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Price Bargaining Without Supply Control

Henry W. Kinnucan

Primary food producers are permitted to bargain as a group for higher prices. Supply response, however, is critical to the long-run success of producer cartels. This article presents a model that elucidates that role of supply response in agricultural price bargaining when no overt action is taken to limit quantity and participation in the cartel is voluntary. Free-riding, for example, is seen as having a dual nature: it undermines the cartel's influence at the negotiating table but it enhances the cartel's ability to sustain a negotiated price increase by attenuating supply response. That price bargaining can result in significant transfers from processors to producers when demand is inelastic and supply is uncontrolled is highlighted in the empirical application.

Price bargaining is a common feature of American agriculture, thanks to federal legislation that protects agricultural producers, including fishermen, from antitrust exposure (Frederick). Yet the scholarly literature is virtually devoid of studies that elucidate the economic effects of agricultural price bargaining in any systematic fashion. Early work by Helmberger and Hoos remains the theoretical foundation for the few existing studies on agricultural price bargaining (e.g., see French and the references cited therein). The Helmberger and Hoos' model, however, treats buyers of agricultural products as a colluding monopsony, which may overstate the market power enjoyed by middlemen. Ladd extends Helmberger and Hoos's analysis, but does not address the long-run effects of price bargaining, the major focus of this paper. Discussing noncooperative game theory, Sexton identifies a number of principles (e.g., first-mover advantage and the importance of patience and outside options) that appear to apply to agricultural bargaining situations, but assumes that the quantity sold is independent of the bargaining outcome.

The objective of this research is to determine the price and quantity impacts of agricultural price

bargaining when supply is uncontrolled. The lack of supply control is important because it is a salient feature of agricultural bargaining structure, to wit (French, p. 17):

Farmer bargaining associations are voluntary cooperatives organized to give individual farmers a greater voice and (hopefully) more power in dealing with what, for most commodities, is a relatively small number of processor buyers. These associations are a type of cartel that controls the disposition of the members' product *but that has no control over the quantity produced*. Individual farmer members behave approximately as perfect competitors in production, i.e., they generally do not take account of the possible effect of their own output on price received [italics added].

This lack of supply control is beneficial in that it limits the bargaining associations' ability to exercise undue market power.¹ But it raises questions about the long-term effectiveness of agricultural bargaining associations in that any price increases obtained by the cartel could easily be dissipated by the ensuing production responses, especially if demand at the farm level is price inelastic. The problem of supply response is exacerbated if price bargaining causes farm prices overall to rise, which

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¹ Whether supply control is permissible conduct under the law granting agriculture antitrust protection is a matter of debate among antitrust experts. Frederick (pp. 58-59), however, argues that the Federal Trade Commission has ruled favorably on specific instances in which producers have limited production for the purposes of price enhancement.

appears likely given the substitutability between cartel and non-cartel output.

This paper explores these issues by developing a model that describes the price and quantity impacts of price bargaining in a market-equilibrium setting. An advantage of the model is that it side-steps the well-known indeterminacy of the bilateral bargaining solution (Henderson and Quandt, pp. 244–49), yet yields testable hypotheses about the role of market supply and demand elasticities and free riding on cartel effectiveness.²

The model's usefulness is demonstrated by an application to price-bargaining in the catfish industry. The catfish industry is an insightful case study because it represents features common to other agricultural bargaining situations (e.g., voluntary membership in the bargaining association, lack of supply control, atomistic competition among farmers, and small number of processor buyers, see Iskow and Sexton) and data are available to test hypotheses about cartel effectiveness.

I begin by discussing the model. Hypotheses generated from the model are then tested via joint estimation of price-transmission and demand equations. A key insight from the analysis is that free riders, i.e., producers who choose not to participate in the cartel but benefit from any spillover effects of the cartel price onto the market price, may actually assist the cartel by attenuating supply response, the Achilles' heel of collective bargaining schemes.

Model

Consider the following Muth-type equilibrium-displacement model

$$\begin{aligned}
 (1) \quad \ln Q_d &= -N \ln P_w && \text{(wholesale-level demand)} \\
 (2) \quad \ln P_f &= T \ln P_w && \text{(wholesale-farm price transmission)} \\
 &\quad + L \ln P_B \\
 (3) \quad \ln Q_s^B &= E \ln P_B && \text{(cartel supply)} \\
 (4) \quad \ln Q_s^{NB} &= E \ln P_f && \text{(non-cartel supply)} \\
 (5) \quad \ln Q_d &= k_B \ln Q_s^B && \text{(market-clearing equilibrium)} \\
 &\quad + k_{NB} \ln Q_s^{NB}
 \end{aligned}$$

where Q_d is the quantity demanded of the processed product at wholesale, Q_s^B is the quantity

supplied of the farm product by cartel members, Q_s^{NB} is the quantity supplied of the farm product by non-cartel members, P_w is the wholesale price of the processed product, P_f is the farm product's market price, and P_B is the floor price negotiated (or announced) by the cartel, which is assumed to reflect the supply-inducing price for cartel members.

In this model, P_B is assumed to be exogenous. All inventories (live and processed) are assumed to be "pipeline" stocks, so changes in inventories associated with changes in the floor price are negligible. Arbitrage between cartel and non-cartel producers is disallowed. That is, I assume that institutional or practical barriers exist to prevent cartel members from obtaining non-cartel output for resale at the floor price. N and E are demand and supply elasticities, respectively, and T is the wholesale-farm price-transmission elasticity.³ L is a structural elasticity that indicates the percent change in the farm price associated with a one percent change in the floor price, assuming supply is fixed. L henceforth will be called the "bargaining elasticity." k_B and k_{NB} indicate the proportion of total production that is represented by cartel and non-cartel members, respectively. Given the negative sign in equation (1), N , E , T , and L are assumed to be positive. However, because cartel participation is voluntary, L is assumed to be less than one and will be zero if the cartel is ineffectual.

The price-linkage equation (equation (2)) is a quasi-reduced form that describes the behavior of the marketing group, i.e., processors and the bargaining association (Hildreth and Jarrett). That the equation accurately depicts the relationship between the wholesale price and the farm price rests on the assumption that forces that cause the two prices to change (e.g., shifts in retail demand or farm supply) exert their influences separately rather than in combination (Gardner, p. 404).⁴ If

³ A reviewer questioned whether the supply elasticities might differ between cartel and noncartel producers because, for example, cartel members pay dues which affect costs. Although the model could be modified to examine the implications of heterogeneous supply response, I avoid this complication primarily because in the application discussed later dues are negligible, 0.1¢/lb. of product sold or less than 0.15% of farm price on average. However, in a different application in which organizational costs are high, it may be fruitful to extend the model to permit differential supply response.

⁴ As pointed out by a reviewer, the price-transmission elasticity does not necessarily have to be positive, as earlier assumed. In particular, if observed changes in the farm-wholesale price spread are due strictly to shifts in the supply schedule for marketing inputs, and if the substitution elasticity between marketing inputs (e.g., plant labor) and the farm-based input (e.g., live catfish) is less than the absolute value of the wholesale-level demand elasticity, then T in equation (2) is negative (Gardner, p. 404, fn. 10). In the more usual case in which observed margin changes are driven chiefly by shifts in farm supply or retail demand, the elasticity is expected to be positive.

² I do not wish to trivialize the indeterminacy problem. As Sexton ably argues, bilateral-bargaining theory provides useful insights, despite the multiplicity of equilibria. It is just that from a longer-run perspective, I believe that market power is less germane than supply response.

this is not the case, a more complicated form of the price-transmission equation may need to be specified (Wohlgenant and Mullen).

The market-clearing mechanism in the model may be thought of as representing a mixture of goal- and nongoal-equilibrium processes (Chiang, pp. 35–36). That is, in the closed portion of the market, an *ex post* goal equilibrium is achieved that represents the final outcome of the bargaining or “price-signaling” process. (Because negotiated or announced prices are “sticky” (typically fixed for three months or longer), and reflect nonmarket factors (e.g., negotiating skill), it is reasonable to assume that producers regard these prices as exogenous.) In the open portion of the market, a nongoal equilibrium is achieved that reflects the outcome of two opposing forces: processors competing in the open (non-cartel) market for the available (lower-cost) supply, and “seepage” from the closed market due to the extra supply stimulated by the higher cartel price. Depending upon the relative strengths of the opposing forces, the equilibrium farm price consistent with equation (5) may be higher or lower than the price obtained in a pure nongoal (market) equilibrium.

The effect of a change in the floor price on the equilibrium farm price can be determined by substituting equations (1)–(4) into equation (5) and solving for $\text{dln } P_f$, which yields

$$(6) \quad \text{dln } P_f = \{ (LN - k_B ET) / (N + k_{NB} ET) \} \text{dln } P_B.$$

The term in braces in equation (6) is the *reduced-form* coefficient for $\text{dln } P_B$: it measures the effect of an increase in the floor price on farm price after taking into account supply response and middlemen reactions to the floor price. This effect may be positive, zero or negative depending on the relative magnitudes of the two terms in the numerator of (6). In particular, for an increase in the floor price to increase the farm price, it must be the case that $LN > k_B ET$.

If supply is fixed ($E = 0$), the reduced-form coefficient in equation (6) reduces to the structural parameter L . Thus, theory predicts that if supply is fixed, an increase in the floor price always increases the farm price, assuming the floor price is effective, i.e., $L \neq 0$. If supply is not fixed, the relationship between the floor price and the farm price is indeterminate without information about the relative magnitudes of the supply and demand elasticities, the bargaining elasticity, the transmission elasticity, and the proportion of total production controlled by the cartel.

The effect of an increase in the floor price on the

wholesale price is obtained by substituting equation (6) into (2), which yields

$$(7) \quad \text{dln } P_w = \{ -E (k_B + k_{NB} L) / (N + k_{NB} ET) \} \text{dln } P_B.$$

Equation (7) indicates that an increase in the floor price always decreases the wholesale price for normal sloping supply and demand curves. However, if total supply is fixed, as would be true in the “short run” (e.g., within one year following the increase in the cartel price for many commodities) equation (7) indicates that the wholesale price is unaffected by the floor price. Thus, from the processor perspective, the bargaining association represents an unambiguous threat to profit margins, unless supply is fixed.

The effect of an increase in the floor price on industry output is obtained by substituting equation (7) into (1), which yields

$$(8) \quad \text{dln } Q = \{ E N (k_B + k_{NB} L) / (N + k_{NB} ET) \} \text{dln } P_B.$$

Equation (8) indicates that so long as supply or demand is not perfectly inelastic, an increase in the floor price always increases industry output. The magnitude of the output response depends in part on the level of cartel participation. For example, if participation is complete ($k_B = 1.0$), the reduced-form coefficient in equation (8) reduces to the supply elasticity E , which in general is greater than equation (8)’s reduced-form coefficient.⁵ Thus, theory predicts that the bargaining association, if successful, will enlarge industry output.

Free Riding

Returning to equation (6) and setting $\zeta = [LN - (1 - k_{NB}) ET] / (N + k_{NB} ET)$, the effect of free riding on the ability of the bargaining association to enhance farm price can be determined by taking the partial derivative of ζ with respect to k_{NB} , which yields:

$$(9) \quad \partial \zeta / \partial k_{NB} = E [TN(1 - L) + ET^2] / (N + k_{NB} ET)^2.$$

Equation (9) indicates the effect of an increase in free riding (reduced cartel participation) on the ability of the cartel to raise farm price. The sign of equation (9) depends on the magnitude of the bar-

⁵ To see this, assume that $E > \{N E (k_B + k_{NB} L) / (N + k_{NB} ET)\}$. With some algebra, this inequality reduces to $N(1 - L) > -ET$, which always holds for normal sloping supply and demand so long as $L \leq 1$. (Recall N is defined to be positive.) Because L is expected to be less than one, the original assumption holds.

gaining elasticity L and will always be positive for $L \leq 1$. Because L in general is expected to be between zero and one, equation (9) yields the hypothesis that increases in free riding *increases* the cartel's price-enhancement ability. The economic rationale for this somewhat surprising result inheres in the uncontrolled nature of supply response: as cartel membership increases (free-riding decreases) the proportion of producers responding to the higher cartel price increases, which undermines the cartel's price-enhancement ability.

Note that the foregoing results pertain to a *given value of L* . To the extent that L is itself influenced by free riding; for example, by diminishing the cartel's influence at the bargaining table, free riding can still damage the cartel's overall effectiveness. The important point, however, is that if the cartel does not take steps to control supply response, free riders to some extent serve this function *de facto*, and thereby enhance the cartel's effectiveness, *ceteris paribus*.

The relationship $LN > k_B ET$ from equation (6) can be used to define a *minimum-effective bargaining elasticity*, i.e., the minimum numerical value that L must obtain if the bargaining association is to secure price enhancement in the face of supply response. The minimum-effective bargaining elasticity is $L^m = k_B ET / N$. That the minimum-effective bargaining elasticity increases, *ceteris paribus*, with increases in cartel participation underscores the dual nature of cartel membership: a high level of participation strengthens the cartel's hand at the negotiating table (which is manifested by an increase in the *ex ante* value of L), but it undermines the cartel by accentuating supply response, which raises the minimum value that L must achieve to render the cartel effective.

The foregoing model is consistent with the view that price bargaining acts as a corrective for information-based deficiencies in the market mechanism (Breimyer, pp. 129–31). In particular, the signaling aspect of price bargaining may hasten price discovery, which is akin to a technical change that shifts the supply schedule for marketing inputs down. A downward shift in the marketing-inputs' supply schedule in general will cause the farm price to rise and/or the wholesale price to fall (e.g., see Kinnucan and Nelson). The model is also consistent with Bunje's assertion (p. 37) that "... bargaining cannot overcome the law of supply and demand."

Application

A key parameter in the analytical model is the bargaining elasticity. To estimate this elasticity,

and to demonstrate the model's usefulness, I use data for the Catfish Bargaining Association (CBA), which was formed in 1989 in an effort to raise the price received by catfish producers.

The CBA operates in a manner similar to that described by French. The membership decides on a price it thinks the market will bear given anticipated market conditions and the estimated total supply of fish for the contract period. Prior to July 1, 1991, The Catfish Institute—the producers' bargaining representative—negotiated with processors to secure the desired floor price (Allen). Once an agreement was reached, the negotiated price floor was announced, which all CBA members and affected processors were expected to honor. Starting July 1, 1991, the CBA abandoned face-to-face negotiations with processors in favor of voluntary adherence to a "recommended minimum price" established by association members.⁶ The CBA makes no attempt to limit production or to assign marketing quotas. Because of escape clauses in the original contracts (e.g., association members with pre-existing production contracts could sell for less than the floor price and no minimum-purchase requirements were imposed on processors), compliance with the negotiated floor prices was essentially voluntary, as is the case for the recommended minimum price.

The relationship between CBA's voluntary floor prices and the market price is estimated jointly with wholesale demand via the equations (time subscripts suppressed):

$$(10) \quad \ln P_f = a_0 + a_1 \ln P_w + a_2 \ln W + a_3 \ln P_B + a_4 \ln P_{f-1} + u$$

$$(11) \quad \ln Q = b_0 + b_1 \ln P_w + b_2 \ln M + b_3 \ln A + b_4 \ln Q_{-1} + b_5 TR + \sum_{i=1}^3 c_i S_i + v$$

where P_f is the pond-bank price of live catfish; P_w is the average wholesale price of processed fish; W is the minimum-wage rate (line workers in catfish processing plants tend to be paid at or slightly above the minimum wage); P_B is the announced floor price in force during period t ;⁷ Q is the total quantity of catfish sold by U.S. processing plants; M is the total U.S. imports of processed catfish; A

⁶ According to Allen, the switch from formal contracts to "jaw bargaining" occurred in response to large supplies of fish that had accumulated following the original series of contracts, a telling point.

⁷ The announced floor price is defined to be greater than or equal to the market price. So prior to November 1989 and for several months in 1991 and 1993 when the floor price was permitted to "float" or the market price moved above the negotiated price, the floor price was set equal to the farm price.

is total industry expenditures on advertising; TR is a trend variable ($TR_t = 3, 4, \dots, 96$ for March 1986 through December 1993) that reflects normal demand growth associated with a new product (per capital catfish consumption increased tenfold between 1980 and 1993); S_i are quarterly dummy variables; and u and v are random disturbance terms. All money-denominated variables in the model are deflated by the Consumer Price Index (1967 = 100).

Equation (10) is similar to the price-transmission equation specified by Zidack, Kinnucan and Hatch except that it is expressed in logarithmic rather than linear form and the farm price rather than the wholesale price appears as the dependent variable. The logarithmic specification was selected because recent analysis by Nyankori suggests this form fits the data better than the linear form. The farm price is specified as the dependent variable to permit a direct test of whether the structural elasticity defining the relationship between the announced floor price and the market price is indeed nonzero.

Equation (11) is similar to the wholesale demand equation estimated by Zidack, Kinnucan and Hatch except that income is omitted from the model and advertising is expressed as contemporaneous rather than lagged four months. Income is omitted because Zidack, Kinnucan, and Hatch found it to be insignificant. Advertising is expressed without a lag under the hypothesis that consumer delay in responding to changes in advertising expenditures is less likely now than the advertising program has been in force for seven years (since April 1987).⁸ Following Zidack, Kinnucan and Hatch a marketing cost variable is excluded from equation (11), which is a derived-demand equation, because previous analysis indicated it was non-significant.

That an increase in the negotiated (or announced) floor price causes an increase in the farm price is tested by forming the hypothesis:

$$(12a) \quad H_N: a_3 = 0$$

$$(12b) \quad H_A: a_3 > 0.$$

Hypothesis (12) represents a one-tail test that can be tested with a standard t -statistic.

Data and Estimation Procedure

The model was estimated with 94 monthly observations covering about four years of CBA non-

Table 1. Comparison of the CBA Floor Price and the Market Price for Catfish, 1989–93

Date	Floor Price	Market Price	Difference
	----- ¢/lb. -----		
November 1989	70	64	6
January 1990	75	68	7
March 1990	80	78	2
December 1990	75	72	3
April 1991	70	69	1
July 1991	63	63	0
February 1992	58	56	2
March 1992	65	60	5
February 1993	70	67	3
October 1993	75	73	2
1989–93 Average	70.1	67.0	3.1

intervention (1986.3–89.10) and four years of intervention (1989.11–93.12).⁹ The first two observations are lost due to the presence of the lagged dependent variable in the empirical model and the estimation procedure to be discussed later.

The price and quantity data for catfish were obtained from Tables 11, 12, 14 and 17 of USDA's *Aquaculture Situation and Outlook Report*. Data for the CPI and the minimum wages rates were obtained from the *Statistical Abstract of the United States* and the Bureau of Labor Statistics' *Detailed CPI Report*. The advertising data were obtained from the advertising agency handling the account for The Catfish Institute, the industry marketing organization responsible for advertising and producer price negotiations over the sample period. These data are actual, not budgeted, expenditures for catfish ads in all media, chiefly magazines and radio.

The data on the announced floor price were obtained from various issues of *The Catfish Journal*, which reported the negotiated or "recommended minimum" price and its effective duration. The announced floor price and the market price of catfish at the time in which the announced price was to go into effect are reported in Table 1. Since its inception, the CBA on average has negotiated a price that was 3.1 cents per pound higher than the contemporaneous market price, a 4.6% nominal increase over the average market price for the 1989–93 period.

Owing to zero observations for advertising, one dollar was added to each monthly observation (zero and non-zero values alike) after deflation to

⁸ Note that the model still permits advertising carryover via the lagged dependent variable.

⁹ The data period starts in 1986 to reflect USDA's more uniform reporting of price and quantity data beginning January 1986, especially for further-processed catfish products.

permit taking logarithms. Because the average un-deflated monthly expenditure during periods of advertising was about \$125,000, this adjustment has a minuscule effect on raw data values.

The wholesale price and imports are determined simultaneously with the farm price and domestic quantity, thus equations (10) and (11) contain right-hand side variables that are endogenous. Moreover, the disturbances in the two equations are likely to be correlated. Therefore, I estimated the model as a system using 3SLS. The instruments included the predetermined variables in equations (10) and (11) plus the lagged values of P_w and M .

Prior to estimation by 3SLS, I tested the equations for serial correlation using Durbin's m test, the preferred test statistic for equations that contain lagged dependent variables (Kmenta, pp. 333–34). The hypothesis of first-order serial correlation could be rejected for the demand equation, but not for the price-transmission equation. Thus, the price-transmission equation was corrected for serial correlation using Hatanaka's two-step procedure in LIMDEP (Greene, pp. 274–75 and 411). Unless stated otherwise, hypothesis testing is based on a t -test at the 5% probability level.

Estimation Results

Estimation results in general are satisfactory (Table 2). The R^2 's of 0.95 and 0.98 suggest the equations provide a good fit to the data. Most of the estimated coefficients have the expected sign and are significant. The lagged dependent variables in both equations are significant at the 1% level or lower and the estimated coefficients lie between zero and one, as required to satisfy stability conditions.

The estimated long-run demand elasticity, which is obtained by dividing the wholesale-price coefficient by one minus the coefficient of the lagged dependent variable, is -0.32 . Zidack, Kinnucan, and Hatch's estimate was -1.01 based on 1980–89 data and Kinnucan *et al.*'s estimate was -1.54 based on 1980–83 data. The smaller elasticities in the more recent periods indicate that catfish demand is becoming less elastic over time.

The estimated long-run advertising elasticity of 0.0066 is close to Zidack, Kinnucan, and Hatch's estimate of 0.0075. The insignificance of the imports variable may reflect the declining importance of imports as a supply source in U.S. markets. (In recent years, catfish imports have declined to less than 2% of processor sales.)

The seasonal dummy variables are significant,

Table 2. 3SLS Estimates of Catfish Demand and Price-Transmission Equations, March 1986–December 1993 Data

Variable	Catfish Demand		Price Transmission	
Constant	6.019	(7.53) ^a	-0.765	(-2.41)
$\ln Q_{-1}$	0.419	(6.39)	—	—
$\ln P_w$	-0.184	(-1.83)	0.308	(2.55)
$\ln M$	-0.0020	(-0.09)	—	—
$\ln A$	0.00383	(4.83)	—	—
$\ln P_{F,1}$	—	—	0.250	(3.09)
$\ln \bar{W}$	—	—	-0.0077	(-0.15)
$\ln P_b$	—	—	0.595	(10.16)
TR	0.0041	(6.84)	—	—
S_1	0.187	(11.90)	—	—
S_2	0.035	(2.04)	—	—
S_3	0.067	(3.67)	—	—
R^2	0.950		0.983	
ρ^b	-0.024		0.632	

^aNumbers in parentheses are asymptotic t -ratios.

^bAutocorrelation coefficient prior to adjustment for serial correlation. The price transmission equation was corrected for serial correlation using Hatanaka's two-step procedure.

which suggests that catfish demand is subject to seasonal shifts and is highest in the first calendar quarter (Lenten period). Trend is positive and significant, which suggests that catfish is still in the growth phase of the product life cycle (e.g., see Zidack, Kinnucan and Hatch).

Turning to the price-transmission equation, the estimated (long-run) wholesale-farm price transmission elasticity is 0.41. This suggests that the farm price is relatively insensitive to changes in the wholesale price, which may reflect processor market power (e.g., Kinnucan and Sullivan). The labor cost variable is not significant, contrary to expectations.

The key policy variable, the announced floor price, is positive and highly significant (t -ratio of 10). The estimated short- and long-run elasticities are, respectively, 0.60 and 0.80. These elasticities imply that if the announced floor price increases 1%, and *supply is fixed*, the farm price can be expected to increase 0.6% immediately and 0.8% after sufficient time has elapsed for the farm price to adjust fully to a change in the announced floor price. Thus, the hypothesis that the CBA has had a favorable impact on the market price of live catfish is supported by the data.

Recall from the earlier discussion that the condition $L N > k_B E T$ must obtain if an increase in the floor price is to increase the farm price when supply response is permitted. Substituting the empirical estimates of $L = 0.80$, $T = 0.41$, and $N = .32$ into this expression, and setting the producer sign-up parameter k_B equal to 0.80 (an estimate of

Table 3. Model Parameters and Baseline (1993) Values, U.S. Catfish Industry

Item	Definition	Value
<i>Model Parameters:</i>		
L	CBA Bargaining Elasticity	0.80
T	Wholesale-Farm Price Transmission Elasticity	0.41
N	Wholesale-level Demand Elasticity	0.32
E	Farm-level Supply Elasticity	0.15, 0.58
k_B	Production controlled by CBA (prop. of total)	0.50, 0.80
$d \ln P_B$	Percent change in CBA price/100	0.0442
<i>Baseline Values:</i>		
P_f	Farm Price (\$/lb.)	0.71
Q_f	Liveweight Quantity (mil. lbs.)	459.0
P_w	Wholesale Price (\$/lb.)	2.19
Q_w	Processed Quantity (mil. lbs.)	233.5

the upper bound of participation over the 1989–93 period) yields the inequality $E < 0.78$. This means that the supply elasticity for catfish must be less than 0.78 for the CBA to be effective at raising the farm price without overt supply control. If producer participation drops to 50%, the minimum-effective supply elasticity increases to 1.25. These results, which quantify the relationship between free riding and supply response discussed earlier, suggest that catfish supply may be relatively price inelastic for the CBA to extract sustained benefits for producers.

Simulation

An estimate of the actual CBA-based benefits to producers—and the corresponding costs to processors—can be determined by simulating equations (6)–(8) utilizing elasticity estimates obtained from the econometric model and assumed values for the supply elasticity as indicated in Table 3. Zidack, Kinnucan and Hatch estimate a catfish supply elasticity of 0.15; Branch and Tilley estimate a “harvest response” elasticity of 0.58. Both estimates are used in the simulations to gauge the sensitivity of results to supply response. In addition, the proportion of total pond production controlled by the CBA is set alternatively to 0.50 and 0.80 to assess the importance of this parameter to model results. These values appear to represent the range of participation enjoyed by the CBA since its inception in 1989. The percent change in the floor price is set equal to 4.42%, the average percent change over the 1989–93 period.

Results indicate that the announced floor price always increases the farm price for the parameter values in Table 3, but that the magnitude of the price increase is sensitive to the CBA participation rate and supply response (Table 4). The largest

price augmentation, 2.82%, occurs when supply is relatively unresponsive to price ($E = 0.15$) and CBA participation is relatively low ($k_B = 0.50$). When supply is relatively elastic ($E = 0.58$) and participation is high ($k_B = 0.80$), the increase in farm price is reduced to 0.78%. Overall, it appears that compared to the supply elasticity, results are relatively insensitive to CBA participation. Thus, for the parameter values indicated in Table 3, cartel participation has a minor effect on rent dissipation (to be discussed later).

Simulated CBA impacts on the wholesale price range from -1.69% to -6.66% and are largest when producer participation is high and supply is relatively elastic. Moreover, these price impacts in every case exceed the quantity impacts, which indicates that the announced price floor causes a reduction in processor revenues. That is, the estimated CBA-induced increases in quantity, which range from 0.54% to 2.13%, are not sufficiently large to compensate for reductions in processor price. Overall, supply response is seen as attenuating the CBA effect on farm price and accentuating the CBA effect on wholesale price.

One way to gauge the relative CBA impacts on producers and processors is to measure the associ-

Table 4. Simulated Effects of a 4.42% (3.1 ¢/lb.) Increase in the Announced CBA Price for Alternative Values of the Supply Elasticity (E) and CBA Participation (k_B)

Variable	$E = 0.15$		$E = 0.58$	
	$k_B = 0.50$	$k_B = 0.80$	$k_B = 0.50$	$k_B = 0.80$
	----- % change -----			
$d \ln P_f$	2.82	2.74	1.37	0.78
$d \ln P_w$	-1.69	-1.91	-5.23	-6.66
$d \ln Q$	0.54	0.61	1.67	2.13

ated changes in producer surplus (quasi-rent) at each market level. For this purpose, I set k_B equal to 0.50 and simulated the model for alternative values of the supply and demand elasticities as indicated in Table 5. Looking first at the effects for $N = 0.32$, results indicate that if supply is relatively inelastic ($E = 0.15$), the increase in producer surplus at the farm level exceeds the reduction in producer surplus at the wholesale level, resulting in a slight net gain for the industry as a whole. However, if supply is relatively elastic ($E = 0.58$), processing-sector losses exceed farm gains by nearly 6:1.

If the demand elasticity is increased from 0.32 to unity, the elasticity estimated in earlier work, the adverse effects of a relatively elastic supply response are attenuated but processor losses still outweigh producer gains (Table 5). If the supply elasticity is reduced to $E = 0.15$ and demand is unitary elastic, processor losses are relatively modest compared to producer gains. The incidence of bargaining association impacts, therefore, is sensitive to supply and demand elasticities. In this application, net gains to the industry as a whole (producers and processors) are largest when supply is relatively inelastic and demand is relatively elastic. Given my "best guess" supply and demand elasticities ($E = 0.15$ and $N = 0.32$), it appears that CBA-induced gains to producers have been modest (\$9.23 million in 1993) and sufficient to offset losses to processors.

Concluding Comments

The major theme of this paper is that supply response is critical to the success of cartel-like ar-

rangements in agriculture. In the case of the Catfish Bargaining Association, producers elected to elevate price above prevailing market prices, but failed to take corresponding action to limit supply. The inevitable increases in supply that are stimulated by effective price floors undermine the ability of agricultural bargaining associations to sustain meaningful price enhancement for any length of time. Fortunately for the CBA and its producer members, however, catfish supply is sufficiently price inelastic to render collective action effective, at least for the modest increases in market price induced by the cartel thus far.

The econometric estimates suggest that about 80% of the increase in the announced CBA-floor price appears as an increase in the farm price when supply is fixed. Given that CBA participation never represented more than 80% of total production and probably averaged closer to 55% over the 1989–93 period (Allen), this suggests that CBA price-enhancement extended beyond cartel membership. This does not necessarily mean, however, that non-participants are free riders in the ordinary sense of the term. As revealed by the comparative-static model, free-riding serves the important economic function of limiting the supply increases associated with the cartel price. Thus, enlarging cartel participation does not necessarily enhance a cartel's effectiveness when supply is uncontrolled.

Apart from any potential losses to consumers, the clear losers in this producer-cartel pricing scheme are processors. According to my analysis, processors always lose from successful producer bargaining, unless supply is unresponsive to price. For the parameter values that appear to govern the catfish industry in recent years, the simulation results indicate that the CBA at best is a break-even proposition for the industry as a whole, and may have resulted in significant transfers from processors to producers.¹⁰ Thus, to the extent that producers have ownership interest in the processing sector through cooperatives or vertical integration, the net gain to producers is ambiguous. Still, my results overall suggest that price bargaining associations can be effective at enhancing farm income—provided supply is sufficiently price inelastic to limit the increases in output that inevitably flow from price-enhancement endeavors in a competitive industry.

Table 5. Incidence of CBA on Producer Surplus at Farm and Wholesale for Alternative Values of the Demand Elasticity (N) and Supply Elasticity (E)

Variable	$N = 0.32$		$N = 1.00$	
	$E = 0.15$	$E = 0.58$	$E = 0.15$	$E = 0.58$
	----- million dollars -----			
$d PS_f^a$	9.23	4.51	10.73	8.82
$d PS_w$	-8.68	-27.00	-2.96	-10.61

^a $d PS$ represents the change in producer surplus. It is calculated using the basic formula $d PS = d \ln P P^* Q^* (1 + 0.5 d \ln Q)$ where P^* and Q^* are the initial equilibrium values of price and quantity reported in Table 3. The sign-up parameter k_B is set to 0.50 in these simulations. Note: the annual cost of running the CBA was about \$150,000 (Allen).

¹⁰ This conjecture is consistent with the fact that Delta Pride, a major processor and a producer-owned cooperative, required "paybacks" from farmers to cover operating losses sustained following the signing of contracts in 1989–91.

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