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ENVIRONMENTAL QUALITY, ENVIRONMENTAL REGULATION AND THE STRUCTURE OF ANIMAL AGRICULTURE

by

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To analyze whether or not environmental regulations impact the structure of animal agriculture, it is first necessary to ask "what is meant by structure?" Numerous definitions of structure exist and are commonly used to analyze dramatic changes occurring in the animal agriculture subsectors. These changes, and therefore the term *structure*, may refer to such factors as the distribution of sales, revenues, and profits; the importance of farm income as the primary family income source; concentration of production within a geographic region or by a small number of firms; degree of specialization; ownership and control of inputs and outputs; and the number and size distribution of farms (Offutt, Hoppe et al.). While each of these factors helps to evaluate changes occurring in the animal agriculture subsectors, we suggest that the crux of the economic and social debate surrounding environmental regulations and the structure of industrialized animal agriculture centers around three factors: changes in the *size of operations*, changes in the *form of vertical coordination*, and shifts in the *location of animal agriculture*. To that end, we ask the question "have environmental regulations impacted these three factors?" Furthermore, we look beyond the current structure and address the question "might environmental regulations affect the future structure of animal agriculture?"

Because we focus on three specific factors to describe structure, it is worthwhile to define what we mean by each. First, we propose that the structure of animal agriculture can be characterized by the *size of the operation*. In this sense, we are referring to the physical size of the operation defined by the number of head or acres of land, rather than defined by gross revenues or farm income. We choose to do so because we believe the social and environmental issues associated with animal agriculture are the result of the number of animals per associated land base, rather than the dollar value attached to any farm operation. In the

case of animal agriculture, issues associated with the size of the operation are closely linked to the issue of *animal density*, here defined as the number of animals per unit of land. To a large degree, the increase in animal density has been the result of increased specialization and changes in the type of vertical coordination.

Second, we use the term *form of vertical coordination* to describe changes in the type of coordinating mechanism at various stages of input supply, production and marketing. Characterizing vertical coordination as a spectrum, with cash or spot markets on the far left and complete ownership integration at the right, changes in the way that farmers and farms operate can be identified. As an illustration, one can think of a hog farmer who raises his own corn which he then feeds to his hogs and, in turn, markets the hogs at the local livestock auction. In this case, the farmer is his own feed supplier (ownership integrated between these two stages), but markets his hogs as a blind cash transaction. Alternatively, one could think of a contract pork producer who in return for a predetermined contractual fee, raises hogs owned by another party, the contractor. The contract producer provides his own land and facilities but has feed delivered to his farm by the contractor and is not involved in any marketing decisions. This scenario illustrates a case where neither spot markets (a loosely-coordinated system) nor complete ownership integration (a tightly-coordinated system) occurs, but rather the form of vertical coordination, production contracting, falls elsewhere in the spectrum. We raise the issue of form of vertical coordination, because we believe, like size of operation, it is at the base of discussions involving the structure of animal agriculture.

Finally we focus on the issue of *location of animal agriculture*. Locational changes in animal agriculture are characterized by two different types of adjustments: a) shifts of animal production between regions and b) clustering of production within a region. We focus on these two phenomena because we believe that environmental problems, both real and perceived, attributed to animal production arise from characteristics of and changes in not only how but where production takes place.

Have Environmental Regulations Impacted the Structure of Animal Agriculture?
We address this question by analyzing the effect of environmental regulations on each of the three factors used to describe the structure of animal agriculture.

Size
To begin, we raise the question of whether or not environmental regulations have impacted the size, and more specifically the movement toward larger size, of livestock and poultry farms. We conclude the answer is ambiguous and there is evidence that environmental regulations have both facilitated and hampered the movement toward larger farms.

The greatest factor driving the movement toward larger farm size has been the introduction and adoption of new technologies, that for the most part, have not been scale neutral. Improved disease control and feed programs, coupled with the movement toward confined production

operations and greater fixed investments, have led producers to increase output, lower per unit costs of production, and adjust to new sources of risk. Evaluating pork production, Good determined that hog production costs for a large, specialized farm in North Carolina were approximately 10% less than for a traditional hog farm in the Midwest. Without any significant change in overall supply, early adopters of new technologies which lower per unit costs are able to enjoy positive economic profits. As first adopters of new technologies expand production, the inevitable outcome will be an increase in overall supply leading to a decrease in market price. Therefore, marginal producers are forced to either adopt low-cost technologies, exit from the industry, or search for alternative production and marketing relationships that lower the cost of production. Harrington and Reinsel emphasize that differences in production technologies due to the adoption of technological innovations and form of vertical coordination are the driving force behind the increasing size of farms.

Recognizing that technological change has been the primary driving force toward larger farm size, what role has environmental regulation played in changing farm size? In states such as Minnesota, South Dakota, and Nebraska, where regulations require balancing manure nutrient applications to nutrient use by crops, farms are required to own or acquire the rights to apply manure on farmland. This has the potential to increase production costs as external costs of manure management are internalized. As herd size increases, diseconomies in manure management exist when land application at an *agronomic rate* is required (Martin and Zering; Hoag and Roka; Northrop and Zering). These diseconomies are primarily the result of transport and application costs and are further exaggerated when the land base is constrained. Should these diseconomies represent a significant portion of production cost, we would expect to see a movement toward smaller farms rather than larger farms, or at a minimum, a decrease in the acceleration of the movement toward large farms with a high level of animal density.

In contrast to the diseconomies associated with nutrient balancing, in states where environmental regulations reach beyond this to include permitting, certification, storage, treatment or management standards, the high fixed costs of complying with such regulatory requirements are more easily met by farms with high animal numbers (Davis et al., Bennett and Osburn). Because no immediate payoffs occur to offset upfront compliance costs, large farms are better positioned to spread these costs over a greater number of production animals. When these requirements are applied to all sizes of farms, the relative cost of compliance is much greater for small farms than for large farms. Therefore, if technological benefits and the costs of compliance favor larger farms, we would anticipate a movement toward larger farms.

Despite the evidence of differences in compliance costs for large and small animal operations, there has yet to be any *empirical* evidence that these cost differences have, in fact, been a significant cause of farm size changes. Empirical evidence exists that economies of scale and size in production are factors which are contributing to changes in farm size. However, no one to date has attempted to separate out, empirically, the relative importance of the myriad of factors contributing to the observed transition to larger farms.

Vertical Coordination

The movement toward larger farms with higher animal densities has been combined with changes in the type of coordinating mechanism used by input suppliers, farmers and packer/processors. A growing body of literature exists, both empirical and theoretical, as to why certain forms of vertical coordination occur. Within this literature, there is a general consensus that several key factors are involved in the movement from spot markets to more tightly-coordinated forms of vertical coordination such as production contracts and large-scale ownership integration.[1] These factors include reduced transaction costs, increased responsiveness to consumer demand, improved quality control (e.g., food safety, consistency, and uniformity), risk shifting and risk reduction, and production efficiencies from specialization. In addition, for many young farmers, pork production contracts have been viewed as a means to get started in farming and obtain easier access to capital (Rhodes and Grimes). It is not unheard of for lenders to offer 100% financing to pork producers who hold only a hog finishing contract as collateral.

Recognizing that there is a trend toward more tightly-vertically coordinated animal agriculture systems, what then is the relationship between environmental regulations and vertical coordination? First, as the use of production contracts increases, concerns arise over the fact that contractors control feed and animals, but manure handling costs are borne by contract growers. However, as evidenced by the actions of one major North Carolina contractor who reportedly pulled hogs from a contract grower's facilities overnight after the grower was cited for not being in compliance with environmental regulations, contractors are highly motivated to meet and in some instances exceed environmental regulations (Martin and Zering). Conversely, contractors are less motivated to include feed additives, such as phytase which has the potential to reduce the amount of phosphorus excreted by broilers and swine, when such additives increase feed cost to the contractor.

Proposed federal legislation aims to make animal owners, regardless of whether or not these individuals are physically involved with day-to-day animal care and husbandry, responsible for manure management. An unanticipated but potential implication of such legislation may be a movement toward large-scale ownership integration. Contractors would reduce environmental risks by acquiring more land and directly controlling land application. Consequently, by increasing the level of integration, contractors internalize environmental risk rather than leave them in the hands of contract growers who may not comply or would require significant monitoring.

Second, an alternative viewpoint suggests that environmental regulations may impact the movement toward production contracts rather than large-scale ownership integration as a form

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[1]While recognizing that there are many forms of vertical coordination along the spectrum (e.g., cooperatives, alliances, marketing contracts), for purposes of this discussion, we choose to focus on the movement towards production contracts and large-scale ownership integration.

of vertical coordination. Gillespie, Karantininis and Storey found that environmental mandates affecting the Quebec hog industry encouraged integrators to discontinue expansion by ownership integration and to return to production contracting. The impetus for this was the requirement that producers own enough land on which to spread manure at acceptable rates. Without the ability to contract with producers, particularly at the finishing phase where the greatest volume of swine manure is generated, integrators would be required to own the land, thereby increasing their capital investment.

A final issue governing the relationship between environmental regulations and vertical coordination is the movement toward more specialized livestock and poultry farms. As farms have moved away from their traditional base as diversified animal-feed operations and toward more specialized livestock and poultry farms, environmental concerns arise due to the increase in animal density without a coinciding increase in the availability of cropland for manure application. Increased specialization is particularly apparent in the broiler chicken industry where production contracts are the dominant form of vertical coordination accounting for roughly 90% of production. In the pork industry, where production contracts account for approximately 25% of total hog inventory, contracting accentuates the limited land base under a farmer's control. Because feed is not provided by the contract grower, the contract grower does not necessarily own or control the acreage necessary to apply increasing volumes of manure nutrients. However, here regional differences are quite acute. Whereas contract hog farms in North Carolina tend to be less than 100 acres with high animal-to-land ratios, a recent survey of pork producers in Michigan showed that over two-thirds of the responding contract growers were also significant cash crop farmers (Martin). Similarly, growth in contract pork production in the Oklahoma and Texas Panhandles has been facilitated by the large land base available to balance manure nutrients with crop utilization.

In general, we conclude that there is conflicting evidence as to what role environmental regulations have played in the form of vertical coordination. Certainly, there is a movement away from spot markets to a more tightly-coordinated industry structure. However, a myriad of factors, including transactions costs, risk, consumer demands, and reduced production costs resulting from specialization, has facilitated the transition.

Before moving to issues of location, the role of state-level anticorporate farming laws and their impact on structure merits discussion. At least nine Midwestern states prohibit corporations from owning farmland or farm operations.[2] Krause argues that the intent of anticorporate legislation is to "exclude large outside agribusinesses and conglomerates from direct production and from controlling farm production (Krause, as reported in Knoeber)." Knoeber

[2]Exceptions and exemptions to the bans are found in most state laws. For instance, most states allow family farm corporations or limited liability corporations. Some allow certain types of corporations to engage in farming activities, but place restrictions on the number of shareholders and/or the residencies of the shareholders. In addition, others permit authorized farm corporations.

suggests that corporations are singled out because of their size, rather than the particular form of business organization. However, by limiting the organizational structure of farming and therefore the form of vertical coordination, these states make social and economic choices to limit the choice of coordinating mechanisms available to farmers and the livestock and poultry subsectors. By doing so, producers are constrained to operate in a different business environment relative to their counterparts in other states. Of the nine states with explicit anticorporate farming laws, only three, Minnesota, Oklahoma, and Missouri, have experienced a growth in total hog inventories over the last 10 years. Smith and Kuch raise the question of whether environmental regulation "may be used as an additional barrier against entry of industrialized operations [p.1246]." Certainly, the existence of anticorporate farming laws is likely as important as, if not more important than, environmental regulation in affecting locational changes in an industry becoming more tightly coordinated.

Location

Have environmental regulations influenced changes in location, either between or within regions, of animal production? Consider first changes in location between regions. That industries move to areas which offer a lax environmental regulatory environment is a common conjecture. In a recent survey article, Jaffe et al. examined the "widespread belief that environmental regulations have a significant effect on the siting of new plants in the United States [p. 148]."[3] Their review of the research evidence indicated that such concerns "may not be well-founded [p.148]." Anecdotal evidence suggests that such concerns also may not be well-founded in agriculture. In her review of changes in the dairy industry, Purvis explains:

> "Texas dairy producers resent the sweeping generalization that they fled California's stringent environmental laws, seeking a more laissez-faire situation in the Texas of the early 1980s. They moved to Texas seeking inexpensive land, low-cost feedstuffs, and proximity both to a dairy service infrastructure (such as veterinarians and nutritionists) and to urban amenities (the Dallas-Fort Worth metroplex) [p.24]."

Other evidence exists to suggest that regional changes in the location of animal production do not correlate with the existence of lax environmental regulations. Using indicators of states' commitment to and institutional capability for environmental protection programs, Lester classified states according to their likelihood to implement environmental regulations. According to his classification, the environmentally progressive states (CA, FL, MD, MA, MI, NJ, NY, OR, WA, and WI) are those judged to have both a strong commitment to and the institutional capability for environmental protection. The "strugglers" (CN, DE, HI, ID, IA, ME, MN, MT, NC, ND, NH, NV, RI and VT) are states that have the commitment, but lack

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[3]Jaffe et al. reviewed research addressing manufacturing firms rather than natural resource-based industries (such as agriculture) because 1) "that's where the research is [p.136]" and 2) because of their wish to examine the issue of "flight" of industries in the manufacturing sector from the U.S. to other countries.

institutional capability and/or resources. The "delayers" (AL, AK, AR, GA, IL, LA, MO, OH, OK, PA, SC, TN, TX, VA and WV) are those states that have the institutional capabilities for but a weak commitment to environmental protection and are therefore likely to maintain the status quo. The environmentally regressive states (AZ, KY, KS, MS, NE, NM, SD, UT and WY) have neither the commitment nor the institutional capabilities to pursue environmental protection (Lester).

In Figure 1, each state's classification is overlaid with statistics indicating the change in the state's relative rank in pork production. Figure 1 illustrates that both increases and decreases in relative ranks have occurred in states with similar environmental classifications. Although this does not rule out the possibility of environmental regulations impacting changes in the location of animal agriculture, it does suggest that there are other forces, such as clustering and agglomeration economies, driving the shifts.[4]

Clustering in animal agriculture arises from production facilities locating in close proximity to one another within a given region (Pagano and Abdalla). Clustering is a cumulative phenomenon. The establishment of a processing facility, for example, draws increasing numbers of producers. Once sited, producers tend to adopt production and manure management technologies to achieve improvements in economies of size, adding animals to generate revenue to pay for such technological improvements. In addition, new entrants are attracted by the positive economic dynamics of a well-established cluster and its allied agribusinesses, and greater production volume from existing production facilities and new entrants triggers expansion in processing capacity (Norris and Thurow).

The development of a cluster of beef feedlots in the High Plains during the 1970s and 1980s has been attributed to proximity to feed-grain supplies and large slaughter plants, a favorable climate, readily available supplies of feeder cattle, and proximity to southern and western markets for processed beef (Dietrich et al.). Construction of feed mills and poultry processing facilities in eastern Oklahoma resulted in a significant regional growth in broiler production. Growth in eastern North Carolina's hog industry, spurred by investments on the part of three major integrators, in turn led to the construction of a packing facility in neighboring Bladen County, thereby strengthening the incentives to further increase production in that region.

It is the clustering phenomenon that has, more often than not, triggered changes in environmental regulations. States which have recently passed laws focusing on manure management are responding to significant growth in animal numbers and clustering and to resulting concerns about animal densities, nutrient balances, and water and air quality. However, regulations requiring stringent manure management are less likely to affect where livestock operations are sited than how they are managed. Instead, it appears that local land

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[4]Regional shifts of similar magnitude have been observed in the cattle feeding, broiler and dairy industries.

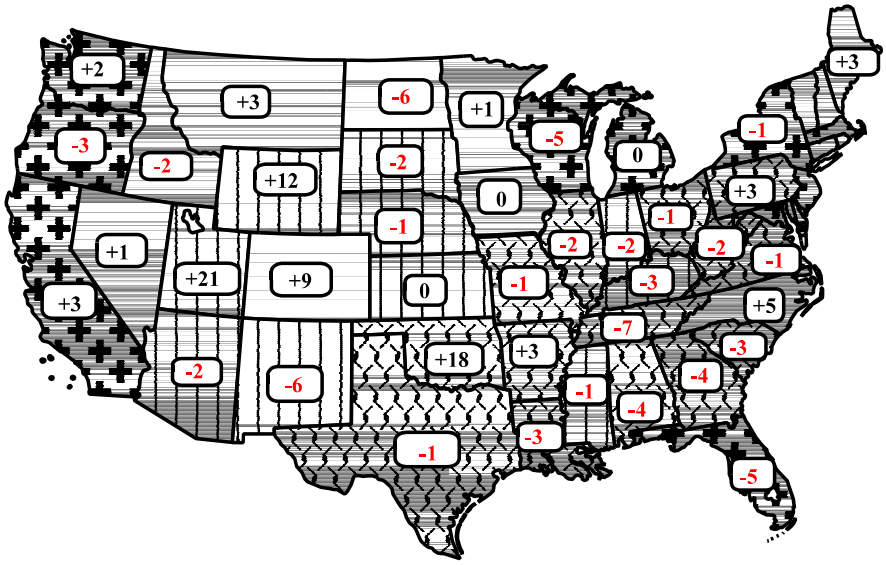
use policy is playing a significant role in livestock siting decisions. Localities in Minnesota and Michigan are using zoning authority to guide, and often limit, the siting of new and/or expanding livestock operations. While evidence about the rationality of zoning decisions is mixed, it appears that local zoning boards are attempting to consider not only environmental concerns (e.g., prevention of water quality problems) but also social and quality of life concerns (proximity of operations to public facilities, residential areas, etc.).

Conclusions

We believe it is an oversimplification to state that environmental regulations have significantly impacted the structure of animal agriculture. Moreover, we suggest that changes in farm size, form of vertical coordination and location of animal agriculture are, themselves, the cause of changes in environmental regulations. The driving force behind these changes is a myriad of economic, social and environmental factors.

Technological change has been the greatest driving force in changing farm size, but the impact of this change is intertwined with a host of influences. Production contracts and large-scale ownership integration have changed the face of American agriculture by impacting the economic and social status quo. As animal industries continue to evolve, public policies, including environmental regulations, will have the potential to impact industry structure. The cost of environmental compliance has the potential to impact farm size, coordination mechanism and location of animal agriculture. However, as more states institute manure management standards, expect climatic and geologic factors to be more important influences on structure than environmental regulations per se. Climatic and geographic factors, which vary widely, make it much less costly to comply with environmental regulations in some regions than in others, so state and federal standards for manure management may cause larger shifts between regions. Local land use policies will likely affect location in terms of how they address the clustering phenomenon. In short, empirical research is needed to determine the magnitude and direction of impact of these contemporaneous economic, social, and environmental forces on the changing structure of animal agriculture.

Figure 1. States' Likelihood to Pursue Environmental Protection and States' Change in Relative Rank



Lester's (1994) classification of states' likelihood to implement stringent environmental regulations:

= environmentally progressive states
= "strugglers"
= "delayers"
= environmentally regressive states

Number indicates the change in the state's relative rank between 1985 and 1997, based on December 1 Hog Inventory, USDA.

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