Slotting Allowances as a Facilitating Practice by Food Processors in the Grocery Channel: Profitability and Farm Surplus Effects

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Abstract: Slotting allowances, which are lump-sum transfers paid by manufacturers to retailers in return for various retailer concessions, are an increasingly common practice in wholesale grocery transactions. A relatively vast literature examined slotting allowances; however, two important features have been ignored: (i) the role of food processors in determining these wholesale price arrangements; and (ii) the effect of this payment structure on economic surplus in the vertical market system. This paper provides each of these links. The model derives slotting allowances as a profit-maximizing contractual arrangement for food processing firms, then employs the optimal contract terms to obtain implications for farm surplus, processor surplus, and total surplus in the grocery channel. Central results are that facilitating practices by food processors in the wholesale grocery market raise farm prices, increase farm surplus, and induce positive changes in total surplus in the grocery channel.

Key words: Oligopsony; vertical structure; rent-shifting; slotting allowances

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I. Introduction

Since the mid-1980s, slotting allowances, which has become the generic term for lump-sum entry fees paid by manufacturers to retailers for access to the consumer market, have become an increasingly common practice in wholesale grocery contracts. Slotting allowances are paid in return for various forms of retailer consessions, including one-time payments for new product introduction, periodic stocking fees, charges for manufacturer sales presentations, and display fees for special merchandising and promotion. The salient characteristic that unifies these pricing structures is that a slotting allowance is a lump-sum charge that does not vary with subsequent retailer sales.

Although a relatively vast literature has contributed to the theory of slotting allowances, there is still no consensus on the purpose of these fees. Indeed, there is considerable disagreement even on the central policy issue of whether slotting allowances have pro-competitive or anti-competitive effects. Under circumstances of asymmetric information, slotting allowances can enhance efficiency in the food system by serving as a signaling and screening device for new products with uncertain quality attributes (see, e.g., Lariviere and Padmanabhan; Sullivan). When uncertainty exists regarding new product performance, Richards and Patterson interpret slotting allowances as the value of a retailer's option to delay investment until product acceptance is known; manufacturers must pay the reservation level of the option to induce this retailer investment. Under imperfect competition, however, it is well-known that slotting allowances can reduce efficiency by providing retailers with an instrument to exercise market power. Cannon and Bloom and Desiraju show that imperfectly competitive retailers have the incentive to use slotting allowances as a method to price discriminate among manufacturers. Shaffer demonstrates that slotting allowances can be employed as a facilitating practice by retailers who seek to reduce downstream price competion in the consumer market. By using a slotting allowance to extract revenue from food manufacturers, a retailer can commit to pay a higher wholesale price. A higher wholesale price paid by the retailer increases the unit cost of the manufactured good, which softens price competition in the consumer market by signaling rival retailers that she does not intend to aggressively price the product.

The theoretical literature on slotting allowances has yielded essential insights into the role of this payment practice in the food system, but, at the same time, fundamental new questions have been raised. If slotting allowances serve as a signaling device for new products with uncertain quality attributes, then why are lump-sum payments also made by food manufacturers to transact well-established products for which brand acceptance is relatively well understood? The simularity of the payment structure that supports slotting allowances for new product introduction and for periodic activities such as stocking, displaying, merchandising and product promotion suggests the need to develop a unifying theory to encompass a general class of two-part tariff arrangements in the grocery channel. If, on the other hand, slotting allowances serve as a mechanism for retailers to exercise market power over food manufacturers, then why are these lump-sum charges levied most frequently in the highly-concentrated, processed food categories of the grocery market? Slotting allowances are commonly transacted in highly consolidated food processing industries that compete in product classes such as frozen foods, dry grocery, beverages, and microwavable shelf-stable foods. In the much-studied product class of fresh produce products, by contrast, it is almost exclusively the shippers of bagged salad and other fresh-cut, branded products --and not the commodity shippers-- who make access payments to retailers (USDA/ERS). In cross-section of wholesale goods, the idea that a retail agent would choose to selectively employ a price instrument on the most highly concentrated supplier markets goes against everything we know about market power.

Why are slotting allowances observed, almost exclusively, in the processed food categories of the supermarket? This paper develops a theory of slotting allowances from the perspective of food processing firms. Given the importance of the food processing sector as a source of value-added in the grocery channel, it is surprising to note that the role of the food processor in slotting allowance arrangements is a subject that has been entirely ignored.

Our observations are based on a vertical market structure in which grocery production is organized between an upstream farm product market and a series of subsequent downstream finished product markets. In the upstream market, competitive producers sell a homogeneous farm product to an imperfectly competitive food processing sector. This conceptual treatment is broadly consistent with an emerging literature in this *Journal* on imperfect competition in the food system, which posits an oligopsonistic relationship in markets where farm product producers meet food processing firms (see, e.g., Chen and Lent; Sexton; Wann and Sexton; Hamilton and Sunding; Alston, Sexton, and Zhang). Unlike previous research on slotting allowances, which has not explicitly considered the upstream farm product market, the focus here on the food procesing firm provides a formal link to derive welfare implications in terms of farm surplus, processor surplus, and total surplus measures in the grocery channel.

The possibility that the contract terms governing slotting allowances are derived by food processors raises an entirely new set of questions regarding the purpose of these fees. For instance, under what circumstances would a food processor with a sizable market share of a finished product wish to make a lump-sum payment to a retailer? What is the mechanism through which a food processor can increase her profitability with a slotting allowance and what are the optimal contract terms that encompass it? Do these optimal terms coincide, in some fashion, with the observed practices employed in the retail grocery market? And, finally, what implications do processor incentives for slotting allowances entail for the size and distribution of welfare changes in the food system? The goal of this paper is to develop a model that is capable of offering some insight into these questions.

An essential finding of the paper is that the optimal contract form for a food processor involves the payment of a positive slotting allowance. The welfare implications of this finding, moreover, are, at first blush, both surprising and counterintuitive. Slotting allowances as a facilitating practice by food processors in the wholesale grocery market induce positive changes in both farm surplus and total surplus in the vertical market system.

The remainder of the paper is structured as follows. Section 2 develops a mathematical model to characterize the optimal contract terms for a food processor in the wholesale grocery market. Section 3 derives implications for slotting allowances on the size and distribution of welfare changes in the grocery channel. Section 4 discusses the empirical evidence that supports this view of slotting allowance contracts and section 5 concludes.

2. The Model

The starting point for analysis is an imperfectly competitive vertical food system in which an upstream farm sector sells a raw product to an imperfectly competitive food processing industry, which subsequently refines and sells a finished wholesale product to downstream retailers. Following Just and Chern, Chen and Lent, Hamilton and Sunding, and Allston, Sexton, and Zhang, we treat food processors as oligopsony buyers of a homogeneous farm product in the upstream market.

The model considers slotting allowances as a fixed price contract form. A fixed price contract, which specifies a wholesale price and a lump-sum transfer between a manufacturer and a retailer, is a commonly employed contract form in the grocery industry (USDA/ERS).[1]

Consider an upstream industry that produces a homogeneous farm product, X.[2] The farm product is sold in an oligopsony market comprised of n food processing firms. The level of farm product use by processor i is denoted x_i and total raw product use in the industry is $X = \sum_i x_i$. The price in the farm product market is given by the inverse supply function for the raw product, $W = W(X)$, where $W'(X) > 0$. In the processing sector, the processing technology of firm i is

[1] A fixed price contract is also the form considered in Shaffer's seminal paper on slotting allowances.

[2] Under circumstances in which processors compete to procure heterogeneous farm products, such as would be the case when farm product suppliers produce locationally differentiated commodities, the qualitative predictions for the optimal processor contract are identical to those described here. For the interest of model clarity, we abstract from this consideration here; however, results on the optimal contract form under heterogeneous product competition are available from the author upon request.

described by the production function $y_i = f_i(x_i)$, with $f_i'(x_i) > 0$ and $f_i''(x_i) \leq 0$, where y_i is the (potentially heterogeneous) finished wholesale product produced by processor *i*. In the absence of any slotting allowance arrangement, we assume food processor *i* sells the finished wholesale product to a competitive retail intermediary at a non-contracted wholesale price of P_i^w.[3] Further downstream, of course, is the consumer market; however, with a competitive retail intermediary, the structure of this market plays no role in the analysis and can therefore be suppressed.

Strategic interaction between food processing firms is modeled as a three-stage game, the timing of which is described in Figure 1. In the first stage, the contract stage, food processor *i* writes an observable and non-renegotiable contract with one or more of its downstream retailers. The terms of the contract specify a contract price for the wholesale product (r_i) in exchange for a slotting allowance to be made from the processor to the retailer (S_i). The equilibrium value of the slotting allowance is allowed to emerge without restriction on sign. In the second stage, the acceptance stage, the retailer either accepts or rejects the processor's contract. If the contract is accepted, the food processor pays a slotting allowance of S_i to the retailer in return for an agreement to purchase the finished product at a unit price of r_i. If the contract is rejected, then the food processor sells the finished product to retailers at the non-contracted wholesale price, P_i^w. In the third and final stage, the procurement stage, food processors compete in a Cournot oligopsony to acquire the farm product.

Throughout, it is assumed that

$$W'(X) + x_i W''(X) > 0, \forall i, \tag{1}$$

which ensures the existence and stability of the farm product equilibrium.[4] Condition (1) implies that the marginal profit of each processor declines with the its rival's procurement level.

The model is solved using backward induction. Hence, the analysis begins with the procurement stage, followed by the acceptance and contract stages respectively. Consider the

[3] This is essentially the inverse of the approach employed by Shaffer, who treats slotting allowances as contractual arrangements between oligopoly retailers and perfectly competitive food manufacturers. As described in some detail below, these opposing approaches yield surprisingly similar qualitative predictions for optimal contract design.

[4] Expression (1) is sufficient for the Routh-Hurwitz condition to hold on the Jacobian of (3) and (4) below.

case of duopsony processors, which are denoted processor 1 and 2. In the procurement stage, suppose a downstream retailer has accepted the contract proposed by food processor *i*. In this event, the objective function of processor *i* is

$$\pi^i\left(x_i, X, r_i, S_i\right) = r_i f_i(x_i) - W(X)x_i - S_i, \qquad i=1,2. \tag{2}$$

where $W(X)x_i$ is the variable cost of farm product procurement for processor *i*. In addition, there is also a sunk cost component that explains the existence of imperfect competition in the processing sector; however, this is omitted because it plays no role in the analysis. Maximizing (2) with respect to x_i yields the following necessary condition:

$$\pi_i^i \equiv r_i f_i'(x_i) - W(X) - x_i W'(X) = 0, \qquad i=1,2, \tag{3}$$

where the subscript on the food processor profit expression denotes the partial derivative with respect to the procurement quantity, x_i.

In the procurement stage, the level of farm product use by each firm and total industry farm product use, which are denoted $x_i^c(r_1, r_2),\ i = 1,2$ and $X^c(r_1, r_2)$ respectively, are obtained by simultaneously solving equations (3).

Totally differentiating (3) yields the comparative statics effects associated with the processor's choice of r_i. Noting that $\pi_{ii}^i < 0$, $\pi_{ij}^i < 0$, and $\Delta = \pi_{ii}^i \pi_{jj}^j - \pi_{ij}^i \pi_{ji}^j > 0$ by (1), the comparative statics effects are as follows:

$$\frac{\partial x_i^c(r_1, r_2)}{\partial r_i} = \frac{-f_i'(x_i^c)\pi_{jj}^j}{\Delta} > 0, \tag{4}$$

$$\frac{\partial x_j^c(r_1, r_2)}{\partial r_i} = \frac{f_i'(x_i^c)\pi_{ji}^j}{\Delta} < 0. \tag{5}$$

Next define the ratio of comparative statics effects in (4) and (5) as

$$\frac{\partial x_j}{\partial x_i}(x_j^c, X^c) = \frac{\partial x_j^c(r_1, r_2)/\partial r_i}{\partial x_i^c(r_1, r_2)/\partial r_i} = \frac{W'(X^c) + x_j^c W''(X^c)}{r_j f_j''(x_j^c) - 2W'(X^c) - x_j^c W''(X^c)}, \tag{6}$$

which is negative by (1).

In the acceptance stage, a retailer is willing to accept the contract proposed by a processor provided it receives a payment no less than its opportunity costs. With a competitive retail industry, these opportunity costs can be normalized to zero without loss of generality.

Accordingly, the retailer accepts the contract proposed by processor *i* whenever

$$(P_i^w - r_i)y_i + S_i \geq 0\,. \tag{7}$$

In the contract stage, processor *i* chooses the terms of the contract so as to maximize profits in (2) subject to the participation constraint (7) and the procurement stage solutions above. Substituting the procurement stage solutions into (2) and (7), the contracting problem is

$$\underset{r_i, S_i}{Max}\,\pi^i(r_i, S_i) = r_i f_i(x_i^c) - W(X^c)x_i^c - S_i$$

$$s.t.\;\; (P_i^w - r_i) f_i(x_i^c) + S_i \geq 0$$

The optimal terms in the processor's contract specify that the retailer participation constraint be met with equality in (7), from which results the following unconstrained problem:

$$\underset{r_i}{Max}\,\pi_i(r_i) = P_i^w f_i(x_i^c) - W(X^c)x_i^c\,. \tag{8}$$

Notice in (8) that only the indirect effect of the contracted wholesale price remains; the direct effect of the contract price on the profitability of processor *i* is exacly offset by the payment of the slotting allowance.

Differentiation of (8) with respect to r_i yields the necessary condition for a profit-maximizing contract,

$$\left(P_i^w f_i\,'(x_i^c) - W(X^c)\right)\frac{\partial x_i^c}{\partial r_i} - x_i^c W\,'(X^c)\frac{\partial X^c}{\partial r_i} = 0\,. \tag{9}$$

Proposition 1. The non-cooperative Nash contract equilibrium for food processor i, i=1,2, is characterized by

(i) a wholesale price above the non-contracted price ($r_i^* > P_i^w$); and

(ii) a positive slotting allowance ($S_i^* > 0$).

Proof. Let $x_i^* = x_i(r_1^*, r_2^*)$, *i*=1,2 denote the solution to the Nash equilibrium described by (9). To determine the equilibrium choice of r_i^*, substitute the procurement stage solution (3) into (9), from which obtains

$$\left(P_i^w - r_i^*\right) f_i\,'(x_i^*) = x_i^* W\,'(X^*)\frac{\partial x_j}{\partial x_i}(x_j^*, X^*) < 0\,, \tag{10}$$

where the inequality holds by expression (6). Hence, the optimal contract terms of processor *i* specifies a wholesale price above the non-contracted wholesale market price for the processed good, $r_i^* > P_w$, *i*=1,2.

To compensate the retailer for the higher expense on wholesale transactions, the optimal contract terms specify a positive lump-sum payment. The optimal level of the slotting allowance, S_i^*, is given by (7) as

$$S_i^* = (r_i^* - P_i^w) f_i(x_i^*) > 0, \qquad i=1,2. \tag{11}$$

A slotting allowance is an attractive arrangement for a food-processing firm. Through the use of the optimal slotting allowance (10), the processor is able to support a higher wholesale price in its contract with a retailer, which, in turn, shifts the processor's marginal value product function outward relative to the rival processor in the farm product market. This shift increases the marginal profitability of farm input procurement for the contracted firm. In total, of course, the direct contribution of the higher wholesale price to the processor's profit is exactly offset by the payment of the slotting allowance. Nonetheless, the outward shift in its marginal value product function alters the set of credible actions for the processor in its rivalry for the oligopsony input. A higher wholesale price purchased with a compensatory slotting allowance changes the reaction function of the contracted processor, thereby allowing the firm to commit to a higher procurement level which increases its oligopsony rent.

The formal structure of the precommitment mechanism derived above is similar to the form of the optimal contract design in the vertical separation literature (see, e.g., Lin, Bonanno and Vickers, Coughlin and Wernerfelt, Shaffer, Kühn, and Hamilton and Stiegert). A slotting allowance that supports a higher wholesale price for the processor is a commitment mechanism that creates an *ex post* beneficial expansion in its level of farm product procurement. Through use of this mechanism, the payment of a slotting allowance alters the non-cooperative oligopsony equilibrium in favor of the contracted processor.

The noncooperative Nash contract equilibrium is characterized by the use of slotting allowance by each food processor. Nonetheless, the noncooperative Nash contract equilibrium is jointly sub-optimal for the processors. The joint profit level of the two processors would be higher if slotting allowances were reduced below the Nash equilibrium levels. However, if one processor chooses not to pay a slotting allowance, it cannot expect to deter the rival processor from making a slotting allowance to secure a relatively higher wholesale price. The non-contracting processor, in this case, would be worse off than if it had joined the contract game.

3. Welfare Implications

The welfare consequences of the noncooperative Nash contract equilibrium are summarized as follows.

Proposition 2. At the noncooperative Nash contract equilibrium:

(i) the joint profitablity of food processors would increase if slotting allowances were reduced;

(ii) farm surplus would decrease if slotting allowances were reduced.

Proof. First note by (7) that the equilibrium level of the access payment by each processor increases monotonically with the contract price. Therefore, it is sufficient to show that joint profitability of food processors would rise, and farm surplus would fall, in response to a decrease in the contract prices.

For part (i), the joint processor profit function is $\Pi(r_1, r_2) = \pi^1(r_1, r_2) + \pi^2(r_1, r_2)$. Since $\frac{\partial \pi^i(r_1, r_2)}{\partial r_i} = 0$ at the Nash equilibrium point, it follows that

$$\frac{\partial \Pi(r_1^*, r_2^*)}{\partial r_i} = (P_j^w - r_j^*) f_j{}'(x_j^*) \frac{\partial x_j(r_1^*, r_2^*)}{\partial r_i} - x_j^* W'(X^*) \frac{\partial x_i(r_1^*, r_2^*)}{\partial r_i}, \qquad i = 1,2.$$

Substituting in for $(P_j^w - r_j^*) f_j{}'(x_j^*)$ from (10) and gathering terms yields

$$\frac{\partial \Pi(r_1^*, r_2^*)}{\partial r_i} = x_j^* W'(X^*) \frac{\partial x_i(r_1^*, r_2^*)}{\partial r_i} \left[\left(\frac{\partial x_i}{\partial x_j}(x_i^*, X^*) \right) \left(\frac{\partial x_j}{\partial x_i}(x_j^*, X^*) \right) - 1 \right], \quad i = 1,2, \qquad (12)$$

which is negative by (1), (4), and (6). Hence, a reduction in r_i^*, i=1,2, increases the joint profitability of food processors.

For part (ii), farm surplus at the noncooperative Nash equilibrium point is given by

$$G(r_1^*, r_2^*) = W(X^*)X^* - \int_0^{X^*} W(z)dz,$$

which implies

$$\frac{\partial G(r_1^*, r_2^*)}{\partial r_i} = W'(X^*)X^*\left(\frac{\partial X(r_1^*, r_2^*)}{\partial r_i}\right), \quad i=1,2, \tag{13}$$

which is positive by (1), (4), and (5). Therefore, a reduction in r_i^*, i =1,2, decreases farm surplus.

Relative to the baseline case without slotting allowances, the noncooperative Nash contract equilibrium involves larger farm surplus. This is because the higher wholesale price negotiated by each food processor in its contract increases the level of input procurement in the farm product market, which correspondingly increases the equilibrium farm price.

Figure 2 demonstrates the effect of a unilateral slotting allowance contract on total surplus in the vertical market system. The figure depicts the special case of linear farm supply and pure processor intermediation, $f_i(x_i) = x_i$, i =1,2. In the figure, $W_R^n(x_1^n) = W_R^n(X^n - x_2^n)$ and $W_R^c(x_1^c) = W_R^c(X^c - x_2^c)$ denote the (inverse) residual farm supply function facing processor 1 in the non-contracted and contracted case, respectively, where each residual supply function is obtained by shifting the farm supply function to the left (by either x_2^n or x_2^c units). A unilateral arrangement by processor 1 for a slotting allowance has a beneficial profit effect for processor 1, because the higher contract price reduces the equilibrium level of farm product procurement by processor 2 through expression (5). This effect is shown in the figure by the outward shift in residual supply in the contracted case. The marginal outlay schedule corresponding to each residual farm supply function defines processor 1's reaction function in each case, which is denoted in the figure by $R_1^n(x_2^n)$ in the non-contracted case and $R_1^c(x_2^c)$ in the contracted case.

As a benchmark, consider the case of a competitive farm product market. This situation is depicted in Figure 2 by the market quantity, X^*, which is where the farm supply function, *W(X)*, equates with the non-contracted wholesale grocery price, P^w, where $P^w = P_1^w = P_2^w$ is implied by the case of pure processor intermediation. Under a non-contracted oligopsony configuration, the equilibrium level of farm product use for processor 1, x_1^n, is determined by the intersection of the marginal outlay schedule $R_1^n(x_2^n)$ with the wholesale price, P_w, which results in an equilibrium farm price of W^n and a total level of input procurement of X^n. The effect of a contractual arrangement by processor 1 to pay a positive slotting allowance results in the two effects shown in Figure 2: (*i*) the contract provides processor 1 with a relatively higher wholesale price, $r_1 > P_w$; and (*ii*) the higher wholesale price shifts the reaction function of processor 1 outward from $R_1^n(x_2^n)$ to $R_1^c(x_2^c)$. The equilibrium level of farm product use by processor 1 in the contracted case, x_1^c, is determined by the intersection of $R_1^c(x_2^c)$ with the contract price, r_1, which results in an equilibrium farm price of W^c and a total level of farm product procurement given by X^c. Ignoring distributional considerations, a lump-sum transfer from processor 1 to its retailer(s) has no welfare implications; thus, the welfare gain under the slotting allowance is the shaded region in the figure.

In general, it is possible for processor 1's slotting allowance to decrease welfare in the farm system; however, this is only possible under extreme forms of asymmetry in the processing technology. Suppose, for instance, that processor 2 is the more cost-efficient food processor in the sense that $f_2'(\bar{x}) > f_1'(\bar{x})$ and $f_2''(\bar{x}) > f_1''(\bar{x})$ for all $\bar{x}$. Under these circumstances, if processor 1 writes a contract for a higher wholesale price, then there are two countervailing effects on vertical market surplus. First, the total level of farm product use increases, which has a positive effect on economic surplus, but, second, the output increase comes at the expense of a redistribution in production from the relatively low-cost processor to the high-cost processor, which reduces allocative efficiency in the processing sector. In the case of pure processor intermediation depicted in Figure 2, this latter effect of redistributing production between the two processors has no welfare implications. Nonetheless, if the processing technology differs substantially across food processors, it is conceivable that the loss in processing efficiency could swamp the positive farm surplus effect associated with the output increase.

In a symmetric processor configuration, $f_i(.) = f(.)$, i =1,2, the noncooperative Nash contract equilibrium is associated with a positive welfare effect in the vertical market system. The pro-competitive effect of slotting allowances in this case is summarized as follows.

Proposition 3. At a noncooperative Nash contract equilibrium with symmetric food processors, total surplus in the vertical system would fall if slotting allowances were reduced.

Proof. Total surplus in the vertical system is $V(r_1, r_2) = \Pi(r_1, r_2) + G(r_1, r_2)$. At the noncooperative Nash equilibrium point, the effect of a change in the wholesale price of processor i is thus given by the sum of effects in (12) and (13). Combining these expressions gives

$$\frac{\partial V(r_1^*, r_2^*)}{\partial r_i} = W'(X^*)\frac{\partial x_i(r_1^*, r_2^*)}{\partial r_i}\left[x_i^*\left(1+\frac{\partial x_j}{\partial x_i}(x_j^*, X^*)\right)+x_j^*\frac{\partial x_j}{\partial x_i}(x_j^*, X^*)\left(1+\frac{\partial x_i}{\partial x_j}(x_i^*, X^*)\right)\right].$$

Letting $x_i^* = x^*$, i =1,2, denote the level of farm product procurement by each processor in a symmetric oligopsony configuration, and noting that $\frac{\partial x_i}{\partial x_j}(x_i^*, X^*) = \frac{\partial x_j}{\partial x_i}(x_j^*, X^*)$ in the symmetric case, the equation reduces to

$$\frac{\partial V(r_1^*, r_2^*)}{\partial r_i} = x^* W'(X^*)\frac{\partial x_i(r_1^*, r_2^*)}{\partial r_i}\left(1+\frac{\partial x_j}{\partial x_i}(x_j^*, X^*)\right)^2,$$

Which is positive by (4).

In a symmetric processor configuration, the noncooperative Nash contract equilibrium is associated with pro-competitive effects in the food system. Relative to the case of wholesale grocery transactions that do not involve slotting allowances, the joint profitability of food processors is lower, but the level of farm surplus is higher, and total surplus in the vertical market system is larger under an arrangement in which positive slotting allowances are paid.

The market equilibrium that supports each of the propositions above is sub-game perfect. Nonetheless, in dynamic processor games, it is possible that trigger strategies could be employed to avoid the profit-reducing effect of positive slotting allowances. The collusive outcome can be analyzed as follows. Let $x_i^m = x_i(r_1^m, r_2^m)$, i =1,2, denote the joint profit maximizing levels of farm input procurement, where r_i^m are the joint profit maximizing wholesale prices. The solution to the cooperative profit maximization problem provides the following result.

Proposition 4. The cooperative solution that maximizes joint processor profit is characterized by negative slotting allowances.

Proof. At the jointly optimal solution, $\frac{\partial \Pi(r_1^m, r_2^m)}{\partial r_i} = 0$, i = 1,2, where

$$\frac{\partial \Pi(r_1, r_2)}{\partial r_i} = \frac{\partial \pi^1(r_1, r_2)}{\partial r_i} + \frac{\partial \pi^2(r_1, r_2)}{\partial r_i}.$$

Making use of (3), the joint optimum simultaneously solves

$$\left[(P_1^w - r_1) f_1'(x_1) - x_1 W'(X)\right] \frac{\partial x_1(r_1, r_2)}{\partial r_1} + \left[(P_2^w - r_2) f_2'(x_2) - x_2 W'(X)\right] \frac{\partial x_2(r_1, r_2)}{\partial r_1} = 0. \quad (14)$$

and

$$\left[(P_1^w - r_1) f_1'(x_1) - x_1 W'(X)\right] \frac{\partial x_1(r_1, r_2)}{\partial r_2} + \left[(P_2^w - r_2) f_2'(x_2) - x_2 W'(X)\right] \frac{\partial x_2(r_1, r_2)}{\partial r_2} = 0. \quad (15)$$

By inspection of (14) and (15), the unique solution to this problem is

$$P_1^w - r_1^m = \frac{x_1^m W'(X^m)}{f_1'(x_1^m)} > 0, \quad \text{and} \quad P_w - r_2^m = \frac{x_2^m W'(X^m)}{f_2'(x_2^m)} > 0.$$

Thus, the joint profit maximizing contract prices are set below the non-contracted wholesale prices. Accordingly, the levels of the access payments that maximize joint processor profit are

$$S_1^m = -x_1^m W'(X^m) \frac{f_1(x_1^m)}{f_1'(x_1^m)} < 0, \quad \text{and} \quad S_2^m = -x_2^m W'(X^m) \frac{f_2(x_2^m)}{f_2'(x_2^m)} < 0.$$

In a collusive situation, the processors maximize joint profit by establishing contract terms with retailers that stipulate negative slotting allowances in exchange for lower wholesale prices. A reduction in the wholesale price induces a downward shift in the marginal value product function of each processor for the farm input, which increases the joint oligopsony rent by reducing procurement levels and depressing farm prices towards the monopsony level.

4. Extensions and Empirical Implications

In section 2, the observed structure of slotting allowances in wholesale grocery transactions was demonstrated to be consistent with the optimal contract design of a food-processing firm. The central observation that supports this result is that the payment of a slotting allowance allows a food processor to support a higher wholesale price in its contract with the retailer.

By structuring wholesale grocery transactions with the use of a slotting allowance, an oligopsony processor is able to shift rent in the farm product market by contracting for a retailer concession (i.e., a higher price) that induces an upwards shift in its marginal value product function. The intuition for this result is as follows. Under an arbitrary set of conditions in the farm product market, it is possible to express the Stackelberg leader-follower equilibrium for processors *i* and *j*, respectively, as a procurement quantity pair, (x_i^*, x_j^*). Moreover, it is generally possible to derive this same procurement quantity pair as the outcome of a simultaneous-move game in which processor *i* has a higher marginal value product, at the equilibrium levels, than processor *j*. This is precisely the nature of the optimal contract arrangement for a slotting allowance. The contract specifies a higher wholesale price in return for a slotting charge, which allows the processor to commit itself through what amounts to a shift parameter in its marginal value product function.

In wholesale grocery transactions, slotting allowances are often paid by food processors in exchange for other retailer concessions besides a higher wholesale price. The simple form of the contractual arrangement considered above represents only one type of practice commonly employed in wholesale grocery markets. Slotting allowances are also paid in return for various other retailer concessions, such as to acquire relatively more desirable shelf-space or to establish terms of an exclusive dealing arrangement. Nonetheless, to the extent that these forms of retailer concessions induce an outward shift in the marginal value product function of the contracted processor, such considerations would not change the qualitative implications of the model.

For certain contract forms, a processor may be able to use a slotting allowance to establish a unilateral commitment mechanism. The obvious example is a contract that stipulates exclusive dealing, which, at least potentially, forecloses a dominant share of the retail channel to the rival processors. Similarly, if the quantity of a processed good sold at a given price is a function of product placement in the retail store, preferential shelf-space arrangements can provide another form of unilateral commitment mechanism.

The empirical implications of the model provide a stark point of contrast with existing models of slotting allowances based on imperfectly competitive firms. In Shaffer's theory of retailer-designed contracts, for example, the situation is reversed in the sense that the food manufacturer (and not the retailer) is driven down to his reservation level of profit by the terms of the contract. Positive slotting allowances and higher wholesale prices obtain in this case as well; however, the implication for market performance in an environment with retailer-designed contracts is exactly opposite to that described here. When a retailer commits to a higher wholesale price through a slotting allowance, the contractual arrangement lessens price competition at the retail level by reducing the incentive for rival retailers to compete aggressively in the downstream grocery market. This is because a contractual arrangement by a retailer to pay a higher wholesale price to a food manufacturer signals an intent to set a correspondingly high price in the consumer market, which provides the rival retailer with an incentive to raise her retail price in response.[5]

Does a retailer oligopoly model based on strategic complements result in an outcome that is observationally equivalent to the outcome of a processor oligopsony model based on strategic substitutes? There is one important exception. In a retailer oligopoly configuration, a necessary condition for a slotting allowance to increase retailer profit is that the practice supports a higher retail price, which implies that contracts reduce the quantity of retail grocery sales. Conversely, the empirical implication of the present model is that a higher wholesale price is accompanied by

[5] In the parlance of game-theory, this is known as playing a "puppy dog" strategy.

a larger quantity of retail grocery sales and a non-increasing retail price. It is therefore possible to gain insight into the nature of these contractual arrangements, in particular whether they are motivated predominantly by food processors or by grocery retailers, by examining the effect of access payments on retail grocery sales and prices.

Figure 3 depicts annual U.S. grocery sales over the 1970-2000 period for all grocery stores and for supermarkets (in 1982-84 dollars adjusted by the food-at-home index). The figure shows that annual grocery sales, both in the U.S. grocery market and in U.S. supermarkets, have increased in a fairly stable manner over the period in which access payments emerged.[6] These trends provide some preliminary evidence that access payments do not appear to have substantively decreased the quantity of grocery transactions.

Table 1 reports several relevant price trends in the retail grocery industry. The first two columns of the table compare price changes in the consumer price index (CPI) to trends in U.S. at-home food consumption, which excludes food sold in restaurant establishments. Notice that the food-at-home index has not increased relative to other consumer prices in the period, which provides some descriptive evidence that slotting allowances have not been employed as an instrument to increase retail grocery prices. The last two columns of Table 1 compare price trends for all fruit and vegetables with that of fresh fruit and vegetables. The essential difference between these two series is that the price trend for all fruit and vegetables includes processed canned and frozen goods; hence, the last two columns of Table 1 are broadly suggestive of the price changes for fresh and processed produce over the period.[7] Notice that the average retail price of fresh fruit and vegetables, commodities for which there is little evidence of slotting allowances, has increased relative to the price index for all fruit and vegetables. To the extent that slotting allowances are predominantly used to structure the wholesale transactions of

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[6] The two discontinuities in the supermarket sales series reflect upward revisions in the nominal volume that defined a supermarket. In 1973, the minimum sales volume required to be classified as a supermarket increased from $0.5 million to $1 million, and, in 1981, it increased from $1 million to $2 million.

[7] Prior to 1997, the U.S. Bureau of Labor Statistics does not report disaggregated price data on processed and non-processed foods. Beginning in 1978, there is data available on retail prices of fresh and frozen vegetables; this information is used to construct Figure 4.

processed foods, therefore, evidence in the produce markets indicates that these contractual arrangements have decreased retail grocery prices for processed goods relative to commodities. This evidence is broadly consistent with the theory that slotting allowances are motivated by the incentives of food processors to capture oligopsony rent in upstream farm product markets.

Regardless of the direction of the contractual arrangement in an imperfectly competitive food system, the defining feature that supports either theory of slotting allowances as a facilitating practice stems from changes in the dynamic profile of wholesale prices. The available time series data on wholesale prices, unfortunately, is limited. To derive implications for wholesale price movements, Sullivan provides a proxy for the general wholesale price trend across all grocery products by combining measures of retailer gross marketing margins with time series data on retail grocery prices between 1961-1986. Making use of this proxy, Sullivan suggests that the gross margin of grocery retailers did not decrease in the period in which slotting allowances emerged as a common grocery practice.

Two stylized facts in the grocery industry provide some indication as to why the gross retail marketing margin may have increased over the period in which slotting allowances emerged. First, as Sullivan points out, the period associated with non-decreasing retail marketing margins is characterized by a rapid increase in the number of grocery products stocked.[8] For example, between 1978 and 1987, A. C. Nielsen reports a 34.4 percent increase in the number of dry grocery items stocked and numerous trade articles report similarly high rates of growth in frozen and refrigerated items in grocery stores in the 1980s. Accordingly, it is likely that fixed costs in grocery stores have substantially increased over the period, which would indicate that the general underlying trend (in the absense of lump-sum transfers) may have been towards increased retail margins over the period. For this reason, the non-decreasing marketing margins observed over the period are not inconsistent with contractual arrangement that re-structure wholesale grocery transactions between lump-sum and per-unit transfers. Second, and

[8] Indeed, Sullivan's theory of competitive shelf-space allocation predicts a correspondence between product proliferation and the use of slotting allowances.

perhaps more compelling, evidence based on this proxy of gross marketing margins provides only an aggregative trend across all retail grocery products, for which processed goods are a subset. To the extent that slotting allowances are employed strictly for the processed product classes, it is important to compare the relative trends in grocery marketing margins on commodities and processed goods.

Figure 4 depicts the relative trends in the marketing margin for fresh and frozen vegetables.[9] The marketing margin is taken to be the difference between the CPI and producer price index (PPI) for fresh and frozen vegetables, respectively, where the relative producer and consumer prices for each series are normalized to zero in 1978. Notice that the marketing margin for fresh vegetables has increased substantially relative to that for frozen vegetables in grocery stores, which is consistent, in this case, with a general re-distribution of the retail margin between processed goods and commodities. Moreover, to the extent that increased retailer fixed costs can be attributed to the high rate of growth in frozen and refrigerated grocery products, which are relatively capital-intensive, the figure indicates that a substantial degree of cross-subsidization has taken place between the marketing margins on fresh and processed vegetables. The decrease in marketing margins for processed goods relative to commodities over this period is consistent with the hypothesis that contractual arrangements for slotting allowances are motivated by food processing firms.

5. Concluding Remarks

This paper has demonstrated that slotting allowances may be motivated, not by grocery retailers, but by food processing firms. The model considered a profit maximization problem for an oligopsonistic food processor that resulted in an optimal contract design that conforms to a commonly observed practice in wholesale grocery transactions; a fixed price contract.

[9] The margins for fresh and frozen vegetables are chosen for the comparison here, because, prior to 1997, the U.S. Bureau of Labor Statistics does not report price data on canned vegetables or on frozen and canned fruits.

The payment of a slotting allowance by a food processor was shown to provide a commitment mechanism that allows rent-shifting to occur in the farm product market. The noncooperative Nash contract equilibrium of the model was demonstrated to involve mutual contracts to pay slotting allowances to grocery retailers. Relative to the case of wholesale grocery transactions that do not involve slotting charges, moreover, the noncooperative Nash equilibrium was associated with superior welfare properties. For the equilibrium contractual arrangement with positive slotting allowances, farm surplus was shown to increase, and, in the case of a symmetric processor oligopsony configuration, total surplus in the vertical market system was demonstrably larger.

The results of the model were then contrasted with the structure of the optimal contract design that supports slotting allowances as a mechanism to increase retailer profits. Under each contractual arrangement, the optimal contract form specifies a higher wholesale price in exchange for a positive lump-sum transfer; however, the model implications were found to differ substantively in their predictions for retail grocery price and quantity movements. Evidence was provided to support differential trends in the retail prices of commodities and processed products in a fashion that is consistent with the present theory.

The model results raise interesting opportunities for future research into the nature of wholesale grocery transactions, particularly with regard to the optimal design of bilateral processor-retailer contracts. Under circumstances of bilateral contract design, the essential incompatibility between retailer and processor incentives for slotting allowances is the determination of an agreeable output level. A contract that specifies a higher wholesale price allows oligopsony rent-shifting only to the extent that processed output increases, whereas considerations of retailer profitability suggest the use of contractual arrangements as an instrument for output reduction.

The solution to this bilateral contracting problem may provide important insight into other observed trends in the grocery industry. For example, a contractual arrangement for a slotting allowance can increase the output of an individual processor and concurrently decrease retail output through the specification of an exclusive-dealing contract that forecloses a dominant share of the retail grocery market to rival food processors. Alternatively, it may be possible to support bilateral contractual arrangements that involve multiple processors through product-line expansion of processed goods in the retail market. To the extent that consumer demand for processed products is characterized by imperfect substitutability across varieties in a product class, so that average retail prices increase with the number of products for a given quantity of output, it is possible that the optimal bilateral contract form contributes to product proliferation in the retail market. Future analyses of optimal bilateral contractual arrangements in the food system may thus provide important insights to link the coincident trends toward slotting allowances and product proliferation in the processed product classes.

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Figure 1. The Timing of the Game

Contract Stage: Food processor i chooses contract terms (r_i, S_i)

→

Acceptance Stage: Grocery retailer(s) accept or reject the contract

→

Procurement Stage: Food processors choose procurement levels of the farm product (x_i, $i = 1,2$)

Figure 2. Residual Farm Supply and the Welfare Implications of Off-Invoice Fees.

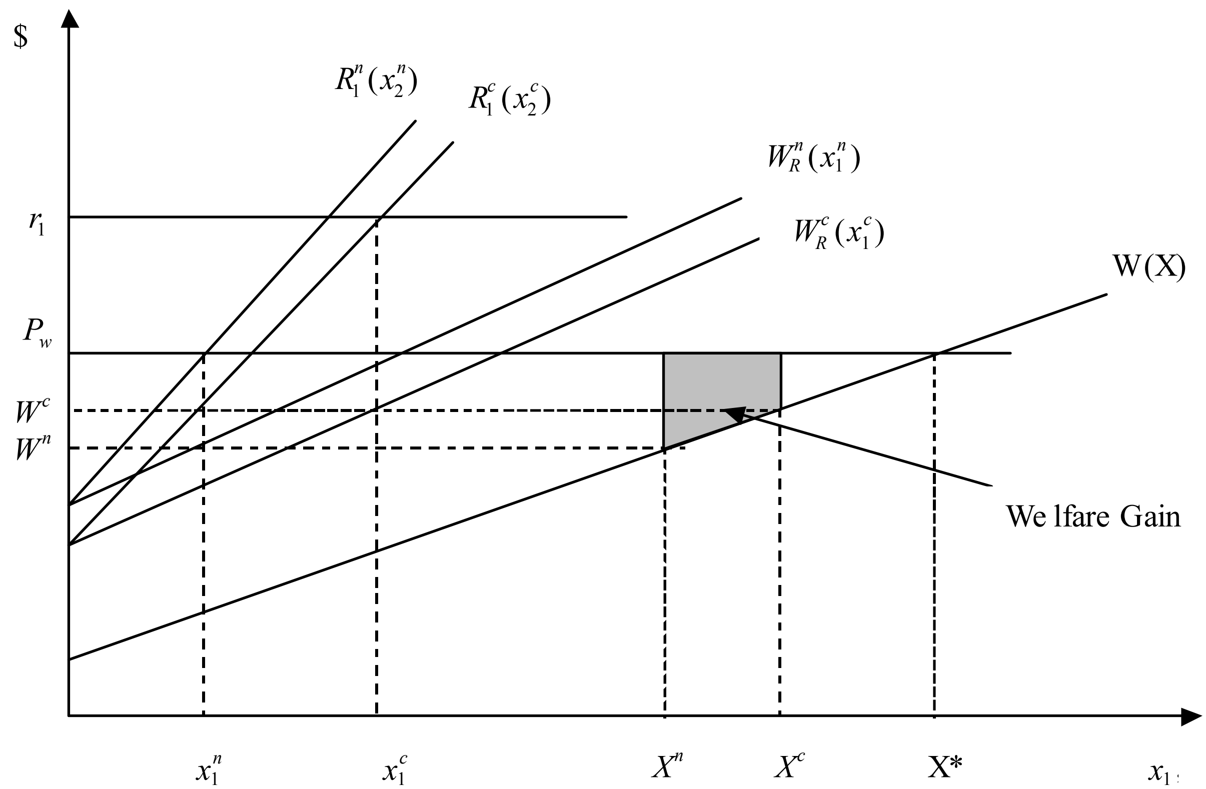

FIGURE 3. Annual Grocery Sales in Billions of 1982-84 dollars.
Source: Progressive Grocer, *Annual Report of the Grocery Industry* (April, 1971-2001).

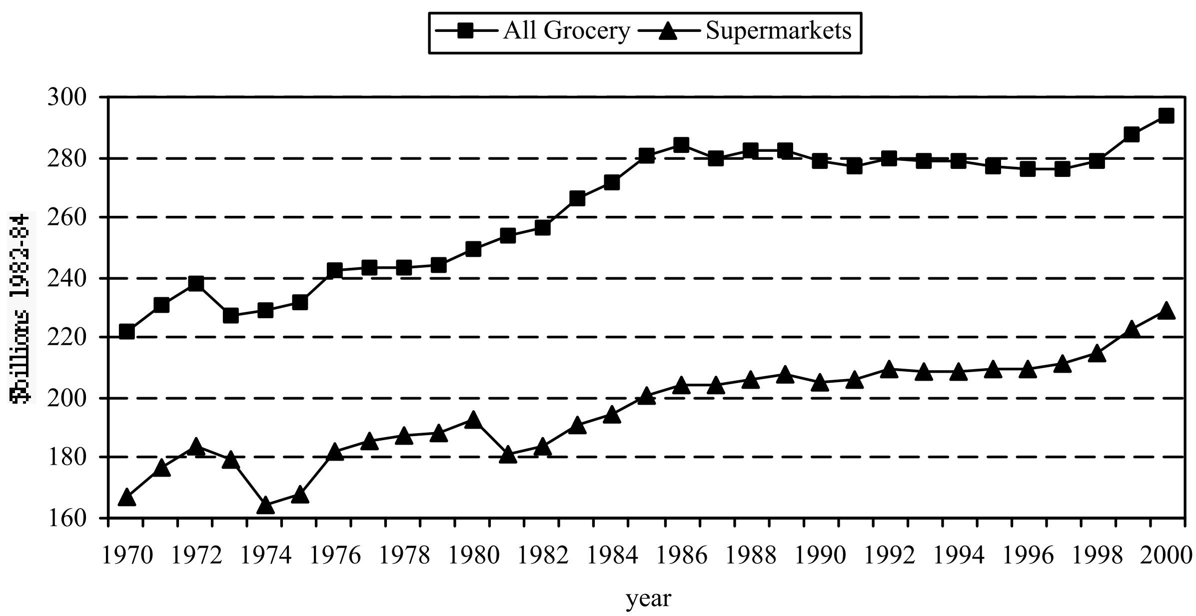

TABLE 1. The CPI, Food-at-Home, Fruit and Vegetables, and *Fresh Fruit and Vegetables Indexes*

Year	CPI	FAH	F&V	Fresh F&V
1966	100.0	100.0	100.0	100.0
1967	103.1	99.7	100.0	100.3
1968	107.4	103.1	107.8	109.6
1969	113.3	108.0	109.3	111.5
1970	119.8	113.4	113.5	116.7
1971	125.0	116.2	119.2	121.4
1972	129.0	121.3	124.9	128.2
1973	137.0	141.2	142.3	151.1
1974	152.2	162.2	165.8	162.8
1975	166.0	175.6	170.9	166.6
1976	175.6	179.3	175.4	170.6
1977	187.0	189.8	191.6	193.8
1978	201.2	209.7	212.9	218.9
1979	224.1	232.4	230.0	235.6
1980	254.3	251.1	246.5	253.3
1981	280.6	269.3	276.3	283.6
1982	297.8	278.7	291.3	299.4
1983	307.4	281.5	292.2	298.5
1984	320.7	292.0	317.4	331.0
1985	332.1	296.3	325.5	339.6
1986	338.3	304.8	328.5	349.8
1987	350.6	317.9	357.7	392.6
1988	365.1	331.3	384.7	421.4
1989	383.0	352.8	414.4	457.3
1990	403.4	375.9	447.4	498.5
1991	420.4	385.8	467.9	539.0
1992	433.0	388.6	466.7	529.4
1993	446.0	398.0	477.5	552.9
1994	457.4	409.4	495.5	578.0
1995	470.4	422.7	533.6	637.8
1996	484.3	438.4	552.3	655.7
1997	495.4	449.1	563.1	666.9
1998	503.1	457.7	595.2	715.8
1999	514.2	466.5	609.9	734.4
2000	531.5	477.0	614.4	739.3

SOURCE: U.S. Bureau of Labor Statistics (http://stats.bls.gov/sahome.html), May 3, 2001.

NOTE: All price indexes are for all urban consumers; the U.S. city average is in 1966 dollars. CPI = the consumer price index. FAH = the food-at-home index. F&V = the fruit and vegetables index. Fresh F&V = the fresh fruit and vegetables index.

FIGURE 4. Percentage Change in Marketing Margins for Fresh and Frozen Vegetables, 1978-2000. Source: U.S. Bureau of Labor Statistics (http://stats.bls.gov/sahome.html).