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Too Much of a Good Thing?

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WELFARE EFFECTS OF ECO-LABEL PROLIFERATION: TOO MUCH OF A GOOD THING?

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ABSTRACT— Given that existing food eco-labels are still not well defined in consumers' experience, there is potential for new labels to generate more confusion. Consumers incur fixed costs to learn about a label's meaning. Market shares for existing certifications may be eroded by perceptions that new products are good substitutes for them. The eco-label certifier must respond with information that reduces these costs or lose consumer and producer confidence in the label. Using a model of spatial competition in attribute space, the effect of search costs and educational expenditures on market share and price for competing certifiers is simulated. The results show that educational spending and/or improvements in efficiency of educational spending increase market share when consumer search costs are positive. Underspending on consumer education reduces the price a firm is able to charge within its market niche. The consumer and producer surplus effects of new certifier entry are calculated using a simulation model of market segmentation. Under the assumptions made, segmentation reduces producer surplus while keeping consumer surplus about the same. Market prices decline due to associated search costs as share is captured from the conventional segment by eco-labels. Within segments, consumers gain at the expense of producers, even if market share is maintained by existing eco-labelers after entry of new labels, and even if consumer search costs decline.

-----KEY WORDS-----

eco-labeling, market segmentation, organic agriculture, product differentiation, search costs, simulation, spatial competition

Welfare Effects of Eco-label Proliferation: Too Much of a Good Thing?

I. Introduction

An eco-label differentiates a food product that a consumer would find otherwise indistinguishable from the same item grown using functionally equivalent inputs. The label itself is an indicator of voluntary compliance with third party standards for environmentally and socially preferred production methods. Eco-labels have been used since the 1970s for a variety of nonfood products covered by more than two dozen programs in Europe, Asia and North America (Erickson and Kramer-LeBlanc). In the food industry, besides organic certification there are more than a dozen certifications for environment-oriented production systems that permit minimal chemical use (The Food Alliance, unpublished). Consumer interest in purchasing "green" characteristics in food products is growing, as evidenced by national and regional surveys documenting consumers' interest in obtaining environmental benefits with their purchases (Lefferts; The Hartman Group, 1996; The Food Alliance [TFA]).

Eco-label programs appeal to producers who envision market recognition in the form of higher market share or price premiums for investments in "green" technologies (Erickson and Kramer-LeBlanc). The production process cannot be discerned by organoleptic characteristics of the food item, so consumers cannot observe whether the item contains the attributes they seek. The producer can transmit this information to the consumer via a label. Credibility of the label and clarity of the information conveyed are essential for labels to improve market efficiency. The certifier assures product integrity and conformance to label requirements by inspection of the producer's operation. Eco-labeling organizations design the criteria used.

The more different eco-labels there are, the more likely a consumer will find a product in the market that exactly matches his or her ideal characteristics set for the product class. Yet, unless new consumers are attracted to a market, a successful new eco-label reduces market share for existing categories of a good if it is closer to what some consumers want than any other product in the market. This process was termed cannibalization by Scherer, and is more severe the more closely the new product substitutes for an existing product.

If a new eco-label certifies characteristics that are similar to an existing label or are perceived to be similar, the products are likely to be seen as good substitutes by consumers. The nature of the label affects the quality of information transmitted, with single attribute certifications being more comprehensible than multi-attribute (report card) labels (Erickson and Kramer-LeBlanc; The Hartman Group, 1997). Seals of approval by certifying organizations can be granted for either type, and offer a visual cue as to the underlying characteristics set. Vagueness in the characteristics set being certified is more likely to result in consumer confusion about the label's meaning and its distinction from other labels. Consumers may then perceive greater substitutability among labeled products than is the true case.

Terms like "sustainably produced" or "responsibly produced" may vary by certifying organization and generate confusion over the exact characteristics of the product. For example, consumers may believe "sustainably produced" is a substitute for "organically produced" or "IPM-certified" because these all suggest reduced chemical use, which may be the characteristic the consumer is seeking. Given that existing eco-labels (such as organic and residue-free) are still not well defined in consumers' experience (Gilbert), there is substantial potential for new labels with vague criteria that are not legally defined to generate more confusion.

This type of confusion raises two concerns among producers and certifying organizations. First, fixed costs to consumers of learning about and understanding a label's meaning, identifying desired products, and verifying the certification increase. Even if consumers can differentiate the labels, they may have difficulty accessing the desired products if the item is not available where they normally shop or is not easily located within a store. The eco-label certifier[1] must then respond in some way that reduces these costs or lose consumer and producer confidence in the label. The response could include improvement in quality or quantity of information transmitted, which would entail spending more on consumer education.

A second concern is that market shares for existing certifications will be eroded by perceptions that new products are good substitutes for them. Organic certifiers have expended substantial effort building recognition of their labels, even to the point of proposing national certification requirements. Even after more than 10 years of educational efforts, consumers are still confused about the meaning of an organic label. Entry of new eco-labeled products with similar sounding process requirements could increase confusion so that product distinction is more difficult. If the new products are less expensive than organics and are perceived to deliver the same benefits, consumers will choose the eco-labeled products over organic products.

The objective of this paper is to evaluate the effects of information costs and market segmentation on consumers, producers and certifiers. In Sections II and III, the relative position of eco-labeled foods and consumer behavior with respect to eco-labeled foods is described. Section IV models certifier behavior and the effect of information costs on market share with an application to fresh carrots. Section V quantifies producer and consumer surpluses in segmented markets for eco-labelled carrots. Section VI focuses on policy implications of the results.

II. Relative Market Position of Eco-labeled Foods

The market for eco-labeled foods may be described by a continuum of sustainable food production processes, with increased ecological compatibility associated with increased costs. Figure 1 describes this continuum for crop production with conventional agricultural systems, defined as those that use synthetic chemicals and which do not require soil enhancement and water quality protection, at one extreme and organic, defined as using no synthetic chemicals and emphasizing soil and water quality protection and improvement, at the other extreme.[2]

Other "sustainable" certifications fall somewhere along the continuum. The closer to an existing product, the greater the substitutability of the new product. Figure 1 shows the location of integrated pest management (IPM), which relies on pest scouting, biological treatments and synthetic chemical applications when necessary to control economic loss. IPM lies relatively closer to conventional production on the continuum because synthetic chemicals are permitted and resource management is related to production efficiency (Hollingsworth, Coli and Hazzard; Govindasamy, Italia and Rabin). "Eco-X" is a proxy for eco-labeled systems that incorporate reduced chemical principles and explicit goals for soil and water quality protection, such as The Food Alliance eco-label (TFA, unpublished). As defined here, an "Eco-X" system would be relatively closer to organic on the continuum.

For any given crop, organic standards are the most difficult to meet, the most costly for producers and typically more expensive for consumers. Costs are higher for several reasons. Physical transition costs are penalties in yield or cost due to agroecosystem adjustments and management inefficiencies while learning new practices (Irwin Hewitt and Lohr, 1995). Management cost penalties may be reduced by farmer education, but biophysical adjustments are determined by crop, current practices and farm situation. The most important financial constraints during conversion are lack of access to premium prices until conversion is complete, conversion-related investments and disinvestments and information-gathering costs for production and marketing (Padel and Lampkin). There is substantially less information about designing organic systems and less current research on organic methods and markets than for other systems (Lipson). Price premiums over conventional foods average 30 percent, but vary by type of product, local supply, outlet type and other factors

Conventional practices are the easiest and least costly to follow and cheapest for consumers.[3] University and private sector researchers, extensionists, and industry sales people provide information support for conventional systems. Natural capital, such as soil organic matter, is not of concern for conventional systems, so substitutions of chemical inputs may be made without regard to the impact on soil ecology. Inputs are readily available and marketing is relatively uncomplicated and highly integrated for most products, reducing associated costs.

An eco-labeled product may not cost more than it conventional counterpart, depending on technology selected and its similarity to existing practices. For example, IPM technology is well established for many crops and information and materials needed are readily available. Although consumers state a willingness to pay more for IPM-certified crops (Govindasamy, Italia and Rabin; Anderson *et al.*), they are often sold at no premium over conventional. The more change a certifiable production system requires from existing practices, the more costly conversion will be. Similarly, the more stringent the requirements for certification and the more quality dimensions certified, the more costly is the process for the producer.

If the horizontal line in Figure 1 is viewed as an attribute axis and also contains the entire market availability of a good, from conventional to organic, then entry of new eco-labeled products must cannibalize existing products' market shares. Which products lose and how much share a new entrant takes from the losers depends on the perceived quality-price tradeoffs made by consumers. For a market consisting of organic, IPM-certified and conventional foods, successful introduction of "Eco-X" at the point in Figure 1 could reduce the market share of any or all of the three alternatives.

The entire market may contract to a narrower attribute range. For example, the national emphasis on bringing agricultural land under IPM methods (Govindasamy, Italia and Rabin) could shift the right-hand endpoint of the continuum to become IPM as conventional is eliminated from the graph. The total market size would not be affected, but differentiation would become more difficult because the range of possible attributes is narrowed. Proliferation of labels in a smaller attribute space could increase market share of the remaining certifiers, but might also increase consumer confusion, reducing the chance to profit from differentiation.

III. Consumer Behavior

Consumers trade off price and quality, selecting the best quality products given prices and their budget constraints. Product attributes are subjectively judged and ranked to form a quality set (Lancaster). Each consumer conceptualizes an ideal level of the attributes. If a consumer's ideal attribute set is not represented in the market, then he or she must decide whether to compromise on one of the desired attributes using a quality-price tradeoff or not buy the product.

Consumers are willing to pay more the more closely the product matches their ideal, and pay a maximum for a perfect match. Figure 2 shows product attributes in price-quality space, where the quality may be any attribute of value to consumers, with more of the attribute implying unambiguously better quality. Willingness to pay for a product is higher as perceived quality increases, and to the extent that products can be differentiated by quality, higher prices may be charged by producers. Here, the relationship is shown to be curvilinear with a decreasing marginal willingness to pay for higher quality, although this is testable empirically for a given product. Product A commands a higher price than product B or any other lower quality product. The choice of product A or B depends on income and prices of other goods consumed.

If consumers believe no quality difference exists between two products, such as A and C in Figure 2, but A sells for a higher price, then those consumers who value the attribute will purchase C. If consumers face two equally priced products, such as B and C, but B is perceived to be lower quality, then consumers will purchase C. Suppose organic foods are represented by point A, IPM-certified foods by point B and "Eco-X" foods by point C. The quality measure might be reduction in synthetic chemical use. The perception of relative quality of the three products is critical in the choice the consumer makes. If "Eco-X" is perceived to be very close to organic on the attribute continuum shown in Figure 1 and is sold at the price for C in Figure 2, then "Eco-X" will take market share from both organic and IPM-certified products. Consumers attempt to maximize perceived quality subject to prices and their budget constraints.

The market for eco-labeled foods appears to be characterized by horizontal differentiation. This means consumers as a group display asymmetric preferences according to the location of a product on the continuum (Beath and Katsoulacos). Under horizontal differentiation, at equal prices, all products are sold in positive amounts. A consumer prefers the product closest to his or her ideal attribute ranking, which may not be the same as another consumer's ranking. Consumer studies indicate that even at a zero price premium, only 46 to 71 percent would purchase reduced chemical or organic products (The Hartman Group, 1996; Misra, Huang and Ott; The Packer).

However, The Hartman Group (1996) documented that respondents in their survey of 1,874 consumers who were unwilling to purchase sustainably produced foods had inadequate information about environmental issues or the connection between agriculture and the environment. This suggests that lack of information, rather than asymmetric preferences, may be responsible for the observed responses.

Certifiers prefer to view the market as vertically differentiated, in which quality ratings are consistent across consumers and higher quality products command higher prices. Further, certifiers tend to assume that a product that reduces synthetic chemicals more will be viewed as higher quality by all consumers. The Hartman Group's (1996) results confirmed the top environmental concerns of consumers in grocery product selection are pesticides in water, in the wildlife environment and as residues on food. Consumer surveys reviewed by Govindasamy, Italia and Rabin indicated pesticide residues and pesticide safety issues are significantly more important than other food hazards in consumer decisions.

Thus, there appears to be agreement on what attribute is important, but not the ranking of products in terms of best achieving this attribute. This disagreement is highlighted by a New Jersey survey by Govindasamy, Italia and Rabin which found that respondents were willing to pay higher premiums for IPM-certified than for organic produce, regardless of the premium level set. Disagreement among certifiers themselves as to ranking may be transmitted to consumers through the information provided about the relative benefits of the certifications.

There is insufficient information at this point to discern which is the true state since there is strong evidence of consumer confusion about the certification categories. A market that would display vertical differentiation if product attribute levels were well known might appear to be horizontally differentiated if there is confusion about relative quality. As a consequence, certifiers may underinvest in consumer education. The influence of educational spending is explicitly considered in the models that follow in Sections IV and V. In Section IV, the effect on market share and optimal firm price of consumer search costs and certifier expenditures to reduce these costs is explored.

IV. Certifier Behavior

Certifiers try to establish market share by selecting a location on the characteristic space between the extrema of organic and conventional certification.[4] Differentiation confers the opportunity to set price over the space occupied, but competition with certifiers adjacent in attribute space results in oligopolistic interdependence rather than pure monopoly power. Benson and Faminow showed that consumer confusion, high search costs, and imperfect information due to heterogeneous product/price offerings are not completely responsible for price differences under geographic competition. The same result may hold with attribute competition.

Typically, a certifying organization develops its standards in accordance with what it believes farmers will adopt, what consumers will buy and what the organization believes is socially important (TFA, unpublished). In this regard, it takes other certifiers' behavior as given, assumes that rivals will match price changes if necessary (but is not concerned if they do), and tries to maximize the market share around its location on the continuum. A certifier competes with firms adjacent to it in the characteristic space for the space between them. The farther the certifiers are from each other in the measure of the characteristic, the larger the market share each could potentially command, and the less likely their products are to be perceived as substitutes.

If new consumers are not attracted to the market with the new eco-label, shares will be cannibalized by adjacent certifiers (Scherer). Unlike cases cited by Conner where firms proliferate products proximal to their own location to take up space in the continuum and serve as barriers to entry, the high fixed costs of developing and certifying a standard prevent eco-labelers from doing this. A certifier also would not relocate on the continuum once a position is established because it is prohibitively expensive to do so. Choice of criteria for certification and education of consumers about the standards is critical for eco-labelers.

Consumers may incur search costs to learn about the various certifications, to identify and verify the product as matching the preferred certification and to physically locate the product for purchase. In return, certifiers spend money to provide educational materials in a variety of media to differentiate their certifications and to let consumers know where to purchase their products. This search cost, called consumption cost by Park and Florkowski, does not vary with the quantity purchased and is incurred at the exposure to the new certification. Because this is a fixed cost, the effectiveness of educational spending on reducing consumer search costs affects the intercept of the demand curve. Confusion due to certification proliferation can raise search costs and increase spending for all certifiers, even those already in the market. Investment in education by a certifier depends on the perceived information needs of the targeted consumers.

Landon and Smith showed that both individual firm and collective reputation based on previous quality evaluations are used by consumers as information for current product selection. Group designations and classification schemes have as large an effect on price premiums as that associated with individual firm reputation. This result implies that additional fixed educational costs are incurred by certifiers who relocate on the quality continuum.

The effect of consumption costs and educational spending on market share and price may be explored using a spatial competition model cast in characteristics space. Following Benson and Faminow's derivation for geographic spatial competition, let certifier A's profit function be

[illegible] **(1)**

where p_A is the certifier's price, k_A are variable costs, F_A are fixed production costs and M_A are fixed costs of educating consumers about the certification process and where to find products. The bracketed terms, explained below, constitute the aggregate demand for A's product, found by integrating linear demand from 0 to U, the distance in characteristic space over which A attracts customers. This form is substituted for quantity in the usual firm profit function.

The certifier's price is delivered price less the cost to the consumer of moving distance U to A's location. U is A's share of the total available market between A and its adjacent rival, B. The cost per unit distance is c, analogous to transportation cost in the location model, and here is given by the price premium, if any, between A and B. This is the cost to the consumer of moving to the new product.

The constants a and b are the intercept and slope parameters from the inverse demand curve, assumed to be linear. S_A is the net fixed consumption cost to the consumer of searching for A's product. The net search cost should be a negative function of the amount the certifier spends on education. Several forms would give an downward-sloping curve, but some, such as $1/M_A$ are undefined if the certifier spends nothing on education. I specify a linear form for S_A

$$S_A = s_A - gM_A \tag{2}$$

where s_A is the total consumer search cost for A's product and g is a positive constant that relates the effect of the firm's educational expenditure to net search cost. Firms are assumed not to spend more than would be required to educate consumers so that $s_A - gM_A \geq 0$.

Profit maximization for A requires that

$$\frac{d\pi_A}{dp_A} = U\left(a - 2p_A - \frac{cU}{2} - S_A + k_A\right) + \frac{dU}{dp_A}(p_A - k_A)(a - p_A - cU - S_A) = 0 \quad . \tag{3}$$

Benson and Faminow pointed out that under the assumption of Löschian behavior, firms assume their market boundaries are fixed, $dU/dp_A = 0$ and the second portion of the equation disappears. This is a reasonable assumption for certifiers, who tend to expect that the market share they capture is dependent on the quality offered, not the price. Adjacent rivals are expected to match price changes so that net change in market share is zero.

Solving equation (3) for firm A's price gives

$$p_A = \tfrac{1}{2}(a + k_A - S_A) - \frac{cU}{4} \qquad \textbf{(4)}$$

and solving a similar profit function for firm B, given Löschian behavior yields

$$p_B = \tfrac{1}{2}(a + k_B - S_B) - \frac{c(D - U)}{4} \qquad \textbf{(5)}$$

where D is the total market for which firms A and B compete, set equal to 1 to represent the total distance between rivals. Then (D-U) is firm B's share of the market between A and B.

In addition to the conditions in equations (4) and (5), firms share a common boundary that demarcates the consumer who is indifferent between A's and B's products, given quality and price differentials. This boundary occurs where

$$p_A + cU + S_A = p_B + c(D - U) + S_B \qquad \textbf{(6)}$$

Benson and Faminow demonstrated that a relatively efficient firm that has lower variable production costs also has lower price and larger geographic market share than its adjacent rival. However, the introduction of S_A can alter this result through search costs, firm expenditures on education and effectiveness of educational spending. If certifiers A and B are competing, they each face the requirement given in equation (3). The firms could face different positive net consumer search costs if either one of the products requires more effort on the part of the consumer or one firm spends more than the other on consumer education. I assume that the effectiveness of a dollar spent on consumer education is equivalent for each firm, although quality of marketing materials could conceivably alter this term as well.

Suppose firm A spends less on education than firm B, which might be the case for a certifier whose product characteristics are already well known, or whose product is easily found in markets. Then let $M_B = M_A + x$. Substituting these values and equation (2) into equations (4), (5) and (6) and solving the three equations simultaneously gives

$$U^* = \frac{(s_B - s_A - gx)}{3c} + \tfrac{1}{2}D \qquad \textbf{(7)}$$

for firm A's share of the market contested with firm B. Firm A's market share is more or less than half the distance between A and B by the amount that net search costs differ, divided by three times the price premium. The quotient in equation (7) is undefined for c equal to zero.

Optimal prices for firm A and B are given by

$$\begin{aligned} p_A^* &= \tfrac{1}{2}(a + k_A - S_A) - \frac{cD}{8} - \frac{(s_B - s_A - gx)}{12} \\ &= \tfrac{1}{2}\left[a + k_A - (s_A - gM_A)\right] - \frac{cD}{8} - \frac{(s_B - s_A - gx)}{12} \end{aligned} \qquad \textbf{(8)}$$

and

$$\begin{aligned} p_B^* &= \tfrac{1}{2}(a + k_B - S_B) - \frac{cD}{8} + \frac{(s_B - s_A - gx)}{12} \\ &= \tfrac{1}{2}\left\{a + k_B - \left[s_B - g(M_A + x)\right]\right\} - \frac{cD}{8} + \frac{(s_B - s_A - gx)}{12} \quad . \end{aligned} \qquad \textbf{(9)}$$

These will not necessarily be market prices, since they prevail in the contested space between the firms. In Section V, I determine prices that arise from market segmentation for aggregate demand and supply.

Connor suggested using the price differential between A's and B's products as the value for c, analogous to transportation costs in a spatial model. However, unlike transportation costs, the direction the consumer is moving (toward A or toward B) affects whether the premium is an additional burden on the consumer or a savings. If B's product is more expensive than A's, say organic vs. conventional, then firm B's optimal price will be greater by the adjusted premium, captured by cD/8 in equation (9). The differential is negative as the consumer moves from B to A, so -c, rather than c is appropriate in this situation.

Equations (7), (8) and (9) can be used to show the effect of changes in M_A, M_B, s_A, s_B and g on market share and firm prices. Firm B's market share is (D-U*). The firm level effects of increasing expenditures on consumer education relative to what other firms are spending and relative to consumer search costs for other firms' products reveal the value of effective information programs. Equations (7), (8) and (9) were simulated using a program written in GAUSS 3.1 (Aptech Systems, Inc.) with demand intercept and slope coefficients calculated from elasticity of demand, price and quantity utilization of fresh carrots.

Over 60 percent of surveyed consumers rated fresh vegetables as the product category most in need of eco-labeling (The Hartman Group, 1997). Carrots were selected because they are grown successfully both organically and conventionally, and face strong demand. From 7 to 34 percent of organic growers produced carrots as one of their crops in 1994 (USDA, 1996; Organic Farming Research Foundation, 1996). The Packer noted that 15 percent of consumers buying organics purchased fresh carrots . Greene and Calvin reported that organic carrots are susceptible to many pests, suggesting that cost savings from reduced chemical use could induce farmers to switch into nonorganic IPM-type technologies that permit some chemical use. You, Huang and Epperson calculated the 1997 elasticity of demand for carrots at -0.40. The USDA (1998) listed retail price of fresh carrots at $0.511 per pound and domestic utilization at 3,582.9 million pounds in 1997.

For convenience, variables costs k_A and k_B were assumed to be zero and the distance D between the two firms was assumed to be one. The price differential c was assumed to equal $0.10 per unit distance (market share percentage point) in all cases, with Firm B's product accruing the premium. This is a 20 percent premium over the retail price of $0.511 per pound.

The efficiency of educational spending by either firm was set at 0.50, so that for each $1.00 spent by the firm on education, search costs to consumers were reduced by $0.50. This parameter may overstate or understate true educational efficiency, but no studies were found that addressed this issue. Empirically, educational efficiency is less than 1.0. Education about organic products has been extensive, yet 75 percent of consumers in a nationwide survey still incorrectly defined organic as "chemical-residue free" (Gilbert). For IPM technology, only 19 percent of respondents in a New England survey had heard of IPM and 24 percent of these could not identify what it meant or gave an incorrect definition (Anderson *et al.*). As similar-sounding eco-label standards enter the market, this confusion may grow. Better information may be needed to distinguish among labels. I also simulated the model with g equal to 0.70 to examine the effect of improving the efficiency of educational spending.

The baseline results for the simulation are given in Table 1. In the Baseline case, neither firm faces consumer search costs and neither spends money on educating consumers. This case represents the isolated effect of the price premium favoring Firm B's product. The market between A and B is equally divided as U* equals 0.50. Firm A's price for fresh carrots is $0.88 per pound and Firm B's is $0.91.

The search costs in Case 1 represent the market division between conventional with consumer search costs of zero, and an eco-labeled product with search costs of $0.05 per pound, which is 10 percent of the retail price of $0.511. This is a reasonable value for s_B given the current state of confusion over certification standards for eco-labeled products. When Firm B mistakenly or deliberately ignores consumer search costs, A captures 67 percent of the market, and the optimal price differential even with the price premium is only $0.01 per pound. As Firm B raises its educational spending, A's share declines and the differential increases in B's favor. However, it is not until Firm B matches spending to consumer costs that it recaptures half the market and regains the $0.03 per pound differential established in the Baseline case. When its competitor faces no search costs, the best Firm B can do is to capture half the available market.

Cases 2 through 4 describe situations in which both firms face the same consumer search costs, set at $0.05 per pound, which might occur with competing eco-labeled products. In Case 2, both firms are assumed to spend equal amounts on consumer education, both starting with zero spending and increasing to the amount that fully covers search costs. In all cases of equal expenditures, even with underallocation to education, the market is equally divided. Underspending for education relative to consumer search costs reduces the price both firms can charge, but maintains a differential between optimal firm prices. Case 3 shows the effect of one firm underspending while the other covers its consumers' search costs. Here, the firm that underspends claims less than half the market. The effect of the price premium is to maintain Firm B's optimal price as higher than A's, even when Firm B has a lower market share due to spending less on consumer education. The differential favoring B is lower with underspending.

When educational efficiency is improved, as in Case 4, both optimal price and market share may be affected. When both firms cover their consumers' search costs, they halve the market, but both are able to set higher prices than in the Baseline case. When one of the firms covers search costs and the other underspends, the former receives a market share greater than 50 percent and experiences a favorable change in the optimal price differential. Due to the price premium, B's price is always higher. Compared with Case 3, the optimal prices are higher under the same relative educational spending patterns due to the improved educational efficiency.

These results suggest that firms competing for a market niche representing the attribute space between them should pay attention to the search costs consumers incur in learning about, identifying, verifying and locating the eco-labeled products. With sufficient educational spending to reduce consumer costs, firms can avoid a disadvantageous market share position. If search costs for existing firms increase with the introduction of new certifications, they will be faced with the need to continually increase educational spending. Improved educational efficiency could address this problem, since better information should result in less confusion.

The difficulty with the spatial characteristics approach is that it gives useful outcomes about the effect of consumer information on market shares and optimal pricing in the niche between two firms, but cannot provide information about the entire market. Wildman and earlier, Scherer, described a method similar to the one used in this section for determining the extent of cannibalization and the resulting effects on consumer and producer surplus of new differentiated product entry. However, their method requires that there be a single price in the market and that the entrant select a location midway between two adjacent competitors.

To examine changes in welfare surpluses due to introduction of eco-labeled products it is necessary to model the entire market with producers and consumers. A market segmentation approach is used in Section V. The model is simulated for situations of differing market shares for eco-labeled products and net search costs to evaluate the effect of these factors on welfare.

V. Market Segmentation With Eco-Labels

Eco-labeling permits differentiation by production process in the market for any food item that can be produced with ecologically compatible means. To the extent that an eco-label stimulates consumers to choose a more environmentally acceptable product over another, or to pay a higher price for a labeled product, the market system is successful in transferring consumer surplus to producers who undertake these practices. The certifier transmits information between producers and consumers via the label and education programs to communicate the unobservable attributes associated with the good.

In developing certification standards, the certifier must consider the reaction of both producers and consumers to the requirements. Even though there may be a small percentage of producers and consumers exhibiting inelastic response to price, both groups may arbitrage across categories of eco-labels, subject to costs of production and budget constraints. Segmenting the market for certifications permits comparison of producer and consumer surpluses to test claims made by certifiers about effects of proliferation.

Using a spatial model and linear demand, Wildman showed how proliferation affects both producer and consumer surplus for a single product holding availability and prices of other products constant. In an application to ready-to-eat cereals first proposed by Scherer, Wildman demonstrated that consumers gain from new product introduction and producers gain and consumers lose from price increases that typically follow new product introduction. Wildman noted that the resulting welfare effects from the spatial model were ambiguous.

A market segmentation approach that permits price variability across quality groups and nonequal market shares was developed by Tauer and applied to bST-produced and non-bST-produced milk. Using elasticities of supply and demand, Tauer constructed the market curves for milk and partitioned the market into bST and non-bST use according to consumer preferences and technology cost differences for the two types of milk. A weighting term representing the cost advantage of the technological change was divided into the slope of the supply curve, rotating the segmented non-bST and bST supply curves and making them steeper than the single market curve. A term representing the share of consumers who refuse to drink bST milk was similarly divided into the slope of the demand curve to generate steeper non-bST and bST demand curves. The non-bST curves were steeper than the bST curves.

By varying elasticities and the cost weighting term, Tauer simulated consumer and producer surpluses for pre-bST, unsegmented post-bST, and segmented post-bST milk markets. He concluded that segmentation may produce higher prices and larger surpluses for both bST users and non-bST users with lower total quantity produced than if the market had not been segmented. Consumers are better off after segmentation due to the availability of non-bST milk for those who prefer it, although those who are indifferent pay a higher price under some circumstances. When consumers stop buying milk altogether in response to bST use, both producer and consumer surpluses drop significantly, emphasizing the importance of labeling as a means to verify the segmented markets since consumers cannot detect bST use by inspection.

I adapt Tauer's model with modifications to account for consumer search costs and for two, three and four labels, rather than the two-product model used by Tauer. The demand curve is specified as

$$P_j = (a - S_j) + \frac{b}{R_j} Q_j \qquad \textbf{(10)}$$

where P_j is equilibrium price, Q_j is equilibrium quantity, S_j is net search cost as defined in equation (2), and R_j is the market share for the j^{th} label. The constants a and b are the intercept and slope of the demand curve. For the unsegmented market containing only the conventional item, S_j equals zero and R_j equals one.

The supply curve is

$$P_j = (c + T_j) + \frac{d}{W_j} Q_j \qquad \textbf{(11)}$$

where P_j and Q_j are as previously defined. T_j is the production cost differential of the j^{th} label compared with conventional and W_j is a weight representing technological change associated with the j^{th} label. The constants c and d are the slope and intercept of the supply curve. For the unsegmented conventional market, T_j equals zero and W_j equals one.

Market share, R_j, net search cost, S_j, and production cost differential, T_j, along with a, b, c, and d are set exogenously for equations (10) and (11). Price, P_j, quantity, Q_j, and the weight, W_j, are solved for. With three unknowns another equation is required for identification.

Relative prices are specified as

$$P_j = (1 + T_j + \frac{P_j - P_i}{P_i}) P_i \qquad \textbf{(12)}$$

where the price for the j^{th} eco-label is greater than the conventional price, P_i, subscripted here with i for convenience, by the cost differential, T_j, and by the weighted price premium. In equation (12), only T_j is exogenously set. The simultaneous equation model given by equations (10), (11), and (12) differs from Tauer's model by incorporating search costs and price premiums, which are assumed to derive from preferences for the benefits obtained from the attribute described by the eco-label. Also, here the eco-label incurs a cost disadvantage in production relative to conventional, where Tauer specified a cost advantage for bST technology.

Figure 3 describes a possible market outcome when a conventional market is segmented into conventional and organic production. The subscript "NO" refers to the unsegmented conventional market, in which no organically certified products are sold. When this market is segmented, the organic (subscripted "O") and conventional (subscripted "C") supply and demand exhibit steeper slopes than in the unsegmented market. In addition, the intercept of the organic demand curve, D_O, shifts downward by the amount of search costs, S_j, and the intercept of the organic supply curve, S_O, shifts upward by the amount of the production cost differential, T_O.

With the elasticities assumed in Figure 3, both the organic price, P_O, and the conventional price, P_C, are higher than the pre-organic price, P_{NO}. All consumers would pay more after the introduction of organics, but consumer surplus could still increase since those who prefer organic now have the option of purchasing it. Producers receive a higher price whether they produce organically or conventionally, but the total quantity produced in the market is less than if the market were not segmented. As Wildman noted, and Tauer demonstrated, the results are ambiguous unless elasticities are known so that welfare effects may be calculated. As more segments are added, the results become even more complicated analytically because the relative location of the supply and demand curves for each label depend on search costs, production costs, market share and the technology weight.

I simulated several cases of the effects of market segmentation for fresh carrots using an adaptation of Tauer's GAUSS program. I used the demand elasticity (-0.40), price ($0.511 per pounds) and quantity (3,352.8 million pounds) given in Section IV and a supply elasticity of 0.02 (Buxton). The demand intercept and slope were a equals 1.7885 and b equals -0.0004. The supply intercept and slope were c equals 25.0390 and d equals 0.0076.

Four situations are examined under the Baseline case - unsegmented conventional, segmentation with organic, segmentation with IPM-certified and organic and segmentation with IPM-certified, eco-X and conventional, where the descriptions are drawn from the example presented in Section II. The market shares, R_j, are assumed to be 40 percent for IPM, 5 percent for eco-X and 5 percent for organic. The production cost relative to conventional, T_j, are assumed to be 2 percent higher for IPM, 5 percent higher for eco-X and 10 percent higher for organic. Consumer search costs relative to conventional, S_j, are assumed to be 5 percent higher for IPM and 10 percent higher each for eco-X and organic.

The Baseline parameters for market shares, production costs, and consumer search costs are based on market conditions, existing research and anecdotal information from industry representatives. However, these values are used for exposition only and should not be taken as documenting the current status of each eco-label.

Table 2 shows the impact of market entry by eco-labels, with sequential entry by organic, IPM-certified and eco-X labels. The unsegmented conventional price and quantity are the same as the initial parameters. Producer surplus is 1,696 units and consumer surplus is 2,141 units. Market segmentation into conventional and organic maintains the same price at $0.51 per pound on average, but the organic price is higher at $0.56 per pound by a 10 percent price premium. Market share for organic is 5 percent. The entry of an organic segment at this low market share has little impact on quantity and consumer surplus, but reduces producer surplus by 0.5 percent to 1,688 units.

Further segmentation into IPM-certified leaves conventional market share at 55 percent when the 40 percent share for IPM and the 5 percent share for organic are deducted. The weighted market price falls to $0.50 per pound, with conventional below this level at $0.49 and the price for organic falling to \$0.54 while IPM price is intermediate at \$0.51. Again, there is limited effect on quantity and consumer surplus, but producer surplus under the three-label segmentation is 2.4 percent lower at 1,655 units than without segmentation. The organic sector shifts some producer surplus to consumers, with a net increase in total surplus of 1.3 units. The conventional sector loses producer surplus as it loses market share.

The final segmentation adding eco-X reduces conventional market share to 50 percent, after other shares have been deducted. Since eco-X only captures 5 percent of the market, it has no impact on the weighted price of \$0.50 per pound, nor on the prices for conventional or organic. The IPM price drops to \$0.50. The effects on quantity and consumer surplus are negligible, but producer surplus is 2.9 percent lower at 1,647 units than without segmentation. As before, transfers from producers to consumers take place for all existing labels, and consumer surpluses increase within the organic and IPM categories. The conventional sector continues to lose market share, experiencing a decline in both producer and consumer surplus.

Under the assumptions made, these results indicate several conclusions. First, market segmentation due to entry of eco-labels improves consumer surplus in the segments that do not lose market share because there are more choices matching consumer preferences. Second, the increase in consumer surplus comes at the expense of producer surplus when entry causes segment prices to decline. The search cost disadvantages of eco-labeled foods as described in equation (10) are responsible for the price decreases, and dominate the production cost differences. Third, total consumer and producer surpluses decrease when the segment losing share to new entrants is the dominant, lower price sector, here being conventional. The welfare loss is negligible for consumers at 0.1 percent and much larger for producers at 2.9 percent.

Overall, economic surplus declines by 1.3 percent as the market segments are added for IPM, eco-X and organic.

Table 3 shows the effects of relative changes in market shares for IPM, eco-X and organic compared with the three-label market under Baseline assumptions. In Case 1, eco-X is assumed to attain a 40 percent market share, with 5 percent for IPM and organic and 50 percent for conventional. In Case 2, organic is assumed to reach a 40 percent share, with 5 percent for IPM and eco-X and 50 percent for conventional.

Considering conventional share fixed at 50 percent, allocating the larger remaining market share to IPM produces the highest weighted price, $0.50 per pound, and the highest segment prices, $0.49 for conventional, $0.50 for IPM, $0.51 for eco-X and $0.54 for organic, of the three cases. Quantity is highest in this case at 3,350 million pounds compared with 3,348 million for eco-X dominant and 3,347 million pounds for organic dominant. The quantity produced by each dominant segment declines slightly due to increasing relative production costs across the segments, from IPM (2 percent) to eco-X (5 percent) to organic (10 percent).

Total producer surplus is highest at 1,647 units when IPM dominates the 50 percent that is not conventional, and declines by 1.8 percent to 1,1617 under eco-X dominant and by 1.9 percent to 1,615 under organic dominant. Although the specified dominant share was the same, organic producers enjoyed the highest producer surplus at 666 units when they controlled 40 percent market share, followed by IPM at 658 units, and Eco-X at 650 units when these segments dominated with 40 percent share. Total consumer surplus decreases only slightly across the cases, with the largest transfers from producer to consumer surplus occurring when organic dominates the eco-label segments with a 40 percent share.

Achieving dominance among the eco-labelers is no guarantee against transfers of producer to consumer surplus for a certifying organization. The higher priced organic segment retains more of the total economic surplus for producers than do the lower priced eco-labels, but consumers still have greater surplus.

Table 4 shows the effects of changes in relative consumer search costs, S_j, for the IPM, eco-X and organic segments with the three-label market under Baseline assumptions. In Case 3, organic search costs are assumed to be 15 percent, with 10 percent for IPM and eco-X. In Case 4, organic is assumed to incur search costs 5 percent higher than conventional, with 10 percent for IPM and eco-X. In the Baseline case, IPM was assumed to incur 5 percent higher search costs and organic and eco-X incurred 10 percent higher costs.

The search cost assumption for organic has no effect on either weighted price ($0.49 per pound) nor prices for each segment ($0.48 for conventional, $0.49 for IPM, $0.50 for eco-X, and $0.53 for organic) because organic commands only 5 percent market share and relative production costs do not change. At these identical prices, quantity is the same whether net search costs are higher or lower, but the share for the organic market increases 3.8 percent from 156 million pounds to 162 million pounds as search costs decline from 15 percent to 5 percent.

Total producer surplus is higher at 1,619 units when organic search costs are 5 percent than at 1,610 units when these costs are 15 percent, with search costs for all other segments fixed. The organic segment gains 4.6 percent in producer surplus, from 81 to 85 units and 8.7 percent in consumer surplus, from 92 to 100 units, even though total consumer surplus is unchanged. Consumer surplus for conventional and IPM declines as net search costs for organic consumers decline, but this effect is negligible for the eco-X segment. The difference in search costs has little effect on transfers from producer to consumer surplus, with consumers' share of total surplus at 53 percent when search costs are 15 percent and at 54 percent when search costs are 5 percent.

Whether search costs are higher or lower than the other eco-labels, producer surplus is still lower than consumer surplus. However, total producer surplus increases substantially with a reduction in search costs, while total consumer surplus does not change. Within the segment experiencing the net search cost reduction, both producer and consumer surplus increase as search costs decline, with little of the consumer improvement deriving from losses to producers.

VI. Summary and Policy Recommendations

Existing certifying organizations, such as the organic segment, are concerned that confusion generated by similar sounding certifications could reduce their market share if consumers view the competitors as good substitutes for organics. New entrants want to supply the market with more alternatives than organic and conventional, and may not provide sufficient education for consumers to differentiate their products from existing labels. This paper examines the effects of proliferation and information costs on consumer and producer welfare.

Certifier behavior drives eco-label proliferation, since these organizations are the conduit for information about production process from producers to consumers. The results in Section IV show that educational spending and/or improvements in efficiency of educational spending increase market share when consumer search costs are positive. Underspending on consumer education reduces the price a firm is able to charge within its market niche. If a rival is spending adequately on consumer education, the rival will capture a larger share of the contested market. Uncertainty about consumer search costs and educational efficiency make it difficult for firms to adopt this approach. Future research by certifiers should include issues such as the effectiveness of advertising and education materials, not just in label recognition, but in discernment of the differences between the new label and existing ones.

In Section V, a market segmentation of a conventional market with one, two and three eco-labels is used to evaluate the effect of proliferation on producer and consumer surpluses. Under the assumptions made about market share, production cost differential and net consumer search costs, segmentation reduces producer surplus while keeping consumer surplus about the same. Market prices decline as share is captured from the conventional segment by IPM, eco-X and organic labels. Within segments, consumers gain at the expense of producers, even if market share is maintained by existing eco-labelers after entry of new labels, and even if consumer search costs decline. The organic sector maintains prices above the weighted average market price under all scenarios examined, and even an increase of market share from 5 percent to 40 percent does not alter the transfer of surplus from producers to consumers.

The negative effect of search cost differentials on prices dominates the positive effect of technology cost differentials in this case. Through their influence on slope and price intercepts, the demand and supply elasticities for a food are important determinants of this relative cost effect. Where demand is more elastic than supply, the search cost effect dominates.

A key question facing the federal government is whether to intervene in the markets for eco-labels to try to eliminate misrepresentation of claims (Erickson and Kramer-LeBlanc). Lack of scientific foundation for claims made and vagueness in terminology lead to consumer confusion as eco-labels proliferate in the market. Some programs control the supply of eco-labels at a threshold quantity, or restrict the total supply that can be certified under a given eco-label. The United States is considering national standards for food eco-labels that would provide legal definitions and process guidelines (Deborah Kane, The Food Alliance, personal communication).

Recommendations from this study are that both government and industry should concentrate on improving educational efficiency and industry should spend as necessary to alleviate consumer confusion. Government regulations on terminology used in eco-labels could enhance their clarity for consumers and reduce education costs for certifiers. Industry efforts to provide information that is comparative with other labels can also improve clarity. This will reduce both net search costs for the product and the possible negative influence of confusing information from competing eco-labelers.

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Footnotes

[1] The term "certifier" is used interchangeably with "certifying organization" in this paper, although a certifier may be an agent of the certifying organization whose role is limited to inspection of the production process.

[2] These features of organic systems are more typical of certification programs run by producers and nonprofit entities. Government certification programs often exclude requirements to maintain or improve soil and water quality.

[3] Externality costs of all systems are excluded from consideration of production costs. However, consumers value the benefits of more ecologically compatible systems in determining their price-quality tradeoffs.

[4] Of course, conventionally produced foods are not certified at all. Even without a certifier, one may treat the absence of a certification as an extreme condition on the continuum. I use the case of 100 percent conventional food for the unsegmented market in Section V.

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Table 1. Spatial Competition Model Under Differing Assumptions About Consumer Search Costs, Educational Expenditures and Educational Efficiency

s_A	s_B	M_A	M_B	U*	P_A^*	P_B^*
BASELINE CASE Neither Firm Faces Search Costs						
0.00	0.00	0.00	0.00	0.50	0.88	0.91
CASE 1 Firm B Faces Search Costs, Firm A Does Not						
0.00	0.05	0.00	0.00	0.67	0.88	0.89
0.00	0.05	0.00	0.05	0.58	0.88	0.90
0.00	0.05	0.00	0.10	0.50	0.88	0.91
CASE 2 Both Firms Face Search Costs, Both Spend Equally						
0.05	0.05	0.00	0.00	0.50	0.86	0.88
0.05	0.05	0.05	0.05	0.50	0.87	0.89
0.05	0.05	0.10	0.10	0.50	0.88	0.91
CASE 3 Both Firms Face Search Costs, One Underspends						
0.05	0.05	0.05	0.10	0.42	0.87	0.90
0.05	0.05	0.10	0.05	0.58	0.88	0.90
CASE 4 Improved Educational Efficiency, g = 0.70						
0.05	0.05	0.10	0.10	0.50	0.89	0.92
0.05	0.05	0.05	0.10	0.38	0.88	0.91
0.05	0.05	0.10	0.50	0.62	0.89	0.90

Table 2. Impact of Market Entry by Eco-labels

	Price ($/lb.)	Quantity (10^6 lbs.)	Producer Surplus	Consumer Surplus
BASELINE CASE				
No organic	0.51	3352.80	1696.15	2141.60
Segmentation with organic	0.51	3352.16	1687.55	2141.46
Conventional	0.51	3197.54	1602.04	2050.36
Organic	0.56	154.62	85.51	91.10
Segmentation with IPM and organic	0.50	3350.37	1655.13	2139.47
Conventional	0.49	1874.19	909.75	1216.71
IPM	0.51	1319.25	661.30	828.93
Organic	0.54	156.93	84.08	93.83
Segmentation with IPM, eco-X and organic	0.50	3349.89	1647.03	2139.01
Conventional	0.49	1708.53	823.31	1112.24
IPM	0.50	1323.12	658.46	833.80
Eco-X	0.51	160.79	81.51	98.51
Organic	0.54	157.45	83.75	94.46

In the Baseline case, market shares are 40% for IPM, 5% for eco-X and 5% for organic; production costs relative to conventional are 2% higher for IPM, 5% higher for eco-X and 10% higher for organic; consumer search costs relative to conventional are 5% higher for IPM, 10% higher for eco-X and 10% higher for organic.

Table 3. Effects of Changes in Relative Market Shares for IPM, Eco-X, and Organic

	Price ($/lb.)	Quantity (10^6 lbs.)	Producer Surplus	Consumer Surplus
BASELINE CASE				
Segmentation with IPM, eco-X and organic	0.50	3349.89	1647.03	2139.01
Conventional	0.49	1708.53	823.31	1112.24
IPM	0.50	1323.12	658.46	833.80
Eco-X	0.51	160.79	81.51	98.51
Organic	0.54	157.45	83.75	94.46
CASE 1				
Segmentation with IPM, eco-X and organic	0.49	3348.08	1617.75	2138.14
Conventional	0.47	1729.86	805.99	1140.18
IPM	0.48	168.33	80.07	107.97
Eco-X	0.51	1290.09	649.50	792.69
Organic	0.52	159.80	82.20	97.30
CASE 2				
Segmentation with IPM, eco-X and organic	0.49	3346.93	1615.51	2138.69
Conventional	0.46	1746.17	792.28	1161.78
IPM	0.47	170.00	78.74	110.12
Eco-X	0.48	164.75	78.65	103.42
Organic	0.53	1266.01	665.84	763.37

In Case 1, market shares are 50% for conventional, 5% for IPM, 40% for eco-X and 5% for organic. In Case 2, market shares are 50% for conventional, 5% for IPM, 5% for eco-X and 40% for organic. All other parameters are as specified for the Baseline case.

Table 4. Effects of Changes in Relative Consumer Search Costs for IPM, Eco-X, and Organic

	Price ($/lb.)	Quantity (10^6 lbs.)	Producer Surplus	Consumer Surplus
BASELINE CASE				
Segmentation with IPM, eco-X and organic	0.50	3349.89	1647.03	2139.01
Conventional	0.49	1708.53	823.31	1112.24
IPM	0.50	1323.12	658.46	833.80
Eco-X	0.51	160.79	81.51	98.51
Organic	0.54	157.45	83.75	94.46
CASE 3				
Segmentation with IPM, eco-X and organic	0.49	3348.45	1610.11	2138.04
Conventional	0.48	1722.54	812.01	1130.56
IPM	0.49	1308.00	636.63	814.84
Eco-X	0.50	162.27	80.47	100.33
Organic	0.53	155.65	80.99	92.31
CASE 4				
Segmentation with IPM, eco-X and organic	0.49	3348.77	1618.51	2138.01
Conventional	0.48	1719.41	814.56	1126.45
IPM	0.49	1305.43	638.52	811.65
Eco-X	0.50	161.94	80.71	99.92
Organic	0.53	161.99	84.73	99.99

In Case 3, consumer search costs are higher than conventional by10% for IPM, 10% for eco-X and 15% for organic. In Case 4, search costs are higher by 10% for IPM, 10% for eco-X and 5% for organic. All other parameters are as specified for the Baseline case.

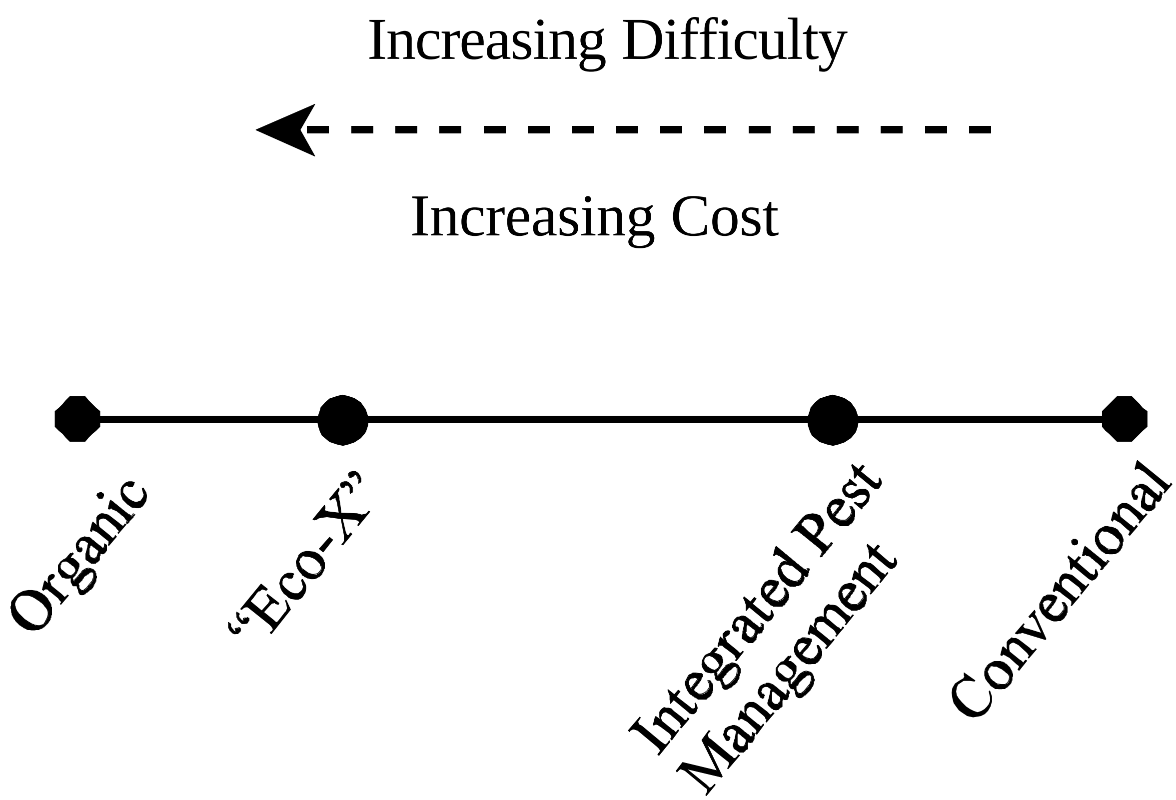

Figure 1. Continuum of Agricultural Systems Based on Ecological Compatibility

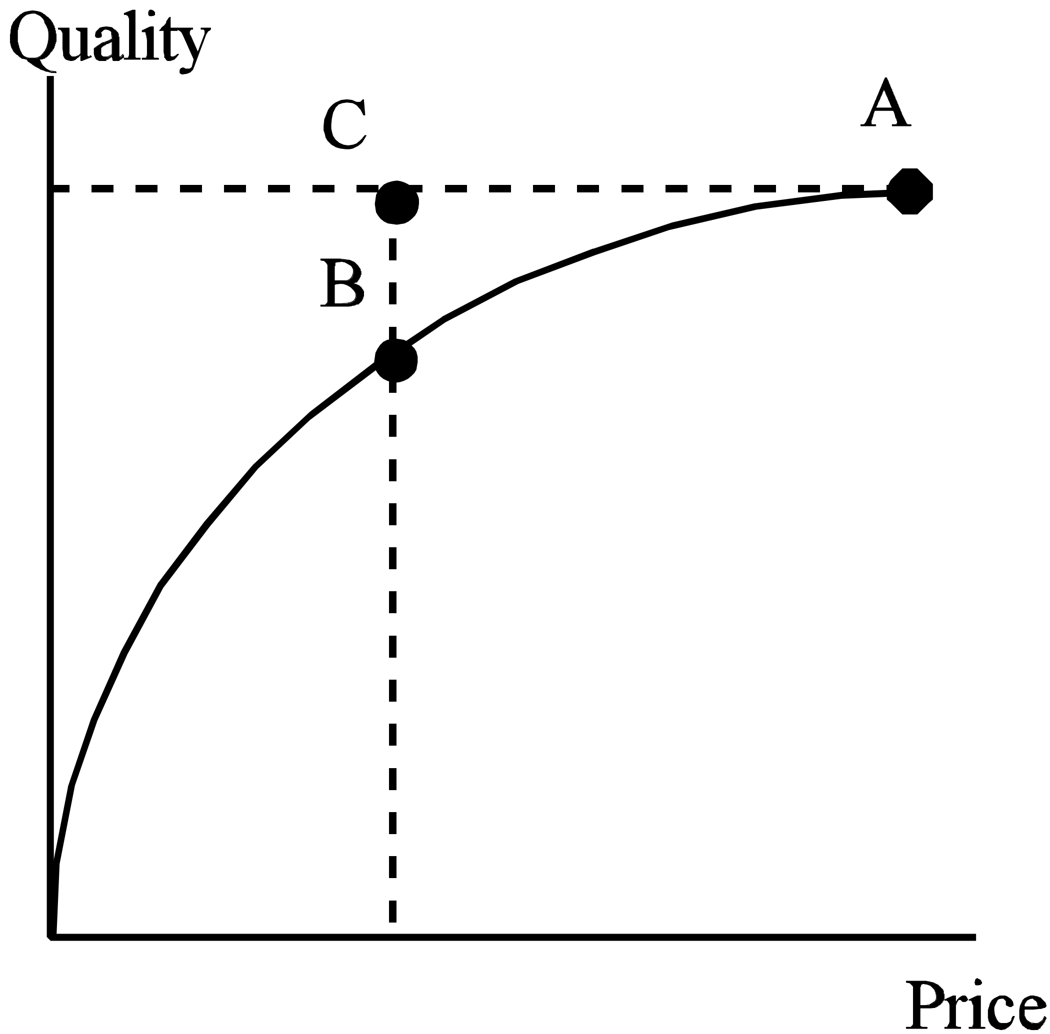

Figure 2. Product Attributes in Quality-Price Space

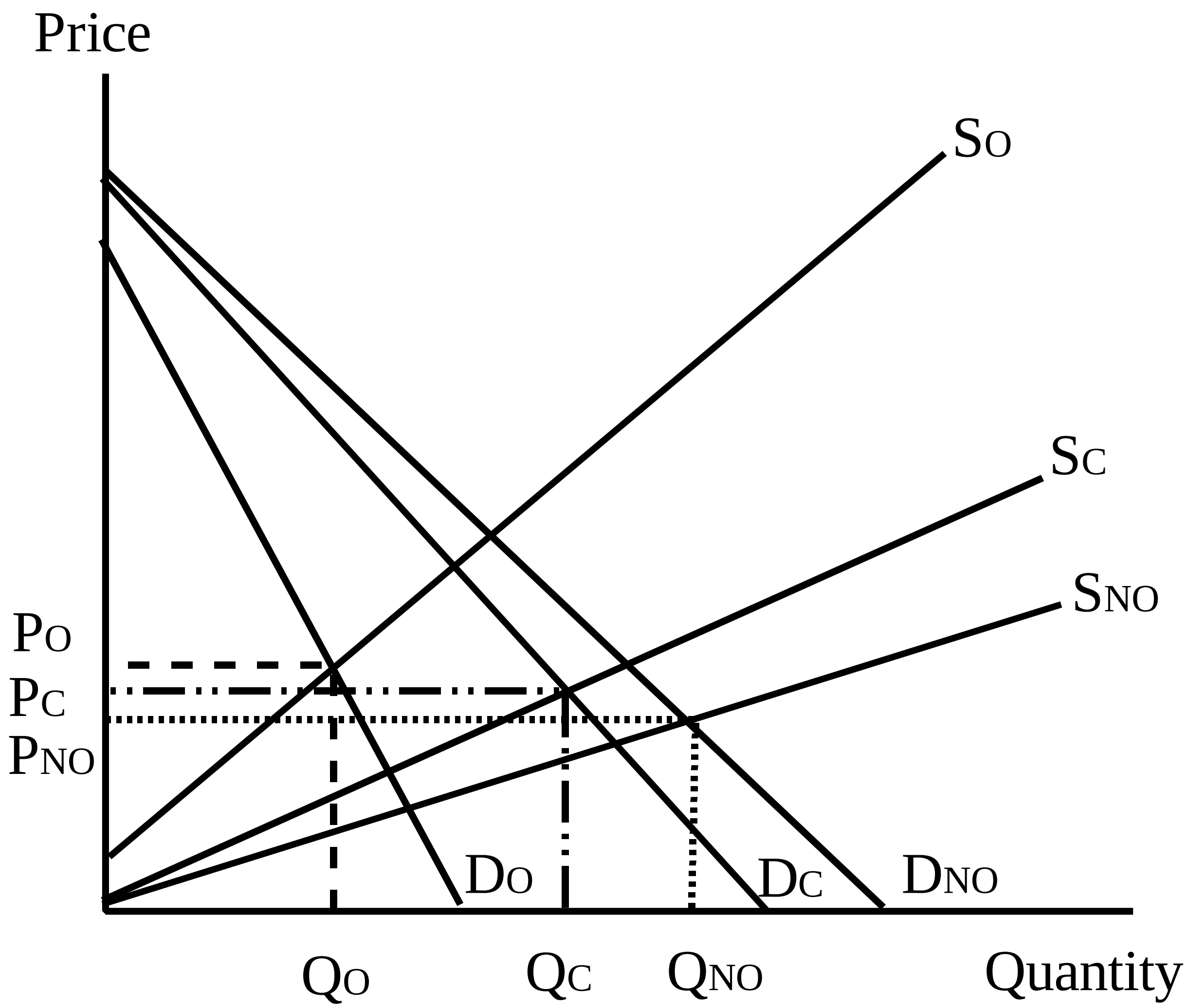

Figure 3. Market Segmentation With Conventional and Organic Products

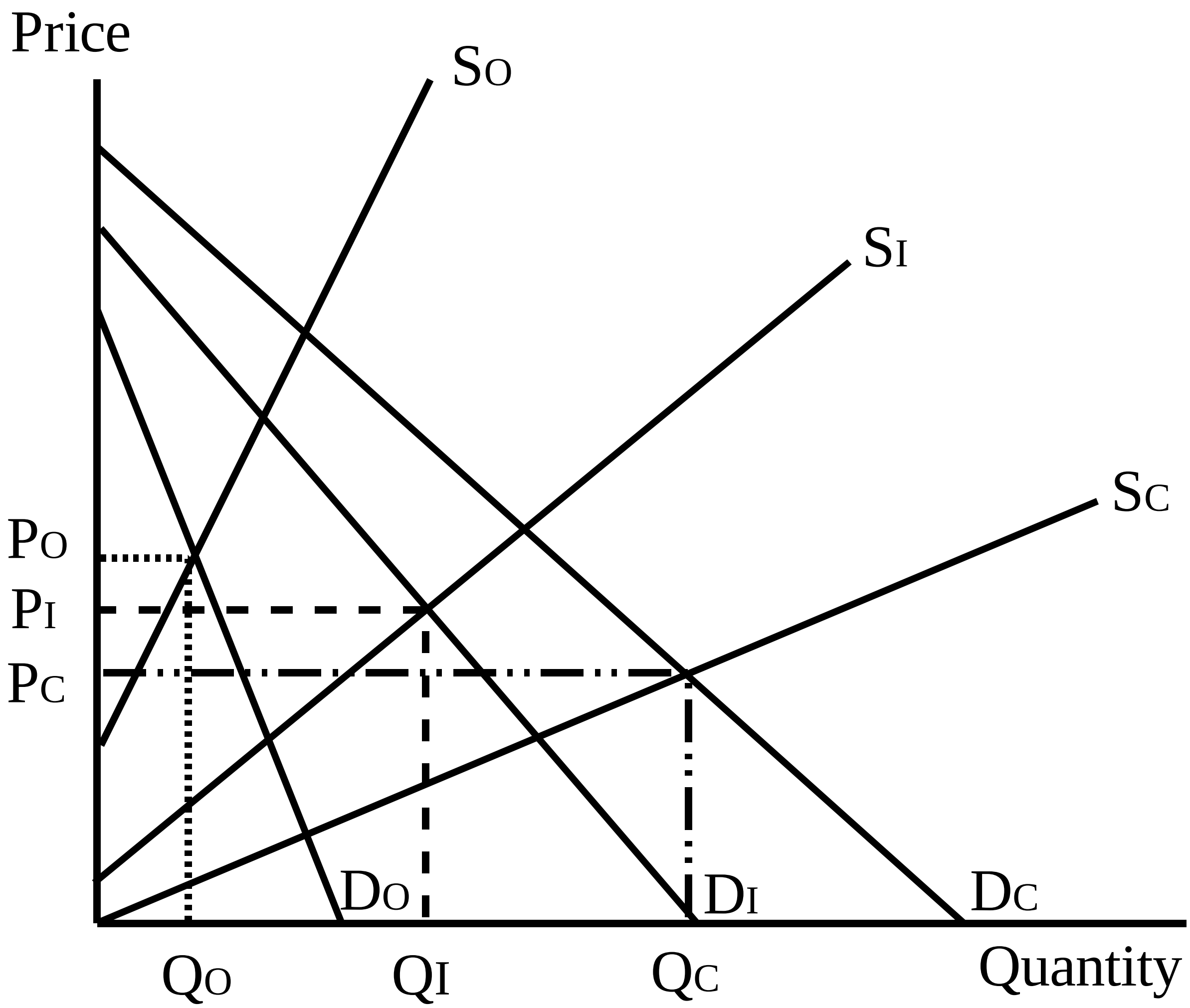

Figure 4. Market Segmentation with Conventional, IPM-certified, and Organic Products