Testing the Impact of Corporate Farming Laws on Hog Industry Growth: A Partial Adjustment Approach

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Abstract

This paper analyzes the impact of corporate restrictions on the growth of the Nebraska hog industry. It utilizes a partial adjustment model to test the hypothesis that the restrictions hamper the development of the state's hog industry. The results support the argument that the regulations have slowed the growth of the Nebraska hog industry.

The purpose of this paper is to analyze how the exclusion of nonfamily corporations from the Nebraska hog industry has influenced the industry's development. Corporate farming has long been publically debated in Nebraska. In the 1960s, corporations started to engage in production agriculture. Many people saw this as a threat to the family farm and, as a result, sought restrictions on corporate activities in agriculture (Knoeber 1997). The failure of the Nebraska legislature to pass corporate restrictions resulted in an initiative petition to enact regulations through the referendum process.

Initiative 300 (I300) prohibits acquisition or operation of agricultural land by: (1) nonfamily farm or ranch corporations and (2) by nonfamily farm or ranch syndicates including limited partnerships. To qualify as a family farm corporation the firm has to be engaged in farming or ranching or in the ownership of agricultural land. A majority of the voting stock has to be owned by family members. Krause (1983) states that corporate farming laws such as I300 intend to "preserve and protect the family farm as the basic unit of production" and "stem the influx" of investments in agriculture by "nonfarm outsiders." Opponents of such restrictions argue that the initiative will prevent certain types of economic development and expansion desirable to the state. At the time of the enactment of I300 in 1982, about 3,000 of Nebraska's 60,000 farms were organized as corporations. Nonfamily corporations averaged sales of more than $1 million each. About 19 percent of the hog sales were made by corporations.

Hypothesis

Our hypothesis is that elimination of the corporate organizational option in Nebraska has reduced the organizational flexibility that is available to hog farmers in other states and that was

available in Nebraska before I300 was passed. Larger firms in particular may need to operate as corporations to acquire adequate amounts of growth capital. Without this option in Nebraska, the hog industry's growth may be retarded. In the framework of a partial adjustment model with a variable speed of adjustment, we hypothesize that the speed at which the hog inventory of Nebraska farms adjusts toward a desired level has decreased since enactment of Initiative 300.

Nerlove's Partial Adjustment Model

The partial adjustment model, or stock adjustment model, with constant speed of adjustment was first suggested by Nerlove (1956) to justify the specification of distributed lags in his work on demand analysis for agricultural and other commodities. This type of model is based on the following behavioral assumption. There exists a desired level of capital stock, which the entrepreneur thinks is right for a smooth production process. This desired level of capital stock is determined by output controlling variables such as price and cost. The model of desired stock cannot be estimated because it is unobservable. To replace it, the stock adjustment principle is postulated. The actual change in the capital stock in any one period is only a fraction of the desired change. Technological rigidities, habit inertia, resource constraints, and institutional control are among the reasons that are frequently cited as impediments to full adjustment.

We focus on the latter two. We hypothesize that the restrictions on corporate farming prevent firms from acquiring adequate growth capital to adjust inventory to the desired level. In recent years, the hog industry has been moving toward the development of larger, capital intensive confinement units that require substantial investments. Family farm resources alone cannot always raise the necessary capital. This causes a less rapid response to changes in market conditions.

Single-Equation Model

The first model analyzes the Nebraska hog industry as a whole. The dependent variable is the total on-farm hog inventory. The adjustment of inventory is a fraction of the adjustment toward the desired level:

$$I_t - I_{t-1} = \lambda(I_t^* - I_{t-1}) \tag{1}$$

For our analysis, we use a model with a variable speed of adjustment that is controlled by two dummy variables:

$$\lambda = \alpha_0 + \alpha_1 D_1 + \alpha_2 D_2 \tag{2}$$

The dummy variable D_1 accounts for the resource constraint caused by the changes in the demand conditions for feed grains in the early 1970s[1]. This variable has the value of one for all observations after June 1974 and zero otherwise. The institutional constraint generated by Initiative 300 is simulated by dummy variable D_2. Initiative 300 was enacted in November 1982. Because of the lag in production, we assume that its impact on the hog inventory in Nebraska was first seen in the December 1983 figures. Therefore, the second dummy variable has the value of one for all observations after December 1983 and zero otherwise.

The desired inventory is based on a supply function introduced by Tryfos (1974). The desired inventory (I_t^*) is calculated as a function of the price of hogs received by farmers (P_{t-2}) and the cost of feed (C_{t-2}):

$$I_t^* = \beta_0 + \beta_1 P_{t-2} + \beta_2 C_{t-2} \tag{3}$$

The model uses semiannual observations. We lag the price and cost variable two periods because of the approximately one-year lag between the breeding decision and the marketing of the finished

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[1]The opening of the grain export markets, particularly to the USSR caused a shift in the feed grain demand function which resulted in a shift in the hog supply.

hog. This assumes that the inventory on the farm at time t is the result of the breeding decision that was made in period t-2. It follows the assumption that farmers hold a constant conjecture about price and cost for two periods in advance.

Equations (2) and (3) are substituted into equation (1) and it is used to solve for the inventory variable (I_t):

$$I_t = (\alpha_0 + \alpha_1 D_1 + \alpha_2 D_2) \cdot (\beta_0 + \beta_1 P_{t-2} + \beta_2 C_{t-2} - I_{t-1}) + I_{t-1} \qquad (4)$$

This variable speed of adjustment model is overparameterized and intrinsically nonlinear. Consequently, the task of estimation is carried out by the nonlinear procedures of SHAZAM.

Multiple-Equation Model

The hog industry uses different production systems:

- Farrow-to-finish farms, which involve all stages of production from breeding through finishing to market weights of about 225 pounds.

- Farrowing-nursing farms, which sell 40–60 pound feeder pigs.

- Grow-finish farms, which grow and finish feeder pigs to market weights.

The hog industry has been moving toward a production system with separate breeders and growers since the time I300 was enacted. To analyze the impact of I300 on the breeding and market stock separately, we create a second model. It specifies separate equations for breeding and market stock.

The desired breeding inventory (BS_t^*) is a function of the feeder pig price lagged one period (FP_{t-1}) because the decision to retain a certain breeding stock on the farm is controlled by the feeder price at the time the sow is bred. Inventory is also driven by the cost of feed (CI_t) and the price of the slaughter sows (SP_t):

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$$BS_t^* = \beta_0 + \beta_1 FP_{t-1} + \beta_2 C1_t + \beta_3 SP_t \tag{5}$$

The desired market stock is determined by the hog price (P_{t-1}), the breeding stock (BS_{t-1}), and the cost of feed ($C2_{t-1}$). The production decision regarding the market stock is made at the beginning of the finishing period. We assume that producers hold a constant conjecture about next period's hog price:

$$MS_t^* = \gamma_0 + \gamma_1 P_{t-1} + \gamma_2 BS_{t-1} + \gamma_3 C2_{t-1} \tag{6}$$

The adjustment mechanism for breeding and market stock is formulated as:

$$BS_t - BS_{t-1} = \lambda_1(\alpha) \cdot (BS_t^* - BS_{t-1}) \tag{7}$$

$$MS_t - MS_{t-1} = \lambda_2(\omega) \cdot (MS_t^* - MS_{t-1}) \tag{8}$$

where the λs are functions of the time dummy:

$$\lambda_1 = \alpha_0 + \alpha_1 D_2 \tag{9}$$

$$\lambda_2 = \omega_0 + \omega_1 D_2 \tag{10}$$

Because of the limited availability of data on feeder pig prices, we have to limit the analyses to the time period from 1974 to 1996. Consequently, we use only one dummy variable. The dummy variable D_2 has a value of 1 for the time periods after December 1, 1983.

Substituting equations (5) and (6), and equations (9) and (10) into equations (7) and (8) respectively gives the following system:

$$BS_t = (\alpha_0 + \alpha_1 D_2)(\beta_0 + \beta_1 FP_{t-1} + \beta_2 C1_t + \beta_3 SP_t - BS_{t-1}) + BS_{t-1} \qquad (11)$$

$$MS_t = (\omega_0 + \omega_1 D_2)(\gamma_0 + \gamma_1 P_{t-1} + \gamma_2 BS_{t-1} + \gamma_3 C2_{t-1} - MS_{t-1}) + MS_{t-1} \qquad (12)$$

The breeding and market stock equations are estimated as seemingly unrelated regressions. This variable speed of adjustment model is also intrinsically nonlinear. The task of estimation is carried out by SHAZAM's nonlinear procedures for seemingly unrelated regression systems.

Limitations of the Models

We hypothesized that the firm makes only a partial adjustment λ. Griliches (1967) showed that the parameter λ can be interpreted as the sum of the relative cost of being in disequilibrium (forgone profits) and of making the adjustment to the desired value (e. g., capital investments). The higher the adjustment cost, the slower the rate of adjustment. The term disequilibrium refers to a state that is not optimal. But the optimal value is derived without any consideration of the costs of adjustment, and then the adjustment costs are superimposed through the partial adjustment mechanism. If the model is properly formulated, taking into account all costs, including the costs of adjustment in the derivation of the optimum value (I_t^*), then the disequilibrium disappears. The partial adjustment model is a useful way to model the adjustment costs that cannot be directly observed, but it is, in a sense, an imperfectly specified model.

A second limitation is the assumption that λ always lies between 0 and 1. This is a strong assumption that implies that inventory is sluggish and never overshoots the equilibrium level I^*. There is no a priori reason why this should hold. If the assumption is dropped, however, it is no

longer true that we can use ΔI_t to classify observations as belonging to positive or negative differences between the desired and actual levels (Maddala 1983).

Data

The following data are used in the analysis:

Inventory:

- All hogs and pigs, breeding stock, and market stock.

All inventory data is on-farm inventory as reported in "Hogs and Pigs" by the National Agricultural Statistics Service for December 1963 to December 1996. Following Tryfos' hog supply model, we use the number of pigs on farm on June 1 and December 1 as the inventory variable.

Prices:

- Finished hogs: barrows and gilts, price received per cwt. by Nebraska producers at Omaha.

- Feeder pigs (40–50 #), price received per head by Nebraska producers at Omaha.

- Sows, price received per cwt. by Nebraska producers at Omaha.

All of this data is reported monthly. The prices used in the models are deflated semiannual averages of monthly observations of cash prices from January to June and from July to December.

Costs:

The cost variable covers the main components of the feed rations. The rations are calculated according to the recommendations given in table 8 of "Estimated Crop and Livestock Production Costs" by the University of Nebraska Extension staff. The prices used are: monthly corn price received per bushel by Nebraska producers and the monthly price per cwt of soybean meal (44% protein). Semiannual averages were calculated from the monthly observations. The January to June

averages pertain to the June 1 inventory; the July to December averages pertain to the December 1 inventory data. All prices are deflated by a GDP deflator with a 1992 base.

Results:

The nonlinear regression results of the single-equation model are presented in Table 1.

Table 1: Regression results of nonlinear estimation of equation (4)

Parameter	Estimated Value	T-Ratio
α_0	0.79746	3.1910
α_1	-0.57070	-2.4883
α_2	-0.18067	-2.2411
β_0	3044.3	33.938
β_1	133.46	3.0849
β_2	-8.0301	-2.6175
ρ	-0.22516	-1.2863

The estimate of the speed of adjustment coefficient before June 1974 is 0.797, with a t-statistic of 3.19. The grain market shift of the early 1970s caused the adjustment speed to drop to 0.227. The change in market conditions raised the cost of adjusting the inventory toward the equilibrium compared to the cost of being out of equilibrium. At the time of the enactment of I300 in 1982, the adjustment coefficient is reduced by another 0.181 (t-statistic of -2.241) to 0.0461. The coefficients of the price and cost variables have the expected sign and are all significant at the 5% level. The quasi-R^2 of the model is 0.85.[2] Figure 1 illustrates the correlation between the predictions and the actual inventory of the single-equation model.

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[2]The quasi-R^2 is calculated as the squared correlation between the actual and predicted dependent variable.
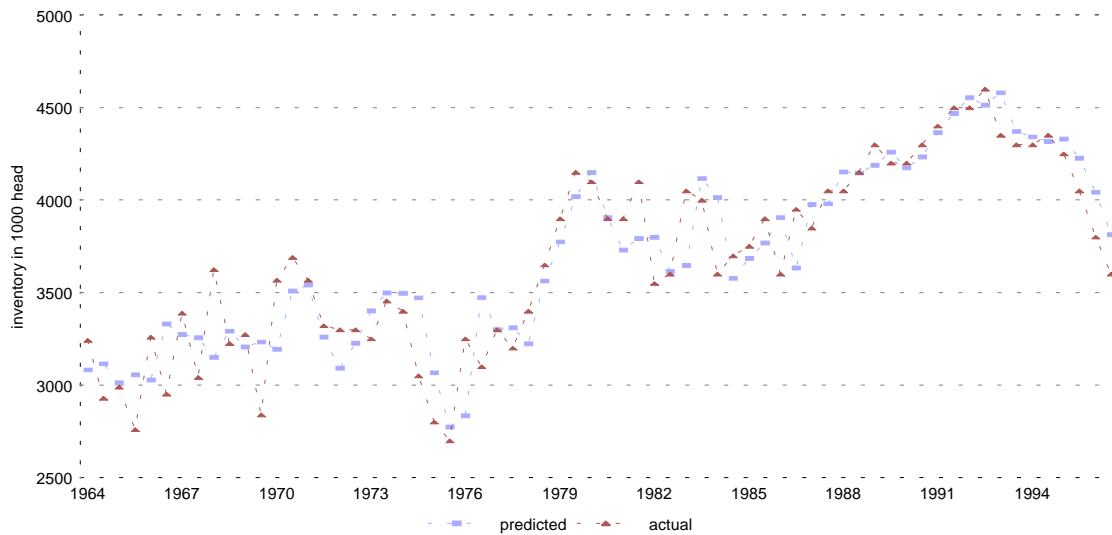
Figure 1: Predicted vs. Actual Inventory; Single Equation Model

This result supports our hypothesis that elimination of the corporate organizational option in Nebraska reduced the organizational flexibility that is available to hog farmers in other states and that was available in Nebraska before I300 was passed. In order to respond to consumer demand for a high quality and low-cost meat product, it is virtually inevitable that the hog industry will continue to introduce new, sophisticated technologies and move toward a higher degree of production concentration and integration. The structure of the hog industry is rapidly evolving with increasing shares of production concentrated in fewer, larger units. Bigger firms in particular may want to operate as corporations to maintain their competitiveness. Without this option in Nebraska the adjustment to desired inventories may be impeded.

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To affirm the significance of the change in 1983, we systematically tested for significant changes in the adjustment speed around the time of the enactment of I300. We ran the model repeatedly with a modified dummy variable D_2, which simulated structural breaks between June 1981 and 1986. The configuration of the dummy variable D_2 described above (see p. 3), resulted in the best fitting model. This supports our hypothesis that I300 had an impact on the behavior of the hog industry.

The results of the seemingly unrelated regression estimation are presented in table 2.

Table 2: Results of the seemingly unrelated regression estimation of equations (11) *and* (12)

Parameter	Estimated Value	T-Ratio
$\alpha 0$	0.16427	2.4422
$\alpha 1$	-0.096987	-2.2316
$\beta 0$	568.53	6.4123
$\beta 1$	23.985	2.0638
$\beta 2$	-2.0224	-1.2505
$\beta 3$	-18.956	-1.8123
$\omega 0$	0.44419	3.3470
$\omega 1$	-0.30044	-2.9817
$\gamma 0$	-95.929	-0.20242
$\gamma 1$	44.305	2.7804
$\gamma 2$	6.2308	5.5698
$\gamma 3$	-54.600	-1.7907
ρ	-0.49901	-5.6362

The speed of adjustment of the breeding stock equation is 0.164 before 1983 and reduces to 0.0673 after I300 became effective. The adjustment speed of the marketing stock was 0.444 before 1983 and was slowed down to 0.144. All adjustment coefficients are significant at the 5% level. The quasi-R^2 of the breeding and market stock equations are 0.83 and 0.87 respectively.

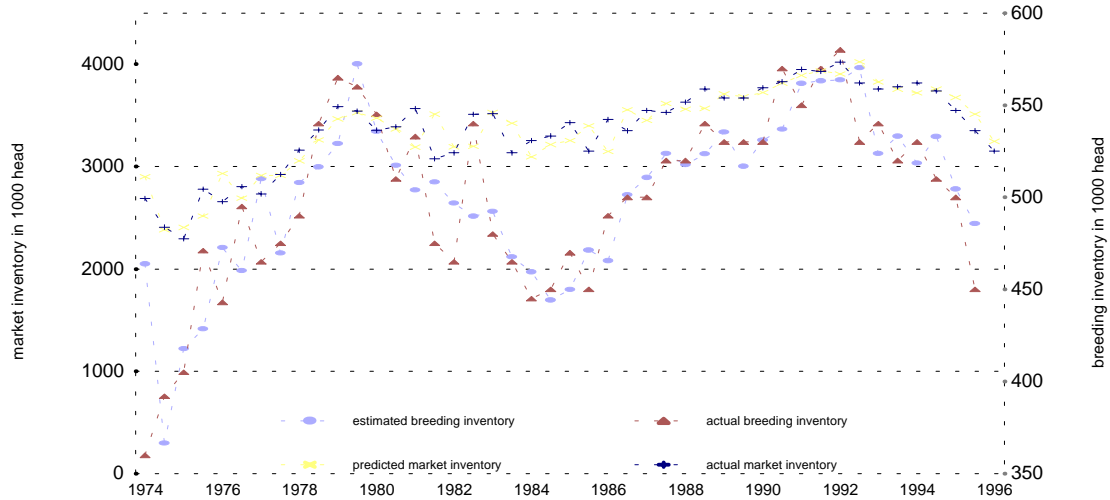Figure 2 illustrates the multiple equation model.

Figure 2: Predicted vs. Actual Inventory; Multiple Equation Model

The breeding stock shows an adjustment speed of less than half of the market stock before and after I300 took effect. The reduction in 1983 was 59% for the breeding stock and 68% for the market inventory. These reduction rates preserved the ratio of the speeds found before the change. The difference in technology used in breeding and finishing operations explains the difference in adjustment speeds. Breeding requires a higher capital investment than finishing. Breeding stock is investment capital itself and has a slower turn-over rate than the market stock. The market inventory can be more easily adjusted by purchasing feeder pigs and selling finished pigs at varying weights. Testing the hypothesis that the speed of adjustment is equal for the breeding and market stock ($\alpha_1 = \omega_1$) shows that this hypothesis can be rejected at the 5% level (Wald $X^2 = 3.8022$). The coefficients on the structural variables all have the expected signs. The results show that feeder pig price has the strongest impact on the breeding inventory, while cost plays a lesser role. For finishing operations, the cost of feed is the dominant factor.

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Conclusions:

The results support the argument that Initiative 300 has slowed but not stopped the growth of the Nebraska hog industry and the economic development associated with it. Assessing the impact of legal restrictions such as I300 is difficult because of the dynamic environment in which economic and social decisions are made. The effects of a single variable such as I300 cannot be completely isolated from other institutional and economic forces. This applies especially to Nebraska agriculture where dramatic changes took place in the 1980s, regarding land values, credit conditions, commodity prices, and export markets.

The enactment of Initiative 300 also coincided with major technological changes in the hog industry. In the late 1970's, most of the major producers invested into new sow confinement units with expected life spans of about 15 years. The technological renewal period was primarily completed by 1983. Since 1994, we have observed increased investment activities into the next generation of hog facilities. This contributed to the lack of investments after the enactment of I300.

Our analysis uncovered that a structural change took place in 1983, but further analyses are necessary to clearly attribute certain effects to particular causes. We will further refine our analysis to isolate the impact of I300. Because our main argument hinges on the idea that the corporate restrictions prevent the industry from acquiring the necessary capital, we will focus on the upward adjustment. Introducing asymmetrical adjustment processes for positive and negative differences into the model may shed more light on the effect of the initiative. To neutralize the effect of technological change, we plan to compare our findings for Nebraska to other states with and without corporate farming restrictions.

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