for less “heaping,” and subsequently yield quantities that are less than those measured by a standard bushel container. Accordingly, bushel containers have been standardized according to the diameter of their brim.

³³ Sale by weight laws were designed simply to eliminate the use of the dry measure, not to require all goods to be sold exclusively by weight. As one official noted, an essential feature of any sale by weight law was a provision that allowed goods to be sold by count as well as weight. (Report of the 17th National Conference, 1924)

³⁴ Report of the 19th National Conference on Weights and Measures, pg. 60.

³⁵ It appears that compliance may have been as simple as posting a sheet of statutory bushel weights for each commodity offered. Weights and Measures appears to have been trying to nudge the public in the direction of requesting that their purchases be measured in units of weight rather than by dry measure.

ignored the new requirements. Officials were perplexed by the apparent apathy of the general public, who continued to order goods by dry measure with no regard for the statutory weight equivalents.³⁶ In response, W&M simply eliminated the dry measure altogether in 1922. By 1924, an official from New Jersey reported that, "The weight method of sale is already being put into effect . . . and in their advertisements the chain stores have eliminated all reference to dry measure and are listing the dry commodities which they offer for sale on the pound or numerical-count basis."³⁷

Despite the appearance that W&M regulations precipitated the move towards the elimination of the dry measure, there is some evidence to suggest that the industry was already heading in that direction. An official from Indiana, speaking in 1926, argued that statutory bushel weights and other sale by weight laws were largely superfluous given that most sellers had already adopted sale by weight on their own:

"The bulk of vegetables and fruits are sold to the consumer in small quantities over the retailers counter. Such sales are universally made by weight throughout the

³⁶ Weight and Measures had a terrible time trying to enforce the law. This statement by a New Jersey official is indicative of their frustration:

"The purchasing public were continuing in the same rut . . . so we just decided to take away the dry measure all together and force the issue. It is characteristic of the public that it must be protected against itself. People, it seems, only take a passing interest in matters that are likely to entail an exercise of their mental faculties . . . It is therefore only by compelling people to take some interest in their economic welfare that any advancement can be made."

The responses of many judges were even more perplexing to W&M officials. In one case, when Illinois officials charged a peddler with selling potatoes by dry measure, the judge responded that the ordinance was a "darn-fool ordinance passed by a lot of darn-fool aldermen. He said that a peck measure had been a peck measure for 40 years and that people were used to it and could tell what they were getting."

³⁷ Report of the 17th National Conference on Weights and Measures, pp 38-40.

state. The dry measure has long been eliminated as a retail method of selling fruits and vegetables.”³⁸

He goes on to state that there were still potential problems with the street peddlers, who were reluctant to purchase scales and sell by weight.³⁹ Although Miller was referring explicitly to produce sales in Indiana, the trend toward replacing the dry measure with sales by weight appears to have been much broader. Two years later, at the 1928 Conference, the Southern Division President of the Atlantic & Pacific Tea Company (A&P) suggested that dry measures were becoming a thing of the past:

“Weights in the sale of groceries are displacing the use of measures as an indicator of quantity; and the sale of commodities in sealed packages, packed in small units in quantities by machinery, has simplified distribution, eliminated waste, protected the product, and saved repairs on counter scales by reducing their use, and by adequate supervision the packer has improved the general quality of products and the accuracy of weights.”

He went on to suggest that A&P was on the cutting edge of produce pricing methods:

“It would be a splendid thing for us, and one which we are constantly striving for, if all our merchandise could be sold by the pound. I believe we have been the pioneers in selling bananas by the pound. We find that we have better satisfied customers when we sell cabbage, turnips, onions, apples, and similar vegetables and fruits by the pound *where the size is not graded* (my emphasis). Oregon box apples, and other graded fruits we, of course, sell by the dozen. We are obligated in a great many instances to follow local customs in this respect, but nothing could please us more than a uniform method of selling all of this merchandise by weight all over the country.”⁴⁰

³⁸ Report of the 19th National Conference on Weights and Measures, pg. 65.

³⁹ This reluctance of “casual” sellers to incur the fixed cost of a scale seems to be quite persistent. At the present day farmers market in Bozeman, some sellers offer apples and pears by the quart; and W&M officials in Seattle note that the casual sellers at Pike’s Place Market (known as “day-stallers”) have historically been averse to using scales.

⁴⁰ Report of the 21th National Conference on Weights and Measures, pg. 81.

These views were reinforced further at the 1929 Conference, where a representative of the National Association of Retail Grocers remarked, "I may say at this time that most of the up-to-date retail dealers sell all bulk goods by weight and other goods by numerical count."⁴¹

Historical Pricing and Current Regulation

The fact that W&M regulations differed by state makes it difficult to trace the evolution of pricing practices. Another source of information on the evolution of pricing methods is the Guidelines for Methods of Sale published in the National Institute of Standards and Technology (NIST) Handbook 130. These are federal guidelines that have been adopted by all but 2 states (Louisiana and Wyoming). The guidelines for produce are listed in table 4.⁴² A number of sources from NIST and various state level W&M departments have suggested to me that the guidelines are based largely on historical methods of sale. Although I was not able to confirm this speculation, the guidelines do appear to be consistent with other available information on historical pricing methods.

⁴¹ The specific "other goods" mentioned were bunched items and heads of lettuce.

⁴² The current guidelines appear to have been drafted in 1979. I was unable to locate the guidelines that predated these. These guideline are merely recommendations for state regulators. Enforcement seems to vary considerably across states (and even across cities in the same state), but in general enforcement does not seem to be very heavy. Indeed, most emphasis seems to be directed towards the following guideline:

"Recognizing the difficulty faced by consumers when more than one method of sale is employed in the same outlet for the same product, noncomparable methods of sale (e.g., weight and measure) for the same produce item in the same outlet should be minimized." (NIST Handbook 130, pg. 189)

There appears to be some confusion among W&Ms officials as to whether this refers to switching prices over time or offering different prices at any given time.

There are, however, some oddities in the guidelines. For example, radishes are specified to be sold only by the pound, while in practice they are (and have been) universally sold by the bunch. Leeks are also specified to be sold only by the pound, although Albertson's in Bozeman sells them by the bunch, just like green onions. Finally, although there is overwhelming evidence that onions and potatoes were once sold by dry measure, they are here specified to be sold by weight only.

Nevertheless, the current guidelines appear to be roughly consistent with both past and current pricing practices. What is perhaps most interesting is the amount of flexibility in the guidelines. With the exception of avocados and corn-on-the-cob — which are specified to be sold by count only — and some of the odd inclusions in the sale by weight category (mentioned above), most items can be sold either by weight or count. Indeed, the only substantial method of sale restriction is with respect to sale by dry measure. This suggests that many of the goods that are currently offered for sale by weight may have been offered on a per each basis in the past.

Evidence from old newspaper advertisements lends additional support to this claim. Table 5 shows a breakdown of items advertised in the Bozeman Chronicle from the 1920s to the 1950s. The information is necessarily limited by the fact that sellers only advertise a portion of their commodities. Nevertheless, there appears to be a slight trend from sale by each to sale by weight. For example, head lettuce goes from being priced by the each in the 20s, 30s, and 40s, to by the pound in the 50s. A number of other items, such as oranges, apples, grapefruits, and lemons make a similar transition. (It almost appears that a some sellers began experimenting with pricing by the pound in the 1950s).

It is also interesting that a number of items such as celery, asparagus, broccoli, watermelons, and tomatoes — items which would seem to avail themselves to by the each or by the bunch pricing — were priced by the pound at an early period.

Prepackaged & Pre Priced Produce

Available evidence suggests that by the 1960s, pricing practices were very similar to what we see today. Nevertheless, in the mid 60s, there appears to have a been an attempt by major retailers to significantly revamp the pricing and sale of produce. At the 1965 National Weights and Measures Conference, an attorney from Safeway stores presented a paper outlining the industry's interest in moving towards prepackaging and individually price marking all produce items. The program was referred to as "product unitization", and it was advanced as way to facilitate quality protection, buyer convenience, and faster checkout.

The unitization program entailed pricing all items by the pound and then pre-weighing and price marking individual produce units (such as individual heads of cabbage) or bunched or packaged units (such as asparagus and apples). For example, a price per pound would be posted for an offering — say heads of cabbage — and then price tags would be placed on *individual heads* of cabbage, indicating the price of each particular head. A single scale would then be placed in the produce section so that buyers could periodically check the seller's measurements. Safeway's purpose at this convention was

to convince Weights and Measures regulators that package labeling requirements in many jurisdictions were too onerous to make such a program profitable.⁴³

Four years later, at the 1969 conference, "product unitization" was again brought to the attention of W&Ms officials. R. B. Crosset, the owner of a wholesale distribution company, presented a paper outlining a strong trend toward prepackaging, wrapping, and "traying" of produce items. He also noted the development of a substantial middle-man processing industry servicing some of the smaller retail merchants (larger chain stores were doing the processing themselves): "We are packaging some 40 items, from bananas to zucchini, and each package is pre-priced according to weight or count." Again, Crosset argued that packaging requirements in some jurisdictions made pre-sale produce processing unprofitable.

There is good reason to believe that pre packaging and pre pricing produce items was directed primarily at reducing weighing costs at the check-stand. At the time, these weighing costs were still a serious consideration for sellers. Scales were cumbersome, and checkers were required to make manual price calculations at the checkout counter. Studies of supermarket operation from the 1960s (Brand, 1963; Harwell, 1965) indicate that weighing produce items at the checkout counter decreased checkout productivity and

⁴³ Most jurisdictions required the product name, net weight, price per pound, and the name and address of the original packer or distributor to be printed on the label. It also appears that in some jurisdictions, W&M officials required certain items such as lettuce and celery to be priced by the each. I was not able to find any indication of how widespread such restrictions were.

led to higher levels of checker error.⁴⁴ In the case of high volume sellers, these costs appear to have been great enough to warrant keeping an attendant in the produce section to weigh and price-mark purchases. One study recommends that stores in which produce sales exceed \$4,000 per week employ metering attendants in order to avoid the reduction in check-stand productivity (Brand, 1965).

But it is important to note that, for many items at least, pricing by the each would have served the same purpose as pre pricing individual units of produce. Obviously, for high volume items such as green beans, selling by the each was clearly an infeasible alternative to weighing. But for items such as cabbage, lettuce, and celery (and, to a lesser extent, even apples or tomatoes), by the each pricing would seemingly have been a feasible alternative to selling by the pound from bulk.

In short, for a time sellers appear to have been willing to incur the labor cost of individually price-marking these goods in order to avoid the alternative of average pricing.⁴⁵ This not only reinforces the notion that weighing was a substantial cost, but

⁴⁴ Brand's comments in particular suggest that the technology was still primitive: "Produce scales at check stands are like lost children. You are likely to find them in the most unexpected places . . . but worst of all are the scales that are located to the right of the cash register, which necessitates every item being transferred from the left hand to the right hand, and after being weighed, from the right hand to the left for disposal to the counter."

⁴⁵ It is not clear how prevalent "product unitization" became. A manager from Safeway vaguely recalled seeing a good deal of pre-packaging in the 1960s, just about the time that weighing attendants were starting to disappear from the produce floors. But the fact that Safeway was addressing the issue before the National Conference suggests that it had plans to incorporate the scheme on a broad scale.

furthermore it is consistent with the notion that measurement and adverse selection of average priced items also represented substantial costs to the seller.

Current Pricing Practices: Anecdotal Evidence From the Industry

If the costs of distributional measurement are a significant determinant of pricing, then we might expect pricing managers would take them into consideration when setting prices. As a first test of my predictions, I interviewed several pricing managers from major retailers about their choice of pricing methods. Often, their discussion of the problems with average pricing directly mirrored the predictions developed in the previous chapter. For example, one district manager maintained that if the units vary too much in size, they cannot all be sold at one price. Another stated that he favored pricing by the each over pricing by the pound provided that the items were not too variable in size. At times, however, explanations of the pricing decision were couched in terms of psychological marketing. Below, I briefly outline some of the most common industry perceptions of pricing differences and argue that they are consistent with the basic predictions of the measurement cost model.

A consistent perception in the industry is that, under certain conditions, a price per each tends to yield higher sales volume than an equivalent pound price because customers do not have to weigh the produce to determine the approximate unit price. This is consistent with the notion that a price per each contains more immediate information than a price per pound. But what are the "certain conditions" that seem to limit the practice of pricing by the each? One of the more common explanations is that as the value of the

individual units increases — i.e., the each price — posting a price per pound makes the produce appear to be a better bargain.⁴⁶ Hence, asparagus bundles are priced by the pound because they would sound too expensive if priced by the bunch, while radishes are cheap enough to sell by the bunch.

How does this “irrational buyer” argument fit with the measurement cost model? Recall that the price per each can be thought of as $P_{ca} = P_{lb} * (\text{mean weight})$, where P_{lb} is the implicit price per pound. The price per each gets larger as the underlying price per pound increases or as the units get larger (holding the price per pound constant). But an increase in either of these factors will also increase the value dispersion of the distribution (because the weight dispersion tends to increase roughly proportionately with the mean weight). In my sample of produce prices, a 1 percent increase in the mean value leads to a .85 percent increase in the value variance. Hence, although managers may base their pricing decisions on the information most available to them — that is, the average price — their explanations are largely consistent the measurement cost predictions. Presumably, “sticker shock” shows up on the accounting ledger in the form of lower sales margins (retail price minus wholesale cost). In the industry, this is referred to as shrink: the price is too high to sell all of the units before substantial deterioration sets in. But cherry picking or damage due to excessive sorting would have the same end result. Hence, what looks like “sticker shock” to the pricing manager may well be the result of excessive measurement and adverse selection.

⁴⁶A number of managers referred to this explicitly as the “sticker shock” phenomenon, suggesting that it is a well established part of industry folklore.

Another common argument deals with some of the accounting problems associated with pricing by the each. A standard pricing procedure in the industry is to choose a retail price markup that yields a certain gross profit margin.⁴⁷ One of the major difficulties with fresh produce is that these calculations have to take into account the natural — or unnatural — shrink of the product. For example, a box of unripened bananas that weighs 40 pounds at the time of wholesale purchase can lose as much as 5 pounds by the time they ripen (Brand). Also, depending on how long it takes the commodity to sell, some portion of the good will deteriorate or be damaged from handling.

According to some industry managers, using an each price for a product that has a good deal of variation in size makes it difficult to calculate the correct markup. In particular, estimates of the return on the bin of produce tend to overstate the actual return. Obviously, if buyers are selecting units at random, pound pricing and each pricing should lead to roughly equivalent returns. Indeed, it is only if buyers begin to pick out the higher valued units, creating more damage and shrink in the process, that there should be any difference between pound pricing and each pricing.

⁴⁷Most produce retailing texts have extensive coverage of how to determine the markup that is consistent with a predetermined gross margin.

CHAPTER 5

DATA AND VARIABLES

Testing the measurement cost predictions requires retail level data on changes in the marginal benefits of search for specific produce commodities. Holding constant the buyer's marginal cost of search, a bin of produce with higher marginal benefits of search would be expected to elicit more intensive buyer search. From the basic model of search outlined in chapter 3, the marginal benefits of search will increase with an increase in the price per pound or an increase in the weight variance of the distribution, all else equal.

The data consist of several years of weekly price and weight observations for a large sample of produce commodities. Data were collected from the population of 5 retail grocers in Bozeman, Montana during two distinct intervals: from 1991-1994, and again from June of 1997 to May of 1998. (I will refer to these as sample A and sample B for the duration of the paper.)⁴⁸ The basic unit of observation is a bin of produce offered by one of the sellers in the sample for a given week. Each observation includes the type of produce, the method of pricing (per-each, per-pound), the posted price, and an estimate of

⁴⁸ The core group of commodities sampled are the same for both samples. Items included in sample A but not sample B are: potatoes, cherries, papaya, tangerines, nectarines, peaches, plums, and strawberries sold by dry measure. Items included in sample B but not sample A are: ugli fruit, carambola (starfruit), oroblanco, cherimoya, pomelo, horned melon, asparagus bunches, Belgian endive, chayote squash, and raddichio.

the weight dispersion of the offering (standard deviation of the weights of individual units).

Variation in the Dependent Variable

The dependent variable, *Each*, is a dichotomous variable indicating the method of pricing employed for a specific offering of produce (1 if the item is priced by the each and 0 if priced by the pound). The most illuminating way to look at the nature of the pricing variation is to break the full sample down by commodity type. Tables 2 and 3 report the mean of *Each* for individual produce commodities from samples A and B. A mean of 1.00 indicates that the commodity was priced exclusively by the each.

Perhaps the most striking feature of these tables is the consistency of pricing within individual commodities, both over time and across individual sellers. Pricing methods vary substantially across commodities, but for any given commodity the variation is minimal.⁴⁹ Of the commodities that do vary in their method of pricing, almost all of the variation is between sellers. (For example, eggplants have a mean of .76, but for any given seller, the mean is 0 or 1). If anything, these tables overstate the amount of pricing variation across sellers. Grapefruits, for example, seem to differ in pricing depending on whether they are a large or small variety, but these differences are consistent across sellers. Also, squash are universally sold by the pound except during special sales in the fall when some sellers offer them by the each.

⁴⁹ In sample A, a number of the commodities were offered during special dime and quarter sales at a price per each. Given the exceptional nature of these sales, I have presented the means without these observations.

Tables 2 and 3 suggest two additional points worth noting. First, the consistency of pricing, both over time and across sellers, suggests that sellers are not attempting to create noise around the price of a good or mask price increases. Creating noise around the price distribution can be seen as a way for sellers to price discriminate by sorting out high and low opportunity cost buyers.⁵⁰ Instead, pricing managers generally imply that there is strong competitive pressure to minimize pricing differences (i.e., by the each or by the pound) with competitors.

Second, the general consistency of pricing methods implies a lack of pricing flexibility that may appear inconsistent with the main hypothesis of this study. If buyer measurement is really a significant determinant of the pricing method, then changes in the search parameters should lead sellers to adjust their methods from time to time. Switching the method of pricing, however, is not likely to be costless for buyers or sellers. All of the pricing managers that I spoke with suggested that switching between each and pound prices has a tendency to increase the buyer's cost of determining the price of the commodity. This is one reason that sellers may be reluctant to switch from a pound price to an each price even if the item is heavily discounted.⁵¹

The absence of time series variation in the dependent variable means that the primary test of the measurement cost predictions will be cross sectional. In other words,

⁵⁰ See Salop, 1977.

⁵¹ In marketing this is known as the "reference price" phenomenon. According to this view, consumers become referenced to the "normal" price of a good and judge the value of any discount relative to that reference price (Nagle, 1982). Along similar lines, pricing managers argue that switching from a price per pound to a price per each eliminates the buyer's context for evaluating the bargain.

the main empirical question that I examine is, why are some commodities consistently priced by the pound and others consistently by the each? A difficulty here is that intrinsic quality differences between commodities cannot be controlled for. Additionally, I examine the issue of price variation across sellers. The question here is whether the characteristics of a particular seller's offering (price per pound and weight dispersion) are useful for predicting that seller's method of pricing.

Buyer Search Variables

The buyer search variables come from the model of buyer search developed in the previous chapter. They will serve as proxies for the level of buyer measurement that would be expected if the offering of produce was average priced.

Pound Price is the price per-pound of the commodity under observation. For items that are explicitly priced by the pound, it is simply the posted price at the time the weighing takes place. Where items are sold by the each, an implicit price per pound is calculated by dividing the posted unit price by the mean weight of the distribution. This would be the expected price per-pound with no search, and so it appears reasonable as an approximation of *Pound Price*.

Weight Deviation, reported in units of ounces, is the standard deviation of the weight distribution corresponding to a given price observation. This was calculated from the weights of 13 randomly selected units from the produce offering.⁵² In some cases, less

⁵² Given that goods were weighed on the sellers' premises during business hours, a true random sample could not be achieved. Nevertheless, data collectors made efforts to select units blindly for weighing.

than thirteen units were available for weighing. For example, sellers often do not stock more than seven or eight eggplants on the shelf at one time. The smaller sample is not problematic here because the full population is actually being measured. Alternatively, if the data collector arrived at the store when a distribution had been heavily picked over, the measures of mean and standard deviation could be biased. To avoid any extreme bias in this variable, observations with sample sizes of less than 6 were dropped from the analysis.

Average Purchase Size Variable

In addition to the retail price data, it was necessary to collect information on the number of units purchased by the average consumer for each type of commodity. Unfortunately, the consumer level transaction data required to calculate this average is not readily available. Although modern scanner systems provide retailers with a massive quantity of sales information, the data are generally aggregated and hence not very useful for determining the average purchase size characteristics of different produce commodities. To construct a proxy, I surveyed produce managers from 5 grocery retailers in Bozeman, MT, asking them to sort produce commodities into 5 different groups according to the number of units purchased by the average consumer. The possible groupings were: **group 1** = 1 unit, **group 2** = 2 to 3 units, **group 3** = 4 to 5 units, **group 4** = 6 to 9 units, or **group 5** = 10 or more units.

The manager responses can be used to create both an ordinal and cardinal measure of average purchase size. To create a simple ordinal ranking, I took the average of the responses for each item and rounded to one digit. For example, if a set of responses was

1, 1, 2, 2, 1; then the average response was 1.4, which rounds to 1. These rankings are used to create the purchase size dummy variables. In addition, I calculated the average purchase size as a cardinal number in the following manner. Taking the average number of units associated with each response category, the responses above would be 1, 1, 2.5, 2.5, 1; for an average of 1.6. This average is the *Purchase Size* variable.

An immediate objection to these measures, apart from their crudeness, is that they do not vary with changes in price. Seasonal and even weekly price fluctuations for fresh produce are often large, and an ideal measure of purchase size would capture these fluctuations. This difficulty is somewhat mitigated by the fact that switching between each and pound prices within a given commodity is extremely rare. Price switching, and the absence of it, will be discussed in greater detail in the next chapter. A more important limitation of these measures is that the variance of the purchase sizes may also be an important factor for sellers. Although the burden of counting 4 or 5 units may be relatively trivial, if customers frequently purchased in larger (and smaller) quantities, then the cost of counting the larger transactions could be great enough to warrant pricing by the pound. It seems likely, however, that the variance of the purchase size will be highly (and positively) correlated with the purchase size variables described above.

Quality Variability

As discussed earlier, quality variation is likely to have an effect on the buyer's search behavior and, ultimately, on the seller's incentive to price by the pound. Because there is no adequate proxy for quality dispersion, the regression analysis may suffer from

omitted variables bias. If the level of quality dispersion is correlated with any of the regressors, then the estimated coefficients will be biased and inconsistent.

Because there is no prediction for the effect of changes in quality variation on the seller's pricing decision, it is impossible to determine the direction of bias on independent variables that are correlated with quality variation. Nevertheless, it is useful to examine which variables are potentially subject to an omitted variables bias. There is no a priori reason to think that quality variability will be correlated with either the weight dispersion or the average purchase size of the commodity. Price, on the other hand, could be correlated with quality variation in two primary ways.

First, suppose that two distributions of oranges have the same level of variability in some quality dimension such as juiciness. Let the first distribution sell for \$1 per pound, and the other for \$2 per pound. Although the level of quality variability is the same for both distributions, the value of the quality variability will be greater for the more expensive commodity. Alternatively, it could be that higher priced commodities are subjected to more intensive quality grading at the grower and distributional levels, resulting in an inverse relationship between price and quality variability.

CHAPTER 6

EMPIRICAL TESTS AND RESULTS

I have suggested that the seller's choice between by the each and by the pound pricing can be modeled as a simple benefit-cost calculation. Average pricing eliminates weighing costs, but it simultaneously introduces counting costs and the potential for costly buyer measurement. The basic prediction relating to these measurement costs is that an increase in the level of buyer measurement over size, holding constant the average number of units transacted, increases the cost of pricing by the each relative to the cost of pound pricing. Although these costs cannot be measured directly, a logit model can be used to estimate the probability that an offering of produce with certain characteristics will be priced by the each. A set of proxy variables for the level of buyer measurement are predicted to be negatively correlated with the probability of by the each pricing.

Logit Specifications

The choice among logit specifications is determined by whether individual observations are the fundamental units of analysis, or whether the choice variable is naturally organized in groups (Pindyck and Rubinfeld, 1991). If the data are grouped,

then the frequency of an event within each group can serve as an estimate of the probability of observing an event for that group. In the present case:

$$P[Each]_i = Each_i / n_i$$

where *Each* is the number of observations priced by the each, and n_i is the total number of observations in group i . From these probability estimates, the log of the odds can be calculated and regressed on group characteristics with Ordinary Least Squares (OLS) estimation.⁵³

The data for this analysis are naturally grouped by commodity type, and hence one way to specify the model would be to regress the logits of the group frequencies on average group characteristics. However, given the complete lack of price switching within most of the produce groups, such a proportions analysis is clearly inappropriate. In particular, notice that when $P[Each]_i$ equals 0 or 1, the log of the odds will be undefined. Green (1993) has suggested the ad hoc fix of adding or subtracting 0.001 for these cases. But if the bulk of the proportions are very close to 0 or 1 — as is the case here — OLS produces poor estimates because the dependent variable will be distributed with a variance of the form:

$$V_i = n_i / [Each_i (n_i - Each_i)]$$

which explodes as $Each_i / n_i$ approaches either 0 or 1 (Pindyck and Rubinfeld, 1991).

The standard alternative to a proportions analysis is to estimate a logit model on individual price observations with Maximum Likelihood estimation. Unhappily, the absence of price switching within groups raises problems here as well. With this

⁵³ The log of the odds is $\ln[p_i / (1-p_i)]$

specification, each weekly price and weight observation constitutes a unique observation. Hence, an underlying assumption of this specification is that sellers are making a pricing decision each week based on the price and weight characteristics of commodities for that week. Although such a proposition is not completely implausible, there is little evidence in the data to suggest that sellers are behaving this way. Instead, they appear to be making pricing decision based on the average price and weight characteristics of commodities.⁵⁴ If this is the case, a logit estimation using individual observations would be roughly equivalent to stacking identical data sets. Standard errors will be biased downward, increasing the likelihood of a type I error in inference.

One way to bypass this difficulty is to partition the data into two groups: commodities that are consistently priced, and commodities that exhibit variation in pricing across sellers. As noted earlier, most of the commodities in the sample are consistently priced. Because these commodities exhibit no pricing variation, the entire commodity group can be treated as individual observations ($Each = 0$ or 1), and a standard logit can be estimated on the average characteristics of individual commodities (price, weight dispersion, purchase size). The few commodities that exhibit pricing variation can be analyzed individually with simple t-tests.

Although this procedure eliminates the problem of biased inference, it has the disadvantage of censoring potentially important information. In particular, any commodity that does not exhibit a consistent pricing scheme across sellers must be dropped from the

⁵⁴ This is probably due to the fact that it is not costless to switch prices, and that the *Value Deviation* parameters (price and weight) do not fluctuate sufficiently to warrant the cost of a switch.

regression. To the extent that the elimination of information is not random, coefficient estimates will be biased. To allow for the comparison of standard errors and regression coefficients, the measurement cost predictions are tested with both the ungrouped and grouped data. The ungrouped data are described in tables 4 and 5, and the grouped data are described in tables 6 and 7.

Model Specification For Ungrouped Data

The simplest specification would include the actual level of value dispersion (*Pound Price · Weight Deviation*) as an independent variable:

$$1. \quad P[Each]_{it} = f(\text{Value Deviation}_{it}, \text{Inedible}_i, \text{Alterable}_i, \text{Purchase Size}_i)$$

where subscript i refers to commodity type i , and t the time of the observation. *Inedible* is a dummy variable indicating that the item is decorative (ornamental corn, gourds, etc.), and *Alterable* is a dummy variable indicating that the item can be altered prior to purchase.⁵⁵ As discussed in Chapter 3, *Value Deviation* is the variable that determines the marginal benefits of search.

Because *Value Deviation* is composed of two separable factors — *Pound Price* and *Weight Deviation* — a more appropriate specification will disentangle the effects of each factor. Such a specification will have to account for their interaction. To see why, consider how an increase in price would affect the level of search if all units were the same size. While the increase may lead buyers to search more over quality attributes, they still

⁵⁵Obviously, any produce item can be altered (or damaged); but as noted earlier, my intention is to isolate items where consumers can gain by dismembering inedible or undesirable parts of the commodity.

will not gain any benefit from searching over size. As the units begin to vary in size, however, the increase in price will begin to affect the level of search; this effect will be greater for greater levels of size variability. In short, the price per-pound can be thought of as the value of an additional unit of size; hence, the marginal effect of an increase in this value depends on the degree of variability in size.

This multiplicative interaction can be illustrated formally. Consider the functional relationship between the probability that a seller will post a price per each, $P[Each]$, and the buyer's incentive to measure:

$$P[Each] = f(\sigma_v)$$

where $\sigma_v = \text{Pound Price} \cdot \text{Weight Deviation}$ is the standard deviation of the values. The effect of a change in price on the probability of observing a price per each rather than a price per pound is:

$$\begin{aligned} \partial P[Each] / \partial \text{Price} &= f'(\sigma_v) \cdot (\partial \sigma_v / \partial \text{Price}) \\ &= f'(\sigma_v) \cdot \text{Weight Deviation} \end{aligned}$$

In other words, the marginal impact of a change in *Pound Price* will be greater for higher levels of *Weight Deviation*, and vice versa. This interaction effect can be captured by including the product of these variables (*Value Deviation*) in a regression with *Pound Price* and *Weight Deviation*.

$$2. \quad P[Each]_{it} = f(\text{Pound Price}, \text{Weight Deviation}, \text{Value Deviation}_{it}, \text{Inedible}_i, \text{Alterable}_i, \text{Purchase Size}_i)$$

As discussed earlier, a limitation of these cross sectional specifications is that they do not control for commodity specific differences in quality variation or cost of

measurement. To the extent that these factors are uncorrelated with the regressors, however, estimated coefficients should be unbiased. One more point is worth noting. The use of *Weight Deviation* as an independent variable leads to an errors in variables problem. Because *Weight Deviation* is an *estimated* parameter of the underlying produce distribution, it contains an error component that will become compounded with the error term for the regression. The result is that *Weight Deviation* will be correlated with this compounded error term. Provided that the two individual error terms (the regression error and the error in *Weight Deviation*) are uncorrelated, the coefficient estimate on *Weight Deviation* will be attenuated.⁵⁶

Given these caveats, the two equations to be estimated are:

3.
$$\text{logit}[\text{Each}]_{it} = a + b_1 \text{Value Deviation}_{it} + b_2 \text{Inedible}_i + b_3 \text{Alterable}_i + b_4 \text{Purch Size}(2-3)_i + b_5 \text{Purch Size}(4+)_i + e_{it}$$
4.
$$\text{logit}[\text{Each}]_{it} = a + b_1 \text{Pound Price}_{it} + b_2 \text{Weight Deviation}_{it} + b_3 \text{Value Deviation}_{it} + b_4 \text{Inedible}_i + b_5 \text{Alterable}_i + b_6 \text{Purch Size}(2-3)_i + b_7 \text{Purch Size}(4+)_i + e_{it}$$

The purchase size dummy variables separate the commodities into groups with average purchase sizes of 1, 2-3, and 4 or more units.⁵⁷ Negative coefficients are expected for the

⁵⁶ See Greene (1993, 280-281) for a discussion of measurement error and attenuation of the coefficient estimates.

⁵⁷ It is not possible to separate the commodities into finer purchase size groupings (e.g., 1, 2-3, 4-5, 6-9, 10+) due to the lack of pricing variation within the higher purchase size groupings. For example, because all commodities with the dummy variable *Purch Size(6-9)* equal to 1 are priced by the pound, this variable will be a perfect predictor of the dependent variable and the model will not converge.

two *Purchase Size* dummies, although a coefficient of zero on *Purchase Size(2-3)* would not be surprising. This would indicate that the cost of counting produce is constant up to 4 or 5 units. Positive signs are predicted for coefficients on *Inedible* and *Alterable*.

In equation 3, the prediction is for a negative coefficient on *Value Deviation*. In equation 4, the individual effects of *Pound Price* and *Weight Deviation* are included, and *Value Deviation* is the multiplicative interaction of these terms. The marginal effect of *Pound Price* will be a linear function of *Weight Deviation* and vice versa:

$$\partial \logit[Each]/\partial \text{Pound Price} = b_1 + b_3 \cdot \text{Weight Deviation}$$

$$\partial \logit[Each]/\partial \text{Weight Deviation} = b_2 + b_3 \cdot \text{Pound Price}.$$

Clearly, a negative sign is predicted for the coefficient on *Value Deviation* (b_3). Also, in order for the marginal effects to be negative for all values *Weight Deviation* and *Pound Price*, the coefficients on these variables (b_1 and b_2) must be negative or zero. Notice that coefficients of zero on either of these variables would not be inconsistent with the interactive effect discussed above. This would simply indicate that, for example, when goods are perfectly homogeneous in size (the weight dispersion is zero), the marginal effect of an increase in price is also zero.

Model Specification For Grouped Data

With a few exceptions, the model specifications for the grouped data are the same as equations 3 and 4 above. The *Inedible* dummy employed in equations 3 and 4 cannot be used in these regressions due to insufficient price variation within the dummy variable groupings (see footnote 57). Hence, observations on inedible commodities are dropped

from these regressions. Also, the *Alterable* variable was consistently insignificant in these specifications, and because it did not alter the signs or magnitudes of the other coefficients, it was dropped from these smaller sample size regressions.

The two equations to be estimated are:

$$5. \quad \text{logit}[Each]_i = a + b_1 \text{Value Deviation}_i + b_2 \text{Purch Size}(2-3)_i \\ + b_3 \text{Purch Size}(4+)_i + e_i$$

$$6. \quad \text{logit}[Each]_i = a + b_1 \text{Pound Price}_i + b_2 \text{Weight Deviation}_i \\ + b_3 \text{Value Deviation}_i + b_4 \text{Purch Size}(2-3)_i + b_5 \text{Purch Size}(4+)_i + e_i$$

As an alternative to the *Purch Size* dummies, these grouped specifications are also estimated with *Purchase Size*, the cardinal measure of average purchase size derived from my survey of produce managers (described in the previous chapter).

Again, a negative coefficient is predicted for *Value Deviation* in equation 5. In equation 6, *Value Deviation* is the multiplicative interaction term for *Pound Price* and *Weight Deviation*. Predictions for the marginal effects and individual coefficients are the same as for the ungrouped specifications.

Regression Results

The results of logit regressions for equations 3 and 4 (ungrouped data) are reported in Tables 10 and 11. Results for equations 5 and 6 (grouped data) are reported in Tables 12-15. Equations 4 and 6 are also estimated without the interactive variable (*Value Deviation*) to allow for a more thorough evaluation of the interactive specification.

In addition to the logit coefficients, I have reported the marginal effects where coefficients are statistically significant at the .10 level. These marginal effects are linear approximations of the change in the predicted event probability for a one standard deviation change in the independent variable (or a unit change in dichotomous variables) holding all other variables constant at their means. The linear approximation for a change in the i^{th} variable is provided by $\Delta p_i = b_i \cdot \Delta x_i (1 - p_i) \cdot p_i$, where p_i is the predicted probability of an event holding all other independent variables constant at their means, b_i is the estimated coefficient on x_i , and Δx_i is the chosen level of change in x_i . Notice that the magnitudes of these effects may differ substantially depending on whether p_i is estimated at the means of the independent variables or at some other level. Furthermore, because these are linear approximations of nonlinear changes in probability, estimates involving large changes in x_i may be absurdly large (e.g., a change in probability exceeding 1). Accordingly, these marginal effects are reported only as crude estimates of the relative magnitudes of the coefficients. Where prediction is of primary interest, a more accurate alternative is to use the estimated model to calculate the difference in the predicted event probability (p_i) at an initial and shocked level of x_i .

Looking first at the results for the ungrouped data (tables 10 and 11), the marginal effects in the first 2 models all line up with the expected signs. In model one, *Value Deviation* has the correct sign in both samples. In model 2, *Pound Price* has the wrong sign, but the marginal effect is negative when calculated at the mean of *Weight Deviation*. Indeed, the estimated marginal effect is positive only when *Weight Deviation* is less than

0.08 ounces in sample A and 0.12 ounces in sample B. These are minuscule amounts of variation.⁵⁸

The other control variables perform largely as expected. Items that can be altered prior to purchase appear more likely to be priced by the each, all else constant, as do inedible commodities. Items with average purchase sizes of 4 units or more are less likely to be priced by the each, but the effect of moving from 1 unit to 2-3 units is less conclusive. A particularly odd feature of these results is the large difference in Chi-Square statistics for *Purch Size(2-3)* between sample A and sample B. The *Purch Size(2-3)* coefficient is positive in both samples, but in sample A it is not significantly different from zero.

Given that standard errors for the ungrouped data are likely to exhibit bias, the results from the grouped data are of primary concern for testing the measurement cost hypotheses (grouped results are reported in tables 12-15). The results for model 1 — *Value Deviation* and purchase size controls only — are consistent across samples and specifications. *Value Deviation* has the correct sign and is significant at the .05 level or better in all 4 regressions, and the magnitudes of the marginal effects appear to be substantial.⁵⁹

The results from the interactive specification are slightly less conclusive. Consider first the results where dummy variables are used to control for average purchase size

⁵⁸ The minimum *Weight Deviation* observed was 0.02 for sample A and 0.09 for sample B.

⁵⁹ All significance levels mentioned in the text are for two-tailed tests.

(tables 12 and 13). In Sample A, none of the measurement cost variables are individually or jointly significant. In Sample B, the individual coefficients again are not significant, but *Weight Deviation* and *Value Deviation* are jointly significant at the .05 level.⁶⁰ In contrast, when the interactive term is omitted (model 3), *Weight Deviation* is significant at the .10 level in sample A, and at the .01 level in sample B. *Pound Price* is also significant in sample B.

In tables 14 and 15, the purchase size dummies are replaced with the cardinal measure, *Purchase Size*. With one exception, the results generally suggest that the models are robust with respect to the specification of the average purchase size variable. The exception is the interactive specification for sample A (compare model 2 in tables 12 and 14). In table 12, *Value Deviation* has the wrong sign, and the standard error is quite large relative to the coefficient estimate. But when *Purchase Size* replaces the dummy variables (table 12), the coefficient on *Value Deviation* changes to the correct sign, and *Weight Deviation* and *Value Deviation* are jointly significant at the .10 level. In sample B the results are generally unchanged, except that *Pound Price* and *Value Deviation* are jointly significant at the .10 level.

The relative performance of the 3 models presented here can be examined by comparing the maximum values of the log-likelihood function for the restricted and

⁶⁰ The H_0 for this test is: $b_2 + b_3 \cdot \text{Pound Price} = 0$, where b_2 is the coefficient on *Weight Deviation*, b_3 is the coefficient on *Value Deviation*, and *Pound Price* is held at its mean.

unrestricted models.⁶¹ Model 2 is the unrestricted model, because the effect of *Weight Deviation* on the log of the odds ratio is allowed to vary with the value of *Pound Price*, and vice versa. In model 3, the effects of *Pound Price* and *Weight Deviation* are constrained to be constant; in model 1, the effects of *Pound Price* and *Weight Deviation* are constrained to be equal. Hence, it is expected that model 2 will provide the best explanation of the data.

Likelihood ratio tests on the restrictions between models 1 and 2 generally support this prediction. For the ungrouped data, the Chi-Square statistics in samples A and B (106.3 and 48.58, respectively) are both significant at the .01 level. For the grouped data, Chi-Square statistics for the restrictions on the regressions in tables 12, 13 and 15 (5.66, 4.95, and 4.98, respectively) are significant at the .10 level.

The tests on the restrictions between models two and three are less conclusive. For the ungrouped data, the Chi-Square statistics are significant at the .01 level in both samples (18.7, 11.7), but none of the restrictions are significant in the grouped data regressions. This would seem to suggest that the interactive term does not add any relevant information. However, recall that *Value Deviation* is jointly significant with *Weight Deviation* in most of the regressions. The fact that tests on the single restriction $Value\ Deviation=0$ are consistently insignificant may be due to the high correlation between *Value Deviation* and *Weight Deviation* (simple correlation of 0.87).

⁶¹ The likelihood ratio test statistic, $-2 [\ln L_R - \ln L_U]$ (where subscripts R and U refer to the restricted and unrestricted models), is distributed Chi-Square.

Pricing Variation Within Commodity Groups

Up to now, I have considered only the consistent cross-sectional variation in pricing; that is, I have only examined the characteristics of commodities that are always priced in the same manner by all of the sellers in the sample. There are two other important kinds of price variation. First, a number of commodities vary in their pricing across sellers.⁶² For example, iceberg lettuce is sold by the each by two of the sellers in the sample (County Market and Town & Country), and by the pound by the others. Second, there are some commodities that exhibit peculiar pricing differences, even though pricing does not vary across sellers. For example, small grapefruits are priced by the each while large grapefruits are priced by the pound; and green bell peppers are always priced by the each while red, orange, and yellow peppers are more frequently priced by the pound. These two types of pricing variation present another opportunity to test the measurement cost predictions. The key question to be considered is whether differences in the *Value Variation* of different offerings can account for these pricing differences.

Variation Across Sellers

There are a number of potential explanations for why certain commodities vary in pricing across sellers. First, the method of pricing simply might not matter very much for some commodities; that is, the cost tradeoffs between posting a pound price and letting buyers sort at an average price may be roughly equal. If this is the case, then the choice of

⁶²See tables 2 and 3 for a list of the commodities that vary in pricing.

pricing is random but, once the choice is made, sellers stick with it to minimize customer confusion. Alternatively, the offerings of various sellers could be significantly different in their average price and weight characteristics, and these differences could account for the relative use of pound and each pricing. Finally, sellers may cater to clientele with significantly different opportunity costs. Because search costs are opportunity costs, this explanation suggests that sellers in low income areas — holding constant the *Value Deviation* of the commodities — would be more likely to constrain measurement by pricing commodities by the pound.

This last explanation is not generally supported by the data. Indeed, the simple fact that so many commodities are sold consistently *across sellers* would seem to contradict the notion that differences in clientele are a particularly important factor in choosing the pricing method. The relative importance of the first 2 explanations can be tested by examining the differences in the mean *Value Deviation* of commodities according to their method of pricing. For example, it is expected that iceberg lettuce that is priced by the pound will have a significantly greater *Value Deviation* than lettuce that is priced by the each. A difficulty with this test is that it ignores the question of why sellers are offering commodities with significantly different attributes.

Tables 14 through 16 present the results of t-tests for differences in the *Value Deviation* for those commodities that differ in pricing across sellers. For each commodity, the observations are grouped by the method of pricing. The basic prediction is that the

mean *Value Deviation* will be greater for groups of commodities that are priced by the pound.⁶³

The results are somewhat mixed. Red bell peppers do not seem to show any significant differences in means across each and pound priced offerings. Garlic shows a significant difference in sample A but not in sample B. The difference for eggplants is in the right direction in both samples, but the t statistics are rather weak. Iceberg lettuce, however, shows a strong difference in *Value Deviation* for both samples. It is interesting to note that in sample A (1991-1994), Safeway was the by the each seller, while in sample B (1997-1998), Safeway had switched to a price per pound. Similarly, Van's IGA priced by the pound in sample A, but by the each in sample B. Also, it is important to note that in both samples, the difference in *Value Deviation* between each and pound priced sellers is caused primarily by price. There are no significant differences in the weight characteristics of each and pound priced offerings.

In sum, the evidence suggests that for some commodities the method of pricing does not matter very much. This might actually be expected if commodities exhibited large fluctuations in price or size variability over time. For example, if half of the time it pays to price by the each (say, because the offerings are very homogeneous), but the rest of the time the offerings are variable enough to warrant pricing by the pound, then the buyer may do best by picking one pricing method and sticking with it (to avoid confusion

⁶³ Unlike in the regression models, there are no individual prediction for *Pound Price* and *Weight Deviation*, because a simple comparison of means on one variable does not hold the other constant. A group of observations that are priced by the each could be very variable in size but cheap relative to the other group, resulting in a *Value Deviation* that does not differ from the pound priced group.

from frequent switching between pricing methods). In such cases, differences in pricing across sellers would appear to be random.

Variation For Specific Commodities

In addition to pricing differences across sellers, there are several commodities that avail themselves to simple tests of the measurement cost predictions. These tests are especially compelling because the pricing variation tends to be consistent across sellers within the sample. Tables 18-20 reports t-tests for the following items:

Albertson's Celery. Albertson's carries two distinct offerings of celery: Blue Band, priced by the pound; and Red Band, priced by the each. These are offered side by side in the Bozeman store. In both samples, the *Value Deviation* for Blue Band celery is significantly greater than for Red Band celery by as much as 7 cents. Furthermore, when the *Value Deviation* for Red Band celery is compared against celery from all other sellers (all sold by the pound), the difference is again 7 cents in both samples.⁶⁴ Hence, it appears that Albertson's Red Band celery differs significantly from both its own Blue Band celery and from celery offered by other sellers in the sample.

Green and Red Bell Peppers. While green bell peppers are almost universally priced by the each, red bell peppers are more likely to be sold by the pound. For example, 53 percent of the red pepper observations in sample A were sold by the pound, and 32 percent were sold by the pound in sample B. This tendency for red bell peppers to be sold by the pound suggests that red bells may on average have a higher *Value Deviation* than

⁶⁴ $t = 4.10$ in sample A and $t = 2.37$ in sample B.

green bells. Indeed, in both samples the *Value Deviation* for red bell peppers was significantly greater than for green bell peppers by as much as 9 cents.

Grapefruits. Most sellers carry both small grapefruits (weighing approximately 10 ounces each) and large grapefruits (weighing approximately 15 ounces each). It is typical for small grapefruits to be priced by the each and large grapefruits by the pound. In both samples, the *Value Deviation* for grapefruit priced by the pound was significantly greater than for grapefruit priced by the each by as much as 8 cents.

To gain a better feel for the magnitudes of these differences, consider the following thought experiment. Stigler's table of expected minimums (see table 1) suggests that, with a normal distribution, 4 searches will on average yield a unit that is roughly one standard deviation away from the mean. Hence, by looking at the differences in average *Value Deviation* between pound priced and each priced offerings, we can approximate the difference in the dollar return from search for different offerings. Take large and small grapefruits as an example. If a buyer were to conduct 4 searches for each unit purchased, he would average an added gain of 4 cents when searching over large as opposed to small grapefruits. Supposing that it takes 10 seconds to conduct each set of 4 searches, this would amount to an additional per minute return of 24 cents, or a per hour return of \$14.40.

CHAPTER 7

CONCLUSION

When wealth is left in the public domain, competition for that wealth leads to outcomes that are inefficient compared to nirvana scenarios where all product margins are allocated by price. Pricing, however, requires measurement, and subsequently it may be optimal for some wealth simply to be left unclaimed. As Barzel (1997) notes, a basic implication of profit maximization in the face of costly measurement is that wealth left in the public domain is wealth that individuals have *chosen* not to claim. This paper provides empirical support for that prediction. Retail produce sellers appear to choose between average pricing and explicit pricing of bulk commodities in a manner that is consistent with the minimization of pre-sale measurement costs.

The empirical goals of this research were quite modest, and a number of issues remain unexplained. Perhaps foremost of these is the fact that several commodities appear to differ in pricing by region. For example, data from North Carolina retailers indicate that broccoli, cauliflower, iceberg lettuce, cantaloupes, honeydew melons, and oranges are consistently priced by the each in this market. Simple t-tests, like the ones presented in the previous chapter, do not show a statistically significant difference in the *Value Deviation* between Bozeman and North Carolina offerings. Pricing managers that I spoke

with indicated that regional pricing differences such as these have existed for some time (see footnote 28). If this is true, then current pricing differences may partly be a legacy of historical differences in the cost or characteristics of produce by region. For example, the cost of shipping produce may have once been great enough to create substantial differences in retail prices across regions. Another possibility is that there are substantial and persistent differences in quality variability between offerings in various regions. Although we do not fully understand the implications of quality variability for the optimal level of search over size, there is reason to believe that it may be an important determinant of the costs of buyer measurement.

Another issue left unexamined is the importance of differences in buyer opportunity costs for the seller's pricing decisions. In this study, buyers were assumed to have homogeneous search costs. But the basic model presented here predicts that sellers who cater to clienteles with low opportunity costs will be more likely to price by the pound. Finally, a more complete knowledge of early pricing practices could provide helpful support to the empirical work in this paper.

BIBLIOGRAPHY

- Akerlof, George A., "The Market for 'Lemons': Quality Uncertainty and the Market Mechanism." Quarterly Journal of Economics. (84) 1970: 488-500.
- Allen, Douglas W., "What Are Transaction Costs?" Research in Law and Economics. (14) 1991: 1-18.
- Barzel, Yoram, "Measurement Cost and the Organization of Markets." Journal of Law and Economics. (25) 1982: 27-48.
- Barzel Yoram, "Some Fallacies in the Interpretation of Information Costs." Journal of Law and Economics. (20) 1977: 291-307.
- Barzel, Yoram, Economic Analysis of Property Rights. Cambridge: Cambridge University Press, 1997.
- Borcherding, Thomas E. and Silberberg, Eugene, "Shipping the Good Apples Out: The Alchian and Allen Theorem Reconsidered." Journal of Political Economy. (86) 1978: 131-138.
- Brand, Edward A., Modern Supermarket Operation. New York: Fairchild Publications, 1963.
- "Buying Commodities By Weight Or Measure." Misc. Publications, Department of Commerce, Bureau of Standards, No. 45, 1920.
- Cheung, Steven N.S., "Private Property Rights and Sharecropping." The Journal of Political Economy. (76) 1968: 1107-1112.
- Freidman, Lawrence, "Psychological Pricing in the Food Industry." Prices: Issues in Theory, Practice, and Public Policy. Ed. Phillips, Almarin and Williamson, Oliver E., Philadelphia: University of Pennsylvania Press, 1967: 187-201.
- Gastwirth, Joseph L., "On Probabilistic Models of Consumer Search for Information." The Quarterly Journal of Economics. 38-50.

- Goldman, Arieh and Johansson, J.K., "Determinants of Search for Lower Prices: An Empirical Assesment of the Economics of Information." Journal of Consumer Research. (5) 1978: 176-185.
- "Guidelines for Methods of Sale." Handbook 130: Uniform Laws and Regulations. Department of Commerce, National Institute of Standards and Technology (NIST), 1998: 189-190.
- Greene, William H., Econometric Analysis. New York: Macmillan, 1993.
- Hanssen, Andrew, "The Block-Booking of Films: A Re-Examination." Unpublished Manuscript. Department of Agricultural Economics, Montana State University, 1999.
- Harwell, Edward M., Checkout Management. New York: Chain Store Publishing Corporation, 1965.
- Hirshliefer, J., "Where Are We in the Theory of Information?" American Economic Review. (63) 1973: 31-39.
- Johnson, Ronald N., "Search Costs and Asymmetric Price Responses in Retail Gasoline Markets." Unpublished Manuscript. Department of Agricultural Economics, Montana State University, 1999.
- Kenny, Roy W. and Klein, Benjamin, "The Economics of Block Booking." Journal of Law and Economics. (26) 1983: 497-540.
- Larson, Richard J., Introduction to Mathematical Statistics. New Jersey: Prentice Hall, 1986.
- Leed, Theodore W. and German, Gene A., Food Merchandising: Principles and Practices. New York: Lebhar Friedman, Inc., 1973.
- Leffler, Keith B. and Rucker, Randal R., "Transaction Costs and the Efficient Organization of Production: A Study of Timber-Harvesting Contracts." Journal of Political Economy. (99) 1991: 1060-1087.
- Lippman, Steven A. and McCall, John J., "The Economics of Job Search: A Survey." Economic Inquiry. (14) 1976: 155-173.
- McManus, John C., "The Costs of Alternative Economic Organizations." Canadian Journal of Economics (8) 1975: 334-350.

- Mood, Alexander M. and Graybill, Franklin A., Introduction to the Theory of Statistics. New York: McGraw-Hill, 1963.
- Nagle, Thomas T., Strategy and Tactics of Pricing. New Jersey: Prentice Hall, 1995.
- Pindyck, Robert S. and Rubinfeld, David L., Econometric Models and Economic Forecasts. New York: McGraw Hill, 1991.
- Pratt, John D., Wise, David A. and Richard Zeckhauser, "Price Differences in Almost Competitive Markets." The Quarterly Journal of Economics. May 1979: 189-212.
- "Report of the 17th National Conference on Weights and Measures." Misc. Publications, Bureau of Standards, No. 64, 1924.
- "Report of the 19th National Conference on Weights and Measures." Misc. Publications, Bureau of Standards, No. 74, 1926.
- "Report of the 21st National Conference on Weights and Measures." Misc. Publications, Bureau of Standards, No. 97, 1928.
- Rothschild, Michael, "Searching for the Lowest Price When the Distribution of Prices Is Unknown." Journal of Political Economy. (82) 1974: 689-711.
- Salop, Steve, "Information and Monopolistic Competition." American Economic Review. (66) 1976: 240-245.
- Stigler, George J., "The Economics of Information." The Journal of Political Economy. (69) 1961: 213-225.
- Stigler, George J., "Information in the Labor Market." The Journal of Political Economy. (70) 1962: 94-105.
- Stigler, George J., Price Theory. Chicago: University of Chicago Press, 1986.
- Telser, L.G., "Searching for the Lowest Price." American Economic Review. (63) 1973: 40-51.
- Umbeck, John, "Shipping the Good Apples Out: Some Ambiguities in the Interpretation of 'Fixed Charge'." Journal of Political Economy. (88) 1980: 199-208.

APPENDIX
TABLES

Table 1: Expected Minimum Prices and Marginal Benefits of Search for a Normal Distribution of Prices

Search	Expected Minimum	Marginal Benefits of Search
1	μ	—
2	$\mu - .564\sigma$	$.564\sigma$
3	$\mu - .864\sigma$	$.300\sigma$
4	$\mu - 1.029\sigma$	$.165\sigma$
5	$\mu - 1.163\sigma$	$.134\sigma$
Source: derived from Stigler (1961)		

Table 2: Pricing Frequencies for Commodities, Sample A

Prodtype	Each Frequency	Prodtype	Each Frequency	Prodtype	Each Frequency
Bananas	0.00	Artichokes	1.00	Apricots	0.14
Broccoli	0.00	Avocados	1.00	Asian Pears	0.64
Cabbage	0.00	Coconuts	1.00	Celery	0.17
Cantaloupes	0.00	Corn-cob	1.00	Eggplants	0.84
Carrots	0.00	Corn-ornamental	1.00	Garlic	0.57
Cauliflower	0.00	Cucumbers	1.00	Grapefruits	0.52
Cherries	0.00	Green Bell	1.00	Iceberg Lettuce	0.32
Gourds	0.00	Green Onions	1.00	Limes	0.78
Granny Apples	0.00	Kiwis	1.00	Red Bell Peppers	0.52
Grapes	0.00	Lemons	1.00	Squash	0.14
Honeydew Melons	0.00	Mangoes	1.00	Yellow Bell Peppers	0.60
Mushrooms	0.00	Papaya	1.00		
Nectarines	0.00	Persimmons	1.00		
Onions	0.00	Pomegranates	1.00		
Orange Bell Peppers	0.00	Pumpkins-mini	1.00		
Oranges	0.00	Radishes-bunch	1.00		
Peaches	0.00	Red Leaf Lettuce	1.00		
Pears	0.00	Romaine Lettuce	1.00		
Pineapples	0.00	Strawberries-Bulk	1.00		
Plums	0.00				
Potatoes	0.00				
Pumpkins	0.00				
Red D. Apples	0.00				
Strawberries-Bulk	0.00				
Tangerines	0.00				
Tomatoes	0.00				
Watermelons	0.00				
Zucchini	0.00				

Table 3: Pricing Frequencies for Commodities, Sample B

Prodtype	Each Frequency	Prodtype	Each Frequency	Prodtype	Each Frequency
Asparagus	0.00	Artichokes	1.00	Asian Pears	0.64
Bananas	0.00	Avocados	1.00	Celery	0.18
Belgian Endive	0.00	Bunch Carrots	1.00	Eggplants	0.65
Broccoli	0.00	Chayote Squash	1.00	Garlic	0.59
Cabbage	0.00	Coconuts	1.00	Grapefruits	0.42
Cantaloupes	0.00	Corn-cob	1.00	Iceberg Lettuce	0.29
Carrots	0.00	Cucumber	1.00	Papaya	0.88
Cauliflower	0.00	Green Bell Peppers	1.00	Pineapples	0.40
Cherimoya	0.00	Green Onions	1.00	Red Bell Peppers	0.68
Granny Apples	0.00	Horned Melon	1.00	Squash	0.19
Honeydew Melons	0.00	Kiwis	1.00	Yellow Bell	0.50
Mushrooms	0.00	Lemons	1.00		
Onions	0.00	Limes	1.00		
Oranges	0.00	Mangoes	1.00		
Oroblanco	0.00	Persimmons	1.00		
Pears	0.00	Pomegranates	1.00		
Raddichio	0.00	Pomello	1.00		
Red D. Apples	0.00	Radishes-bunch	1.00		
Strawberries	0.00	Red Leaf Lettuce	1.00		
Tomatoes	0.00	Romaine Lettuce	1.00		
Watermelons	0.00	Starfruit	1.00		
Zucchini	0.00	Ugli Fruit	1.00		

Table 4: National Conference on Weights and Measures Guidelines for Methods of Sale

Weight or Count		Weight or Bunch	Weight or count, or by dry measure in units not less than 1 peck
Artichokes	Mangoes	Asparagus	Apples
Cantaloupes	Melons	Beets	Beans
Celery	Nectarines	Broccoli	Peaches
Coconuts	Oranges	Carrots	Pears
Cucumbers	Papaya	Cauliflower	Plums
Eggplant	Peppers	Escarole	Tomatoes
Garlic	Persimmons	Green Onions	
Grapefruits	Pineapples	Parsley	
Lettuce	Pomegranates	Spinach	
Lemons	Pumpkins	Turnips	
Limes	Tangerines		

Weight		Weight or Measure	Count
Apricots	Onions	Berries	Avocados
Bananas	Parsnips	Cherries	Corn on cob
Brussel Sprouts	Peas	Cranberries	
Cabbage	Potatoes	Currants	
Dates	Prunes	Mushrooms	
Figs	Radishes	Cherry Tomatoes	
Grapes	Rhubarb		
Greens	Rutabegas		
Kale			
Kholrabi			

Table 5: Advertised Produce from the *Bozeman Chronicle*, 1920-1950
1920s

By the each	By the pound	Other
Head Lettuce, small		Apples by the lot
Head Lettuce, large		Apples by the small lot
Lemons (per dozen)		
Grapefruit (2 for 25 cents)		
Grapefruit (4 for 25 cents)		
Apples		

1930s

By the each	By the pound	Other
Oranges (per dozen)	Celery	Apples by the box
Head Lettuce	Onions (10 lb. bags)	
Bunch Carrots	Potatoes (20 lb. bags)	
Bunch Turnips	Spinach (unbundled)	
	Parsnips	

1940s

By the each	By the pound	Other
Avocados	Asparagus (bunched)	Apples by the box
Head Lettuce	Cabbage	
Lemons (per dozen)	Broccoli	
Grapefruit (4 for 25 cents)	Cauliflower	
Grapefruit (33 cents per dozen)	Tomatoes	
Oranges (per dozen)	Watermelons	
Bunch carrots	Peaches	
Bunch radishes	Rhubarb	
Bunch beets		
Green onions		

Table 5: Advertised Produce from the *Bozeman Chronicle*, 1920-1950, Continued
1950s

By the each	By the Pound	Other
<i>Grapefruit*</i>	<i>Grapefruit</i>	Pears by the lug
<i>Cantaloupe</i>	<i>Cantaloupe</i>	Pears by the half bushel
<i>Lemons (per dozen)</i>	<i>Lemons</i>	Tomatoes in 12 oz packages
<i>Cucumbers</i>	<i>Cucumbers</i>	
<i>Oranges (per dozen)</i>	<i>Oranges (5 lb. bags)</i>	
Pomegranates	Apples	
Avocados	Green bell peppers	
	Head lettuce	
	Bananas	
	Cauliflower	
	Celery	
	Onions	

* items in italics were observed under both by the each and by the pound pricing.

Table 6: Means for ungrouped data, **Sample A**

Variable	N	Mean	Standard Dev.	Minimum	Maximum
Each	2266	0.41	0.50	0.00	1.00
Pound Price (\$/lb.)	2266	1.18	0.90	0.09	11.39
Weight Deviation (oz)	2266	2.15	5.83	0.02	76.16
Value Deviation (\$)	2266	0.09	0.13	0.001	2.01
Alter Quality	2266	0.22	0.42	0.00	1.00
Inedible	2266	0.01	0.12	0.00	1.00
Purchase Size (2-3)	2266	0.30	0.46	0.00	1.00
Purchase Size (4+)	2266	0.33	0.47	0.00	1.00

Table 7: Means for ungrouped data, **Sample B**

Variable	N	Mean	Standard Dev.	Minimum	Maximum
Each	1041	0.46	0.50	0.00	1.00
Pound Price (\$/lb.)	1041	1.54	1.32	0.16	9.90
Weight Deviation (oz)	1041	2.56	5.83	0.09	105.90
Value Deviation (\$)	1041	0.15	0.18	0.005	1.94
Alter Quality	1041	0.24	0.43	0.00	1.00
Inedible	1041	0.01	0.10	0.00	1.00
Purchase Size (2-3)	1041	0.26	0.44	0.00	1.00
Purchase Size (4+)	1041	0.24	0.43	0.00	1.00

Table 8: Means for grouped data, Sample A

Variable	N	Mean	Standard Dev.	Minimum	Maximum
Each	44	0.41	0.50	0.00	1.00
Pound Price	44	1.13	0.59	0.17	2.92
Weight Deviation	44	3.15	8.47	0.03	44.01
Value Deviation	44	0.09	0.11	0.01	0.59
Purchase Size	44	3.48	2.63	1.00	10.00

Table 9: Means for grouped data, **Sample B**

Variable	N	Mean	Standard Dev.	Minimum	Maximum
Each	44	0.50	0.51	0.00	1.00
Pound Price	44	1.94	1.56	0.34	6.56
Weight Deviation	44	3.20	8.86	0.20	59.47
Value Deviation	44	0.19	0.20	0.02	1.16
Purchase Size	44	2.56	2.14	1.00	10.00

Table 10: Logit Estimates and Marginal Effects Ungrouped Data, **Sample A**

Variable	Model 1		Model 2		Model 3	
	Coefficient	Marginal Effect	Coefficient	Marginal Effect	Coefficient	Marginal Effect
Intercept	0.60 (0.11)***		0.04 (0.15)		0.15 (0.15)	
Value Variation	-7.64 (0.73)***	-0.22	-5.79 (1.27)**			
Pound Price			0.49 (0.08)***	-0.07 ¹	0.30 (0.06)***	0.03
Weight Deviation			-0.11 (0.06)*	-0.28 ¹	-0.35 (0.04)***	-0.02
Alter Quality	0.39 (0.12)***	0.09	0.37 (0.12)***	0.09	0.40 (0.12)***	0.09
Inedible	2.63 (0.48)***	0.59	1.54 (0.46)***	0.35	1.30 (0.43)***	0.29
Purch Size(2-3)	0.12 (0.12)		0.05 (0.12)		0.06 (0.12)	
Purch Size(4 +)	-1.77 (0.14)***	-0.40	-1.75 (0.14)***	-0.40	-1.67 (0.14)***	-0.37
lnL	-1315.04		-1261.89		-1271.24	

N=2266

¹ marginal impact of Pound Price at the mean of Weight Deviation, and vice versa

Standard errors are in parentheses.

* statistically significant at the .10 level. ** statistically significant at the .05 level.

*** statistically significant at the .01 level.

Table 11: Logit Estimates and Marginal Effects Ungrouped Data, Sample B

Variable	Model 1		Model 2		Model 3	
	Coefficient	Marginal Effect	Coefficient	Marginal Effect	Coefficient	Marginal Effect
Intercept	0.34 (0.15)**		0.14 (0.20)		0.05 (0.21)	
Value Variation	-2.30 (0.51)***	-0.10	-2.93 (0.84)***			
Pound Price			0.37 (0.08)***	-0.62 ¹	0.20 (0.06)***	0.06
Weight Deviation			-0.01 (0.04)	-1.70 ¹	-0.14 (0.04)***	-0.27
Alter Quality	0.36 (0.16)**	0.09	0.39 (0.17)**	0.10	0.37 (0.16)**	0.09
Inedible	2.09 (1.11)***	0.72	2.28 (1.07)**	0.57	2.32 (1.09)**	0.56
Purch Size(2-3)	0.45 (0.17)***	0.10	0.42 (0.18)**	0.10	0.47 (0.18)***	0.11
Purch Size(4 +)	-1.84 (0.21)***	-0.46	-1.70 (0.22)***	-0.43	-1.61 (0.23)***	-0.39
lnL	-630.78		-606.49		-612.34	

N=1041

¹ marginal impact of Pound Price at the mean of Weight Deviation, and vice versa

Standard errors are in parentheses.

* statistically significant at the .10 level. ** statistically significant at the .05 level.

*** statistically significant at the .01 level.

Table 12: Grouped Data Logit Estimates, Sample A

Variable	Model 1		Model 2		Model 3	
	Coefficient	Marginal Effect	Coefficient	Marginal Effect	Coefficient	Marginal Effect
Intercept	5.02 (2.04)**		3.60 (3.14)		3.65 (3.08)	
Value Deviation	-33.72 (14.97)**	-0.59	0.15 (2.09)			
Pound Price			0.75 (1.47)		0.82 (1.14)	
Weight Deviation			-1.61 (1.56)		-1.52 (0.89)*	-0.50
Purch Size(2-3)	-1.93 (1.34)		-2.17 (1.84)		-2.24 (1.66)	
Purch Size(4+)	-6.15 (1.88)***	-1.20	-5.88 (2.58)**	-0.23	-5.99 (2.11)**	-0.23
lnL	-17.46		-14.63		-14.81	

N=44

Standard errors are in parentheses

* statistically significant at the .10 level.

** statistically significant at the .05 level.

*** statistically significant at the .01 level.

Table 13: Grouped Data Logit Estimates, Sample B

Variable	Model 1		Model 2		Model 3	
	Coefficient	Marginal Effect	Coefficient	Marginal Effect	Coefficient	Marginal Effect
Intercept	3.79 (1.57)**		5.79 (2.25)***		5.69 (2.18)***	
Value Deviation	-13.02 (5.68)**	-0.59	-0.41 (0.53)			
Pound Price			-0.46 (0.58)		-0.81 (0.39)**	-0.18
Weight Deviation			-0.91 (0.58)	-2.00	-1.22 (0.48)***	-1.14
Purch Size(2-3)	-1.68 (1.18)		-2.29 (1.39)*	-0.37	-2.08 (1.28)	
Purch Size(4+)	-4.71 (1.60)***	-1.12	-5.82 (1.90)***	-0.98	-5.36 (1.73)***	-0.75
lnL	-23.34		-20.86		-21.17	

N=44

Standard errors are in parentheses

* statistically significant at the .10 level.

** statistically significant at the .05 level.

*** statistically significant at the .01 level.

Table 14: Grouped Data Logit Estimates, Sample A

Variable	Model 1		Model 2		Model 3	
	Coefficient	Marginal Effect	Coefficient	Marginal Effect	Coefficient	Marginal Effect
Intercept	11.83 (3.94) ^{***}		9.21 (5.99)		8.31 (5.59)	
Value Deviation	-62.51 (25.50) ^{**}	-0.41	-1.85 (2.05)			
Pound Price			1.47 (2.37)		-0.54 (2.01)	
Weight Deviation			-1.29 (1.51)	-0.27 ¹	-2.36 (1.39) [*]	-0.08
Purch Size	-2.62 (0.82) ^{***}	-0.13	-2.43 (1.06) ^{**}	-0.02	-2.06 (0.86) ^{**}	-0.01
lnL	-12.02		-10.07		-10.43	

N=44
Standard errors are in parentheses
¹ marginal impact of Pound Price at the mean of Weight Deviation, and vice versa
^{*} statistically significant at the .10 level. ^{**} statistically significant at the .05 level.
^{***} statistically significant at the .01 level.

Table 15: Grouped Data Logit Estimates, **Sample B**

Variable	Model 1		Model 2		Model 3	
	Coefficient	Marginal Effect	Coefficient	Marginal Effect	Coefficient	Marginal Effect
Intercept	6.64 (2.17) ^{***}		9.14 (3.18) ^{***}		8.63 (2.89) ^{***}	
Value Deviation	-16.49 (5.95) ^{***}	-0.71	-0.76 (0.59)			
Pound Price			-0.30 (0.61)	-0.38 ¹	-0.95 (0.39) ^{**}	-0.14
Weight Deviation			-0.90 (0.63)	-1.83 ¹	-1.46 (0.53) ^{***}	-0.91
Purch Size	-1.61 (0.55) ^{***}	-0.40	-2.01 (0.71) ^{***}	-0.20	-1.74 (0.60) ^{***}	-0.17
lnL	-20.27		-17.78		-18.65	

N=44

Standard errors are in parentheses

¹ marginal impact of Pound Price at the mean of Weight Deviation, and vice versa

* statistically significant at the .10 level. ** statistically significant at the .05 level.

*** statistically significant at the .01 level.

Table 16: t-tests for Red Bell Peppers

Sample A

Variable = Value Deviation			
	N	Mean	Difference
By the pound	25	0.10	0 cents t = -0.06
By the each	25	0.10	

Sample B

Variable = Value Deviation			
	N	Mean	Difference
By the pound	9	0.15	1 cent t = -0.21
By the each	19	0.16	

Table 17: t-test for Eggplants

Sample A

Variable = Value Deviation			
	N	Mean	Difference
By the pound	11	0.17	8 cents t = 1.35
By the each	35	0.09	

Sample B

Variable = Value Deviation			
	N	Mean	Difference
By the pound	9	0.21	6 cents t = 1.32
By the each	17	0.15	

Table 18: t-test for Iceberg Lettuce

Sample A

Variable = Value Deviation			
	N	Mean	Difference
By the pound	40	0.14	4 cents t = 2.13
By the each	19	0.10	

Sample B

Variable = Value Deviation			
	N	Mean	Difference
By the pound	22	0.24	13 cents t = 4.31
By the each	9	0.11	

Table 19: t-tests for Garlic Heads

Sample A

Variable = Value Deviation			
	N	Mean	Difference
By the pound	23	0.08	4 cents t = 4.73
By the each	31	0.04	

Sample B

Variable = Value Deviation			
	N	Mean	Difference
By the pound	12	0.04	1 cents t = 0.85
By the each	17	0.03	

Table 20: t-tests for Albertson's Red and Blue Band Celery

Sample A

Variable = Value Deviation			
	N	Mean	Difference
By the pound (Blue Band)	10	0.14	7 cents t = 2.26
By the each (Red Band)	11	0.07	

Sample B

Variable = Value Deviation			
	N	Mean	Difference
By the pound (Blue Band)	6	0.13	6 cents t = 3.68
By the each (Red Band)	6	0.07	

Table 21: t-tests for Red and Green Bell Peppers

Sample A

Variable = Value Deviation			
	N	Mean	Difference
Red Bell Peppers 47% sold by each	50	0.10	5 cents t = 3.66
Green Bell Peppers 100% sold by each	69	0.05	

Sample B

Variable = Value Deviation			
	N	Mean	Difference
Red Bell Peppers 77% sold by each	28	0.16	9 cents t = 3.53
Green Bell Peppers 100% sold by each	28	0.07	

Table 22: t-tests for Grapefruits

Sample A

Variable = Value Deviation			
	N	Mean	Difference
By the pound	35	0.07	4 cents t = 5.38
By the each	32	0.03	

Sample B

Variable = Value Deviation			
	N	Mean	Difference
By the pound	21	0.11	8 cents t = 5.77
By the each	15	0.03	