# ANTI-CORPORATE FARMING LAWS AND INDUSTRY STRUCTURE: THE CASE OF CATTLE FEEDING

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Nine midwestern states have laws that restrict the involvement of publiclyheld corporations in agriculture. Opponents argue that the laws' direct efforts to regulate ownership structure may have an adverse indirect impact on size structure. Restricting corporate involvement might stifle the emergence and growth of efficient, large-scale establishments if corporations have advantages over other organizational forms in meeting capital requirements. Since 1982, Nebraska has had an anticorporate farming law that prohibits corporate ownership of feedlots. We test whether the implementation of the Nebraska law had an impact on the stochastic process governing the evolution of the state's feedlot size distribution.

*Key words*: cattle feedlots, industry structure, Markov probability model.

Nine states—Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, and Wisconsin—have laws that restrict corporate involvement in agricultural production. (Haroldson 1992). The specific provisions of these laws, commonly known as "anti-corporate farming laws" (Stayton 1991), vary from state to state. Limitations on the size of corporations' agricultural landholdings are a common provision. In some states, corporations are virtually prohibited from owning farmland or operating farms. Other states simply outlaw corporate involvement in specific agricultural activities (Edmondson and Krause 1978). The laws in all of the nine states include an exemption for the authorized "family farm corporation," which is defined in various ways but generally means an incorporated farm enterprise with a limited number of stockholders at least one of whom resides on or operates the farm.[1] Most observers seem to agree with Krause's (1983) judgment that the main intent of these laws is to "preserve and protect the family farm as the basic unit of production"(p. 41). Corporations enjoy the protection of limited liability, and there is a perception that this gives them a significant advantage over other organizational forms. Some have argued that restrictions are needed to provide a "level playing field" among organizational forms so that family farms operated as individual proprietorships or partnerships can compete on an equal footing (Welsh 1998).

This rationale for anticorporate farming laws emphasizes business organizational form and, to be sure, the direct impact of existing laws is the regulation of the *ownership* structure of agriculture. Whether there is an indirect impact on the *size* structure of agriculture is also a matter of considerable interest, however. Some have argued that influencing the size structure of agriculture is actually part of the intended purpose of these laws. Edmondson and Krause maintain that part of the motivation for the laws is to prevent large businesses from dominating agricultural production. The corporation is targeted by the laws, not because of any intrinsic faults, but because it is the organizational form typically used by large firms. Welsh cites the fear of monopolization of the food supply by agribusiness conglomerates as part of the justification for anticorporate farming laws.

Others maintain that "bigness," per se, is not, and should not be, the target of anti-corporate farming laws. Following this point of view, any impact on the size distribution

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This project received financial support from the National Research Initiative Competitive Grants Program (Markets and Trade area), CSREES/USDA, Proposal No. 01-01641. The opinions expressed here are those of the authors and do not necessarily reflect the views of CSREES or USDA. The authors are grateful for helpful comments provided by Neil Harl, Darrell Mark, Marty Strange, Clem Ward, and two anonymous referees.

[1] North Dakota's statute originally applied to all corporations but was brought in line with the other states' laws by a 1981 amendment that added the "family farm corporation" exemption (Krause 1983). Harl (2001, section 51.04) details the provisions of the anti-corporate farming laws in these nine states. As Harl notes, a handful of additional states have relatively minor restrictions on corporate involvement in agriculture.


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of agricultural producers would merely be a side effect rather than part of the laws' legitimate objectives. Opponents of anticorporate farming laws often argue, however, that the laws *are* likely to have indirect effects on size structure and that these potential effects are likely to be adverse. The argument supporting this view draws on a theme that has been present in the agricultural economics literature for decades: achieving economies of scale in agricultural production requires substantial investment, and corporations may have advantages over other organizational forms in meeting the capital requirements of large-scale, cost-efficient operation. Thus, the result of a market-wide restriction on corporate involvement in agriculture might be a producer size distribution that, from the standpoint of cost-efficiency, is too heavily concentrated in the small-firm-size categories.[2]

There have been relatively few economic or quantitative analyses of the effects of anticorporate farming laws.[3] The purpose of this article is to address the question of whether anticorporate farming laws have had an impact on the size distribution of establishments engaged in one particular type of agricultural production: cattle feeding. In the next two sections of the article, we argue that this industry provides a convenient natural experiment for testing the effects of corporate restrictions on industry structure. Among the nation's four leading cattle-feeding states—Texas, Nebraska, Kansas, and Colorado—all have relatively similar technologies of cattle feeding; and all have laws that are regarded as being "friendly" to the cattle-feeding industry, in general; but only one, Nebraska, has an anticorporate farming law that applies to the cattle feeding industry.[4] Nebraska's law is a constitutional amendment that was adopted as a result of a public referendum. The designation used for the referendum, "Initiative 300," has become the common name for the constitutional provision. Our analysis looks for a change in the process of feedlot industry structure dynamics in Nebraska, pre- and post-Initiative 300. In determining whether such a change occurred, we can make use of data from the other three major cattle-feeding states. Tests will show whether the processes of industry structure evolution in these "control" states are similar to that in pre-Initiative 300 Nebraska. If evidence is found supporting the hypothesis of a common process, data from one or more of the control states can be used to help establish the baseline for comparison with the experience in post-Initiative 300 Nebraska.

The remainder of the article is organized as follows. The next section summarizes the provisions of Nebraska's Initiative 300. In the following section, we briefly review the political history of Initiative 300 because it is relevant to the question of whether the implementation of the law can be treated as the basis for a natural experiment for testing the impact of corporate bans. We also consider the mechanism by which a state-level corporate ban might conceivably affect industrial structure within the state. The empirical model section describes the method we use to test for an impact of Initiative 300. Briefly, we adapt techniques discussed by Lee, Judge, and Zellner (1977) to estimate a Markov probability model of the dynamics of industry structure. The framework allows us to test for a change, between the pre- and post-Initiative 300 eras, in the underlying stochastic process governing the evolution of the feedlot size distribution. Data and details of the model specification are introduced. Presentation of our results follows. A final section provides some concluding observations.

## Anti-Corporate Farming Laws in the Leading Cattle-Feeding States

Nebraska's anticorporate farming law is generally considered to be the most stringent in the United States.[5] Adopted as the result

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[2] As will become clear later, matters are somewhat more complicated when considering the possible market structure impact of a state-level corporate restriction.

Q1 [3] Johnson et al. (1988) examined the impact of Nebraska's constitutional amendment restricting corporate farming and found "little evidence that the amendment has either advanced the causes of its proponents or created the extreme negative impacts claimed by its opponents" (p. 52). Knoeber (1997) developed an *indirect* rent-seeking explanation for the existence of these laws: Restricting corporate entry into farming helps to preserve the coalition that has been effective in lobbying for federal farm programs. Welsh, Carpentier, and Hubbell (2001) considered how the restrictiveness of existing laws has changed over the years and used state-level data from the U.S. Census of Agriculture to show that strengthening a law does tend to limit the farmland acreage owned by nonfamily corporations. Matthey and Royer (2001) examined the adjustment processes of state-level hog inventories for Nebraska and other midwestern states and found evidence of a shift in the Nebraska process that coincided with the enactment of the state's corporate farming restrictions. The present article is an extension of an earlier article by Azzam and Azzam (1998).

[4] As of 1 January 2005, these four states accounted for about 64% of all cattle on feed in the U.S. (USDA, Agricultural Statistics Database).

[5] To assess the restrictiveness of anticorporate farming laws, Welsh, Carpentier, and Hubbell (2001) conducted a survey of 15 agricultural lawyers deemed to be experts in the area. Each

of a public referendum known as "Initiative 300," the restrictions appear in Article XII, Section 8(1), of the Nebraska Constitution and have been in effect since 2 November 1982. Corporations and "syndicates" are precluded from owning land used in farming or ranching and from engaging in farming and ranching activities. Limited-liability companies and limited-liability partnerships, two newer organizational forms that are "hybrids" of corporations and partnerships, were not permitted in Nebraska in 1982. When the state legislature authorized the creation of these hybrids in the mid 1990s, the amendment's definition of "syndicate" was broadened to include them. (Thompson 2001) As is the case with other states' anticorporate restrictions, Nebraska's Initiative 300 allows an exemption for "family farm corporations." To qualify as a family farm corporation in Nebraska, a majority of the voting stock must be held by family members and at least one family member must live on the farm or be actively engaged in the labor and management of the enterprise[6] (Thompson). "Farming and ranching" is defined to include livestock ownership and the keeping or feeding of animals to produce livestock or livestock products. The only relevant exemptions are for poultry operations, livestock purchased for slaughter, and livestock purchased and resold within 2 weeks.[7] In contrast to many states with corporate farming laws, there is no exemption for cattle feedlots. Thus, the Nebraska law prohibits entry into the feedlot industry by a non-family-farm corporation or other non-family limited-liability entity. There is a grandfather clause, however, that permits continued operation of corporate-owned feedlots that were in place at the law's implementation. But even in these cases, acquisition of additional land for the purpose of expansion is prohibited.[8]

The remaining three of the four leading cattle-feeding states, Kansas, Colorado, and Texas, have no significant restrictions on corporate cattle feeding by nonfamily businesses. Texas and Colorado have no general anticorporate farming laws, although Texas does have a provision that prevents meat packers from "raising cattle." Curiously, owning and operating feedlots is not considered "raising cattle," however.[9] Kansas does have a general anticorporate farming statute but livestock feeding has always been specifically exempted from the Kansas restrictions.[10]

### Corporate Restrictions and the Size Distribution of Cattle Feedlots

The empirical analysis in this article will address the question of whether Nebraska's corporate restriction had an impact on the size distribution in the state's cattle feedlot industry. In seeking an answer to this question, we will compare the processes of evolution of the feedlot size distribution in Nebraska before and after the implementation of Initiative 300. This approach raises two questions. First, is it permissible to interpret the change in the legal environment brought about by Initiative 300 as the basis for a natural experiment to test the effects of corporate restrictions on industry structure? And second, even if Initiative 300's restrictions on corporations amount to de facto restrictions on the size of feedlots, should we expect to see evidence of this in industry structure at the state level?

Anticorporate farming laws are outcomes of the political process. Nebraska has a law that imposes restrictions on the cattle feedlot industry—Texas, Colorado, and Kansas do not. Perhaps an anticorporate farming initiative succeeded in Nebraska but not in the other states only because the nature of the Nebraska environment was fundamentally different. If this were the case, the effects of the corporate ban in Nebraska might reveal little, if anything, about the potential effects of similar bans in other states. Suppose, for example, that the cattle-feeding business had, for some reason, been less attractive to corporations in Nebraska than in other states. In that event, the political viability of Initiative 300 in Nebraska could simply be a consequence of the fact that corporations had insufficient incentive to lobby against it. One would then expect to see little impact of Initiative 300 on the state's industry structure in terms of either organizational form or feedlot sizes.

It is impossible to precisely quantify all of the political interests favoring and opposing

participant used a numerical scale to rate the "restrictiveness" of laws in each state and for each year. For every year from 1982 (the inception of the Nebraska law) through 1997 (the last year included in their survey), the panel averages of ratings for Nebraska were larger (indicating a greater degree of "restrictiveness") than for every other one of the nine principal anticorporate farming states.

[6] Initiative 300's restrictions also exempt "family-farm limited-liability companies" and "family-farm limited-liability partnerships." These entities have definitions similar to that of "family-farm corporations."

[7] Nebraska Constitution, Article XII, Section 8(1) (F), (N).

[8] *Ibid*, Section 8(1) (D).

[9] Texas Business Corporation Act, Article 2.01(B).

[10] Kansas Revised Statutes, Section 17–5904(8).

a corporate ban in Nebraska and in other states.[11] There is considerable anecdotal evidence, however, suggesting that corporations did perceive Nebraska's Initiative 300 to be inimical to their interests. After Initiative 300 was placed on the ballot as the result of a successful petition drive, a contentious election campaign followed, with business interests facing off against family-farm advocacy groups. Prudential Insurance Company, one of the firms heavily invested in Nebraska farmland at the time, supported the anti-Initiative 300 forces with a donation of $270,000. Some observers believe that the news reports of Prudential's donation triggered a backlash that invigorated the pro-Initiative 300 side and proved decisive in the general election (Hord 2002). Since its passage, corporate interests have challenged Initiative 300 in state and federal courts on constitutional grounds, but these efforts have failed.[12] Future legal challenges are inevitable. In August 2003, the Eighth Circuit Federal Court of Appeals ruled that South Dakota's constitutional "Amendment E" restricting corporate farming violated the U.S. Constitution's Interstate Commerce Clause. Similarities between Amendment E and Initiative 300 lead some legal analysts to speculate that a parallel challenge to Nebraska's law might also now succeed (Aiken 2004).

One frequently recurring theme in the agricultural economics literature is the claim that the realization of economies of scale in agricultural production requires substantial investment, and corporations may have advantages over other organizational forms in meeting the capital requirements of large-scale, cost-efficient operation.[13] The view that the corporate organizational form has an advantage in achieving large firm size is the subject of some dispute. Critics of this view note that the limited-liability feature, while making it easier for the enterprise to attract equity capital, puts lenders at greater risk and thus makes it harder to attract debt capital. Corporations, moreover, could be said to be "penalized" by tax law insofar as their profits are subject to double taxation when paid as dividends. On the other hand, lenders frequently have principals personally co-sign loans to start-up corporations until the businesses get established. This practice extends personal liability up to the amount of the co-signed loan and thus allows unlimited liability to be effectively waived, if necessary, in special circumstances. Correspondingly, there are other aspects of tax law that favor corporations. For example, until 2004, corporations were allowed to deduct employee benefits including health insurance premiums while unincorporated businesses could not. While there are arguments that can be offered on both sides of the debate, certainly there is a widespread perception that the corporate organizational form is most amenable to the attainment of large firm size.

Assuming that corporations do have an advantage in achieving large firm size, a market-wide ban on corporate involvement in production activities might result in a producer size distribution that, from the cost-efficiency standpoint, is too heavily concentrated in the small-firm-size categories. How state-level corporate restrictions might affect the size distribution of producers within the state is a more complicated question, however. In the case of feedlots, for example, the boundaries of fed cattle markets do not respect state lines, so small, noncorporate feedlots in one state face competition from larger, possibly corporate-owned, feedlots in neighboring states as well as from large feedlots in their own state. If small feedlots are inefficient, and if large scale can only be achieved by corporations,

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[11] One important historical reason for Initiative 300's restrictions on investor-ownership of livestock, in particular, is that the federal income tax code in the early 1980s allowed investors to offset earned income with losses from agricultural enterprises including, for example, prepaid expenses for the feeding of cattle owned through corporations or limited partnerships. The perception was that the lure of these tax breaks encouraged corporations to invest in cattle feeding, driving land prices up and cattle prices down. This concern was short-lived, however, because the 1986 Tax Reform Act limited the ability of taxpayers to offset earned income from one enterprise with investment losses from another.

[12] For example, *Omaha National Bank* v. *Spire*, 223 Neb. 209 (1986), *MSM Farms* v. *Spire*, 927 F. 2d 330 (8th Cir. 1991), and *Hall* v. *Progress Pig,* 259 Neb. 407, 610 N.W. 2d 420 (2000).

[13] In an article from the early 1970s, Godwin and Jones (1971) highlight a rising need for capital, resulting from advances in production technology, and the inadequacy of traditional sources of funding to meet this need. In a comment on Godwin and Jones, Schermerhorn (1971) predicts a growing role for publicly held corporations because of their capital-raising abilities. Raup (1973) states that "there are types of farming for which capital requirements and economies of size are often beyond the reach of . . . family-type farms" and mentions "large-scale beef cattle feed lots" (p. 286) as one example. Edmondson and Krause (1978) observe that "new production and marketing technologies . . . require larger sizes to be cost effective" (p. 4). Welsh and Halbrook (1976) **Q2** note that the limited liability and perpetual life features of the corporate form of organization may make it easier for corporations to attract capital. Finally, Matthey and Royer (2001), discussing the hog industry specifically, state that "larger operations, in particular, may need to operate as corporations to acquire adequate amounts of capital" (p. 2).

the main effect of a state-level ban on corporate involvement may be a general decline of the cattle-feeding industry within the state.[14]

In reality, small and large feedlots coexist in all of the major cattle-feeding states, and have for decades. If large feedlots have an efficiency advantage, absent size restrictions, we would expect to see the size distribution evolve, over time, toward greater relative importance of the large size categories. If large feedlots were restricted in a state, perhaps as a by-product of a corporate ban, the market's regional scope suggests that the restriction would not necessarily arrest the decline of small feedlots in the state because they would still fare poorly in competition with more efficient, large feedlots in other states. But the size restriction would, of course, tend to stifle the emergence of new large feedlots in the state. So the relative importance of small feedlots would not decline as rapidly as it would in states without a size restriction. Therefore Nebraska's ban on corporate ownership, if it amounted to a de facto restriction on large size, could still lead to changes in the Nebraska feedlot size distribution which are not mirrored in the evolution of size distributions in other states. Our empirical analysis can be viewed as a test of a joint hypothesis. If Initiative 300 is effective in limiting corporate involvement, if there are economies of scale in feedlot operation, and if corporations have an advantage in achieving large size, we should find that the law altered the dynamics of industry structure in Nebraska.

## Empirical Model

We will characterize the dynamics of establishment size distributions using a model motivated by the first-order Markov process defined as follows. For $t = 1, 2, \ldots,$ let $X_t$ be a discrete random variable taking values in the set $\{1, 2, \ldots, r\}$ and having the property that the probability distribution of $X_t$ depends only on $X_{t-1}$

$$\Pr\{X_t = j \mid X_{t-1}, X_{t-2}, \ldots\} = \Pr\{X_t = j \mid X_{t-1}\} \quad \text{for} \quad j = 1, 2, \ldots, r.$$

We say that the Markov process, or "chain," is "in state $j$ at time $t$" if $X_t = j$. Using the definition of conditional probability

$$\Pr\{X_{t-1} = i, X_t = j\} = \Pr\{X_{t-1} = i\} \Pr\{X_t = j \mid X_{t-1} = i\}.$$

Summing this expression over values of the $i$ index, $i = 1, 2, \ldots, r$, yields

$$(1) \qquad q_j(t) = \sum_{i=1}^{r} q_i(t-1) p_{ij}(t) \quad \text{for} \quad j = 1, 2, \ldots, r; \quad \text{and } t = 1, 2, \ldots$$

where $q_j(t)$ is the unconditional probability that $X_t = j$, and $p_{ij}(t)$ denotes $\Pr\{X_t = j \mid X_{t-1} = i\}$. The interpretation of these $p_{ij}(t)$'s, or "transition probabilities," requires

$$(2) \qquad 0 \leq p_{ij}(t) \leq 1 \quad \text{for} i, j = 1, 2, \ldots, r; \quad \text{and } t = 1, 2, \ldots; \quad \text{and}$$

$$\sum_{j=1}^{r} p_{ij}(t) = 1 \quad \text{for } i = 1, 2, \ldots, r; \quad \text{and} \quad t = 1, 2, \ldots$$

Imagine an independent sample of repeated observations from this Markov chain and suppose that available data consist only of the sample proportions of observations in each state for each $t = 0, 1, 2, \ldots, T$. Denoting the proportion in state $j$ at time $t$ by $y_j(t)$, we have $\sum_{j=1}^{r} y_j(t) = 1$ for all $t$. If these sample proportions are substituted for the corresponding unconditional probabilities in (1), the approximation would introduce sampling error into the equation

$$(3) \qquad y_j(t) = \sum_{i=1}^{r} y_i(t-1) p_{ij}(t) + u_j(t) \quad \text{for} \quad j = 1, 2, \ldots, r; \quad \text{and } t = 1, 2, \ldots, T.$$

This stochastic relation provides a basis for estimating the $p_{ij}(t)$'s using aggregate time series, or "macro," data on the $y_j(t)$'s. Lee, Judge, and Zellner (1977) discuss several approaches to estimation in this context. Two points can be noted immediately. Ideally, the

[14] In this article, we will address the question of whether anti-corporate farming laws have an impact on the size distribution of agricultural production within a state. Others have raised the possibility that these laws might have an adverse impact on a state's overall scale of production. The 1 January 2002 numbers for cattle on feed (USDA, Agricultural Statistics Database) showed that Nebraska, the second largest cattle-feeding state (behind Texas) throughout the 1980s and much of the 1990s, had, for the first time, fallen to third place behind Kansas. Feuz (2002) attributes this to Nebraska's strong restriction on corporate cattle feeding.

estimation procedure should respect the interpretation of the $p_{ij}(t)$'s as probabilities and impose the restrictions in (2). Without further restriction, however, estimation is impossible because (3) involves $Tr(r-1)$ independent parameters and only $T(r-1)$ independent observations.[15]

Our model of the dynamics of an industry's establishment size distribution over time will rely on (3) but with some relaxation of features and interpretations stemming from its Markov probability model underpinnings. The size distribution at time $t$ is characterized by a vector of category shares $y_1(t), y_2(t), \ldots, y_r(t)$ for each of $r$ size categories. Period $t$'s size category share vector is assumed to result from a drawing from a multinomial distribution. Each of the $N(t)$ establishments in the market at time $t$ has probability $q_j(t)$ of falling into size category $j$ for $j = 1, 2, \ldots r$. The category probabilities, in turn, are assumed to be given by ad hoc linear functions of the realized category shares from the previous period

$$(4) \quad q_j(t) = \sum_{i=1}^{r} y_i(t-1)p_{ij}(t) \quad \text{for} \quad j = 1, 2, \ldots, r; \quad \text{and } t = 1, 2, \ldots, T$$

where the $p_{ij}(t)$'s are parameters subjected to the restriction

$$(5) \quad \sum_{j=1}^{r} p_{ij}(t) = 1 \quad \text{for } i = 1, 2, \ldots, r; \quad \text{and} \quad t = 1, 2, \ldots, T$$

to ensure that $\sum_{j=1}^{r} q_j(t) = 1$ for all $t$.[16]

Replacing $q_j(t)$ on the left-hand side of (4) with the corresponding realized sample proportion, $y_j(t)$, is an approximation that introduces error and brings us back, essentially, to (3). The joint distribution of contemporaneous $u_j(t)$'s is determined by the underlying multinomial distribution and has the following features:

$$(6) \quad E[u_j(t)] = 0 \ \text{ for } j = 1, 2, \ldots, r; \ \text{ and } \ t = 1, 2, \ldots, T$$

$$\mathrm{Var}[u_j(t)] = \frac{q_j(t)(1-q_j(t))}{N(t)} \quad \text{for} \quad j = 1, 2, \ldots, r; \quad \text{and} \quad t = 1, 2, \ldots, T$$

$$\mathrm{Cov}[u_i(t), u_j(t)] = \frac{-q_i(t)q_j(t)}{N(t)} \quad \text{for} \quad i \neq j = 1, 2, \ldots, r; \quad \text{and} \quad t = 1, 2, \ldots, T.$$

The covariances between noncontemporaneous $u_j(t)$'s are assumed zero[17]

$$(7) \quad \mathrm{Cov}[u_i(t), u_j(s)] = 0 \quad \text{for } i, j = 1, 2, \ldots, r; \quad \text{and} \quad t \neq s = 1, 2, \ldots, T.$$

To express (3) more concisely, define, for $i$, $j = 1, 2, \ldots, r$,

$$\mathbf{p}_{ij} = \begin{pmatrix} p_{ij}(1) \\ p_{ij}(2) \\ \cdot \\ \cdot \\ \cdot \\ p_{ij}(T) \end{pmatrix}$$

and for $j = 1, 2, \ldots, r$,

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[15] The remaining $Tr$ parameters and the remaining $T$ observations (equations) that are present in (3) are redundant due to the "adding-up" conditions that apply to the transition probabilities and sample shares for each time period.

[16] Because we drop the restriction that $0 \le p_{ij}(t) \le 1$, we call these transition "parameters" instead of transition "probabilities." Of course, estimation of the transition parameters should still respect the restriction that the implied estimates of the category probabilities

$$\sum_{i=1}^{r} y_i(t-1)\hat{p}_{ij}(t)$$

are between 0 and 1 for all categories and for all time periods. Although our estimation method does not impose these restrictions, in practice, they were satisfied in virtually all cases.

[17] Any realistic model of the dynamics of an establishment size distribution over time must incorporate some form of temporal dependence. Zero covariances between noncontemporaneous $u_j(t)$'s is a simplifying assumption used in Lee, Judge, and Zellner's methods. Basically, it forces all of the model's temporal dependence into the evolution of the unconditional category probabilities as characterized by (4).

$$\mathbf{y}_j = \begin{pmatrix} y_j(1) \\ y_j(2) \\ \cdot \\ \cdot \\ \cdot \\ y_j(T) \end{pmatrix}, \quad \mathrm{u}_j = \begin{pmatrix} u_j(1) \\ u_j(2) \\ \cdot \\ \cdot \\ \cdot \\ u_j(T) \end{pmatrix}, \quad \text{and}$$

$$\mathrm{p}_j = \begin{pmatrix} \boldsymbol{p}_{1j} \\ \boldsymbol{p}_{2j} \\ \cdot \\ \cdot \\ \cdot \\ \mathbf{p}_{rj} \end{pmatrix}.$$

Finally, define $\mathbf{X}_j$'s, for $j = 1, 2, \ldots, r$, to be a common $T \times rT$ matrix with, for $k = 1, 2, \ldots, r$, columns $(k - 1)\ T + 1$ through $kT$ given by

$$\begin{bmatrix} y_k(0) & 0 & 0 & \cdot\ \cdot & 0 \\ 0 & y_k(1) & 0 & \cdot\ \cdot & 0 \\ 0 & 0 & y_k(2) & \cdot\ \cdot & 0 \\ \cdot & \cdot & \cdot & \cdot\ \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot\ \cdot & \cdot \\ 0 & 0 & 0 & \cdot\ \cdot & y_k(T-1) \end{bmatrix}.$$

The equations in (3) are then captured by

(8) $\quad \mathbf{y}_j = \mathbf{X}_j\mathbf{p}_j + \mathbf{u}_j \quad$ for $j = 1, 2, \ldots, r$.

Stacking these, we have:

(9) $\quad \mathbf{y} = \mathbf{Xp} + \mathbf{u}$

where

$$\mathbf{y} = \begin{pmatrix} y_1 \\ y_2 \\ \cdot \\ \cdot \\ \cdot \\ y_r \end{pmatrix}, \quad p = \begin{pmatrix} p_1 \\ p_2 \\ \cdot \\ \cdot \\ \cdot \\ p_r \end{pmatrix}, \quad \text{and } \mathbf{u} = \begin{pmatrix} u_1 \\ u_2 \\ \cdot \\ \cdot \\ \cdot \\ u_r \end{pmatrix}$$

and $\mathbf{X}$ is the $rT \times r^2T$ block diagonal matrix with $r$ diagonal blocks each given by $\mathbf{X}_j$.

As noted earlier, (3), now rewritten in the form of (9), contains more parameters than equations. To achieve a more parsimonious specification, the transition parameters are themselves parameterized in terms of $M$ time-dependent exogenous variables $z_m(t)$, for $m = 1, 2, \ldots, M$[18]

(10) $\quad p_{ij}(t) = \sum_{m=1}^{M} d_{ijm} z_m(t)$ for

$$i,\ j = 1, 2, \ldots, r; \ \text{ and } t = 1, 2, \ldots, T.$$

Let $\mathbf{z}$ be the $T \times M$ matrix with $z_m(t)$ in the $t^{\text{th}}$ row and $m^{\text{th}}$ column. For $i, j = 1, 2, \ldots, r$; define $\mathbf{d}_{ij}$ as the $M \times 1$ vector with $m^{th}$ element $d_{ijm}$. Then (10) can be summarized as $\mathbf{p} = \mathbf{Zd}$ where $\mathbf{Z}$ is a block diagonal matrix with $r^2$ diagonal blocks each equal to $\mathbf{z}$ and

$$\mathbf{d} = \begin{pmatrix} \mathbf{d}_1 \\ \mathbf{d}_2 \\ \cdot \\ \cdot \\ \cdot \\ \mathbf{d}_r \end{pmatrix}, \text{ where, for } j = 1, 2, \ldots r$$

$$\mathbf{d}_j = \begin{pmatrix} \mathbf{d}_{1j} \\ \mathbf{d}_{2j} \\ \cdot \\ \cdot \\ \cdot \\ \mathbf{d}_{rj} \end{pmatrix}.$$

The $r$ sets of relations described in (8) are redundant due to the adding up condition requiring category shares to sum to one at all dates. This means that the covariance matrix of $\mathbf{u}$ is singular and, due to (5), any one of the $\mathbf{p}_j$'s can be deduced from the remaining ones. Hence, we replace (9) with an alternative that is obtained by stacking versions of (8) for just $j = 1, 2, \ldots, r - 1$

(11) $\quad \mathbf{y}_* = \mathbf{X}_*\mathbf{p}_* + \mathbf{u}_*$

where $\mathbf{y}_*$, $\mathbf{X}_*$, $\mathbf{p}_*$, and $\mathbf{u}_*$ are appropriately defined sub-matrices of $\mathbf{y}$, $\mathbf{X}$, $\mathbf{p}$, and $\mathbf{u}$, respectively. In particular,

(12) $\quad \mathbf{p}_* = \mathbf{Z}_*\mathbf{d}_*$

where $\mathbf{Z}_*$ is the $(r - 1)\ rT \times (r - 1)\ rM$ block diagonal matrix consisting of $(r - 1)\ r$ diagonal

[18] It is perhaps most natural to think of the change in the establishment size distribution from $t - 1$ to $t$ as attributable to influences present in period $t - 1$. So, in practice, $z_m(t)$ will contain information dated $t - 1$.

blocks each given by the $T \times M$ matrix $\mathbf{z}$, and $\mathbf{d}_*$ is the $(r-1)\, rM \times 1$ vector that is obtained by stacking the $\mathbf{d}_j$'s for $j = 1, 2, \ldots, r-1$. Substituting (12) into (11), we have

$$(13) \quad \mathbf{y}_* = \tilde{\mathbf{X}}_* \mathbf{d}_* + \mathbf{u}_*$$

where $\tilde{\mathbf{X}}_* = \mathbf{X}_* \mathbf{Z}_*$. From (6) and (7), the covariance matrix of $\mathbf{u}_*$ is

$$(14) \quad \boldsymbol{\Sigma}_* = \begin{bmatrix} \boldsymbol{\Sigma}_{11} & \boldsymbol{\Sigma}_{12} & \cdot & \cdot & \boldsymbol{\Sigma}_{1r-1} \\ \boldsymbol{\Sigma}_{21} & \boldsymbol{\Sigma}_{22} & \cdot & \cdot & \boldsymbol{\Sigma}_{2r-1} \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \boldsymbol{\Sigma}_{r-11} & \boldsymbol{\Sigma}_{r-12} & \cdot & \cdot & \boldsymbol{\Sigma}_{r-1r-1} \end{bmatrix}$$

where, for $i, j = 1, 2, \ldots, r-1$

$$\boldsymbol{\Sigma}_{ii} = \mathrm{diag}\left\{ \frac{q_i(t)(1 - q_i(t))}{N(t)} \right\}_{t=1,2,\ldots,T}$$

$$\text{and} \quad \boldsymbol{\Sigma}_{ij} = \mathrm{diag}\left\{ \frac{-q_i(t) q_j(t)}{N(t)} \right\}_{t=1,2,\ldots,T}.$$

Inference will be based on estimation of relations like (13), describing the dynamics of the vector of size category shares for a single industry. The estimation method will be generalized least squares (GLS), which uses the structure of the error term covariance matrix, $\boldsymbol{\Sigma}_*$, to improve efficiency[19]

$$(15) \quad \hat{\mathbf{d}}_* = \left( \tilde{\mathbf{X}}_*' \hat{\boldsymbol{\Sigma}}_*^{-1} \tilde{\mathbf{X}}_* \right)^{-1} \tilde{\mathbf{X}}_*' \hat{\boldsymbol{\Sigma}}_*^{-1} \mathbf{y}_*.$$

In some parts of our application, we will consider multiple industries simultaneously. A stacked model that imposes a particular dynamic process; for our purposes, a particular value of $\mathbf{d}_*$; that is common across $K$ industries would yield a restricted estimator

(16)

$$\hat{\mathbf{d}}_{*R} = \left( \sum_{k=1}^{K} \tilde{\mathbf{X}}_{*k}' \hat{\boldsymbol{\Sigma}}_{*k}^{-1} \tilde{\mathbf{X}}_{*k} \right)^{-1} \left( \sum_{k=1}^{K} \tilde{\mathbf{X}}_{*k}' \hat{\boldsymbol{\Sigma}}_{*k}^{-1} \mathbf{y}_{*k} \right)$$

where symbols have "$k$" subscripts added to identify industries but otherwise have the same interpretations as in the single industry case.[20]

Our approach begins with the specification of a process that governs the dynamics of an industry's establishment size distribution over time. In that process, the probability distribution from which the size distribution is drawn in one period depends, in a fairly general way, on the realization of the size distribution in the previous period. Given this relatively ad hoc modeling approach, it is impossible to ascribe meaningful interpretations to individual parameters. The parameter values must be considered collectively and assessed in terms of their implications for the dynamics of the size distribution.[21]

Our main interest in this study will be to determine whether a given dynamic process, characterized by a given vector of values for $\mathbf{d}_*$, is common to multiple industries, or to multiple subperiods of the observational period for a single industry. These inferences can be based, simply, on Chow tests involving comparisons of restricted and unrestricted sums of squared errors.

For example, suppose we observe the evolution of market structure, characterized by shares of $r$ size categories, in each of $K$ industries over a period of $T$ years. Maintaining the hypothesis of a time-invariant process within each industry, the null hypothesis of a common process across industries can be tested using the following test statistic:

(17)

$$F = \frac{(SSE_R - SSE_U)/[(K-1)Mr(r-1)]}{SSE_U/[K(T(r-1) - Mr(r-1))]}$$

where $SSE_R$ and $SSE_U$ are, respectively, the sums of squared (transformed) errors:

[19] Lee, Judge, and Zellner give the form of $\boldsymbol{\Sigma}_*^{-1}$ corresponding to $\boldsymbol{\Sigma}_*$ in (14). The procedure we use is a "feasible" GLS procedure in which $\boldsymbol{\Sigma}_*^{-1}$ is replaced by an estimate, $\hat{\boldsymbol{\Sigma}}_*^{-1}$, in which the size category probabilities, the $q_j(t)$'s, are consistently estimated by the corresponding population shares.

[20] Equation (16) is the restricted GLS estimator for the stacked multi-industry model based on the assumption that the covariance matrix for the stacked random error vector is block diagonal with diagonal blocks given by the $\boldsymbol{\Sigma}_{*k}$'s. This reflects the simplifying assumption of zero covariances, contemporaneous and noncontemporaneous, across industries.

[21] One could assess the implications of a set of counterfactual values for the parameters using a stochastic simulation approach. Values for size category shares in an initial period, combined with the counterfactual parameter values, imply the parameters of the multinomial distribution from which the next period's category shares are drawn. A realization from this distribution, combined with parameter values again, determines the distribution for the second period following the initial period, and so on. Iterating this process in the obvious way would give one time path from the counterfactual process of market structure evolution. Fundamental aspects of the process could be inferred from a sample of multiple time paths generated in this way.

$$SSE_R = \sum_{k=1}^{K} \left(\hat{\mathbf{u}}'_{*Rk} \hat{\boldsymbol{\Sigma}}_{*k}^{-1} \hat{\mathbf{u}}_{*Rk}\right)$$

$$\text{and} \quad SSE_U = \sum_{k=1}^{K} \left(\hat{\mathbf{u}}'_{*k} \hat{\boldsymbol{\Sigma}}_{*k}^{-1} \hat{\mathbf{u}}_{*k}\right)$$

where $\hat{\mathbf{u}}_{*Rk}$ and $\hat{\mathbf{u}}_{*k}$ are the vectors of residuals for the restricted and unrestricted models. On the null hypothesis, (17) has an F distribution with $(K - 1)\ Mr(r - 1)$ and $K(T(r - 1) - Mr(r - 1))$ degrees of freedom.

## Data and Model Specification

The USDA reports annual fed cattle marketings, by state and by feedlot size category, using seven size categories defined in terms of lot capacities in number of head: less than 1,000, 1,000–1,999, 2,000–3999, 4,000–7,999, 8,000–15,999, 16,000–31,999, and greater than or equal to 32,000. (USDA, Cattle—Final Estimates) Our characterization of the feedlot size distribution for a given year and a given state is the state's vector of size-category shares of annual marketings.[22] Available data for Colorado, Kansas, Nebraska, and Texas span 1968–2003.[23]

Table 1 reports feedlot size category shares for each state for several selected years in the sample. A cursory inspection of these figures reveals that the feedlot industry's structure in all four states exhibits a trend toward larger feedlot size.[24] Over the 1970–2003 period, for example, the shares of the two smallest size categories decreased in all four states, while the share of the largest category increased in all four. It is also clear that there are some obvious differences in industry structure across states. In comparison to the other three states, Nebraska's feedlot industry structure is skewed toward the small feedlot size categories. In the 2003 data, the marketing share of the largest size category is only 13% in Nebraska but no less than 56% in the other three states. Correspondingly, the marketing share of Nebraska's smallest feedlots (6.2%) is over four times greater than the counterpart figures for each of the other three. Furthermore, while the share of the largest size category has grown in all states, the recent rate of growth has been smaller in Nebraska than in the others. Between 1995 and 2003, the share of the 32,000-head-plus category increased from 49% to 58% in Colorado, from 36% to 57% in Kansas, and from 62% to 73% in Texas, but only from 11% to 13% in Nebraska. One might be tempted to attribute these differences in Nebraska's industry structure to an Initiative-300-induced bias in favor of small feedlot size. But, in fact, the comparative importance of small feedlots has been a feature of market structure in Nebraska for some time. For example, in 1980, before Initiative 300 was implemented, the smallest size category contributed 35% of marketings in Nebraska and no more than 6.7% in each of the other three, while the largest size category was responsible for only 7.6% of marketings in Nebraska and no less than 19.6% in Colorado, Kansas, and Texas. If Initiative 300 has an impact on the size distribution, it presumably would take the form of a change in the underlying stochastic process governing the evolution of market structure from one year to the next. Whether there has been such a change is not immediately apparent from a casual inspection of the data and requires a more detailed analysis.

The analysis must recognize, however, that the change in the statutory environment attributable to the implementation of Initiative 300 is merely one factor that might have led to a change in the process of market structure dynamics. Changes in cattle-feeding technology and in relative prices could also have an impact. Therefore, our approach will allow transition parameters to vary over time with changes in exogenous variables, and then carry out tests of stability of the structure mapping the exogenous variables into the transition parameters.

[22] USDA reports the numbers of feedlots by size category. The number of feedlots in the less-than-1,000-head-capacity category is estimated, however, not measured, and the estimation procedures may have different levels of precision in different states. Moreover, these small feedlots represent more than 80% of the total number of feedlots in Kansas, Nebraska, and Texas for almost all years in the sample. Hence, errors in estimation of the number of small feedlots translate into relatively large errors in the implied shares for all categories. Because of the unreliable nature of these estimates of numbers of less-than-1,000-head-capacity feedlots, NASS stopped reporting them for most states after 1995. For these reasons, we choose to characterize the size distribution in terms of category shares of marketings rather than feedlots.

[23] Nonsingularity of $\hat{\Sigma}_*$ requires that the shares be nonzero in all categories and all years. Given our data, this required that reported zero values of the largest category's share in Colorado and Kansas for 1968 and 1969 be replaced with small positive values. Also, in Colorado for 1970 and 1971, two category shares had to be imputed because, for reasons of data confidentiality, a single combined share was reported for the two largest categories in each of these years.

[24] We emphasize that we are characterizing industry structure in terms of the size distribution of establishments, feedlots, not firms. There is a pragmatic reason for this choice: Data on the size distribution of cattle-feeding firms are unavailable. Firm size distribution can be relevant, moreover, to the underlying concern about the possibility of inefficient market structures. Some of the economies of scale in the cattle-feeding industry are multi-"plant" economies; the economy of purchasing feed in train-load quantities, for example.

**Table 1. Feedlot Industry Shares of Annual Marketings, by Lot Size Category for Colorado, Kansas, Nebraska, and Texas for Selected Years**

| | | Feedlot Size Categories (feedlot capacity in head) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | State | <1K | 1–2K | 2–4K | 4–8K | 8–16K | 16–32K | >32K |
| 1970 | CO | 0.151* | 0.058 | 0.066 | 0.124 | 0.171 | 0.278 | 0.152 |
| | KS | 0.262 | 0.027 | 0.057 | 0.112 | 0.165 | 0.261 | 0.116 |
| | NE | 0.453 | 0.122 | 0.112 | 0.120 | 0.086 | 0.060 | 0.047 |
| | TX | 0.031 | 0.017 | 0.036 | 0.089 | 0.232 | 0.292 | 0.303 |
| 1975 | CO | 0.076 | 0.046 | 0.104 | 0.102 | 0.142 | 0.204 | 0.325 |
| | KS | 0.125 | 0.007 | 0.019 | 0.115 | 0.196 | 0.359 | 0.180 |
| | NE | 0.404 | 0.101 | 0.100 | 0.097 | 0.137 | 0.086 | 0.075 |
| | TX | 0.016 | 0.007 | 0.017 | 0.044 | 0.158 | 0.430 | 0.328 |
| 1980 | CO | 0.059 | 0.049 | 0.119 | 0.092 | 0.118 | 0.188 | 0.374 |
| | KS | 0.067 | 0.060 | 0.050 | 0.090 | 0.256 | 0.281 | 0.196 |
| | NE | 0.353 | 0.074 | 0.118 | 0.124 | 0.136 | 0.118 | 0.076 |
| | TX | 0.012 | 0.004 | 0.011 | 0.054 | 0.128 | 0.364 | 0.426 |
| 1985 | CO | 0.040 | 0.050 | 0.109 | 0.109 | 0.140 | 0.161 | 0.391 |
| | KS | 0.027 | 0.017 | 0.047 | 0.099 | 0.254 | 0.275 | 0.280 |
| | NE | 0.302 | 0.065 | 0.111 | 0.111 | 0.187 | 0.122 | 0.102 |
| | TX | 0.014 | 0.002 | 0.004 | 0.034 | 0.123 | 0.254 | 0.569 |
| 1990 | CO | 0.018 | 0.032 | 0.082 | 0.114 | 0.133 | 0.149 | 0.471 |
| | KS | 0.012 | 0.012 | 0.036 | 0.050 | 0.235 | 0.332 | 0.323 |
| | NE | 0.220 | 0.058 | 0.132 | 0.140 | 0.220 | 0.162 | 0.066 |
| | TX | 0.007 | 0.005 | 0.012 | 0.037 | 0.125 | 0.279 | 0.535 |
| 1995 | CO | 0.016 | 0.024 | 0.051 | 0.081 | 0.130 | 0.207 | 0.491 |
| | KS | 0.024 | 0.013 | 0.019 | 0.050 | 0.197 | 0.333 | 0.363 |
| | NE | 0.093 | 0.067 | 0.112 | 0.197 | 0.216 | 0.205 | 0.110 |
| | TX | 0.002 | 0.004 | 0.008 | 0.030 | 0.114 | 0.219 | 0.623 |
| 2000 | CO | 0.012 | 0.020 | 0.033 | 0.094 | 0.096 | 0.199 | 0.546 |
| | KS | 0.016 | 0.008 | 0.021 | 0.046 | 0.154 | 0.319 | 0.436 |
| | NE | 0.056 | 0.062 | 0.110 | 0.180 | 0.232 | 0.238 | 0.123 |
| | TX | 0.003 | 0.001 | 0.003 | 0.020 | 0.076 | 0.187 | 0.711 |
| 2003 | CO | 0.014 | 0.015 | 0.026 | 0.072 | 0.102 | 0.193 | 0.578 |
| | KS | 0.013 | 0.007 | 0.018 | 0.044 | 0.119 | 0.230 | 0.568 |
| | NE | 0.062 | 0.064 | 0.125 | 0.164 | 0.224 | 0.230 | 0.130 |
| | TX | 0.004 | 0.002 | 0.002 | 0.012 | 0.070 | 0.182 | 0.727 |

An asterisk denotes for example, 15.1% of fed cattle marketings in Colorado in 1970 were in the less-than-1,000-head-capacity category.

In building a model of time-varying transition parameters, however, one immediately encounters the problem of scarcity of degrees of freedom. Consider equation (13), the model of market structure evolution for a single industry. The model has $(r - 1)\ T$ equations and $(r - 1)\ rM$ parameters; where $r$ is the number of size categories, $T$ is the length of the time series, and $M$ is the number of exogenous variables including the constant term. To estimate these $(r - 1)\ rM$ parameters, we need $T > rM$. Estimation requires share data for one year prior to the first year entering the sample. So the longest usable time series is only 35 years (1969–2003). Because $r$ is seven, the largest value of $M$ that can be accommodated is only four, allowing at most three exogenous variables in addition to the constant term. Of course, if one maintains the assumption of a stable structure across states, it is possible to pool the data from multiple states, increasing the number of observations and allowing for a richer model of the transition parameters. The objective of the analysis, however, is to test for a regime switch between the pre- and post-Initiative 300 eras in Nebraska. In view of the November 1982 effective date for the Nebraska law, the analysis will assume that any impact on market structure dynamics first manifested itself in the transition in feedlot size distributions occurring between 1982 and 1983. Thus the pre-Initiative 300 era in Nebraska consists of only 14 years (1969–82) of data. For this subperiod, degrees of freedom would be exhausted even with $M = 2$.

As explained in the previous section, our main inferential tool is the familiar Chow test of stability of a model's structure across two or more subsamples. Some relief from the problem of insufficient degrees of freedom is provided by a version of the test sometimes called the "Chow predictive test" (Greene 2000, section 7.6.4.). For example, suppose we have $T_1$, $T_2$, and $T_3$ years of data on the $r$ category shares in industries 1, 2, and 3, respectively, and that the transition parameters are modeled as functions of $M$ exogenous variables where $T_1 \leq rM$ while $T_2, T_3 > rM$. Even though degrees of freedom are insufficient for unrestricted estimation of the transition parameters in industry 1, the null hypothesis of a common structure among the three industries can be tested using the following statistic:

$$F = \frac{(SSE_R - SSE_U)/[(r-1)rM + (r-1)T_1]}{SSE_U/[(r-1)(T_1+T_2) - 2(r-1)rM]}$$

where $SSE_R$ represents the sum of squared (transformed) errors from restricted estimation for all three industries jointly, and $SSE_U$ is the sum of squared (transformed) errors for unrestricted estimation of industries 2 and 3 alone, $SSE_2 + SSE_3$. On the null, the above statistic has an F distribution with $(r-1)\,rM + (r-1)\,T_1$ and $(r-1)\,(T_1+T_2) - 2(r-1)\,rM$ degrees of freedom. Improbably high values for the statistic are evidence against the null. For some intuition to support the formula for this statistic, notice that, for industry 1, with more parameters than observations, unrestricted estimation would result in a perfect fit, $SSE_1 = 0$, therefore only industries 2 and 3 contribute to the unrestricted sum of squared errors. Moreover, obtaining this perfect fit would actually require only $(r-1)\,T_1$ of the $(r-1)\,rM$ parameters; hence the adjustment to the degrees of freedom in the numerator. Several of the test results reported in the next section make use of this Chow predictive test.

Because of the degree-of-freedom problem, in our analysis, we will consider only two exogenous variables (in addition to the constant term) as candidate determinants of transition parameters. One is simply a linear time trend, which might pick up any effects of technology changes that affect market structure at a more-or-less uniform rate over time. The other exogenous variable is a cattle/corn price ratio. Given the predominance of corn in the feed ration, this is a key relative price for the cattle-feeding industry. State-specific data are available for both nominal price series, so the ratio exhibits at least some variation across states as well as over time.[25] Treating the cattle/corn price ratio as exogenous requires comment, however. Certainly the prices of cattle and corn would be jointly determined with the overall scale of the cattle-feeding industry, but here our focus is on industry structure characterized by a vector of size category shares. Except for the possibility that large feeders might exercise market power in their input and/or output markets, it is less clear how market structure would influence prices.[26] A causal flow from the cattle/corn price ratio to market structure is easy to imagine, however. With market structure in continual transition, we would expect that both efficiently and inefficiently scaled operations would coexist at any point in time. But a narrowing of the cattle/corn price margin, for example, would make it more difficult for inefficient operations to survive and would hasten the shift toward efficient size categories.

## Results

In this section, we use the methods sketched in the Empirical Model section to investigate the dynamics of Nebraska's feedlot industry structure.[27] In particular, we will conduct tests to determine whether the stochastic process governing the evolution of market structure changed between the pre- and post-Initiative 300 subperiods of our data (1969–82 and 1983–2003). Even if evidence of such a change were found, of course, we would be unable to conclude with certainty that its cause was Initiative 300's restriction on corporate ownership of feedlots. The inference that Initiative 300 was at the root of any such change is strengthened, however, if the tests are carried out in a way that controls for other effects that may have caused a shift in the dynamics of market

[25] The cattle price series is the "marketing year average price received by farmers" for steers and heifers, in \$/cwt., from USDA, Agricultural Prices. The corn price is a simple average of the monthly prices of "corn for grain," in \$/bu., from USDA, Agricultural Statistics Database.

[26] Even in Texas, the state with the greatest number of "large" feedlots, concentration in the cattle-feeding industry remains relatively moderate. As of 2003, Texas had 49 feedlots in the greater-than-32,000-head-capacity category. These represented 37% of the feedlots of at least 1000-head-capacity, and accounted for 73% of the state's total marketings of fed cattle in that year. The number of firms represented in this group of "large" feedlots was not readily available to us, however.

[27] In an early application of related techniques, Telser (1963) used weighted least squares (but not generalized least squares) estimates of time-varying transition parameters in a Markov probability model to investigate the dynamics of cigarette brand market shares. We have not seen an application, other than our own, in which the testing of structural stability across chains is the main objective.

structure. For this reason, we use (primarily) models that characterize market structure dynamics in terms of time-varying transition parameters. Further, we look to the experiences in other states with no corporate ownership restrictions to see if they are helpful in establishing a baseline for comparison with market structure dynamics in post-Initiative 300 Nebraska.

A natural first step, however, is to test for stability of the vector of time-invariant transition parameters between the two subperiods of interest, using only Nebraska data. The results of this test are reported in line 1 of table 2. Stability can be rejected at a marginal significance level of 1.5%, suggesting that *something* of significance changed in the Nebraska cattle-feeding industry between the two "halves" of the sample. Of course, the relevant "something" that changed need not have been the legal environment with the advent of Initiative 300. Indeed, in each of the other three states, the hypothesis of stability between the 1969–82 and 1983–2003 subsamples is also rejected at comparable or smaller marginal significance levels. (Lines 2, 3, and 4 of table 2).

The next step is to allow for a richer model of market structure dynamics by expressing transition parameters as functions of the time-varying exogenous variables. When using Nebraska data alone for a test of stability across the relevant subsamples, the procedure requires the use of the Chow predictive test and is limited to transition parameter specifications involving just one exogenous covariate (in addition to a constant term) at a time: Adding a second exogenous variable would exhaust degrees of freedom on the 1983–2003 subsample (21 observations) let alone on the 1969–82 subsample (14 observations). When these tests are carried out using specifications including, first, a time trend (line 5), and second, the cattle/corn price ratio (line 6) the evidence for a structural break in 1983 is much weaker: The marginal significance levels are 78% and 5.4% respectively. Constant transition parameters obtain as easily testable parametric restrictions of either of the one exogenous variable specifications. In fact, the constant transition parameter specification can be rejected in favor of the linear-in-time-trend specification, with a marginal significance level of 2.7%.[28] Combining this with the above finding that we cannot reject the hypothesis of stability of the linear-in-time trend specification across subsamples, it appears that one possibility is that the process of market structure dynamics in Nebraska changed smoothly over the past 35 years, in response to unknown factors, rather than abruptly in 1983, due to the implementation of Initiative 300.

The scarcity of degrees of freedom severely restricts the complexity of the transition parameter specifications that can be estimated using data from one state. This problem would be significantly eased if all of the chains that were subject to no corporate restrictions shared a common process. In that event, data from these chains could be pooled and used to estimate a specification of transition parameters that could then be used as a benchmark for comparison with the process in post-Initiative 300 Nebraska. To explore this possibility, we start by conducting tests of stability of various specifications of the transition parameters among the four chains representing states and time periods with no applicable corporate restrictions: Nebraska 1969–82; and Colorado, Kansas, and Texas, 1969–2003. Lines 7, 8, and 9 of table 2 report the results of these tests for transition parameters modelled as linear functions of, respectively, a time trend (trend), the cattle/corn price ratio (ccpr), and both a time trend and the cattle/corn price ratio. Here the results are disappointing: Stability is rejected at very low marginal significance levels in all three cases.

Finding no support for the hypothesis of commonality of the dynamic process among all four chains, we next turn to a search for smaller control groups. There are six candidates. Each has the Nebraska 1969–82 chain combined with either one or two of the Colorado, Kansas, and Texas 1969–2003 chains. For each of these six candidate control groups, three stability tests were carried out corresponding to the three transition parameter specifications: linear functions of a time trend, the cattle/corn price ratio, and both a trend and the cattle/corn price ratio. Among these 18 stability tests, 9 led to rejections of the hypothesis of stability at marginal significance levels of 5% or lower.[29] The nine cases in which stability could not be rejected are reported in Table 2, lines 10 through 18.

[28] When the null hypothesis of constant transition parameters is tested against the alternative of transition parameters that are linear in the cattle/corn price ratio, the marginal significance level is 18.4%

[29] Of these nine rejections, four were at marginal significance levels between 5% and 1%. The others were at marginal significance levels of less than 1%.

**Table 2. Chow Tests of Stability of Feedlot Industry Market Structure Evolution Processes across States/Time-Frames**

| States/time-frames (chains) | Specification[a] | D.o.f.[b] | $F$-stat[c] | $p$-Value[d] |
|---|---|---|---|---|
| 1. NE 69–82, NE 83–03 | constant | 42,126 | 1.673 | 0.015 |
| 2. CO 69–82, CO 83–03 | constant | 42,126 | 2.688 | 0.000 |
| 3. KS 69–82, KS 83–03 | constant | 42,126 | 2.962 | 0.000 |
| 4. TX 69–82, TX 83–03 | constant | 42,126 | 1.630 | 0.020 |
| 5. NE 69–82, NE 83–03 | trend | 8,442 | 0.818* | 0.784 |
| 6. NE 69–82, NE 83–03 | ccpr | 8,442 | 1.572* | 0.054 |
| 7. NE 69–82, CO 69–03 KS 69–03, TX 69–03 | trend | 252,378 | 1.952* | 0.000 |
| 8. NE 69–82, CO 69–03 KS 69–03, TX 69–03 | ccpr | 252,378 | 1.434* | 0.001 |
| 9. NE 69–82, CO 69–03 KS 69–03, TX 69–03 | trend+ccpr | 336,252 | 1.694* | 0.000 |
| 10. NE 69–82, CO 69–03 KS 69–03 | ccpr | 168,252 | 1.074* | 0.303 |
| 11. NE 69–82, KS 69–03 TX 69–03 | ccpr | 168,252 | 1.013* | 0.459 |
| 12. NE 69–82, CO 69–03 | trend+ccpr | 8,484 | 1.219* | 0.183 |
| 13. NE 69–82, KS 69–03 | trend | 84,126 | 0.795* | 0.870 |
| 14. NE 69–82, KS 69–03 | ccpr | 84,126 | 0.599* | 0.994 |
| 15. NE 69–82, KS 69–03 | trend+ccpr | 8,484 | 0.788* | 0.862 |
| 16. NE 69–82, TX 69–03 | trend | 84,126 | 0.929* | 0.639 |
| 17. NE 69–82, TX 69–03 | ccpr | 84,126 | 0.887* | 0.722 |
| 18. NE 69–82, TX 69–03 | trend+ccpr | 8,484 | 1.042* | 0.426 |
| 19. NE 83–03, NE 69–82 CO 69–03, KS 69–03 | ccpr | 84,462 | 1.338 | 0.034 |
| 20. NE 83–03, NE 69–82 KS 69–03, TX 69–03 | ccpr | 84,462 | 1.012 | 0.456 |
| 21. NE 83–03, NE 69–82 CO 69–03 | trend+ccpr | 126,168 | 2.294* | 0.000 |
| 22. NE 83–03, NE 69–82 KS 69–03 | trend | 84,252 | 0.946 | 0.611 |
| 23. NE 83–03, NE 69–82 KS 69–03 | ccpr | 84,252 | 0.946 | 0.610 |
| 24. NE 83–03, NE 69–82 KS 69–03 | trend+ccpr | 126,168 | 0.722* | 0.973 |
| 25. NE 83–03, NE 69–82 TX 69–03 | trend | 84,252 | 0.962 | 0.575 |
| 26. NE 83–03, NE 69–82 TX 69–03 | ccpr | 84,252 | 1.331 | 0.048 |
| 27. NE 83–03, NE 69–82 TX 69–03 | trend+ccpr | 126,168 | 0.791* | 0.918 |

[a]Specification of the transition parameters: Constant; or linear function of a time trend, the cattle/corn price ratio (ccpr), or both a time trend and the cattle/corn price ratio.
[b]$F$-statistic degrees of freedom in the numerator and denominator, respectively.
[c]$F$-statistic for a test of the null hypothesis of stability of the transition parameter structure across all chains versus the alternative of instability. In lines 19 through 27 the test is against a "partially restricted" alternative that maintains stability between (among) chains other than the first. In the other lines, the test is against an "unrestricted" alternative in which each chain is allowed to have a different structure. In cases marked by an "asterisk," degrees of freedom are insufficient for unrestricted estimation of one or more chains, so the Chow predictive test is used.
[d]Marginal significance level for rejection of the null hypothesis of stability.

Each of lines 10 through 18 in table 2 corresponds to a set of chains in a no-corporate-restriction regime that appear to have "compatible" market structure dynamics: At least the hypothesis of stability, within the set of chains, of the indicated transition parameter specification cannot be rejected at conventional significance levels. The final step is to test for a difference between the process characterizing each control group and the process underlying the post-Initiative 300, 1983–2003 experience in Nebraska. The results of these tests, for each of the nine control groups, are reported in lines 19 through 27 of table 2.[30] The results of these tests do not provide an unequivocal answer: Both rejections of stability and failures to reject stability occur. Among the nine tests, three resulted in rejections of stability at marginal significance levels of 5% or less.[31]

## Discussion

Anticorporate farming laws are a feature of the legal environment in several states in the north-central United States. While the direct target of these laws is the ownership structure of agricultural production, there is some concern that they may have an indirect, adverse impact on the size structure as well. The size structures of agricultural production at the state level evolve over time; exhibiting some trends that are common across states and others that are unique to a particular state. At a particular point in time, industry structure in a given state is largely inherited from the past. If the implementation of an anticorporate farming law has an impact on market structure, that impact would be revealed, not in static, point-in-time comparisons of market structure across states with and without laws, but in a change in the process of market structure evolution that occurs in a given state as the law goes into effect. In this article, we have examined the dynamics of the size distribution of establishments in the cattle-feeding industry in Nebraska for any evidence of an impact of that state's anticorporate farming law, Initiative 300.

On the one hand, we found strong evidence that the stochastic process governing the evolution of Nebraska's feedlot size distribution was not invariant across the pre- and post-Initiative 300 eras. But, on the other hand, the same can be said for the dynamics of feedlot size distributions in each of the other major cattle-feeding states, Colorado, Kansas, and Texas, where Initiative 300 played no role. When Nebraska's market structure dynamics were modeled in a way that allowed for smooth variation in the process with changes in exogenous variables, the evidence for an abrupt structural break corresponding to the implementation of Initiative 300 was much weaker. Unfortunately, we were largely unsuccessful in our efforts to alleviate the problem of scarce degrees of freedom by pooling data across states. The idiosyncrasies of state-level industry structure dynamics prevent their representation by a common stochastic process.

While the findings of our analysis are not completely conclusive, at least it is fair to say that we found no strong evidence that Initiative 300 affected the dynamics of feedlot industry structure in Nebraska. Such an effect should have been apparent if three conditions were met: (1) There are economies of scale in feedlot operation, (2) Initiative 300 effectively limits corporate involvement in the industry, and (3) the organizational forms permitted by Initiative 300 are at a disadvantage, relative to corporations, in achieving large firm size. Again, table 1 documents the steady trend toward larger feedlots in all states: the existence of significant economies of scale is not seriously in doubt. The explanation for our results more likely involves the second and third components of the joint hypothesis.

Concerning the effectiveness of Initiative 300's limitation on corporate involvement, the law has, since November 1982, prevented the entry of new corporate-owned feedlots in Nebraska.[32] A grandfather clause exempted corporate-owned feedlots that were in operation in 1982, however, allowing continued operation but prohibiting additional land acquisitions. It is possible that some of these existing corporate feedlots were able to expand their operations without new land purchases. With respect to the capital-raising "disadvantages" of the organizational forms permitted by Initiative 300, the Nebraska law's definition of authorized "family-farm" corporation allows for sale of up to 49% of the firm's stock to non-family-member investors. This feature improves the access to capital for family-farm corporations and may negate at least part of any capital-raising disadvantage. In fact, there are some quite large family-owned cattle feeding operations in Nebraska.[33]

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[30] These tests are against alternatives that could be described as "partially restricted" insofar as stability of the process within the control group is maintained. The same set of tests against an "unrestricted" alternative (processes allowed to differ among control group states) yielded qualitatively similar results.

[31] This last procedure, involving the effort to identify subsets of the no-corporate-restriction chains as viable control groups, is one that we regard as exploratory only. Obviously, its sequential testing approach makes the results difficult to interpret. The general problem of scarcity of degrees of freedom adds one further qualification to all our test results: The failure to find a statistically significant effect could merely reflect low power of the test.

[32] In other states, over the same time period, non-family-farm corporations have grown to prominence in the cattle-feeding industry. Examples include Cactus Feeders, Inc. (with feedlots in Texas and southwestern Kansas), ContiGroup Cattle Feeding Division (Colorado, Kansas, Oklahoma, and Texas), and ConAgra Cattle Feeding Co. (Colorado and Idaho).

[33] Examples include Adams Land and Cattle Company and Dinklage Feedyards. Each of these operations has Nebraska feedlot

Finally, although Initiative 300 does not appear to have affected market structure dynamics in Nebraska, there are, as noted earlier, longstanding and significant differences in the feedlot size distributions between Nebraska, on the one hand, and the other leading cattle-feeding states, on the other. Small feedlots are much more prevalent in Nebraska than in Colorado, Kansas, or Texas. One possible explanation for this is the existence of scale economies in the transportation of feed. In Nebraska, a corn surplus state, feedlots buy corn locally incurring relatively little transport cost and making it less imperative that scale economies be captured. Feedlots in other states, incurring higher feed transport costs on average, face a stronger incentive to exploit scale economies.

*[Received July 2003;
accepted December 2005.]*

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capacities totaling in excess of 90,000 head. Both are among the nation's 25 largest cattle feeders.

**Queries**

**Q1** Author: There is a mismatch in reference listing and reference citation of Azzam and Azzam (1998). Please check.
**Q2** Author: Reference Welsh and Halbrook (1976) has not been listed. Please check.
**Q3** Author: Please provide page range for Aiken (2004).
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