Analyzing The Prices from a Vertical Exchange Mechanism: An Implicit Price Approach
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Jesse and Johnson demonstrated that different contract specifications resulted in different negotiated contract prices. Although the study made a significant contribution to the understanding of factors which affect contract price, the underlying mechanism which generated the different contract prices was not explored. Rosen developed the generating mechanism for the implicit prices of utility bearing attributes of consumer goods. This paper develops the generating mechanism of the implicit prices associated with the marginal value product bearing services associated with the vertical coordinating mechanism used in intermediate markets.

It is hypothesized that there are numerous services and level of services associated with the use of vertical exchange mechanisms [Carl]. Implicit payments are made and received for these service factors, which affect observed prices. The model developed in this paper follows closely the consumer markets article by Rosen in which Rosen uses the hedonic hypothesis that the consumer goods are valued by their utility bearing characteristics.

Examining The Services of a Vertical Exchange Mechanism

When an agricultural good is exchanged between buyer and seller, there are actually two exchanges occurring. The physical good itself is being bought and sold, and payment for services associated with the vertical exchange mechanism is also being made. For example, services associated with use of the spot market would include auction facilities, published price information, the network of transportation to and from the market and technology factors dealing with packaging the product for
transport. In contracting, written specifications pertaining to quality level, special treatment or handling of the product, variety specifications, and determination of when the output will be harvested are all examples of service characteristics which may accompany exchange of the physical good.

The physical good itself will be called the "base good". It is perfectly homogeneous, with no special characteristics of any kind except some composite quality based on industry averages. No services would be attached to it (such as the above service characteristics). Each specific action on the part of those handling the agricultural good are thus part of the "package of services" associated with each vertical exchange mechanism. The base good is identical among exchange mechanisms; the services associated with each mechanism differ, however.

Components of Observed Price

One price is observed in the exchange of the product between seller and buyer. Separate prices for the base good and for each service factor included in the exchange are not observed except for market priced services such as transportation. Each service factor does affect the observed price, and the observed price can be divided into the base good price and payment for each service factor. Equation (1) illustrates this relationship.

\[
(1) \quad P_{EX_i} = P_B + \sum_{j=1}^{r} P_{se_{i,j}} + \sum_{k=1}^{h} P_{m_{i,k}}
\]

where \( P_{EX_i} \) is the observed exchange price on a per-unit basis in each vertical exchange mechanism; \( P_B \) is the base good price on a per-unit basis (It has no subscript because it is identical among all vertical exchange mechanisms); \( P_{se_{i,j}} \) is the weighted sum of r exchange service payments in the \( i^{th} \) vertical exchange mechanism (for example, if \( se_1 \) is a
0-1 variable, its value is simply zero or $P_{se1}$, whereas if it is a continuous variable, its value is $P_{se1}$ times the level of that service offered) and $P_{m_{1,k}}$ is the per-unit cost of service $k$ for which a market price exists.

Services which are demanded by the seller will have a negative effect on price, but services which are demanded by the buyer will have a positive effect on the observed exchange price. This conclusion is intuitive. For the seller to "pay for" services he desired, he would "pay" by accepting a lower exchange price; the buyer would pay for these services directly, which would increase the exchange price.

Equation (1) implies a separate price for each service supplied and demanded in a transaction. These individual prices are not empirically observed, except as market commissions and transportation charges, etc., are directly observed. Yet, if these service factors have value to either party, it is reasonable to expect that indirect payments are made to these factors. These payments are called "implicit prices" [Rosen].

Equation (1) suggests that one manner in which observed prices can be analyzed is to relate implicit service prices to observed exchange price. This approach is basically what is entailed in hedonics. Hedonic prices have been defined as "the implicit prices of attributes and are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them" [Rosen, page 34]. Rosen developed the generating mechanism of implicit prices for consumer products. The next section follows Rosen and develops the generating mechanism of implicit prices for factor market products. This mechanism can be used to analyze the price differences within a vertical mechanism.
Implicit Price Analysis of a Vertical Exchange Mechanism

If each (many) transaction(s) through a coordinating mechanism contain different services or characteristics, it will be assumed that each transaction represents a differentiated product. Therefore, as each party evaluates each available service in determining his optimal combination of services, then he is considered to be evaluating differentiated products.

For illustrative purposes, determining the level of quality will be considered. Let a grower have the option of utilizing different levels of labor in producing different levels of quality in his product. This improved quality would be a service factor if a grower (seller) and processor (buyer) agreed (either explicitly or implicitly) upon a given level of quality in advance. The grower's production function would then consist of the joint output of the base good quantity \( (M_s) \) and the service of quality, \( se_q \); his only variable input would be labor, \( x \). This is shown in Equation (2).

\[
(2) \quad [M_s, se_q] = f(x)
\]

where the variables are as defined. Assuming that prices are competitively determined by the market, the grower's profit function would be in the form of Equation (3).

\[
(3) \quad \pi_s = M_s \cdot p[se_q] \cdot P_x \cdot x
\]

where \( M_s \) is the base quantity, \( p[se_q] \) is the product market price which is a function of \( se_q \), \( se_q \) is the exchange service of quality, \( P_x \) is the variable input price of labor (x). Since \( M_s \) and \( se_q \) are technically interdependent, it is a joint output. The inverse function \( x = g(M_s, se_q) \) can be substituted into the profit function for \( x \) (Equation (4)). Equations
(5) and (6) show first order conditions which determine the optimal level of \( M_s \) and \( se_q \) that maximize profits.

\[
(4) \quad \pi_s = M_s p[se_q] - P_x f[M_s, se_q]
\]

\[
(5) \quad \frac{\partial \pi_s}{\partial M_s} = p[se_q] - P_x \frac{\partial f[M_s, se_q]}{\partial M_s} = 0
\]

\[
(6) \quad \frac{\partial \pi_s}{\partial se_q} = M_s \frac{\partial p[se_q]}{\partial se_q} - P_x \frac{\partial f[M_s, se_q]}{\partial se_q} = 0
\]

Solving (5) and (6) will give the optimal levels of \( M_s \) and \( se_q \) which maximize profit. Once the optimal levels of output \( (M_s^*) \) and quality \( (se_q^*) \) are determined, the optimum level of output and the maximum level of profit will be fixed at the competitive levels \( (M_s^*, \pi_s^*) \) (Equation (7)).

\[
(7) \quad \pi_s^* = M_s^* p[se_q^*] - P_x f[M_s^*, se_q^*]
\]

In order to determine the output price \( p[se_q] \) required for alternate levels of quality \( (se_q) \) per-unit of output, the iso-profit function (Equation (7)) is divided by the optimum output \( (M_s^*) \). The resulting function has unit profit \( (\pi_s^* / M_s^*) \) and the input price \( (P_x) \) as parameters and the level of quality per-unit of output as a variable (Equation (8)).

\[
(8) \quad C_a = g[se_q; \pi_s^* / M_s^*, P_x^*]
\]

Assuming that the grower is in region two of his production function where the marginal product of fertilizer is decreasing, then Equation (8) gives the offer price the seller is willing to accept per-unit of product produced for various levels of quality \( (se_q) \) at a constant profit \( (\pi_s^*) \).

Figure 1 illustrates one such offer curve \( (C_a) \) for the grower producing different levels of quality when unit profit is fixed. Different
Figure 1. Sample hedonic plane representing different observed contract prices based on different levels of service exchanged.
Levels of quality correspond to different output prices. $P_1$ is greater than $P_0$ because the level of quality is greater at $se_q$. Since it is assumed that the marginal product of the input is decreasing, in order to maintain a constant profit level the grower would have to receive an increasingly higher price for high levels of quality (the service output). Thus, the offer curve is increasing at an increasing rate.

In order for exchange to occur, a buyer must be willing to purchase the joint product of base good plus the exchange service of quality at the level and price the grower is willing to produce. Thus, examination of the processor's production function is presented in Equation (9). The two variable inputs are $M_b$ and $se_q$.

$$(9) \quad Y = h(M_b, se_q)$$

where $Y$ is the processor's output. If prices are competitively determined, the processor's profit function would be of the form of Equation (10).

$$(10) \quad \pi_b = P_y h[M_b, se_q] - P[se_q] M_b$$

Maximizing (10) with respect to $M_b$ and $se_q$ reveals the processor's derived demand for the base good and the service of quality (Equation (11), (12)).

$$(11) \quad \frac{\partial \pi}{\partial M_b} = P_y \frac{\partial h[M_b, se_q]}{\partial M_b} - P[se_q] = 0$$

$$(12) \quad \frac{\partial \pi}{\partial se_q} = P_y \frac{\partial h[M_b, se_q]}{\partial se_q} - M_b \frac{\partial P}{\partial se_q} = 0$$

Solving (11) and (12) will give the optimal levels of $M_b$ and $se_q$ which maximize profit. Once the optimal levels of input ($M_b^*$) and quality ($se^*_q$) are determined, the optimal level of input ($M_b^*$) and the maximum level of profit will be fixed at the competitive levels ($M_b^*$, $\pi_b^*$) in (13).
\( \pi_b^* = P_y h[M_b^*, se_q^*] - P[se_q^*] M_b^* \)

In order to determine the input price \( p[se_q] \) required for alternate levels of quality \( se_q \) per-unit, the iso-profit function (13) is divided by the optimum output \( (M_b^*) \). The resulting function has unit profit \( (\pi_b^*/M_b^*) \) and the output price \( (P_y) \) as parameters and the unit level of quality as a variable (14).

\( RP_g = I[se_q; \pi_b^*/M_b^*, P_y^*] \)

Assuming that the processor is in region two of his production function so that the marginal product of each input is decreasing, the bid curve (14) increases at a decreasing rate because the marginal product of \( se_q \) is decreasing. In order to keep profit at the set level, the processor must pay increasingly less for each additional unit of quality because it adds less to total revenue. \( P_1 \) exceeds \( P_0 \) because the level of quality at \( se_{q_2} \) exceeds the level of quality at \( se_{q_1} \).

If grower and processor successfully negotiate an exchange, then these two surfaces \( (G_a \text{ and } RP_g) \) must be tangent to one another at some point. At that point, the level of services and the unit output price will be mutually determined. One such equilibrium point is depicted in Figure 1 \( (P_0) \). Figure 1 also illustrates two different grower locations, representing different observed prices \( (P_0 \text{ and } P_2) \) based on different levels of the service of quality arranged between two different growers and processors.

All firms will not meet at the same equilibrium point unless they have identical production functions, face identical input and output prices and identical attitudes toward risk. Otherwise, different firms with different levels of a characteristic will represent different
observed exchange points. The several different points of equilibrium between buyers and sellers exchanging different levels of the service of quality, map out the hedonic plane (Figure 1). The first derivative of the hedonic function \( p[s_{e, q}] \) with respect to \( s_{e, q} \) gives the marginal implicit price per-unit of quality \( (s_{e, q}) \). That is, the product price changes by a certain amount as quality is increased by one unit. If the functional form of \( p[s_{e, q}] \) is linear, the marginal implicit price per-unit increase in quality is a constant for all levels of quality.

The above model can be easily extended to \( n \) characteristics services and can be used to measure the implicit prices of multiple services provided to the buyer and seller. The different equilibrium points (Figure 1) account for differences in observed exchange price within the same coordinating mechanism. A cross-section regression model analysis with variability in services among the individual observations provides estimates of the implicit prices of services (15).

\[
(15) \quad p_{EX_i} = \beta + \sum_{j=1}^{r} \beta_{se_{i,j}} s_{e_{i,j}} + \sum_{k=1}^{h} \beta_{m_{i,k}} m_{i,k} + \epsilon_i
\]

where the terms are as previously defined except "\(^{\wedge}\)" indicates a regression estimated coefficient, \( i \) indicates the observation number, and \( \epsilon_i \) is the error term associated with observation \( i \).

Applications

This model can be used in empirical applications by individuals evaluating available alternatives, and market analysts examining market performance. Evaluating market performance in thinly-traded spot markets, or comparing prices among alternate vertical exchange mechanisms have both posed problems of interpretation for agricultural economists. With few observations, how reliable are observed prices in terms of "perfect
competition" values? Or when observed prices differ between spot markets and contracting, is there evidence of imperfect competition on this basis? A hedonic price analysis, as applied in the present context, can help answer these questions. From the individual point of view, knowing the implicit price of one service characteristic, both seller and buyer could then evaluate the marginal price relative to their own function to determine the amount of that characteristic they would be willing to buy or sell at that price.

Examples of each application may help illustrate. When markets which were once heavily traded decline in volume, concern may increase as to whether or not observed prices reflect true supply and demand forces. A hedonic price analysis of services associated with that market using time series analysis of such markets during their heavy-volume period could help establish implicit service prices. These values could then be compared to estimates for the same services under present conditions. Changes in estimated values for the same service, especially if accompanied by evidence of market concentration or other factors, could be interpreted as evidence of market problems. Conversely, given that production and consumption factors had not also changed between the two time periods, consistent implicit prices for services would be evidence that the market was still functioning well.

The approach could be useful in industrial organization research. For example, if one assumes that the difference in price between private label corn flakes and Kellogg's Corn Flakes is due to differences in the attendant services plus some market failures—such as monopoly power—then if one could identify the implicit prices due to quality difference, company reputation and other services, the residual difference could be attributed
to monopoly power and other market failures. We can see some problems but if implicit prices could be determined, it would help answer the question of the extent to which price differences are due to product service differences.

The other main application of this type of analysis would be for the individual. Knowing the estimated value of service prices, buyers and sellers could use that marginal value to equate marginal cost and marginal benefit to determine the amount, if any, they would buy or sell of any given service. This would be useful in negotiating contracts.

Although it is not suggested here that this methodology will provide a normative tool by which economists can measure the performance of individual negotiations for contracts, or entire markets, this information could be used in conjunction with other measures of market performance to add to available information for individuals and market analysts.

Caveats

Performing either cross-section or time-series, or pooled analysis using hedonics one would probably encounter at least two difficulties with data. First, in examining individual contracts, prices and contract specifications are generally not published. Thus, information about services and prices in contracts can be difficult to obtain and expensive to collect. Also, it is likely that the more concentrated the buying and/or selling side is, the more difficult it would be to obtain this information.

In collecting time series information, again, availability of data of sufficient historical length can also be a problem. Central agencies often will not have complete series of individual market characteristics, or the market services will change sufficiently over time that time-series analysis become meaningless.

A second difficulty may arise after data is collected. There may be
little variation in service characteristics, especially in contracts. This lack of variability may result from a homogeneous group of buyers and sellers in a given market, but the higher the degree of homogeneity of the production functions of buyers (sellers), the less likely will be the observation of great differences in contract specifications. Since each firm would be maximizing its function, as individual production functions approach uniformity, contract specifications should also approach uniformity. Variation is necessary to establish implicit prices for services.

Summary and Conclusions

The purpose of this paper was to present the generating mechanism of the implicit prices associated with various services available through a vertical coordinating mechanism. It was found that for services associated with a vertical coordinating mechanism which were not explicitly valued by a market, an implicit price could be estimated based on the exchange price of the product and the services of value associated with that good.

References

