Does Branded Food Product Advertising Help or Hurt Farmers?

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An important issue for various commodity check off programs is how to treat processor/handler brand advertising. In programs that include a handler assessment, should handlers be given credit towards their assessment for expenditures to advertise their own brands? A related issue is whether check off funds should be used to subsidize advertising of handlers' brands. For example, the Florida Citrus Commission has used check off funds to support advertising of well-known brands. Export promotion (MPP) funds support brand advertising abroad. The goal of this research is to investigate market conditions when processor/handler brand advertising will benefit or harm farmers in that industry and, correspondingly, lend insight into the question of whether and when promotion funds intended to benefit farmers should be used in support of brand advertising.

In some cases, brand advertising may be more effective in increasing demand for the farm product than generic advertising. For example, Kaiser and Liu (1998) found that brand advertising of cheese increased farm demand for milk, but brand advertising of fluid milk did not. However, a demand shift is only one of two effects that might be expected to result from brand advertising. The second effect is to increase the market power of the advertised brand. Indeed prominent commentators on the market structure of the food industry argue that extensive brand advertising has been a key source of market power in the sector (e.g., Connor *et al.* 1985). If market power increases as a consequence of brand advertising, the advertising firm will, *ceteris paribus*, increase price and reduce sales, thereby curtailing movement of the farm product and reducing farmer welfare. Thus, even if brand advertising is successful in shifting demand, it may be harmful to farmers.

This study utilizes a flexible oligopoly-oligopsony model to study the impacts of brand advertising on farmer welfare. The model is similar to that developed by Huang and Sexton (HS, 1996) and Alston, Sexton, and Zhang (ASZ, 1997) to study the returns to agricultural research under alternative types of imperfect competition. Whereas HS and ASZ studied exogenous

research-induced shifts in farm supply, we study endogenous advertising-induced shifts in consumer demand, but also allow the advertising expenditures to create or reinforce oligopoly behavior among sellers. We utilize a two-stage game formulation, where in stage 1 the firm(s) decide expenditures on brand advertising, and in stage 2 compete in quantities, given the brand identifications created in stage 1. Market equilibria in both the presence and absence of brand advertising are derived. We then compare producer welfare both with and without brand advertising and undertake simulation analyses to isolate market conditions wherein brand advertising is likely to increase or decrease farmer welfare.

The Basic Model

Consider an agricultural industry with n processing firms. A processor is assumed to convert raw product q into processed product g according to the fixed proportions production $g = \min\{q/\lambda, h(\mathbf{Z})\}$, where $\mathbf{Z}$ is a vector of processing inputs, and $\lambda = q/g$ is the fixed conversion rate between raw and processed product. Without loss of generality, we can set $\lambda = 1$ through choice of measurement units, so $q = g$. The cost function associated with this production function is $C(q) = m(q)q + c(q) + f$, where $m(q)$ is the industry inverse supply function for the raw product, $c(q)$ is the cost associated with the processing inputs $\mathbf{Z}$, and $f \geq 0$ represents fixed costs, if any. It will be convenient to assume that the processor operates with constant marginal costs and, hence, $c(q) = cq$.

We assume that firm 1 in this industry produces both a branded and a non-branded product. The products are essentially undifferentiated except the branded product is advertised. The remaining $n - 1$ firms ($i = 2, 3, \ldots, n$) produce only a non-branded product that is identical to the first firm's non-branded product. Without the first firm's brand advertising, all products are homogeneous and all firms face the same market demand. Firms engage in quantity competition in the homogenous product market. Firm 1's brand advertising segments the retail market and creates monopoly market power for firm 1 in the branded market and also expands the total market. Firm 1

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chooses an advertising expenditure, A, in stage 1, and in stage 2, all n firms compete in quantities to be produced. This two-stage game is solved by backward induction, beginning with the stage 2 competition.

Although this model structure is stylized, the basic configuration with a single major branded product and a broad unbranded or generic market segment, is consistent with a large number of agricultural industries. Examples include almonds and Blue Diamond, prunes and Sunsweet, citrus and Sunkist, cranberries and Ocean Spray, grape juice and Welch's, peaches and Del Monte, avacados and Calavo, and raisins and Sunmaid. Notably most of these industries also feature or have featured industry advertising campaigns funded by check-off programs.

Equilibrium without Advertising

To provide a benchmark for comparison, we first study the Cournot equilibrium in the absence of any brand advertising. The total market demand is:

(1) $Q = a - \alpha P$,

where $a > 0$, $\alpha > 0$, Q is output, and P is the output price. The inverse raw product supply is:

(2) $W = b + \beta Q$.

A representative firm i's objective is to:

(3) $\text{Max}\{q\}\ \Pi = [P(Q) - W(Q) - c]q$,

where $Q = \sum_{i=1}^{n} q_i$. The Cournot equilibrium without advertising is characterized by the following relationship between the retail and farm prices:

$(3-1)\quad P\left[1 - \frac{s_i}{\eta}\right] = W\left[1 + \frac{s_i}{\varepsilon}\right] + c$,

where η is the absolute value of the elasticity of retail demand, ϵ is the elasticity of farm supply, and $s_i = 1/n$ is the per-firm market share. Equation (3-1) indicates that the farm-retail price spread

under oligopoly-oligopsony is greater the more inelastic are the retail demand and farm supply and the fewer the number of processing firms. Solving (3-1), (1) and (2) obtains:

$$(3-2) \quad q^0 = \frac{a - \alpha(b+c)}{(n+1)(1+\alpha\beta)}, \quad Q^0 = \sum_{i=1}^{n} q_i^0 = nq^0, \quad P^0 = \frac{a - Q^0}{\alpha}, \quad W^0 = b + \beta Q^0,$$

where superscripts "0" denote equilibirum without advertising.

The Two-Stage Game

We assume that firm 1's brand advertising segments the retail market and creates monopoly market power for firm 1 in its branded market. The demand for firm 1's branded product is:

$$(4) \quad q_B = \left[a + z(A) - \alpha P_B \right] S_B(A),$$

where subscript "B" denotes the branded product, A is firm 1's brand advertising expenditure, S_B, $0 < S_B(A) < 1$, is the branded product's share of the total market, and $z(A) > 0$ denotes advertising's effect on total demand. We represent advertising's effects on total demand and brand share as follows:

$$(5) \quad z(A) = \gamma_0 (A)^{0.5}; \quad S_B(A) = \gamma_1 (A)^{0.5},$$

where γ_0 and γ_1 are advertising effectiveness parameters. The square root specifications insure diminishing returns to advertising and, hence, interior solutions. Square root specifications have been used in several empirical studies of commodity advertising and found to fit the data well (e.g., Alston *et al.*, 1997; Alston *et al.*, 1998). From (1) and (4), the total demand for the non-branded product (subscript N) is

$$(6) \quad Q_N = [a + z(A) - \alpha P_N][1 - S_B(A)].$$

In stage 2, firm 1 chooses q_B and q_{N1} to maximize profit in both the branded and non-branded market:

$$(7) \quad \text{Max}\{q_B, q_{N1}\} \quad \Pi_1 = \Pi_B + \Pi_{N1} = [P_B(q_B) - W(Q) - c]q_B + [P_N(Q_N) - W(Q) - c]q_{N1},$$

where $Q = q_B + Q_N = q_B + \sum_{i=1}^{n} q_{Ni}$. We obtain the following first order conditions for firm 1:

$$(7\text{-}1) \quad P_B\left[1 - \frac{1}{\eta_B}\right] = W\left[1 + \frac{s_1}{\varepsilon}\right] + c,$$

$$(7\text{-}2) \quad P_N\left[1 - \frac{s_{N1}}{\eta_N}\right] = W\left[1 + \frac{s_1}{\varepsilon}\right] + c,$$

where η_j, $j = B, N$ is the absolute value of the price elasticity of demand for the branded and unbranded product markets, $s_1 = (q_B + q_{N1})/Q$ is firm 1's share of the total market, and $s_{N1} = q_{N1}/Q$ is firm 1's market share in the non-branded market.

Firm k's $(k = 2, 3, \ldots, n)$ profit maximization problem is

$$(8) \quad \text{Max}\{q_{Nk}\} \quad \Pi_k = [P_N(Q_N) - W(Q) - c]q_{Nk}.$$

The first order condition is then

$$(8\text{-}1) \quad P_N\left[1 - \frac{s_{Nk}}{\eta_N}\right] = W\left[1 + \frac{s_k}{\varepsilon}\right] + c,$$

where $s_{Nk} = q_{Nk}/Q_N$ is firm k's market share in the non-branded market, and $s_k = q_{Nk}/Q$ is firm k's market share in the total market.

By substituting equations (1), (2), (4), (5), and (6) into the first-order conditions in (7-1), (7-2), and (8-1), and by imposing symmetry among firms when appropriate, we obtain the following system of first-order conditions:

$$(8\text{-}2) \quad \begin{bmatrix} 2(1+\alpha\beta S_B) & 2\alpha\beta S_B & \alpha\beta(n-1)S_B \\ \alpha\beta(1-S_B) & 2[1+\alpha\beta(1-S_B)] & (n-1)[1+\alpha\beta(1-S_B)] \\ \alpha\beta(1-S_B) & [1+\alpha\beta(1-S_B)] & n[1+\alpha\beta(1-S_B)] \end{bmatrix} \begin{bmatrix} q_B^1 \\ q_{N1}^1 \\ q_{Nk}^1 \end{bmatrix} = \begin{bmatrix} S_B X \\ (1-S_B)X \\ (1-S_B)X \end{bmatrix},$$

where superscripts "1" denote euilibirum with advertising, $X = a + z - \alpha(b + c)$, q_B^1 is firm 1's branded product quantity, q_{N1}^1 is firm 1's non-branded product quantity, q_{Nk}^1 is firm k's (non-

branded) product quantity (k = 2, 3, …, n). This system of equations can be rewritten as **Bq = C**, and thus **q = B⁻¹C**:

$$(8\text{-}3) \quad \begin{bmatrix} q_B^1 \\ q_{N1}^1 \\ q_{Nk}^1 \end{bmatrix} = \frac{X}{\lambda} \begin{bmatrix} (n+1)S_B[1+\alpha\beta(1-S_B)] \\ (1-S_B)[2(1+\alpha\beta)-(1+n)\alpha\beta S_B] \\ 2(1-S_B)(1+\alpha\beta) \end{bmatrix},$$

where $\lambda = 2(n+1))(1+\alpha\beta)[1+\alpha\beta(1-S_B)]$. Thus the total quantity produced and sold is

$$Q^1 = q_B^1 + q_{N1}^1 + (n-1)q_{Nk}^1 = q_B^1 + Q_N^1 = \frac{X}{\lambda}\left[2n(1+\alpha\beta-\alpha\beta S_B)-(n-1)S_B\right].$$

The necessary and sufficient condition for farmers to benefit from brand advertising is that total sales, Q, expand as a consequence of advertising. We can show that $Q^1 > Q_N^0 = \dfrac{n[a-\alpha(b+c)]}{(n+1)(1+\alpha\beta)}$

when

$$(9) \quad z(A) > \frac{(n-1)[a-\alpha(b+c)]S_B(A)}{2n\{1+\alpha\beta[1-S_B(A)]\}-(n-1)S_B(A)} .$$

The total quantity of the non-branded product is:

$$Q_N^1 = q_{N1}^1 + (n-1)q_{Nk}^1 = \frac{X(1-S_B)}{\lambda}\left[2n(1+\alpha\beta)-(n+1)\alpha\beta S_B\right],$$

and the equilibrium prices are:

$$P_N^1 = \frac{a+z}{\alpha} - \frac{Q_N^1}{\alpha(1-S_B)}, \quad P_B^1 = \frac{a+z}{\alpha} - \frac{q_B^1}{\alpha S_B}, \quad W^1 = b + \beta Q^1 .$$

Stage 1 solution

In stage 1 firm 1 chooses A to maximize profits given the ensuing behavior in stage 2:

$$(10) \quad \text{Max}\{A\} \quad \Pi_1(A) - A = \Pi_B(A) + \Pi_{N1}(A) - A$$

$$= \frac{X^2}{4\alpha(n+1)^2(1+\alpha\beta)}\left\{4 + \frac{(n-1)(n+3)S_B(A)}{1+\alpha\beta[1-S_B(A)]}\right\} - A .$$

The first order condition leads to the following implicit function:

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(10-1) $\quad 4\alpha(n+1)^2(1+\alpha\beta)\sqrt{A} = \left\{ \gamma_0 XG + \dfrac{\gamma_1(n+3)(n-1)(1+\alpha\beta)X^2}{2[1+\alpha\beta(1-\gamma_1\sqrt{A})]^2} \right\},$

where $X = a + \gamma_0\sqrt{A} - \alpha(b+c)$, and $G = 4 + \dfrac{(n+3)(n-1)\gamma_1\sqrt{A}}{1+\alpha\beta(1-\gamma_1\sqrt{A})}$.

This market is characterized by eight parameters: demand and supply curve slope and intercept terms, farmers' share, $(1-c)$, under perfect competition, number of processing firms n, and the effectiveness of advertising (γ_0 and γ_1). Given values for these parameters, we can solve for firm 1's optimal advertising expenditure A^*, and for the second stage outputs, prices, and producer welfare.

Simulation Analysis

Because the analytical solutions to the two-stage model are rather complex and, we used simulation analysis to study the impact of brand advertising on farmer welfare. We measure farmer welfare in terms of producer surplus (PS) and specifically compare PS in the equilibria both with and without brand advertising. Using the '0' and '1' superscripts to denote, respectively, the equilibrium without and with brand advertising, we have the following specifications for producer welfare:

(11) $\quad PS^\tau = \int_b^{W^\tau} \dfrac{W-b}{\beta} dW = \dfrac{(W^\tau - b)^2}{2\beta}, \quad \tau = 0,1.$

The change in farmers' surplus due to brand advertising is

(12) $\quad \Delta PS = PS^1 - PS^0.$

To construct the simulation, we first employed the normalizations available to us. This was done by setting the aggregate quantity and retail price each to 1.0 at the Cournot equilibrium with n = 2 and no advertising. More specifically, we set

(3-3) $\quad q^0 = \dfrac{1}{2}, \quad Q^0 = 1, \quad P^0 = 1, \quad W^0 = 1 - c - \dfrac{1+\alpha\beta}{2\alpha}$.

From (3-3), the relations among the parameters are thus: $a = 1 + \alpha$, $b = 1 - c - (1 + 3\alpha\beta)/2\alpha$.

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The preceding expressions are used to eliminate the supply and demand curve intercepts, a and b, from the subsequent analysis. The demand and supply slope parameters α and β can be expressed in terms of the farm supply and retail demand elasticities (ϵ and η respectively), each evaluated at the same Cournot equilibrium with $n = 2$ and no advertising as follows:

$$(3\text{-}4) \quad \alpha = \eta, \quad \beta = \frac{2(1-c)\eta - 1}{(1+2\epsilon)\eta}.$$

We next generated a range of reasonable parameter values for γ_0, the effectiveness of advertising in expanding total demand, by applying a modified Dorfman-Steiner condition (Dorfman and Steiner, 1954) to the case of a monopoly/monopsony processing firm who also advertises. Given the demand and supply functions from (1) and (2), we can solve for the monopolist/monopsonist's optimal advertising expenditure, A_m^1, quantity, Q_m^1, and prices, P_m^1 and W_m^1:

$$A_m^1 = \left\{ \frac{\gamma_0[a - \alpha(b+c)]}{4\alpha(1+\alpha\beta) - \gamma_0^2} \right\}^2, \quad Q_m^1 = \frac{a + z - \alpha(b+c)}{2(1+\alpha\beta)}, \quad P_m^1 = \frac{a + z - Q_m^1}{\alpha}, \quad \text{and} \quad W_m^1 = b + \beta Q_m^1.$$

The monopolist/monopsonist's advertising-sales ratio is $\chi = A_m^1 / P_m^1 Q_m^1$. Given values for the demand and supply parameters, we can then set reasonable values for the advertising-sales ratio, χ, and solve to find the implied value of γ_0:

Given γ_0, the brand advertising effectiveness parameter was set simply as $\gamma_1 = k\gamma_0$, where k measures the relative effectiveness of advertising at creating brand market share versus expanding total demand. Finally, we fixed the farm share parameter $1 - c = 0.5$ in all cases.

Simulation Results

Given space limitations, we can present only a brief discussion of the simulation results. The base scenario for the simulations involved setting $1 - c = 0.5$, $\chi = 0.02$, and $\epsilon = 1.5$. The two percent

advertising-sales ratio is consistent with actual brand advertising-sales ratios for agricultural industries with a clearly identifiable primary farm industry (e.g., see Marion *et al.* 1986, Table B-8). The choice of $\epsilon = 1.5$ is somewhat arbitrary, but the supply elasticity is not an important parameter in this analysis—as supply becomes more elastic producer surplus decreases under all sets of market conditions.

Figures 1 and 2 summarize the simulation results. In all cases we examine the change in producer surplus, ΔPS, (equation (12)) due to the introduction of brand advertising. Figure 1 examines the effect on ΔPS of concentration in the processing sector as measured by n. Each panel in Figure 1 features a different choice of k, the relative effectiveness parameter. Figure 2 examines the effect of k on ΔPS, with each panel in Figure 2 depicting an alternative choice of n. The curves in both Figures are "iso-demand-elasticities" that depict ΔPS for a particular value for the elasticity of demand set at the base Cournot duopoly-duopsony equilibrium.

Figure 1 shows that brand advertising is less likely to benefit farmers when the processing industry is relatively unconcentrated. Large values of n imply only limited oligopoly-oligopsony power in the Cournot equilibrium and, accordingly, high levels of producer surplus. Creation of monopoly power through brand advertising therefore has an important adverse effect on producer welfare. When k is small so that advertising is only moderately effective at creating brand identify relative to expanding total demand (panel (a)), farmers benefit for all values of n. However, for larger values of k, farmers' welfare declines from brand advertising when the processing industry is highly unconcentrated (i.e., when n is large). For example, in panel (c), when k = 1.8, farmer welfare declines under any of the demand elasticity specifications for n > 3. In all instances, the welfare effect, whether positive or negative, is exacerbated the more elastic is the retail demand curve. Farmer welfare is a monotone increasing function of sales, so when demand is relatively inelastic, the sales effects of brand advertising are small. When demand is relatively elastic, brand

advertising can have a large effect on sales (either positive or negative) and, accordingly, a large effect on farmer welfare.

In Figure 2 higher values of k represent advertising that is increasingly effective at creating brand market power for the advertising firm. Thus, the firm's optimal advertising expenditure is increasing in k. For small values of k the demand-expanding effect of the higher advertising dominates the market-power effect, and farmer welfare is increasing in k. When n is small, e.g., n = 2 in panel (a), farmers benefit for all values of k included in the figure. In this setting, the market is a highly concentrated duopoly-duopsony in the absence of brand advertising, so the incremental market power created by advertising is small and is dominated by the demand-expansion effect. However, for the larger values of n in panels (b) and (c), the market-power effect from increasing k comes to dominate the demand-expansion effect, causing farmer welfare to decline. Again, the effect, whether positive or negative, is magnified the more elastic is retail demand.

In summary, this paper demonstrates that farmers may gain or lose from brand advertising by downstream processing firms. Farmers are most likely to lose when advertising takes place in relatively unconcentrated processing industries and is relatively more effective at creating brand identity than at expanding demand in total. Whether promotion programs intended to enhance producer welfare should support brand advertising must, thus, be determined on an industry-by-industry basis based on the criteria set forth here.
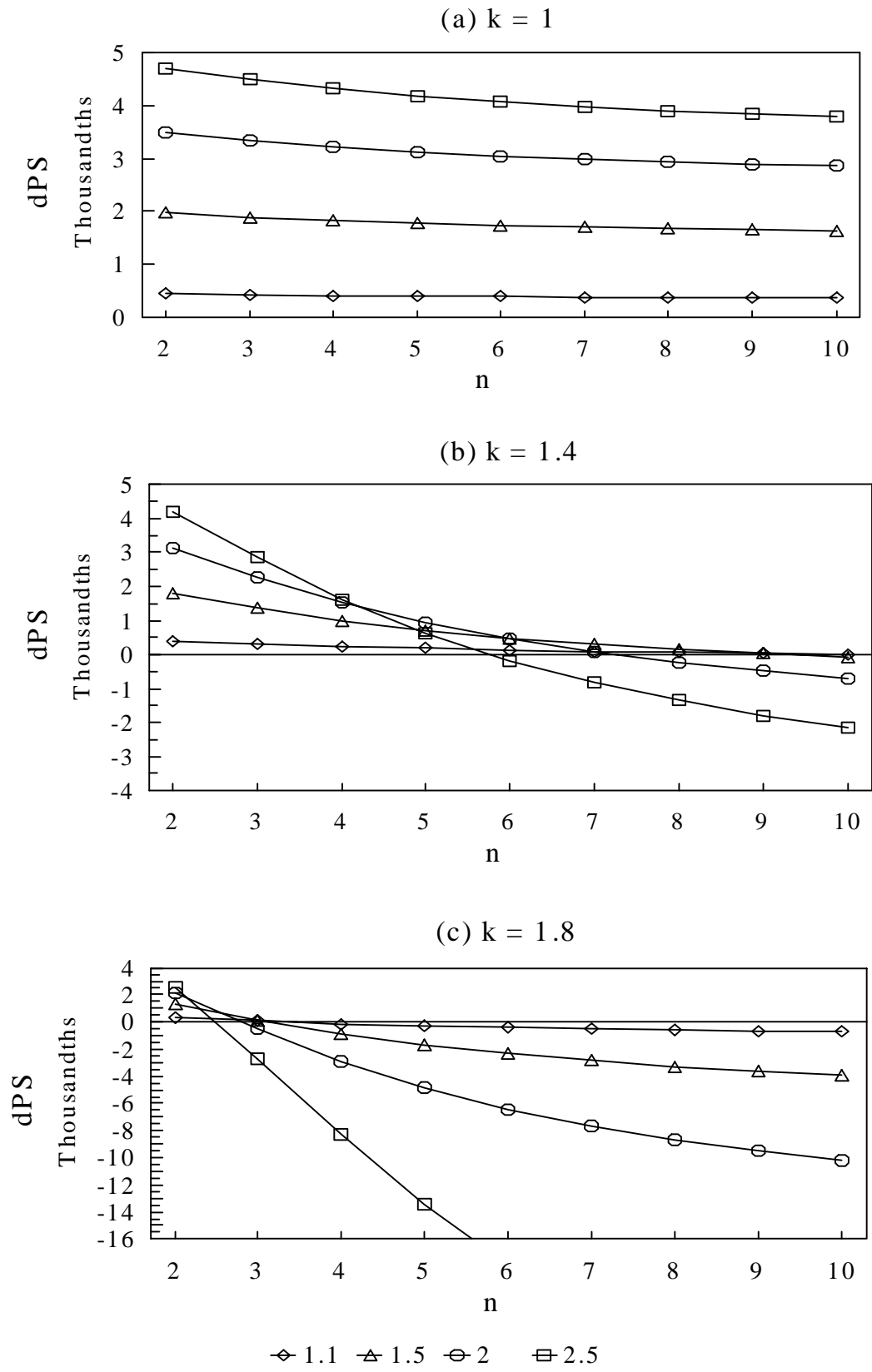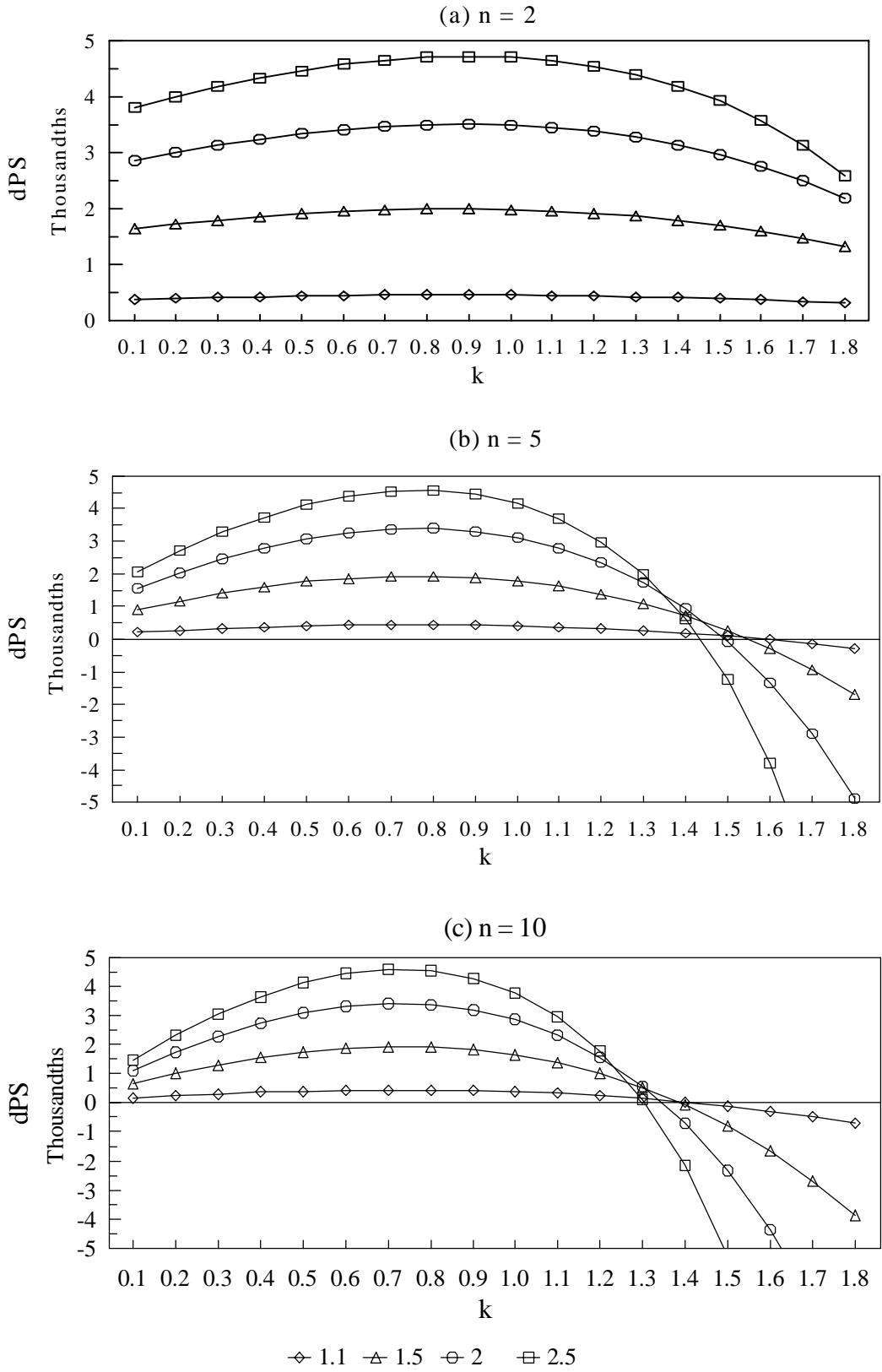
Figure 1: Farmer Welfare as a Function of n

(a) n = 2

(b) n = 5

(c) n = 10

1.1   1.5   2   2.5

Figure 2: Farmer Welfare as a Function of k

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