AN ANALYSIS OF THE SOUTHEASTERN FEEDER PIG MARKET

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The production of feeder pigs as a cash commodity has been widespread in the southeastern U.S. during the past several years. One indication of the extent of marketing pigs at this intermediate stage is the fact that in 1979, 41 percent of the total Tennessee pig crop was sold through organized feeder pig sales (Rawls). This specialized production is continuing in many areas of the Southeast, although a trend has emerged that has more producers holding feeder pigs and feeding them to market weight.

Many previous studies have dealt with the structure of the pork economy at the slaughter, wholesale, and/or retail levels (Crom; Harlow; Hayenga and Hacklander; Meyers, et al.; Tryfos; West). However, no study has considered factors that directly influence the feeder pig market and the implications that these factors have for feeder pig producers.

This study identifies and quantifies factors that influence the market for feeder pigs. In order to fulfill these objectives, an econometric model of the southeastern feeder pig market is fitted, using semiannual data from 1971 to 1980. For this study, the Southeast includes Alabama, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia.

THEORETICAL FRAMEWORK

The theory of production conceptualizes the supply and demand relationship for feeder pigs. The supply of feeder pigs is derived from the production relationship and the relative prices of inputs and the output. It is assumed that feeder pig producers strive to maximize expected profits. Therefore, the supply relationship is

$$(1) \qquad Q^s = s(PFP^*, PCORN^*, R^*)$$

where Q^s is the quantity of feeder pigs supplied, PFP* is the expected price of feeder pigs, PCORN* is the expected price of corn, and R* is the expected interest rate. This specification stems from the assumption that corn and money are the main input items used in feeder pig production. All prices in equation (1) are real prices.

The demand for feeder pigs is derived from the demand for slaughter hogs. This relationship is conceptualized in a manner similar to the supply relationship. Slaughter hog producers are assumed to maximize expected profits. Therefore, the demand for feeder pigs is influenced by the real price of output and inputs. The demand relationship is conceptualized as

$$(2) \qquad Q^d = d(PFP, PMH^*, PCORN^*, R^*)$$

where Q^d is the quantity of feeder pigs demanded, PFP is the current price of feeder pigs, and PMH* is the expected price of market hogs. Again all prices are deflated. All other variables were defined earlier. The price of feeder pigs is known to finishers when production decisions are made because it is a point-input factor. Therefore, the current price of feeder pigs is most appropriate.

Equations (1) and (2) assume that producers of feeder pigs and hogs reach equilibrium instantaneously. In reality, neither the quantity of feeder pigs supplied nor demanded will achieve the desired or equilibrium level. The adjustment process continuously occurs, moving toward the equilibrium amount. The process may be one of partial adjustment, or partial achievement of the desired level, or, perhaps, it will be one of overadjustment (Nerlove). These responses must be considered in an empirical model by some type of dynamic adjustment scheme. In addition, decisions concerning both supply and demand are based on expected or anticipated prices. Because the expected prices are not known, a price expectations model must be used. Empirical evidence of price expectations by hog producers indicates that the extrapolation of the current prices (i.e., naive expectations) is the appropriate model (West, p. 45). This specification is consistent with all of the previously cited research on the hog market.

A Nerlovian lag and a naive-type price expectation model were used in specifying the empirical model for this study. In the supply equation, all expected prices, except that of corn, are represented by prices lagged one period, which were current prices at approximately the time that the feeder pig production decision was made. The expected price of corn is represented by the av-

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erage of corn prices in the two previous periods.

In the demand equation, the expected prices are represented by the prices that were current at the time that the slaughter hog production decision was made, except that the expected price of corn is reflected as the average of the current price and the price lagged one period. The price of feeder pigs is not an expected price as explained earlier. The Nerlovian lag is incorporated by the lagged endogenous variable. The specification also includes dummy variables as intercept shifters for seasonal variation in quantity and to represent the various states for both the supply and demand equations.

The mathematical forms of the supply and demand functions are assumed to be multiplicative power functions. The model is specified in its logarithmic form as

$$(3)\quad Q_t^s = a_o + a_1 PFP_{t-1} + a_2 (PC_{t-2} + PC_{t-1})/2 + a_3 R_{t-1} + (1 - v)Q_{t-1} + a_4 S + \sum_{i=1} \alpha_i D_i$$

$$(4)\quad Q_t^d = b_o + b_1 PFP_t + b_2 PMH_t + b_3 (PC_{t-1} + PC_t)/2 + b_4 R_t + (1 - z)Q_{t-1} + b_5 S + \sum_{i=1} \gamma_i D_i$$

$$(5)\quad Q_t^s = Q_t^d = Q_t$$

where

- t denotes a six-month time period,
- Q_t is the natural log of the quantity of pigs for time t,
- PFP_t is the natural log of the real price of feeder pigs per pound in time t,
- PMH_t is the natural log of the real price of market hogs per pound in time t,
- PC_t is the natural log of the real price of corn per bushel in time t,
- R_t is the real rate of interest in time t,
- S is a seasonal dummy (S=1 if the observation was from the July–December period; S=0 otherwise),
- D_i is the dummy variable to identify the i^{th} state ($D_i = 1$ if the observation is for state i, $D_i = 0$ otherwise),
- v, z, the a_i's, b_i's, α_i's and γ_i's are parameters to be estimated.

The model is simultaneous and overidentified.

The v in the supply equation and z in the demand equation represent the elasticity of adjustment toward a long-run equilibrium quantity. Estimates v and z can be solved from the coefficient for Q_{t-1} in equations (3) and (4), respectively. The long-run coefficients are solved by dividing the as by v in the supply equation and dividing the bs by z in the demand equation (Kmenta, p. 474–79).

Note that the real rate of interest R_t and R_{t-1} enters equations (3) and (4) in a linear form, rather than log-linear. This specification was required because, at times during the study period, the real rate of interest was negative; hence, a pure log-linear form could not be used.

DATA

The slaughter hog, feeder pig, and corn prices are prices received by farmers by state reported in *Agricultural Prices Annual Summary*. The nominal rate of interest was obtained from the *Annual Report of the Farm Credit Administration and Cooperative Farm Credit System*. The rate used was the highest rate for loans from production credit associations. Semiannual rates were interpolated on the assumption that mid-year rates were the average of the preceding and following years. The rate of interest was considered to be equal for all states because of the ease of transferring funds.

All prices were deflated by the price index of items used for (farm) production (*Agricultural Prices Annual Summary*). The rate of interest was deflated by subtracting the rate of increase in the price index of items used for (farm) production.

No data are available on the number of feeder pigs that are actually marketed, which also includes intra-firm transfers. However, close approximation can be made from inventory figures for the month prior to the marketing month. About one-half of a month's beginning 0–60 pound inventory is marketed in subsequent month, since growth from farrowing to 40–60 pound weights requires about two months (*Life Cycle Swine Nutrition*). This method of approximation was used for inventory figures in the months of December and June. These months allow correspondence of pig quantities with the price of feeder pigs reported for January and July (USDA).

Data on the price of corn for Alabama, Mississippi, South Carolina, Tennessee, and Virginia were discontinued in 1977; and data on the price of feeder pigs were discontinued for the same five states in 1978. Therefore, only data for Georgia, Kentucky, and North Carolina were used in the model after the first six months of 1977.

PROCEDURES

An errors-in-variables technique was used to correct for possible errors in measuring the quantity of feeder pigs marketed. This technique involved using all exogenous variables from the system as instrumental variables to form an adjusted quantity variable (Kmenta, pp. 307–13). This method will produce more consistent parameter estimates.

The period of time analyzed in this study is relatively short (10 years) because of the limit on the available time-series data, and also in an effort to obtain estimates on the more current supply and demand situation. This short time series is not adequate for good estimates and statistical tests for each state in the Southeast. For this reason, the data from individual states were treated as observations on cross-sectional units. Therefore, pooled time-series and cross-sectional data were used in the analysis.

Tests were performed to detect serial correlation for a given cross-section unit (state) and heteroskedasticity between cross-section units (Kmenta, pp. 510–11). If the estimate of the autoregressive parameter was greater than its standard error, the variables for that state were transformed. Autoregressive parameters were used to transform both supply and demand equations for Mississippi and North Carolina, and the supply equation for Alabama, Kentucky, South Carolina, Tennessee, and Virginia. The assumption of homoskedasticity could not be rejected for either the supply or the demand functions at the 10-percent level of significance. The procedures used to correct for serial correlation are identical to those used by Balestra and Nerlove, and by Houthakker et al.

RESULTS AND IMPLICATIONS

Table 1 shows the coefficients, standard errors, and long-run elasticities of the feeder pig supply and demand equations. The long-run elasticities were calculated by dividing the short-run elasticities by the elasticity of adjustment for each equation. The elasticity of adjustment is one minus the coefficient for Q_{t-1}. Because the functional form is log linear, the coefficients in Table 1 are short-run elasticities, except for the coefficient for the real rate in interest. Because the real rate of interest entered the equation in a linear form, its coefficient is not an elasticity. The short-run elasticity with respect to the real rate of interest is .001 for the supply equation and −.01 for the demand equation calculated at the mean.

The signs of all coefficients agree with those postulated by economic theory, except the coefficient for the lagged interest rate in the supply equation. This coefficent was also the only coefficient that was less than its standard error; therefore, little confidence can be placed in a conclusion that the coefficient is different from zero. The percentage root mean square error is .019 for the supply equation and .025 for the demand equation. This indicates that both equations explain considerable variation in the dependent variable.

There is a great difference between short-run and long-run elasticities for both the supply and demand equations. The estimates indicate that pig producers take more than 9 time periods (4½ years) to adjust to their long-run equilibrium, and hog finishers require almost 6 periods (3 years) to adjust.

The own-price elasticity of supply is extremely inelastic in the short-run and is still inelastic in the long-run. This reflects producer reluctance to liquidate (or reduce production of) the breeding herd based only on the lower price of feeder pigs. This reluctance owes to the high "fixed" costs involved in feeder pig production, such as equipment and buildings. The .27 long-run elasticity is much smaller than the elasticity of .56 to .82 found by Harlow for market hogs. If Harlow's model were re-estimated using more recent data, his supply elasticity would probably be greatly reduced because of the increase in confinement production. However, one would expect a lower supply elasticity for feeder pigs relative to market hogs, because fixed costs constitute a larger proportion of total costs. Feeder pig producers seem to adjust much more, in the short- and long-run, to changes in price of corn. The long-run elasticity for the price of corn is greater than one in absolute value.

TABLE 1. Results of the Feeder Pig Market Equations

Variable	Unit	Supply	Demand
PFP[a]	coefficient	.03	-.28
	standard error	(.02)	(.23)
	long-run elasticity	.27	-1.65
PC	coefficient	-.15	-.21
	standard error	(.03)	(.10)
	long-run elasticity	-1.36	-1.24
PMH	coefficient	--	.36
	standard error	--	(.30)
	long-run elasticity	--	2.12
R	coefficient	.12	-.34
	standard error	(.14)	(.22)
	long-run elasticity	.01	-.06
Q_{t-1}	coefficient	.89	.83
	standard error	(.04)	(.05)
S	coefficient	.038	.038
	standard error	(.005)	(.004)
D_1	coefficient	.005	.003
	standard error	(.005)	(.008)
D_2	coefficient	.029	.032
	standard error	(.011)	(.012)
D_3	coefficient	.014	.013
	standard error	(.007)	(.008)
D_4	coefficient	-.017	-.017
	standard error	(.007)	(.009)
D_5	coefficient	.028	.065
	standard error	(.010)	(.020)
D_6	coefficient	-.001	-.012
	standard error	(.006)	(.010)
D_7	coefficient	.019	.021
	standard error	(.009)	(.010)

[a] PFP is the price of market hogs (in $ per lb.); PC is the price of corn (in $ per bushel); PMH is the price of market hogs (in $ per lb.); R is the real rate of interest (in percent); Q_{t-1} is the lagged quantity of feeder pigs (in thousands of hd.); S is the seasonal dummy to indicate the fall; D_1 through D_7 are dummy variables identifying Alabama, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee, respectively. The lag structure of these variables is explained in the text.

The own-price elasticity of demand for pigs is inelastic in the short-run, because no substitute exists for feeder pigs in the production of slaughter hogs. However, if producers are given enough time to adjust to the price of feeder pigs, demand is elastic. Harlow found that the farm-level demand elasticity for market hogs was much less elastic (−.35). However, in this model, the demand for feeder pigs is an input demand of specialized pig finishers. These finishers have considerable flexibility in responding to changes in feeder pig prices when given the time to change. The same can be said of the response of hog finishers to changes in the price of corn and market hogs.

A comparison of elasticities in the two equations indicates that the demand (finisher) response to changing factors generally is larger than the supply (producers) response. This situation implies that, once a factor change has occurred, the price of feeder pigs must adjust for equilibrium to occur, *ceteris paribus* (Tomek and Robinson, p. 129–32). This type of supply and demand structure causes considerable volatility in prices. The price risk faced by specialized pig producers may be the reason for the trend away from specializing in feeder pigs.

The coefficients for the seasonal dummy variable indicate that both supply and demand for feeder pigs are larger in the fall. Because the coefficients are equal, there is no regular seasonal price pattern. The feeder pig market has adjusted to match supply and demand in each season without changing prices. Any change in feeder pig prices between seasons results from other factors such as interest rates or market hog prices.

The dummy variable scheme used to indicate the state was based on Virginia. Therefore, all coefficients measure the difference between the respective state and Virginia. Every state which had a greater feeder pig supply than Virginia also had a larger demand. Alabama, Georgia, Kentucky, North Carolina, and Tennessee had both greater supplies and demands for feeder pigs. Mississippi and South Carolina had both lower supplies and demands. This is another instance that indicates that feeder pig markets have tended to stabilize supply and demand so that prices are less variable by state.

Finally, a point concerning interest rates needs emphasizing. At first glance, it appears that hog finishers do not change production patterns substantially if interest rates change. This could be the result of a lack of expertise by producers in judging the direction of interest rate changes. If they are poor at predicting interest rates, it is difficult to react properly. One must also remember that the real rate of interest was very volatile in this time period. It was 6.33 percent in the first half of 1977, and was −10.35 percent in the second half of 1973. Because of this rather extreme volatility, the small elasticity, −.06, does not reflect the absolute importance of the real rate of interest in determining the price of feeder pigs.

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