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Does the Nebraska Livestock Friendly County Program Affect Livestock Expansion in the State?

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DOES THE NEBRASKA LIVESTOCK FRIENDLY COUNTY PROGRAM AFFECT LIVESTOCK EXPANSION IN THE STATE?

by

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Livestock production in Nebraska is a very essential part of the state's economy with cash receipts from all livestock and products valued at $11.9 billion in 2013 (NDA 2015b). The Livestock Friendly County Program (LFCP) was instituted by the Nebraska Legislature in 2003 to further promote livestock development in the state. This thesis examines whether the program has had its intended impact for both cattle and hog farms. The analysis draws on the theory of long-run competitive equilibrium as a guide for the specification of the cattle and hog models. Three alternative specifications of the models using different sets of control variables are used as a test for the robustness of the effect of LFCP.

Results show that while LFCP was robustly statistically significant and positively associated with cattle farm numbers across the three specifications of the model, it was robustly positively associated with hog farm numbers but statistically insignificant. This may be due to counties having more stringent regulations for hog farms despite the livestock friendly designation.

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CHAPTER 1: INTRODUCTION

1.1 Statement of the Problem

Livestock is an essential part of the economy in Nebraska. The Nebraska Department of Agriculture (NDA) reported Nebraska as first in the nation in 2013 in beef and veal exports, valued at $946 million. According to the NDA, every dollar spent on agricultural exports generates $1.22 in economic activity, which equates to beef and veal exports generating over $1.1 billion for Nebraska. In 2014, the state was first in commercial red meat production, commercial cattle slaughter, and cattle on feed. In terms of hog production, it ranked sixth in the number of all hogs and pigs on farms with 3.1 million head in 2014. It also ranked seventh in commercial hog slaughter with over 7.1 million head slaughtered in that same year. Cash receipts from all livestock and products were valued at $11.9 billion in 2013. This is over half of the total cash receipts for agriculture in that year (NDA 2015b).

A significant amount of the workforce is tied to farming and ranching. Livestock processing is the largest employment class in the entire state (NDA 2015b). Continued growth of this industry is considered essential to maintain the prosperity of Nebraskans, particularly those in more rural areas. Moreover, given that the average age of principal farm operators in Nebraska is 55.7 (USDA 2012), continued growth would also require bringing in younger and newer livestock producers.

To that end, the NDA developed the Nebraska Livestock Friendly County Program (LFCP). Introduced in 2003, the LFCP was designed to allow counties to voluntarily join and, when approved, assist them in promoting livestock development

(NDA 2015a). LFCP is a way for counties to signal to livestock producers that they are willing to continue developing the livestock industry. In the words of Greg Ibach, Director of the Nebraska Department of Agriculture, “a big part of the [LFCP] program is to show that Nebraska is putting out the welcome mat for livestock” (Nebraska Farmer 2014).

NDA evaluates a county’s zoning requirements relative to the NDA’s LFCP county zoning guidelines. These county zoning regulations are used to establish setback guidelines for how far away a livestock facility can be from water sources, a neighbor’s residence, or a nearby town. The NDA’s setback guidelines are can be seen in Figure 2.1. By reducing county zoning setback requirements, livestock producers starting an operation should theoretically have an easier time obtaining a county zoning permit. As Figure 2.2 shows the NDA also showcases on its website the 29 counties that have so far received this designation (NDA 2015a).

As the program is in its second decade, an important question, which this thesis addresses, is whether or not the program has achieved its intended effect. The question is not only of academic interest but also of its practical policy relevance. If, for example, the program is not achieving its intended objective, the state may have to devise alternative policy instruments to promote livestock growth within its boundaries.

While research studies of the impact of LFCP per se are, to the author’s knowledge, nonexistent; the topic fits within the larger body of academic literature that examines the effect of demand and cost conditions on business location. As discussed in the literature review section, such conditions include taxation (e.g., Goetz 1997; Helms

1985; Wasylenko 1997), environmental regulation (e.g Gray 1997; Bartik 1989; Azzam et al. 2014), and antitrust enforcement (Feinberg, 2014). In a way, LFCP is a form of environmental regulation intended to incentivize firms to locate in the state.

1.2 Objectives

The objective of this thesis is to examine the impact of the Livestock Friendly County program on livestock expansion in the state. For methodology, this research draws on the theory of long-run competitive equilibrium, similar to Azzam et al. (2014) to specify an empirical model that considers among other factors, the impact of the LFCP on the number of livestock farms in Nebraska. County level data from the USDA National Agricultural Statistics Service, the US Census Bureau, and the US Bureau of Economic Analysis are used in the analysis.

1.3 Organization of the Study

Chapter 2 describes the Livestock Friendly County Program. Chapter 3 reviews the relevant literature. Chapter 4 presents the econometric model, data, and estimation results. Chapter 5 provides a summary and conclusions.

CHAPTER 2: THE LIVESTOCK FRIENDLY COUNTY PROGRAM

The LFCP was initiated in 2003 by the Nebraska Legislature and is administered through the NDA. The goal of the program is to help counties promote the livestock industry. Counties voluntarily apply to be admitted into the program. Each application is evaluated by the NDA to determine if the county is taking measures to support livestock development. One of the main ways the NDA evaluates a county is based upon the counties zoning laws pertaining to livestock. These zoning laws set regulations for how far a livestock facility can be from water ways, lakes, neighboring residences, and towns. The NDA's setback guidelines for acceptance in to the program can be seen in Figure 2.1. The Nebraska Department of Environmental Quality (NDEQ) also has a set of

```
 1,000 animal units - 0.25  mile
 5,000 animal units - 0.375 mile
10,000 animal units - 0.50  mile
20,000 animal units - 0.75  mile
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Figure 2.1: NDA Setback Guidelines For LFCP

livestock waste control regulations that a facility must first meet. Unlike county zoning the NDEQ regulations do not pertain to how far a facility must be from a town, only how far it must be from public drinking water sources (NDEQ 2015). If the county zoning regulations are overly strict, the county may be required to relax them in order to receive livestock friendly designation. With relaxed county zoning laws, it would theoretically mean that a livestock facility should have an easier time obtaining a zoning permit to operate. Once in the program the NDA will periodically review the counties to make sure that they are continuing to positively influence livestock expansion.

In the inaugural year of the program, none of the counties signed up. It was not until 2005 that a county finally entered the program. The following years, 2006 and

2007, 2 counties and 5 counties signed up, respectively. Seven counties signed up in 2012, which is the most of any year in the program's history. A full breakdown of the dates when each county signed up can be found in Appendix A. Currently there are 29 counties that are a part of the program. As can be seen in Figure 2.2 below, they are spread all over Nebraska. In the time period that this study evaluates, 1997-2012, there were 21 counties that had joined the program. The number of livestock operations within the participating counties also varies widely. Cuming County, which has the most cattle on feed in the state, is in the program. The county was also first in total number of hog farms in 2012. In contrast, Grant and Kimball County, which as of 2012 have no cattle on feed, are also in the program. Grant County does not have any hog farms, and Kimball only has ten hog farms which contain a total of 101 head (USDA 2012b).

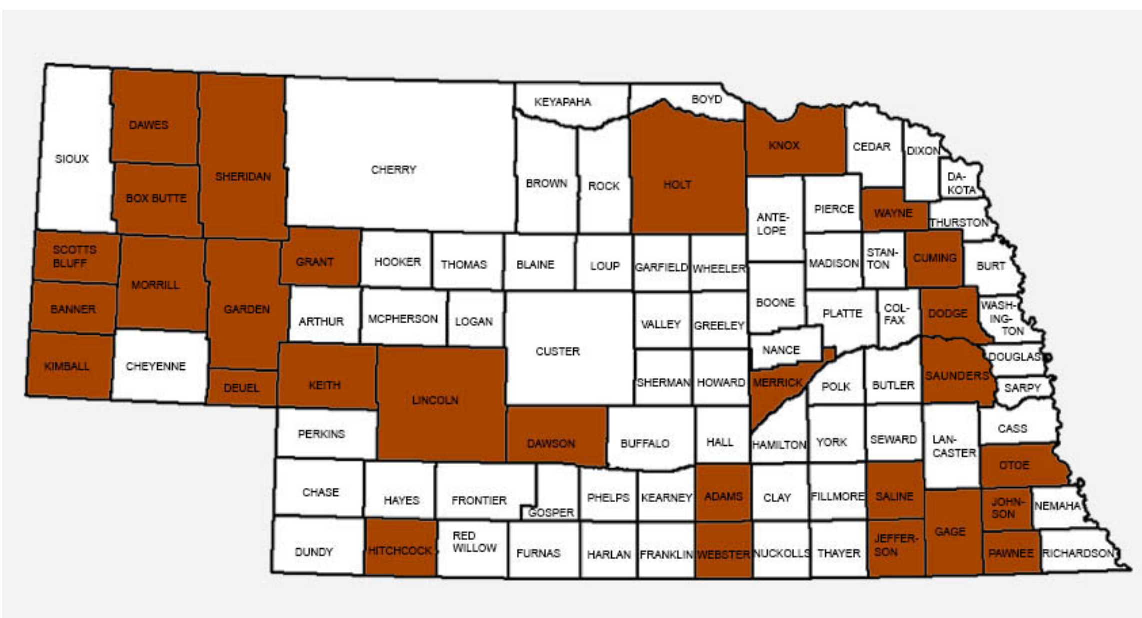

Figure 2.2: NDA Livestock Friendly Counties Map

Until 2015 there was no financial incentive for counties to sign up for the program. In 2015, the Nebraska Unicameral provided financial assistance for roads and bridges in designated livestock friendly counties (Aiken 2015). Prior to this, the incentive came in the form of free advertising and promotion from the NDA. The NDA states that while department staff are out on trade missions and trade promotions they will also be promoting the counties in the LFCP (NDA 2015a). This promotion is to let livestock producers know which counties are supportive of the livestock industry. The goal of this is to encourage producers to set up livestock facilities in those respective counties which, would in turn, stimulate economic growth.

CHAPTER 3: REVIEW OF LITERATURE

The literature pertinent to this thesis is the literature that examines the effect of demand and cost conditions on business locations across states in the United States. Since the LFCP is different than many of the policies that are evaluated in the literature, it is important to look at an array of policies. By examining these different policies it allows for a better understanding of how they affect business location decisions, and thus how a program such as LFCP may affect location as well. As shown by Feinberg (2014), different studies emphasize different conditions. These conditions include: (1) the effect of state taxes on business location (e.g., Wasylenko 1997; Helms 1985; Bartik 1989), (2) the effect of general business climate on business entry, these include studies on the impact of environmental regulation and anti-corporate laws (e.g., Bartik 1988; Gray 1997; Schroeter et al. 2006; Azzam et al. 2014), and (3) the effect of state antitrust enforcement (Feinberg 2014). These different conditions will be outlined by a selection of papers for each. The papers selected have some attributes that this study uses to help direct the empirical model to be specified and estimated in the next chapter.

The first condition revolves around the effect of taxes on business location. Reducing taxes is one of the main ways used to influence firm decisions to choose a location. This is similar to the goal of LFCP in that the reduction in zoning regulations will lead to an increase in firm numbers. With regards to taxes, Wasylenko (1997) reviewed the literature on the effect of state taxes on business location. The most common dependent variables authors use in modeling are income, employment, investment, plant expansions, relocations, and births. These variables are used because they constitute different ways of expressing economic growth. The independent variables used are labor, energy, capital costs, taxes, public expenditure, and agglomeration economies. The studies also include demographic and labor characteristics, such as market size, population, rate of unionization, and right-to-work laws as variables. They are similar to the variables used in the models of the papers that will be discussed in this chapter. They also coincide with other studies that reviewed the literature such as in Arauzo-Carod et al. (2010).

Wasylenko concluded that state taxes have very little impact on the location decision of firms. However, he discovered that when there is a large difference between the average tax levels of economic-rival states; the taxes can have a large impact on location, employment, or investment. Even though Wasylenko was only evaluating taxes at the state level, the reasoning would apply at the county level, as is the case of the LFCP.

In another study on taxes, Helms (1985) used a time series-cross sectional approach to evaluate how state and local taxes affect economic growth. In the model, Helms used state personal income as the dependent variable. For the explanatory variables Helms separated them in to three categories: (1) taxes and other revenue, (2) public expenditures, and (3) demographic and labor characteristics. The taxes and other revenue included property taxes, other state and local taxes, and user fees. These were expressed as a percentage of state personal income. Helms aimed to show that it was important to not only look at how revenue was collected but also how that revenue was spent. That was why the second category of public expenditures was included. This encompassed money spent on highways, public health, education, transfer payments, and other expenditures. The last category included relative wage, unionization rate, and population density. What the research concluded was that if the revenue generated is spent on transfer payments economic growth will be significantly decreased. But when the revenue is used for public services that benefit business related activities, the benefits gained would outweigh the negatives.

Bartik (1989) found similar results in the research of small business entry. However Bartik's model differed from that of Helms as it used both a cross section approach and a panel data analysis. In Bartik's model, small business starts were used as the dependent variable. Bartik's model used a large number of independent variables that were listed in seven different categories; market demand vs supply variables, factor price variables, tax variables, public service variables, financial market variables, demographic variables, and other variables. Similar to Helms, property tax was used as a variable. Bartik also included corporate tax, personal tax, sales tax, sales tax differential for machinery, and small business tax relief. The study included public spending variables. These were public school and higher education spending, as well as police and fire protection spending. Highway density and welfare spending were also included. The rationale for including these variables was the same as Helms, in that Bartik was to show that firm location was impacted by how the money generated from taxes was spent. Other variables included were banking variables; market supply vs demand variables, demographics, and other variables such as unionization and environmental regulations.

Bartik found that the panel data analysis results were more economically sound than those of the cross section approach. Bartik's results were that tax cuts have a small but positive effect on location decisions. However, when the tax cuts led to a reduction in public services that help business related activities there was a reduction in the number of small firms entering the market. Improving roads is a good example of these public services. In Goetz (1987), the author had the same result. In that paper the conclusion was that, for the long term, rural counties that want to attract fruits and vegetables, confectionary products, or fats and oils processors should invest in the transportation infrastructure. While this is not pertinent to this study, future studies of the LFCP would be able to take this in to account since counties in the program will now receive funding for roads.

With regards to the literature on general business climate and its effect on business location, one focus is on environmental regulation. Environmental regulation is important to our study because LFCP is a relaxing of zoning regulations. These zoning regulations have restrictions on how far a facility must be from water. The LFCP can be looked at as a reduction of environmental regulation. Gray (1997) examined the effect of state level pollution regulation on firm births. Gray used Poisson and conditional logit models as well as a linear regression model in the study. Determining the model of choice is dependent upon whether or not a variable changes in all areas in the study or just one. As Gray explains it, if environmental regulation becomes stricter in all areas the Poisson model is a better fit. This is because it would account for this change and all states would have less new firms, whereas in the conditional logit model there would be no effect. Bartik (1988) and Stafford (2000) also used the conditional logit model in their papers.

Gray used data from the Census Bureau to determine firm birth rates at five year intervals. He then divided this number by the number of existing plants for each state to account for differences in scale. Similar to the previous papers discussed, Gray controlled for taxes, factor prices, and labor characteristics. He included state-level environmental regulation variables that include state regulatory spending and business pollution abatement spending. Those industries that had abatement costs that were greater than 3% of total shipment were considered as high pollution industries. Other variables included were on political support. This would be membership in conservation programs, congressional voting records, and an index of state laws.

Gray concluded that states with stricter regulations tended to have a lower number of new firms. These results are the same as Stafford's (2000), who was evaluating the effects of environmental regulation on location decisions of hazardous waste facilities. However, in contrast to both of these papers, Bartik (1988) showed that state level environmental policies had only a small and in some cases a statistically insignificant impact on location. The studies in environmental regulation are not unanimous on what the actual impacts environmental regulation has on firms.

Azzam et al. (2014) examined the effect of environmental regulations on the structure of the hog industry using a long run competitive equilibrium model that determines output and the number of firms simultaneously. The industry is divided into two categories: small hog farms (<2000 head) and large hog farms (> 2000 head). In addition to a measure of environmental stringency, Azzam et al. (2014) considered the price of corn, the price of hogs, the price of transportation, and the percentage of small and large hog farms on contracts. Results showed that environmental regulation decreased the number of large farm operations.

Another focus of business climate literature is anti-corporate laws. Schroeter et al. (2006) examined the effect of Nebraska's anti-corporate law on cattle feeding. Nebraska's law, Initiative 300, put restrictions on corporations' ability to operate within the state. The aim of the study was to determine how the law had changed the distribution of the feedlot industry shares of annual marketings between the seven size categories. Those seven size categories included: (1) <1K, (2) 1-2K, (3) 2-4K, (4) 4-8K, (5) 8-16K, (6) 16-32K, and (7) >32K. For methodology, Schroeter et al. (2006) estimated time-varying transition probabilities of a Markovian model that describes the transition of farms from one size category to another in states with and without anti-corporate laws. The time transition parameters were allowed to vary with profitability of cattle feeding, proxied by the cattle/corn price ratio. Results of this study showed that Initiative 300 had no significant impact on the dynamics of the cattle feeding industry. However, the authors did note that the cattle feeding industry in Nebraska is unique in that it has a larger percentage of smaller feeding operations than those of other large cattle feeding states.

The third focus of the literature on business location is antitrust enforcement. Feinberg (2014) researched the effect of state antitrust on small firm entry. He evaluated the different firm sizes with three different statistical specifications which were: Tobit regression with fixed state effects and then with random effects, and a seemingly-unrelated regression. He evaluated the entry rate of small firms in the manufacturing, wholesale, and retail industries with three employment sizes. Similar to previous studies, he used unionization and population as explanatory variables. He also included variables of gross state product per capita and unemployment. Feinberg also accounted for whether states had a Republican governor and a Republican Attorney General. To represent anti-trust enforcement, the author used antitrust cases per gross state product, horizontal antitrust cases per gross state product, and non-horizontal antitrust cases per gross state product. He also used the four year average of these variables. The study showed that small retail and wholesale firms have a small but positive response to state antitrust enforcement. Those firms that were larger had the opposite response.

While much of the literature deals with industries outside of agriculture, their respective frameworks are still useful insofar as identifying variables useful in studying firm entry and exit. The LFCP is different than any of the policies examined in the literature. But, the goal of it is still to influence firm location decisions. Thus, when data permits, this study will incorporate some of the ideas from the literature when evaluating the impact of LFCP on livestock farms in the next chapter.

CHAPTER 4: ECONOMETRIC MODEL, DATA, AND RESULTS

4.1 Econometric Model and Data

The underlying theory that guides the specification of the econometric model in this thesis is the theory of long-run perfectly competitive equilibrium. The two cornerstones of the theory are perfect competition, meaning that firms (cattle producers and hog producers, in this case) are all price takers and as such no individual producer can affect the price they receive for their output or the price they pay for their inputs; and free entry and exit thereby driving economic profits to zero in the long run. The mechanism can be illustrated as follows. Imagine that firms are initially in equilibrium, and the industry to which they belong is a constant-cost industry, i.e., the prices of inputs the firms use for production do not rise as the industry expands. For a given supply, a shift in demand for industry output increases the price of the product, creating short-run profits. As seen in Figure 4.1, this would be a shift from D1 to D2 which would increase prices from $14 to $18. Short-run profits attract new firms to enter the industry. As more firms enter, industry supply increases causing output price to decline to the point where economic profits are again zero. In Figure 4.1 this would be the shift of supply from S1 to S2. Price would now be back at the original price level before the shift in demand. The new equilibrium in the market will now constitute a different number of firms and with different levels of output. When introducing an added cost such as environmental regulation, the marginal and average cost of every producer also increases, resulting in lesser short-run profits. This would mean that fewer new firms would enter the market when there is a shift in demand. The LFCP is a reduction of the environmental regulations. This means that the marginal and average cost of producers would be reduced compared to those not in the LFCP. This would mean that short-run profits would be greater than if there was no LFCP. Therefore, when comparing to a

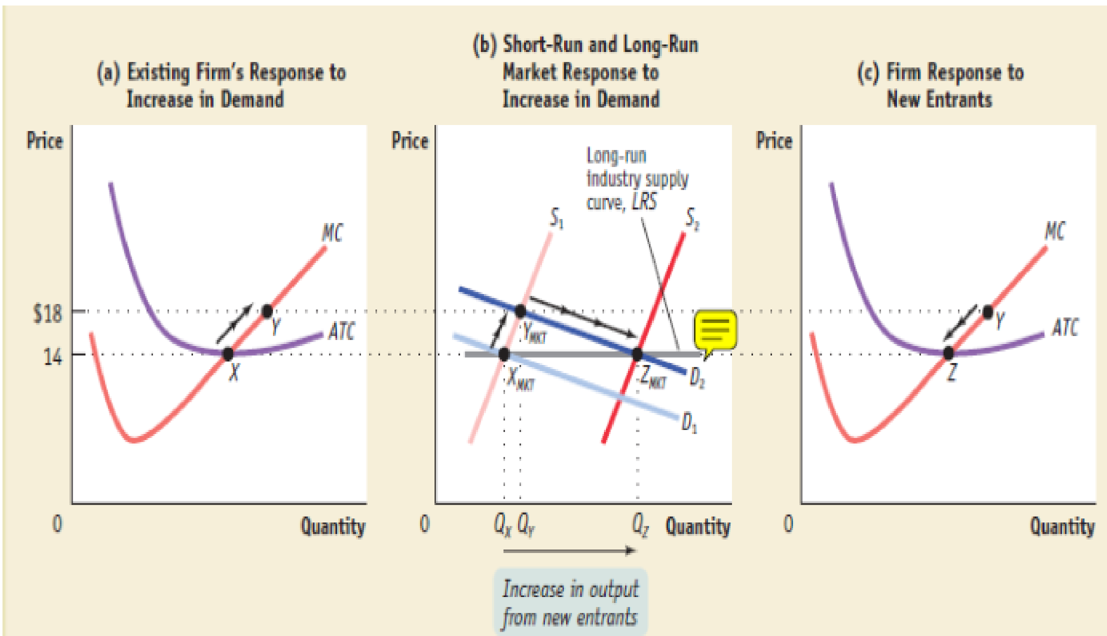

Figure 4.1: The Long-Run And Short-Run Effects Of A Shift In Demand from Krugman and Wells (2012)

situation where there is no LFCP, a higher number of firms should theoretically enter the market when there is a shift in demand. According to Azzam et al. (2014), what happens to the equilibrium number of firms and volume of output in the long-run hinges on how regulation affects marginal cost relative to average cost.

To be consistent with theory, the empirical model for studying the impact of LFCP on firm entry should have cattle and hog farm numbers as dependent variables. The independent variables should include supply and demand shifters for livestock, and other control variables in addition to a variable that indicates which counties have the livestock friendly designation and which do not. The null hypothesis is that, after accounting for other factors affecting livestock farm numbers, there is no difference between the equilibrium number of farms in counties with and without livestock friendly designation.

Specifically, the econometric model to be estimated for cattle farms is:

Equation 1: NCAT = f(LFD, LNCAT, YLFD, LFDN, ETH, ETHN, CPLANT, CPLANTN, PCATD, PCORND, POPD, CATDENS, LCSHARE, INCD, CRD1-CRD7, INTER1-INTER7),

and the econometric model to be estimated for hog farms is:

Equation 2: NHOG = g(LFD, LHNOG, YLFD, LFDN, ETH, ETHN, HPLANT, HPLANTN, PHOGD, PCORND, POPD, CATDENS, LCSHARE, INCD, CRD1-CRD7, INTER1-INTER7).

In what follows, each variable is defined, followed by an explanation of how it is measured, why it is included in the model, and, in parentheses, the data source from which the variable was obtained.

NCAT = *Number of cattle farms in a county for each census*. While it may be argued that LFCP only affects feedlots, it is reasonable to assume that joining the program affects the perception of that county to all producers. So even smaller producers perceive the county as livestock friendly and therefore see it as more accepting of any livestock development. (Sources: USDA 2012b; USDA 2002).

NHOG = *Number of hog farms in a county for each census*. (Sources: USDA 2012b; USDA 2002).

LFD = *Dummy variable for LFCP*. The variable is assigned a value of 1 if a county has livestock friendly designation and zero otherwise. It also takes in to account the when a county joined the LFCP. Those counties that were designated in 2007 were included in the time period from 2002-2007. This would mean that being designated in 2007 still had an impact on 2007 cattle farm numbers. The reasoning for including this is that counties would have had to make adjustments to their regulations before being designated. So they were already acting as a livestock friendly county before they were officially designated. This same reasoning is used for including counties that were designated in 2012 in the 2008-2012 time period. Since stringent environmental regulation is known to raise (private) costs, possibly making firm entry into the industry more difficult, one should expect LFD to affect cattle numbers and hog numbers positively. (Source: NDA 2015a).

LNCAT = *NCAT from the previous census*. Following Gray (1997), this variable controls for differences in scale across counties and assumes the number of farms during the current census is proportional to farms in the previous census. The coefficient of the variable is expected to be positive and less than 1.

LNHOG =*NHOG from the previous census*. The rationale for including this variable is the same used for including NCAT. The Coefficient of this variable is also expected to be positive and less than 1.

YLFD = *Number of years that a county has been in LFCP*. This is included to determine if being in the program longer had increased effect on livestock development. The dates for when each county joined the program are in Appendix A. The coefficient of this variable is expected to be positive as being in the program longer may allow the program to take full effect.

LFDN = *Dummy variable for presence (absence) of neighboring county in LFCP*. The variable is equal to 1 if a neighboring county has livestock friendly designation and zero otherwise. The reason for including this variable was to determine if having a neighboring county in the LFCP could impact livestock expansion. Wasylenko (1997) found that when there was a large difference in the average tax rates between economic rival states there was a significant impact in firm location. Based on these studies the expected result is for the coefficient to be negative. This would be because new producers could decide to locate their facilities in a livestock friendly county in order to take advantage of lowered zoning regulations.

ETH = *Dummy variable for presence (absence) of ethanol plants*. Ethanol has had a large impact on livestock feeding practices with the increases in corn prices and the introduction of dried distiller's grains. To capture the effect of ethanol, ETH is set to 1 if a county has an ethanol plant and zero otherwise (Source: NEB 2015). The variable also includes when an ethanol plant was built. The effect of this variable on livestock farm numbers is ambiguous because while ethanol production may increase corn prices, it also provides a substitute in the form of distiller's grains, especially for cattle.

ETHN = *Dummy variable for presence (absence) of ethanol plants in neighboring counties.* Ethanol plants receive corn from producers from outside of their county and can sell distillers grains outside of their county as well. Therefore an ethanol plant has an impact on those outside of its respective county. Hence ETHN takes a value of 1 if a neighboring county has an ethanol plant and zero otherwise (Source: NEB 2015).

CPLANT = *Dummy variable for presence (absence) of a beef processing plants in a county.* It takes a value of 1 if a county contains a beef processing plant, and zero otherwise. The reason for including this variable is that having a beef processor close would allow producers to easily sell their cattle. As this may result in higher entry of cattle farms, the coefficient of this variable is expected to be positive. (Source: compiled by the author).

CPLANTN = *Dummy variable for presence (absence) of a beef processing plant in neighboring counties.* The variable takes the value of 1 if neighboring county has a beef processing plant and zero otherwise. Presence of a beef processing plant in neighboring counties, by giving more outlets for cattle, should have a positive impact on entry into cattle production. (Source: compiled by the author).

HPLANT = *Same as CPLANT but for hogs*. (Source: compiled by the author).

HPLANTN = *Same as CPLANTN but for hogs*. (Source: compiled by the author).

PCATD = *Average price of cattle per hundred pounds in Nebraska between two censuses*. The prices for 2011 and 2012 were not available through NASS. Therefore the prices from 2007-2010 were averaged. Driven by demand and supply for beef, the price of cattle is a major determinant of profitability in cattle production and, thereby, a driver of entry and exit of operations in the industry. The price of steers, heifers, and GE 500lbs was used as those prices seemed to be the most representative of an average producer. (Source: USDA 2015). The effect of the price of cattle on farm entry is expected to be positive.

PHOGD = *Average price of hogs per hundred pounds in Nebraska between censuses*. Similar to the price of cattle, hog prices for 2011 and 2012 are unavailable through NASS, therefore the prices from 2007-2010 were averaged. Also driven by supply and demand for pork, hog prices are major determinants of hog profitability and, hence, entry and exit of hog farms. Therefore, the coefficient on the hog price variable is also expected to be positive. (Source: USDA 2015).

PCORND = *Average price of corn per bushel in Nebraska between censuses.* Since corn is a major input in livestock production, the price of corn is also a major determinant of livestock profitability and, hence, supply of cattle. An increase in this price would decrease profitability. For this reason, it is expected that the coefficient of the price of corn will be negative (Source: USDA 2015).

POPD = *Average of population density between two censuses*. The expectation is that the higher the population density is in county the smaller the number of livestock farms. (Source: US BEA 2015).

CATDENS = *Cattle density (cattle numbers by land area)*. This variable was included to examine if higher cattle density affects cattle or hog farm numbers. The hypothesis is that a higher cattle density would mean that a county is highly livestock friendly.

LCSHARE = *Cattle numbers in a county as a percent of cattle numbers in the entire state during the previous census*. This variable shows the economic importance of cattle production to a county. The expectation is that this variable will be positive. Having cattle production have a substantial economic impact should increase farm numbers. This would be because the livestock industry is important to the economy of a county and they will continue to support and develop this industry. The variable was included in the hog model instead of a hog share variable due to undisclosed census data for hog numbers for several counties. (Sources: USDA 2012b; USDA 2002).

INCD = *Average per capita personal income for each county between censuses*. Higher per capita personal income could mean several things. It could mean that producers have more income, allowing them to build new facilities. It could also be the result of higher labor costs in a county. Counties with higher per capita personal income may also be resistant to new livestock farms being built. Consequently, the effect of the variable on livestock farm numbers is ambiguous. (Source: US BEA 2015).

CRD = *A dummy variable that corresponds to the crop reporting district the county is located in*. The eight CRDs are; Northwest, North, Northeast, Southwest, Central, East, South, Southeast (see the map in Appendix B). The CRD dummy variable assumes that heterogeneity between clusters of counties within a CRD is more important than heterogeneity of all the 93 counties in the states. (Source: Nebraska DED 2015).

INTER =*Interaction between LFD and CRD*. The hypothesis is that the impact of LFD on farm numbers is not independent from the CRD in which a county is located. The Southwest and Central CRDs did not have any LFD counties as of 2012.

All prices and income were deflated by the CPI with base year of 1997. All livestock and price data are average prices for the state of Nebraska. Prices at the county level are not available. Hence, the empirical model, to be discussed in the next section, accounts only for yearly variation in prices, not variation of prices across counties. In others words, all counties face the same prices during the same census years. Prices are taken to be exogenous to each county.

4.2 Estimation Results

4.2.1 Cattle Models Results

Since livestock friendly designation (LFD) is the key variable, the econometric models of cattle farm numbers and hog farm numbers described in section 4.1 were each estimated using three different versions or models to verify the robustness of the effect of the designation. The three models were estimated using a fixed effects model with correction for heteroscedasticity when the null hypothesis of homoscedasticity is rejected. Heteroscedasticity was only found in Model 3 of cattle farms. Due to the large number of counties, the heterogeneity of counties is captured by including dummy variables of CRDs instead of counties. The assumption is that, while the characteristics of the cluster of counties within a CRD are invariant within a CRD, the characteristics of CRDs vary across the state. A map of the CRDs can be found in Appendix B. The assumption ensures that the regression results are not drained of statistical power to test the effect of LFCP and the control variables because of too many dummy variables. There were 279 observations for cattle and 268 observations for hogs.

Model 1 for cattle includes all the variables discussed in section 4.1 in equation 1. A list of all the variables and their results can be found in Table 4.1. Results show that LFD is positive and highly significant, indicating that, all else equal, farm numbers in counties with livestock friendly designation are higher than those counties without the designation. The other statistically significant coefficients at a minimum of the 10% level are LNCAT, YLFD, PCATD, PCORND, LCSHARE, INCD INTER1, and INTER3. Those that were highly statistically significant at the 1% level are LNCAT, PCATD, PCORND, and INTER3. YLFD and LCSHARE were both statistically significant at the 5% level.

The result for LNCAT is consistent with expectation. The coefficient is both positive and less than 1. This means that current farm levels are highly dependent on past levels. LCSHARE also had a positive coefficient as expected. This implies that the economic importance of cattle to a county attracts new cattle farms. The effect of county income (INCD) is negative, thus counties with higher levels of income have a smaller number of cattle farms. Contrary to expectation, the coefficient for YLFD is negative, implying that being in the program longer has a negative effect on cattle farms. One possible explanation for this would be that those counties that joined early have other unexplained factors leading to the decrease in cattle numbers. These factors may have been one reason that led to the county joining the program. In looking at prices, PCATD was positive. This means that, all else equal, higher cattle prices have a positive impact on cattle farms. The outcome is what is expected as increases in cattle prices means increased livestock profitability. However, the coefficient of the price of corn (PCORND) had a sign that is counter to what was expected. The coefficient was positive indicating that an increase in price would lead to an increase in cattle farms. But increases in the corn price would decrease profitability which should discourage firm entry, all else equal. The reason for this unexpected result may be due to the introduction of dried distiller's grains (DDGS). It became a common substitute for corn in livestock production. Price of DDGS could not be incorporated in the model due to a high correlation with the price of corn. Lastly, the INTER1 and INTER3 variables both had negative coefficients. The ETH, ETHN, CPLANT, and CPLANTN variables were all found to be insignificant.

Model 2 drops the variables ETH, ETHN, CPLANT, and CPLANTN and, rather than considering the prices of cattle (PCATD) and corn (PCORND) separately, the prices are expressed as a ratio (PRATIOC). The variables ETH, ETHN, CPLANT, AND CPLANTN were dropped because they were all found to be statistically insignificant. A price ratio was used to correct for correlation between corn price and income. Again, the coefficient of LFD was positive and highly significant. The other statistically significant variables that are significant at the 1% level are LNCAT, PRATIOC, LCSHARE, INCD, and INTER3. Those that are significant at the 10% level are YLFD, CRD3, CRD5, INTER1, and INTER7. The result for LNCAT was again as expected: positive and less than one. The LCSHARE variable was also positive. The coefficient of the beef/corn price ratio is negative, contrary to expectation. When the ratio increases, one would expect profitability to increase and thus there would be an increase in farm numbers. The reason that the ratio is negative may also be due to the introduction of DDGS. When corn prices began to increase after the introduction of the Renewable Fuels Standard so did production of DDGS, which are used as a substitute to corn. The variable INCD had the opposite sign as that of Model 1 and was positive. This would mean that as income was increasing so were cattle farms. The change in the sign may be due to lesser correlation between income and prices when expressed as a ratio. Lastly there are the CRD and INTER variables. CRD3 and CRD5 were both positive. These would be the Northeast and Central CRDs. This coefficient tells us that counties in CRD3 and CRD5 had on average, holding all other variables constant, 15 and 17 more farms than CRD8. The INTER variables INTER1, INTER3, and INTER7 all had negative coefficients. That would mean that LFD counties in these areas have on average fewer cattle farms than those in INTER8.

Model 3 uses the same variables as Model 2 except that dummy variables for the census years are substituted for the price ratio. YR2 and YR3 correspond to years 2007 and 2012 with the base year being 2002. This was done because the prices that were used did not vary between counties. This meant that there is perfect correlation between census years and prices. Again, LFD is highly statistically significant and positive. The other variables in Model 3 that were statistically significant at the 1% level were LNCAT, YR2, YR3, INTER1, INTER3, and INTER7. YLFD was significant at the 5% level and LCSHARE and INCD were significant at the 10% level.

Since the coefficient of LFD is robustly positive and statistically significant at the 1% level across the three model specifications, it is safe to conclude that, after controlling for other factors that affect farms numbers, the effect of LFD is positive for cattle.

Table 4.1 Results: Cattle Farms As Dependent Variable

	Model 1		**Model 2**		**Model 3**	
	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
Intercept	-381.573***	53.557	13.627	21.023	72.402***	20.859
Livestock Friendly Designation	67.722***	19.373	86.047***	21.365	67.360***	7.323
Lag of Cattle Farms	0.868***	0.021***	0.822***	0.022	0.869***	0.025
Years in LFCP	-6.799**	2.703	-5.239*	2.996	-6.565**	2.968
Neighboring county in LFCP	-3.793	5.893	8.690	6.180	-3.959	5.985
Ethanol plant	0.852	6.114	-	-	-	-
Ethanol plant in neigh. county	-2.057	4.694	-	-	-	-
Beef proc. plant	-13.236	8.622	-	-	-	-
Beef proc. plant in neigh. county	2.271	5.223	-	-	-	-
Cattle Price	4.026***	0.712	-	-	-	-
Corn Price	64.234***	6.514	-	-	-	-
Cattle/corn price ratio	-	-	-1.613***	0.288	-	-
YR2	-	-	-	-	-70.878***	9.637
YR3	-	-	-	-	-60.844***	7.591
Pop. density	0.0184	0.0142	-0.012	0.014	0.009	0.011
Cattle density	0.011	0.046	-0.076	0.049	0.003	0.049
Lag of county share of total production	0.093**	0.044	0.140***	0.048	0.094*	0.057
Per capita income	-1.263*	0.667	1.904***	0.585	-1.207*	0.687
Northwest CRD1	-0.409	9.973	-10.903	10.842	-0.182	7.899
North CRD2	-2.758	8.996	2.783	9.759	-2.414	8.011
Northeast CRD3	6.135	8.174	15.206*	8.927	5.460	7.394
Southwest CRD4	-0.569	9.474	-14.428	10.213	-0.953	7.212
Central CRD5	8.880	9.759	17.625*	10.097	5.577	8.952
East CRD6	-1.055	8.028	3.169	8.341	-0.645	5.792
South CRD7	-8.879	9.596	-14.262	10.436	-8.225	6.681
INTER1	-39.611*	22.498	-48.131*	24.934	-40.269***	15.658
INTER2	-32.688	29.583	-38.568	32.837	-31.760	55.015
INTER3	-75.994***	27.282	-83.462***	30.198	-73.715***	16.549
INTER4	-30.172	25.23	-29.691	28.090	-30.412	21.853
INTER7	-40.555	26.288	-49.168*	29.153	-43.310***	15.59
Num. of Obsv.	279		279		279	
R-Square/Adj R-Sq	0.962	0.958	0.952	0.948	0.962	0.958
Chi-Square[1]	0.2412		0.5535		0.0172	

*Notes: *Statistically significant at 10%, **Statistically significant at 5%, ***Statistically significant at 1%*

[1] *Test statistic for heteroscedasticiy using the White test. Homoscedasticity was rejected in Model 3.*

4.2.2 Hog Models Results

Since LFD is also the key variable in the hog model, three models were used to test for the robustness of this variable. Model 1 uses all the variables mentioned in 4.1 in equation 2. In Model 1 LFD was found to be positive but not statistically significant. This means, all else equal, differences in hog farm numbers between counties cannot be explained by LFD. Variables that are statistically significant at the 1% level are LNHOG, PHOGD, CATDENS, CRD3, and CRD5. Those that are significant at the 5% level are PCORND, AND CRD2. The result for LNHOG is what was expected with a coefficient that was both positive and under 1. This implies that current hog farm numbers are closely associated with past levels. Prices for corn and hogs were both negative. The PHOGD coefficient being negative is contrary to expectation. This would mean that hog farms would decrease when the price of hogs increased. However, an increase in hog prices should move farm entry in the opposite direction. This result could be due to a structural shift in the hog industry towards larger hog farms. PCORND having a negative coefficient is as expected. Increases in the price of corn reduce profitability and as such reduce new firm entry. The result for cattle density was positive and statistically significant. This implies that when cattle density is high there will be more hog farms. One explanation of this could be that areas with high cattle density are more receptive to adding more livestock. The last variables that were significant are CRD2, CRD3, and CRD5. These all had coefficients that were negative. These results tell us that on average, holding all else constant, counties in these crop reporting districts had less hog farms compared to what.

Model 2 removes the variables ETH, ETHN, HPLANT, and HPLANTN and, rather than considering the prices of hogs and corn separately, the prices are expressed as a ratio (PRATIOH). Again, LFD is found to be statistically insignificant. The variables that are statistically significant at the 1% level are LNHOG, CATDENS, CRD5, and CRD7. Those that are significant at the 5% are PRATIOH, INCD, and CRD4. Lastly, those that are significant at the 10% level are CRD1 and CRD2. The result for LNHOG is as expected with a coefficient that is positive and less than 1. CATDENS is again, contrary to what is expected, positive. The coefficient of the hog/corn price ratio (PRATIOH) has a positive and statistically significant coefficient. This is consistent with expectation because as the ratio increases there would be an increase in profitability which should lead to increased entry. In this model, INCD has a positive coefficient. This means that areas with increased income have more hog farms. The change in the sign from Model 1 may be due to lesser correlation between income and prices when the latter are expressed as a ratio. The CRD variables are all negative and none are statistically significant.

Model 3 has the same variables as Model 2 except the price ratio has been replaced by dummy variables for census years. This was done because the prices that were used did not vary between counties. This means that there is high correlation between time and prices. LFD is still insignificant in this model. It was found to be insignificant in all three models. The variables that were significant at the 1% level are LNHOG, YR2, CATDENS, CRD3, CRD5, and CRD7. CRD2 was significant at the 5% level.

Contrary to the results from the cattle model, the variable LFD for the hog model was not statistically different from zero under all three specifications of the three models. Therefore we can conclude that, after controlling for other factors, LFD has no impact on the number of hog farms.

Table 4.2 Results: Hog Farms As Dependent Variable

	Model 1		Model 2		Model 3	
	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
Intercept	107.557***	17.827	-16.181**	6.749	5.083	5.384
Livestock Friendly Designation	2.236	2.236	6.613	5.618	3.712	5.242
Lag of Hog Farms	0.543***	0.016	0.502***	0.015	0.547***	0.016
Years in LFCP	-0.471	0.743	-0.490	0.794	-0.420	0.738
Neighboring county in LFCP	-2.053	1.651	0.125	1.696	-2.174	1.618
Ethanol plant in county	0.826	1.657	-	-	-	-
Ethanol plant in neighboring county	1.001	1.331	-	-	-	-
Pork proc. plant in county	1.999	3.207	-	-	-	-
Pork proc. plant in neigh. county	1.869	1.783	-	-	-	-
Hog Price	-2.731***	0.442	-	-	-	-
Corn Price	-2.412**	1.275	-	-	-	-
Hog/corn price ratio	-	-	0.483**	0.197	-	-
YR2	-	-	-	-	-8.536***	2.203
YR3	-	-	-	-	1.719	1.713
Population density	0.001	0.003	-0.003	0.004	0.001	0.003
Cattle density	0.046***	0.012	0.049***	0.012	0.045***	0.012
Lag of county share of total production	0.009	0.008	0.007	0.084	0.009	0.008
Per capita income	-0.128	0.190	0.428**	0.178	-0.084	0.185
Northwest CRD	-1.883	2.665	-4.733*	2.748	-2.032	2.590
North CRD	-5.022**	2.393	-4.781*	2.509	-5.211**	2.334
Northeast CRD	-6.421***	2.305	-3.518	2.390	-6.253***	2.264
Southwest CRD	-1.365	2.608	-5.339**	2.623	-2.181	2.489
Central CRD	-8.255***	2.637	-8.149***	2.720	-8.899***	2.532
East CRD	-3.111	2.176	-1.657	2.201	-2.861	2.055
South CRD	-6.319	2.682	-9.418***	2.739	-6.998***	2.575
INTER1	0.995	6.295	-0.603	6.54074	-0.889	6.081
INTER2	-1.595	10.507	-4.866	11.059	-2.400	10.288
INTER3	1.002	7.536	-1.906	7.948	0.187	7.396
INTER4	-3.607	7.000	-2.691	7.350	-4.871	6.841
INTER7	-0.164	7.287	-0.913	7.658	-1.689	7.120
Num. of Obsv.	268		268		268	
R-Square/Adj R-Sq	0.931	0.923	0.919	0.912	0.930	0.924
Chi-Square[1]	0.211		0.930		0.997	

Notes: *Statistically significant at 10%, **Statistically significant at 5%, ***Statistically significant at 1% ;
[1] *Test statistic for heteroscedasticiy using the White test. Homoskedasticity was not rejected in all three models.*

CHAPTER 5: SUMMARY AND CONCLUSIONS

This thesis draws on the theory of long-run perfect competition equilibrium to evaluate the impact of the livestock friendly county program on cattle and hog farms in Nebraska. The LFCP is a volunteer program that counties in Nebraska can sign up for. The NDA sets guidelines on zoning regulations for livestock facilities. Counties may be required to modify their zoning setbacks in order to be admitted in to the program. Since, to the author's knowledge, there has been no study on a program such as LFCP, insights from the literature on how taxes, business climate, and anti-corporate laws have been utilized in specifying the model. The evaluation of the LFCP is conducted separately for cattle farm numbers per county and hog farm numbers per county using census data.

Results for cattle farms show that the LFCP had a positive and significant association with cattle farm numbers. This result was robust in all three models that were estimated. This means that we can reject the null hypothesis that the LFCP had no effect. In the case of hog farms the result was that the LFCP was positively associated with hog farm numbers but the association is not statistically significant. In this case we fail to reject the null hypothesis that LFCP has no effect. This result may be due to counties having more stringent regulations for hog farms despite the livestock friendly designation.

Further research looking at the details of zoning regulations for each county and how strict they are would give more definitive results. This would also be useful in determining how strict the NDA enforces the zoning guidelines. Further research could also be done including the LFCP incentive that gives counties money for road construction that was included in 2015.

A major limitation of this study is not accounting for cattle and hog price variation across counties across time because of unavailability of county level price data. How the absence of such variation affects the results is hard to say. However, if county prices are proportional to the average price at the state level, the conclusions should not differ.

Despite the limitations, this is the first analytical study that provides a glimpse at the effectiveness of a state policy that aims to promote more livestock production. It is hoped that the study will generate further interest in studying the impact of LFCP, in particular and environmental regulation, in general, on entry and exit decisions of livestock facilities in the state of Nebraska.

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APPENDIX A

number	County	designation date
1	Morrill	2005 June 15
2	Hitchcock	2006 March 9
3	Webster	2006 March 9
4	Keith	2007 March 1
5	Dawes	2007 August 6
6	Wayne	2007 August 15
7	Adams	2007 August 29
8	Garden	2007 October 12
9	Lincoln	2008 August 12
10	Sheridan	2008 August 12
11	Box Butte	2008 August 12
12	Deuel	2009 February 6
13	Jefferson	2009 June 22
14	Grant	2010 August 2
15	Gage	2012 May 2
16	Scotts Bluff	2012 May 21
17	Saline	2012 July 20
18	Cuming	2012 August 10
19	Kimball	2012 September 25
20	Banner	2012 September 25
21	Holt	2012 November 30
22	Johnson	2013 August 16
23	Dodge	2013 November 27
24	Otoe	2014 February 25
25	Dawson	2014 March 25
26	Merrick	2014 March 25
27	Pawnee	2014 July 25
28	Knox	2014 October 28
29	Saunders	2014 December 16

Figure A.1: Livestock Friendly Designation By Date of State Designation
Notes: Compiled By Professor J. David Aiken

APPENDIX B

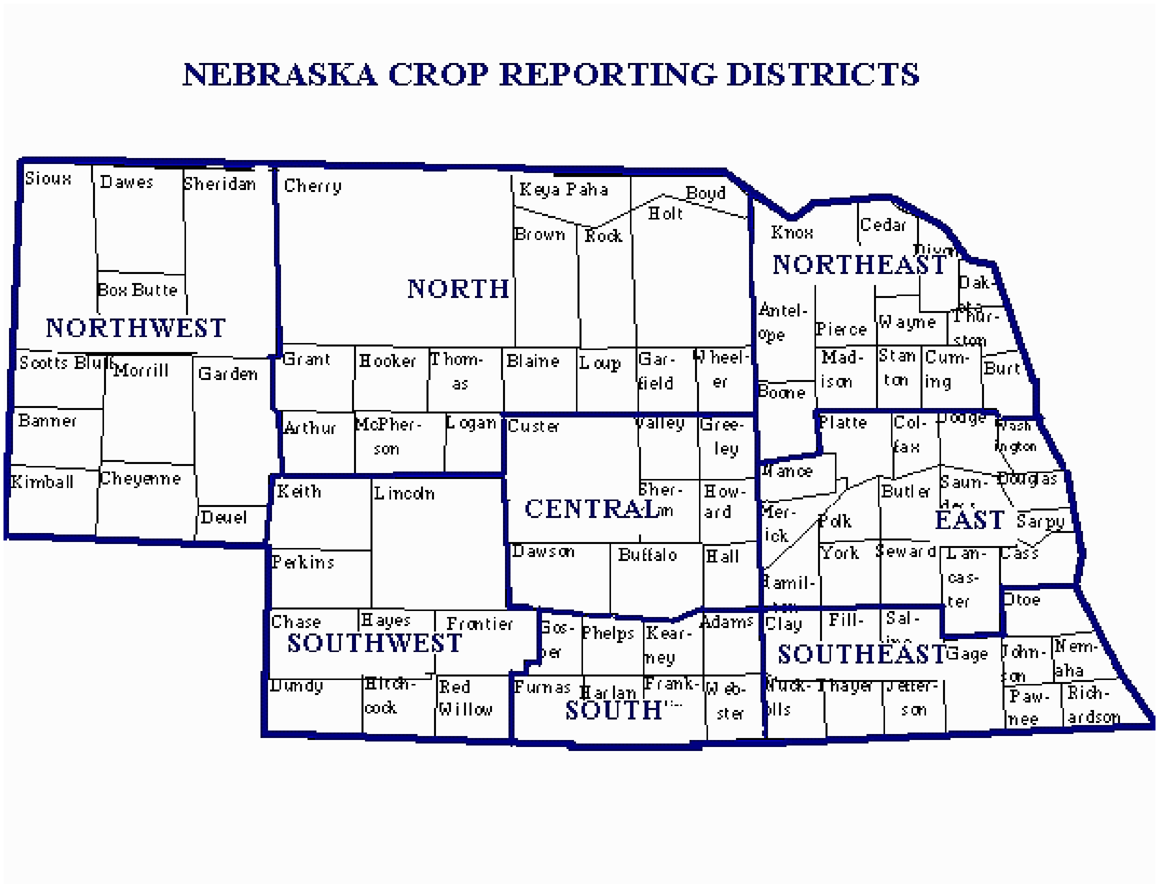

Figure B.1: NDED Crop Reporting Districts.
Notes: for crd Northwest=1, North=2, Northeast=3, Southwest=4, Central=5, East=6, South=7, Southeast=8