SOME EVIDENCE ON PECUNIARY ECONOMIES OF SIZE FOR FARM FIRMS

Bernard V. Tew, Stan Spurlock, Wesley N. Musser, and Bill R. Miller

Economies of size for farm firms in the United States are a traditional interest of agricultural economists (Heady). Continued interest in this topic is related to the implication of economies of size for the size structure of farm firms. The structure issue has the potential to affect not only current farm firms but also agricultural marketing firms, rural communities, and consumers of agricultural commodities (Krause and Kyle). In the past, the relationship between economies of size and farm firm growth was the basis for research. More recently, the relationship of economies of size to public policy issues has gained attention (Bardnam, Hall and LeVeen, Seckler and Young).

Previous research on economies of size focused on technical economies of size internal to the firm (Carter and Dean, Heady, Matulich, Musser and Marable). Researchers rarely considered the effects of pecuniary economies of size arising from decreasing input costs. Instead, constant prices for variable inputs usually were assumed. Krause and Kyle, Raup, and Faris and Armstrong did consider pecuniary economies of size and concluded that they are relevant only for very large farms well in excess of 2000 acres. In part, the assumption of constant input prices reflects the absence of sufficient price data to support research on the subject. This assumption limited previous analysis because any economies of size from purchasing decisions were effectively eliminated.

The purpose of our article is to examine the assumption of no pecuniary economies of size from variable inputs. After a theoretical review of potential sources of pecuniary economies of size, we examine the hypothesis empirically using a sample of sales data from a supplier of agricultural inputs.

THEORETICAL BACKGROUND

Decreases in variable input prices due to increasing quantities purchased have historically been classified as pecuniary internal economies of size (Heady). The source of these economies in the agricultural input sector has received little consideration. One standard theoretical source is technological economies of size from large transactions in the marketing process (Heady, Seckler and Young). An alternative concept which suggests the possibility of price discrimination is that different purchase sizes are different commodities. Though a pure monopoly in the agricultural input market is not being suggested, the possibility of sufficient monopoly power to practice price discrimination is reasonable, especially if the spatial aspect of markets is considered (Bressler and King). Variations in the size of farmer purchases also make price discrimination feasible. Because the transaction costs of search over a wider area and the fixed component of transportation costs would be spread over a larger purchase, it is plausible that farmers with larger purchases would be more price responsive. This phenomenon suggests the price elasticity of demand for inputs would vary directly with size of purchase — a necessary condition for price discrimination. The transaction costs of resale of quantities larger than required for production or of organizing joint purchases could provide separation of markets for different sized commodities which is also necessary for price discrimination. Thus, a spatial concept of markets allows two sources of pecuniary internal economies of size—economies of scale in marketing and price discrimination.

It is important to note that price variations can occur in a market for reasons other than the size of purchase. Prices of firms at different locations could differ because of the interrelationship between volume of sales and technical economies of scale, as well as different transportation costs between manufacturing and retail outlets. The temporal dimension of agricultural input markets could be another source of price variation among transactions. The seasonal nature of agricultural production suggests that demand for many farm inputs would have seasonal variation. Given that agricultural supply firms have economies of size in marketing, it is reasonable to expect prices of inputs to be lower in seasons of peak demand. Consideration of these variations is important

Bernard V. Tew and Stan Spurlock are Graduate Research Assistants, Wesley N. Musser is Associate Professor, and Bill R. Miller is Professor, Department of Agricultural Economics, University of Georgia.

The authors thank the three anonymous referees for their constructive comments on drafts of the article.

in analysis of pecuniary economies of size of purchase. Obviously, the size of purchase could vary among different locations because of geographic differences in size and specialization of farm firms. Larger farm firms may be able to concentrate their purchases during periods of seasonal low prices because of superior access to financial capital and storage facilities. However, smaller purchases made at lower-priced locations and times would also obtain these price advantages. Year to year price variations may be caused by inflationary effects as well as shortages. The 1973-1975 price rise in fertilizers demonstrates the possible occurrence of shortages in the input market. Since then the index of prices paid by farmers has increased, perhaps because of general inflationary trends in the economy.

The general model used in our study reflects the theoretical considerations discussed in this section:

(1) $P_i = f_i(Q_i, M_i, Y_i, L_i)$

where

P_i is the price of input i,
Q_i is the quantity of input i,
M_i is the month in which the purchase was made,
Y_i is the year in which the input was purchased,
L_i is the location of the purchase.

DATA AND METHOD

Data for the analysis consisted of sales receipts in Georgia from January 1975 through December 1978 from 10 different outlet stores for a major agricultural supply firm in the state. Local managers can and do exercise local control over price policy in their particular stores so price variation was expected. The inputs chosen for the analysis were those typically used for the production of corn, soybeans, and peanuts. Price and quantity data were obtained directly from the sales receipts. Initial plans were to specify M_i, Y_i, and L_i as sets of dummy variables. However, the fact that of no purchases were made in some months and at some store locations necessitated respecification of the model. Because most of the purchases occurred in south Georgia, the analysis was confined to that geographic area; dummy variables for southeast and southwest Georgia were created to consider any remaining location effects. The seasonal effects were considered by grouping months into quarters. Because of the lack of purchases in some quarters, the dummy variables for quarters were deleted from the final model. The final model incorporated the reciprocal of quantity ($\frac{1}{Q}$), dummy variables for years 1976, 1977, and 1978 (YRD6, YRD7, YRD8), and a dummy variable representing the southeast area (LO2).

RESULTS

The results of the regression analysis normalized on 1975 and southwest Georgia are given in Table 1. Most important, the quantity coefficients have mixed results. Seven of the 15 equations have significant positive quantity variables. These signs indicate lower prices at larger quantities because of the reciprocal specification. The other eight inputs have insignificant quantity coefficients which indicate that price was insensitive to quantity purchased.

TABLE 1. REGRESSION MODELS FOR SELECTED VARIABLE INPUTS IN SOUTH GEORGIA, JANUARY, 1975 TO DECEMBER, 1978

ITEM (Unit)	INTERCEPT	$\frac{1}{Q}$	YRD 6	YRD 7	YRD 8	LO2	R^2	OBSERVATIONS
AATREX (gal.)	15.12 (71.02)***	1.74 (1.44)	-1.68 (-6.90)***	-2.85 (-9.78)***	-4.71 (-13.83)***	-0.17 (-.78)	.877	42
BALAN (gal.)	6.60 (81.13)***	0.62 (2.59)**	-0.78 (-7.28)***	-0.37 (-3.03)***	0.29 (2.39)**	0.32 (3.15)***	.622	69
BRAVO (gal.)	24.82 (161.37)***	0.85 (2.52)**	-1.71 (-9.77)***	-3.53 (-19.57)***	-2.48 (-16.04)***	1.00 (9.49)***	.673	256
DYANAP (gal.)	6.40 (85.18)***	-0.44 (-0.71)	-0.60 (-5.13)***	-0.06 (-0.66)	0.29 (3.05)***	0.42 (5.23)***	.661	52
LANNATE (gal.)	15.71 (81.77)***	0.47 (1.62)	-0.89 (-3.50)***	0.15 (0.66)	1.35 (6.60)***	0.22 (1.46)	.541	134
LASSO (gal.)	14.68 (76.09)***	1.33 (1.46)	-1.44 (-7.14)***	-0.90 (-4.48)***	-0.59 (-2.84)***	0.34 (2.43)**	.545	55
PARAQUAT (gal.)	19.31 (47.73)***	2.08 (2.55)**	-4.54 (-5.06)***	-4.21 (-4.08)***	-4.29 (-5.87)***	1.97 (2.93)***	.615	42
SEVIN 80% W (cwt.)	145.22 (48.43)***	0.22 (0.58)	47.68 (15.81)***	45.39 (11.27)***	56.88 (16.10)***	0.24 (0.10)	.904	40
TREFLAN (gal.)	26.66 (52.61)***	0.49 (1.37)	-1.36 (-1.91)*	-0.94 (-1.24)	0.03 (0.04)	-1.09 (-2.03)**	.217	45
VERNAM (gal.)	14.35 (61.49)***	1.19 (2.69)**	-0.88 (-2.95)***	0.37 (1.10)	1.51 (4.50)***	0.38 (1.46)	.618	35
LIME (cwt.)	0.75 (52.38)***	0.15 (0.61)	-0.04 (-1.79)*	-0.03 (1.43)	0.02 (1.14)	0.04 (3.12)***	.093	268
AMMONIUM NITRATE (cwt.)	8.23 (116.27)***	0.38 (4.01)***	-1.25 (-13.89)***	-0.95 (-10.05)***	-1.34 (-15.91)***	0.35 (5.02)***	.413	493
FERTILIZER 05-10-15 (cwt.)	5.00 (132.56)***	0.29 (9.76)***	-0.57 (-11.40)***	-0.49 (-6.43)***	-0.64 (-13.79)***	0.32 (7.93)***	.522	401
SOYBEAN SEED BRAGG (bu.)	10.35 (17.60)***	3.02 (1.38)	-4.03 (-2.24)**	6.41 (10.04)***	0.63 (1.06)	-1.17 (-2.31)**	.759	52
PEANUT SEED FLORUNNER (cwt.)	40.12 (101.00)***	0.45 (5.03)***	1.47 (1.76)*	3.37 (4.99)***	3.43 (6.69)***	-0.18 (-0.38)	.661	45

(Student t statistic)
***significant at .01 level
**significant at .05 level
*significant at .10 level

The location and year variables have mixed effects among the inputs. Prices of all of the herbicides were significantly lower in 1976 than in 1975. Aatrex, Bravo, Lasso, and Paraquat were still lower priced in 1978 than in 1975; however, Balan, Dyanap, Treflan, and Vernam had price increases from 1976 to 1978. The insecticides, Lannate and Sevin, were higher priced in 1978 than in 1975. Lime showed a fairly stable price during the four years. Both ammonium nitrate and fertilizer 5-10-15 had price decreases after 1975 with 1978 having the lowest prices. Ten of the 15 inputs were significantly different in price in the southeast area. Treflan and soybean seed were priced lower in that part of the state. All of the other inputs with significant coefficients for the location variables were priced higher in the southeast area.

The mixed results with the quantity variable require further analysis. The regression results suggest pecuniary economies of size for seven of the 15 inputs. To evaluate the economic significance of the regression results, we prepared variable costs budgets for several acreages of peanuts in southwest Georgia. The rates of application for the nine inputs used in peanut producton were obtained from the Georgia Agricultural Extension Service and were assumed constant for all acreages. The budgets reflect 1978 prices which were estimated with the regression equations in Table 1. The budgetary results are given in Table 2.

TABLE 2. PER UNIT COST OF SELECTED VARIABLE INPUTS FOR PEANUT PRODUCTION IN SOUTHWEST GEORGIA FOR VARIOUS ACRES PLANTED, 1978

Selected Variable Input (Application Rate)	Peanut Acreage Planted				
	10A	50A	100A	250A	500A
Seed (1.25 cwt./acre)	43.59	43.58	43.55	43.55	43.55
Fertilizer 5-10-15 (5 cwt./acre)	4.38	4.36	4.36	4.36	4.36
Lime (10 cwt./acre)	0.77	0.77	0.77	0.77	0.77
Bravo (1 gal./acre)	22.43	22.36	22.35	22.34	22.34
Balan (1 gal./acre)	6.95	6.90	6.90	6.90	6.90
Vernam (.25 gal./acre)	16.34	15.96	15.91	15.88	15.87
Lasso (.05 gal./acre)	14.36	14.14	14.12	14.10	14.09
Daynap (.5 gal./acre)	6.66	6.68	6.69	6.69	6.69
Lannate (.25 gal./acre)	17.25	17.10	17.08	17.07	17.06
Per Acre Total Selected Variable Input Cost[1/]	$139.04	$138.53	$138.53	$138.50	$138.49

Five of the nine inputs—seed, fertilizer, Bravo, Balan, and Vernam—were quantity responsive. However, the pecuniary economies of size provided by these input prices had negligible effects on total costs per acre, the difference in costs being $0.55 between 10 and 500 acres.

CONCLUSIONS

The evidence presented supports the standard assumption of constant costs of variable inputs in analysis of economies of size in agriculture. Though about half the inputs demonstrated a significant response to quantity purchased, the price impact had very small effects on unit costs per acre. Thus use of the constant price assumption in economies of size studies causes little bias in the results. Identification of the source of these price reductions in either economies of size in marketing or price discrimination was beyond the scope of our research. Further analysis of the cause of the responsiveness of price to quantity is especially warranted. In such research, marketing cost data need to be collected so that a structural model of an agricultural input firm can be estimated rather than the single equation models used in our study. As suggested by one referee, future research should also consider data from more than one firm—lower prices may be available from the firm patronized by operators of large farms.

REFERENCES

Bardnam, Pranab. "Agricultural Development and Land Tenancy in a Peasant Economy: A Theoretical and Empirical Analysis." *Amer. J. Agr. Econ.* 61(1979):48-57.

Bressler, Raymond G., Jr. and Richard A. King. *Market Prices and Interregional Trade.* New York: John Wiley & Sons, Inc.

Carter, H. O. and G. W. Dean. "Cost-Size Relationships for Cash Crop Farms in a Highly Commercialized Agriculture." *J. Farm Econ.* 43(1961):264-77.

Faris, J. Edwin and David L. Armstrong. *Economics Associated with Size, Kern County Cash-Crop Farms.* Giannini Foundation Res. Rep. 269, University of California, 1963.

Hall, Bruce F. and E. Phillip LeVeen. "Farm Size and Economic Efficiency: The Case of California." *Amer. J. Agr. Econ.* 60(1978):589-600.

Heady, Earl O. *Economies of Agricultural Production and Resource Use.* Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1952, pp. 349-81.

Krause, Kenneth R. and Leonard R. Kyle. "Economic Factors Underlying the Incidence of Large Farming Units: The Current Situation and Probable Trends." *Amer. J. Agr. Econ.* 52(1970):748-60.

Matulich, Scott C. "Efficiencies in Large-Scale Dairying; Incentives for Future Structural Change." *Amer. J. Agr. Econ.* 60(1978):642-8.
Musser, Wesley N. and Ulysses Marable, Jr. "The Impact of Energy Prices on Optimum Machinery Size and the Structure of Agriculture: A Georgia Example." *S. J. Agr. Econ.* 8(1976):205-11.
Raup, Phillip M. "Economies and Diseconomies of Large-Scale Agriculture." *Amer. J. Agr. Econ.* 51(1969):1274-83.
Seckler, David and Robert A. Young. "Economics and Policy Implications of the 160-Acre Limitation in Reclamation Law." *Amer. J. Agr. Econ.* 60(1978):575-88.