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Abstract

This article examines whether the Nebraska Livestock Friendly County Program (LFCP) has resulted in cattle and hog expansion in the state as intended. The analysis draws on the theory of long-run competitive equilibrium to specify econometric models that identify the determinants of cattle and hog farm numbers. Using county level census data, the econometric models were estimated with heteroscedasticity-consistent standard errors and corrected for multicollinearity using the variance inflation factor procedure. Results show an effect of LFCP on both cattle and hog expansion.

Introduction

Livestock is an essential part of the economy in Nebraska. The Nebraska Department of Agriculture (NDA) reports Nebraska leading the nation in beef and veal exports during 2013, valued at $1.128 billion. According to the NDA, every dollar spent on agricultural exports generates $1.27 in economic activity, which equates to beef and veal exports generating over $1.4 billion for Nebraska. In 2015, 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 and seventh in commercial hog slaughter in 2015. Cash receipts from all livestock and products were valued at $14.5 billion in 2014. 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 NASS 2012a), continued growth could facilitate entry of younger and newer livestock producers.

To these ends, the Nebraska Unicameral enacted in 2003 the Nebraska Livestock Friendly County Program (LFCP). The LFCP is designed to allow counties to voluntarily join and, when approved, assist them in promoting livestock development (NDA 2015a). LFCP is a signal to livestock producers that counties are willing to continue developing the livestock industry. In the words of Greg Ibach, Director of the NDA, "a big part of the [LFCP] program is to show that Nebraska is putting out the welcome mat for livestock" (Nebraska Farmer 2014).

As the LFCP is in its second decade, an important research question which this article addresses and which, to the authors' knowledge, has not been addressed in the past, is whether or not the program has achieved its intended effect, i.e., expansion of cattle and hog production. 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 want to consider devising alternative policy instruments to promote livestock growth within its boundaries.

The Livestock Friendly County Program

The LFCP was enacted in 2003 by the Nebraska Legislature and is administered by the NDA. The goal of the program is to further develop livestock in a county. 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 factor that the NDA evaluates a county is based upon the counties zoning regulations pertaining to livestock. These zoning rules regulate how far a livestock facility must be from water ways, lakes, neighboring residences, and towns. The NDA's setback guidelines are: 0.25 mile for operations with 1000 animal units, 0.375 mile for operations with 5000 units, 0.50 mile for operations with 10,000 animal units, and 0.75 mile for 20,000 animal units (NDA 2015c).[1]

The Nebraska Department of Environmental Quality (NDEQ) also has a set of livestock waste control regulations that a facility must first meet. Unlike county zoning, the NDEQ regulations do not regulate how far a facility must be from a town, only how far it must be from public drinking water sources (NDEQ 2015). Once in the program the NDA will periodically review the counties to make sure that they comply with LFCP regulations.

The incentive for counties to join comes 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

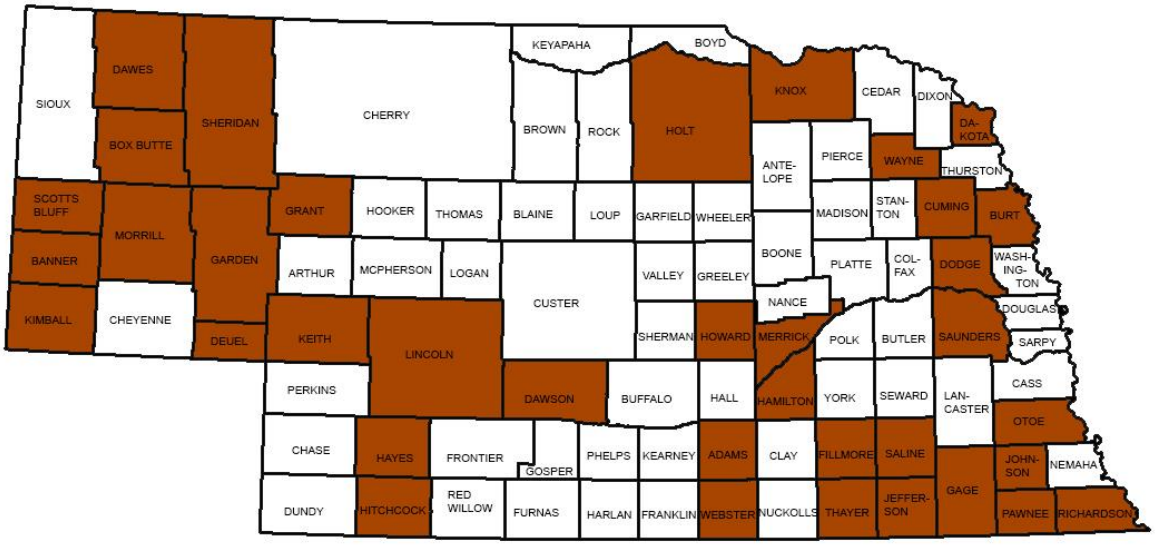
[1] Animal units, in regards to cattle and swine, are calculated by: multiplying the number of slaughter and feeder cattle by 1.0, cow/calf pairs by 1.2, mature dairy cattle by 1.4, swine weighing 55 pounds and over by 0.4, and weaned pigs weighing less than 55 pounds by 0.04 (NDA 2015c).

goal of this is to encourage producers to set up livestock facilities in those respective counties which, would in turn, stimulate economic growth.

Background County Information

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. As of March 2016, there are 36 counties that are a part of the program (Figure 1).

Figure 1: NDA Livestock Friendly Counties Map



In the period between the census years 2002 and 2012, which we consider in this paper, there were 21 counties designated livestock friendly. The counties and their designation dates are listed in the first and second columns of Table 1, respectively. The first county designated as livestock friendly was Morrill on June 15, 2005, and the last county was Holt on November 30, 2012. To align the designated dates with the census years, all counties designated as livestock friendly between June 15, 2005 and the end of 2007 are assigned 2007 as the designation year. Counties receiving the designation after 2007 are assigned 2012 as the designation year.

To get a general sense of the evolution of cattle and hog farm numbers before and since the implementation of the livestock friendly designation, Tables 1 and 1A present the number of cattle farms by census year and by county with and without livestock friendly designation, respectively. Tables 2 and 2A do the same for hog farm numbers.

Starting with cattle, Table 1 lists the number of farms by county and census year and the changes between the census years up to and since 2007. Up to 2007, the changes were negative in almost all counties. Since 2007, of the 21 counties with livestock friendly designation, 16 experienced a net increase. The overall net increase was 634 farms. However, as shown in Table 1A, the

majority of counties without livestock friendly designation also experienced a net increase in cattle farm numbers since 2007, though the rate of change in those counties was 8 percent compared to 12 percent in counties with livestock friendly designation.

TABLE 1: Counties with Livestock Friendly Designation: Designation Date and Number of Cattle Farms by Census Years (2002, 2007, 2012)

County	Designation date	Number of farms			Change	
		2002	2007	2012	02-07	07-12
Adams	08/29/2007	221	163	200	-58	37
Banner	09/25/2012	102	88	95	-14	7
Box Butte	08/12/2008	205	174	209	-31	35
Cuming	08/10/2012	464	411	446	-53	35
Dawes	08/06/2007	280	279	326	-1	47
Deuel	02/06/2009	56	43	54	-13	11
Gage	05/02/2012	551	433	479	-118	46
Garden	12/10/2007	145	133	103	-12	-30
Grant	08/02/2010	70	77	59	7	-18
Hitchcock	03/09/2006	180	132	168	-48	36
Holt	11/30/2012	822	732	810	-90	78
Jefferson	06/22/2009	317	239	308	-78	69
Keith	03/01/2007	150	131	155	-19	24
Kimball	09/25/2012	112	95	120	-17	25
Lincoln	08/12/2008	583	537	625	-46	88
Morrill	06/15/2005	253	280	269	27	-11
Saline	07/20/2012	369	282	352	-87	70
Scotts Bluff	05/21/2012	313	260	396	-53	136
Sheridan	08/12/2008	404	340	337	-64	-3
Wayne	08/15/2007	336	301	246	-35	-55
Webster	03/09/2006	262	224	231	-38	7
Total		**6195**	**5354**	**5988**	**-841**	**634**

Table 1A: Counties without Livestock Friendly Designation: Number of Cattle Farms by Census Years (2002, 2007, 2012)

County	Number of farms			Change	
	2002	2007	2012	02-07	07-12
Antelope	408	323	357	-85	34
Arthur	65	56	75	-9	19
Blaine	87	97	93	10	-4
Boone	411	333	331	-78	-2
Boyd	256	190	194	-66	4
Brown	213	169	211	-44	42
Buffalo	579	507	549	-72	42
Burt	197	164	153	-33	-11
Butler	370	299	328	-71	29
Cass	256	208	213	-48	5
Cedar	615	521	511	-94	-10
Chase	154	120	140	-34	20
Cherry	475	430	461	-45	31
Cheyenne	177	153	166	-24	13
Clay	221	157	163	-64	6
Colfax	285	231	228	-54	-3
Custer	845	799	907	-46	108
Dakota	120	103	110	-17	7
Dawson	408	368	417	-40	49
Dixon	297	244	286	-53	42
Dodge	247	212	210	-35	-2
Douglas	80	75	80	-5	5
Dundy	149	137	122	-12	-15
Fillmore	228	163	166	-65	3
Franklin	207	146	182	-61	36
Frontier	233	196	206	-37	10
Furnas	212	179	177	-33	-2
Garfield	136	164	150	28	-14
Gosper	143	118	142	-25	24

Table 1A (continued)					
County	Number of farms			Change	
	2002	2007	2012	02-07	07-12
Greeley	239	201	273	-38	72
Hall	280	253	256	-27	3
Hamilton	225	160	193	-65	33
Harlan	200	192	176	-8	-16
Hayes	136	136	116	0	-20
Hooker	76	78	74	2	-4
Howard	348	301	361	-47	60
Johnson	253	194	239	-59	45
Kearney	179	155	137	-24	-18
Keya Paha	151	159	187	8	28
Knox	729	559	700	-170	141
Lancaster	483	421	477	-62	56
Logan	88	102	92	14	-10
Loup	106	110	104	4	-6
Madison	385	299	343	-86	44
McPherson	114	110	97	-4	-13
Merrick	278	227	227	-51	0
Nance	230	203	185	-27	-18
Nemaha	213	171	169	-42	-2
Nuckolls	303	224	243	-79	19
Otoe	345	293	341	-52	48
Pawnee	250	197	234	-53	37
Perkins	141	129	107	-12	-22
Phelps	173	160	145	-13	-15
Pierce	426	339	353	-87	14
Platte	423	345	373	-78	28
Polk	232	202	181	-30	-21
Red Willow	223	223	227	0	4
Richardson	312	230	296	-82	66

Table 1A (continued)					
County	Number of farms			Change	
	2002	2007	2012	02-07	07-12
Rock	176	153	179	-23	26
Sarpy	71	80	84	9	4
Saunders	435	360	418	-75	58
Seward	345	294	366	-51	72
Sherman	315	254	278	-61	24
Sioux	214	243	256	29	13
Stanton	339	299	303	-40	4
Thayer	285	197	194	-88	-3
Thomas	59	90	76	31	-14
Thurston	167	117	122	-50	5
Valley	279	258	252	-21	-6
Washington	237	177	230	-60	53
Wheeler	133	133	143	0	10
York	218	180	157	-38	-23
Total	**18888**	**16070**	**17292**	**-2818**	**1222**

For hog farms in counties with livestock friendly designation, the net changes in numbers up to 2007 were negative for 16 of 21 counties. The overall decline was 171 farms. Since 2007, most counties experienced a net loss of farms, with an overall decline of 74 farms. For the other 58 counties, the net change up to 2007 was negative in most of them. Since 2007 the net change was predominately negative, with an overall decline of 663 farms.

What impact, if any, has the livestock friendly designation had on farm numbers in counties with the designation relative to those without is the question we address in the rest of this paper. After a review of related literature and background theory in the next section, the sections that follow present the empirical model and data, estimation results, and summary and conclusions.

TABLE 2: Counties with Livestock Friendly Designation: Number of Hog Farms by Census Years (2002, 2007, 2012)

County	Designation Date	Census years			Change	
		2002	2007	2012	02-07	07-12
Adams	08/29/2007	17	18	8	1	-10
Banner	09/25/2012	3	2	1	-1	-1
Box Butte	08/12/2008	7	6	11	-1	5
Cuming	08/10/2012	200	162	131	-38	-31
Dawes	08/06/2007	8	9	5	1	-4
Deuel	02/06/2009	5	1	6	-4	5
Gage	05/02/2012	123	83	48	-40	-35
Garden	12/10/2007	3	4	7	1	3
Grant	08/02/2010	0	1	0	1	-1
Hitchcock	03/09/2006	12	4	4	-8	0
Holt	11/30/2012	41	39	27	-2	-12
Jefferson	06/22/2009	31	23	21	-8	-2
Keith	03/01/2007	1	3	2	2	-1
Kimball	09/25/2012	10	11	10	1	-1
Lincoln	08/12/2008	21	20	19	-1	-1
Morrill	06/15/2005	11	4	6	-7	2
Saline	07/20/2012	47	30	27	-17	-3
Scotts Bluff	05/21/2012	8	10	38	2	28
Sheridan	08/12/2008	18	6	3	-12	-3
Wayne	08/15/2007	65	31	18	-34	-13
Webster	03/09/2006	14	7	8	-7	1
Total		**645**	**474**	**400**	**-171**	**-74**

TABLE 2A: Counties without Livestock Friendly Designation: Number of Hog Farms by Census Years (2002, 2007, 2012)

County	Number of Farms			Change	
	2002	2007	2012	02-07	07-12
Antelope	62	41	18	-21	-23
Arthur	1	1	1	0	0
Blaine	2	2	2	0	0
Boone	69	47	32	-22	-15
Boyd	23	11	15	-12	4
Brown	9	4	4	-5	0
Buffalo	41	26	8	-15	-18
Burt	33	40	10	7	-30
Butler	39	33	17	-6	-16
Cass	36	26	23	-10	-3
Cedar	177	138	69	-39	-69
Chase	12	12	12	0	0
Cherry	3	4	8	1	4
Cheyenne	4	6	6	2	0
Clay	25	29	16	4	-13
Colfax	100	70	32	-30	-38
Custer	55	29	34	-26	5
Dakota	24	11	11	-13	0
Dawson	37	29	8	-8	-21
Dixon	53	38	27	-15	-11
Dodge	80	62	43	-18	-19
Douglas	8	7	1	-1	-6
Dundy	8	5	4	-3	-1
Fillmore	44	38	17	-6	-21
Franklin	12	8	10	-4	2
Frontier	9	6	5	-3	-1
Furnas	12	4	5	-8	1
Garfield	3	3	1	0	-2
Gosper	4	4	2	0	-2

Table 2A (continued)

County	Number of Farms			Change	
	2002	2007	2012	02-07	07-12
Greeley	22	12	12	-10	0
Hall	20	19	10	-1	-9
Hamilton	26	24	11	-2	-13
Harlan	11	10	5	-1	-5
Hayes	9	7	2	-2	-5
Hooker	0	0	4	0	4
Howard	58	26	20	-32	-6
Johnson	26	16	10	-10	-6
Kearney	16	14	8	-2	-6
Keya Paha	3	1	0	-2	-1
Knox	127	77	48	-50	-29
Lancaster	58	35	21	-23	-14
Logan	3	4	0	1	-4
Loup	3	4	3	1	-1
Madison	53	38	28	-15	-10
McPherson	0	4	2	4	-2
Merrick	15	13	8	-2	-5
Nance	17	20	13	3	-7
Nemaha	28	20	9	-8	-11
Nuckolls	25	13	6	-12	-7
Otoe	63	43	39	-20	-4
Pawnee	43	25	24	-18	-1
Perkins	10	8	5	-2	-3
Phelps	16	6	5	-10	-1
Pierce	90	65	29	-25	-36
Platte	150	138	92	-12	-46
Polk	50	19	17	-31	-2
Red Willow	19	13	5	-6	-8
Richardson	33	25	19	-8	-6

Table 2A (continued)					
County	Number of farms			Change	
	2002	2007	2012	02-07	07-012
Rock	2	4	2	2	-2
Sarpy	9	11	3	2	-8
Saunders	70	42	23	-28	-19
Seward	62	44	36	-18	-8
Sherman	24	12	3	-12	-9
Sioux	3	5	1	2	-4
Stanton	73	44	29	-29	-15
Thayer	18	8	3	-10	-5
Thomas	1	2	1	1	-1
Thurston	43	15	10	-28	-5
Valley	30	34	13	4	-21
Washington	51	43	25	-8	-18
Wheeler	10	4	6	-6	2
York	55	38	25	-17	-13
Total	**2430**	**1739**	**1076**	**-691**	**-663**

Related Literature and Background Theory

As stated at the outset, other than the effort in this article, the authors are not aware of other studies examining the effect LFCP per se or similar designations on entry and exit of firms or farms. There is, however, a large volume of literature that examines the effect of demand and cost conditions on business location across states in the United States. Following Feinberg (2014), the literature can be categorized according to the following taxonomy: (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 farming laws (e.g., Bartik 1988; Gray 1997; Roe et al. 2002; Isik 2004, Schroeter et al. 2006; Azzam et al. 2014), and (3) the effect of state antitrust enforcement (Feinberg 2014).

To the extent that LFCP signals a favorable business climate, and to the extent a favorable business climate implies less farm entry-deterring zoning regulations, the most pertinent literature within the aforementioned taxonomy is that on the effect of business climate on entry and exit, and particularly the Azzam et al.'s (2014) study of the effect of the stringency of environmental regulation has on the structure of the U.S. hog industry.

The background theory used by Azzam et al. (2014), and which we use in this article, is that of long-run perfectly competitive equilibrium (LRCE). Its two cornerstones 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.

A simple algebraic sketch of the theory is as follows.[2] Consider n producers each producing output q with costs $C(q, \boldsymbol{w}, \boldsymbol{R})$, where $\boldsymbol{w}$ is the vector of factor prices, and $\boldsymbol{R}$ is a vector containing regulation or a designation, like LFCP, and other factors such as adjacency to slaughter plants and ethanol plants, for example, implying that the effect of the regulation or designation and other factors occurs through shifting the cost of production. One could think of the variables in $\boldsymbol{R}$ vectors as sources of external economies (or diseconomies) that affects all producers in a county, state, or region. This is in contrast to internal economies that are producer-specific.

The LRCE is characterized by

$$p(nq) = MC(q, \boldsymbol{w}, R) \quad (1)$$

and

$$p(nq) = \frac{C(q, \boldsymbol{w}, R)}{q} \quad (2)$$

where $p(nq)$ is the (inverse) demand for industry output and $MC$is marginal cost. Equation (1) is the short-run profit-maximization condition and equation (2) is the entry condition allowing firms to enter (exit) in response to short-term profits (losses) until marginal and average cost are equal to price in equilibrium, implying zero economic profits in the long run.

Solution of (1) and (2) for q and n yields a function for the equilibrium number of firms (the dependent variable) with output price *p*, factor prices $\boldsymbol{w}$, and the variables constituting the vector $\boldsymbol{R}$, including LFCP, as independent variables. Such function is the basis for the empirical specification used in the next section to estimate the impact of LFCP on livestock expansion using counties as units of observation.

Empirical Model and Data

To be consistent with theory sketched in the previous section, the empirical model for studying the impact of LFCP on firm entry requires cattle and hog farm numbers as dependent variables. The independent variables include cattle, hog, and corn prices, and other 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:

NCAT = f(LFD, YLFD, LFDN, ETH, ETHN, CPLANT, CPLANTN, PCATD, PCORND, POPD, CATDENS, CATSHARE, INCD, CRD1-CRD7, INTER1-INTER7) (3)

[2] For a more technical explanation of the theory, see Azzam et al. (2014)

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

NHOG = g(LFD, YLFD, LFDN, ETH, ETHN, HPLANT, HPLANTN, PHOGD, PCORND, POPD, CATDENS, CATSHARE, INCD, CRD1-CRD7, INTER1-INTER7) (4).

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 is obtained. The data is broken out by county and by census year inclusive of the three census years 2002, 2007, and 2012. Given 93 counties in the state, the number of observations is 279.

NCAT = *Number of cattle farms*. (Sources: USDA 2012b; USDA 2002).

NHOG = *Number of hog farms*. (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 into account the time when a county joined the LFCP. Those counties that were designated in 2007 are 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 may have adjusted their regulations before being designated. So they were probably 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. If livestock expansion was associated with LFCP, then one should expect the coefficient of the dummy variable to be positive and statistically significant. (Source: NDA 2015a).

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 Table 1. 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, implying LFDN having a negative effect. This would be due to new producers deciding to locate their facilities in a livestock friendly county in order to take advantage of livestock friendly 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 as well as sell distillers grains outside of their county. 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 market 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 a 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*. Prices for 2011 and 2012 are not available through NASS. Therefore, the prices from 2007-2010 were averaged. 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 are 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. 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, farm entry and exit. An increase in this price would decrease profitability and discourage entry in the long run. 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 a 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.

CATSHARE = *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 be interpreted several ways. 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 (CRD1), North (CRD2), Northeast (CRD3), Southwest (CRD4), Central (CRD5), East (CRD6), South (CRD7), and Southeast (CRD8) (see the map in Figure 2 in the Appendix). 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.

Estimation Procedure and Results

The cattle and hogs models were estimated using a fixed effects model with heteroscedasticity-consistent standard errors (White, 1980) and correction for multicollinearity using the variance inflation factor (VIF) procedure (Belsley, et al., 1980). The procedure measures the extent to which the variance of a parameter estimate is inflated relative to the orthogonal case (Belsley, et al., 1980). This is superior to simply looking at pairwise correlations because it is possible that a small (large) pairwise correlation does not translate directly into weak (strong) linear dependence

among more than two independent variables. As a rule of thumb, a VIF value exceeding 5 or 10 is indication that the associated regression coefficient is imprecisely estimated because of multicollinearity (Montgomery, et al., 2001).

Finally, due to the large number of counties, the heterogeneity of counties is captured by including dummy variables for 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 Figure 2. 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. Each livestock model was estimated using 279 observations.

Cattle Results

The regression estimates of the full cattle model (equation 1 in section 5) along with t-ratios, p-values, and VIFs are listed under Model 1 in Table 3. The two regression coefficient that fit the VIF rule of thumb discussed earlier are those associated with LFD (9.98) and INTER1 (5.99). This means that the estimated coefficients associated with livestock friendly designation and the interaction between the designation and crop reporting district 1 are respectively inflated by a factor of almost 10 and 6 because they are both highly correlated with at least one of the right hand side variables.

Since our interest is in LFD, we removed INTER1 to correct for multicollinearity. The new parameter estimates along with t-ratios, p-values, and VIFs are shown under Model 2 in Table 1. The correction reduced the VIF associated with LFD coefficient by two-thirds and virtually all the VIFs associated with the rest of the regression coefficients were also reduced.

Results from Model 2 show that LFD is positive and highly significant, indicating that, after controlling for other factors, farm numbers in counties with livestock friendly designation are higher than those counties without the designation. The other statistically significant coefficients at the conventional 5 percent level are YLFD, PCAT, POPDENS, CATDENS, CATSHARE, CRD1, CRD4, CRD7, and INTER3. 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. The PCAT coefficient being negative is also contrary to expectation. This would mean that cattle farms would decrease when the price of cattle increased. However, all else equal, an increase in cattle prices should move farm numbers in the opposite direction. This result could be due to a structural shift in the cattle industry towards larger farms. While the result for CATDENS is negative, implying less entry with increasing cattle density, the result for CATSHARE is positive, indicating that the higher the importance of cattle to a county, as measured by its share in total state cattle, the higher is farm entry. The coefficients associated with CRD1, CRD2, CRD4, and CRD7 show a decline in farm entry in the Northwest, North, Southwest, and South crop reporting districts relative to the Southeast crop districting (the reference district). The interaction between LFD and the Northeast crop reporting district (CRD3) means that livestock friendly counties in the district

have on average fewer cattle farms than livestock friendly counties in the South crop reporting district.

Table 3 : Cattle Regression Estimates with t-Ratios and Variance Inflation Factors (VIF)

	MODEL 1					MODEL 2			
Variable	Para-meter Estimate	t – Value	P-Value	VIF		Para-meter Estimate	t – Value	P-Value	VIF
CONSTANT	518.51	3.88	0.0001	0		523.35	3.92	0.0001	0
LFD	146.66	3.82	0.0002	9.98		80.98	2.81	0.0053	3.49
YLFD	-11.32	-1.85	0.0653	2.22		-13.53	-2.18	0.0299	2.14
LFDN	-7.90	-0.58	0.5625	1.67		-7.33	-0.53	0.5955	1.67
ETH	-14.26	-0.92	0.3591	1.34		-12.39	-0.77	0.4399	1.34
ETHN	-0.77	-0.07	0.9450	1.56		-2.11	-0.18	0.8543	1.55
CPLANT	-36.51	-1.38	0.1695	1.55		-36.58	-1.37	0.1717	1.55
CPLANTN	-21.05	-1.67	0.0961	1.67		-21.22	-1.68	0.0942	1.67
PCAT	-3.95	-2.16	0.0314	2.06		-3.93	-2.15	0.0328	2.06
PCORN	-1.51	-0.09	0.9260	3.48		0.60	0.04	0.9705	3.46
POPDENS	-0.08	-2.87	0.0044	1.63		-0.07	-2.82	0.0052	1.63
CATDENS	-0.76	-5.06	<.0001	2.31		-0.76	-5.07	<.0001	2.31
CATSHARE	1.49	9.92	<.0001	1.89		1.49	9.92	<.0001	1.89
INCOME	-1.11	-0.68	0.4975	2.85		-1.33	-0.82	0.4130	2.83
CRD1	-161.13	-8.35	<.0001	2.52		-176.01	-9.08	<.0001	2.15
CRD2	-180.39	-10.24	<.0001	2.55		-186.92	-10.86	<.0001	2.45
CRD3	46.44	2.03	0.0430	2.28		40.76	1.80	0.0728	2.22
CRD4	-129.66	-6.83	<.0001	2.01		-134.84	-7.19	<.0001	1.97
CRD5	25.81	1.07	0.2848	2.15		19.95	0.83	0.4059	2.11
CRD6	17.89	0.86	0.3882	2.64		12.47	0.61	0.5444	2.57
CRD7	-103.18	-5.96	<.0001	1.96		-108.47	-6.34	<.0001	1.93
INTER1	-94.85	-2.06	0.0407	5.99					
INTER2	27.82	0.19	0.8507	1.79		93.95	0.65	0.5154	1.28
INTER3	-182.40	-3.95	0.0001	2.26		-112.74	-3.19	0.0016	1.42
INTER4	-94.18	-1.81	0.0718	3.22		-23.24	-0.57	0.5685	1.78
INTER7	-33.79	-0.79	0.4325	2.81		37.85	1.37	0.1730	1.64
F Value	24.71		<.0001			25.50	<.0001		
R-Square	0.70					0.70			
Adj-Rsq	0.68					0.68			

Hog Models Results

Results for hogs are reported in Table 4. As to be expected, the two regression coefficients with the higher VIFs are those associated with the livestock friendly designation dummy variable (LFD) and the interaction between LFD and the Northwest crop reporting district (INTER1). Model 2 reports the results without INTER1. Similar to cattle, the regression coefficient of LFD is positive and highly significant, implying that counties designated as livestock friendly experienced a smaller decline in farm numbers relative to counties without. The parameter estimates associated with the price of hogs and the price of corn are statistically significant at the 1 percent and 5 percent levels, respectively, and have the correct signs. This result is in sharp contrast to the result for cattle. The counties' cattle density (CATDENS) and share in total state cattle numbers (CATSHARE) are strongly associated with farm numbers. This could be indicative that cattle counties are receptive to hog expansion.

With the exception of the parameter estimate associated with CRD6 (the East crop reporting district) the rest of the estimated are all significant at least the 5 percent level, with CRD3 (the Northeast crop reporting district) having a higher number of farms relative to the benchmark district (Southeast) and the rest of the districts have lower farm numbers. The interaction between LFD and crop reporting districts is statistically significant for the Northeast only (INTER3) and negative. The negative sign means that livestock friendly counties in the Northeast district have on average fewer hog farms than livestock friendly counties in the South crop reporting district.

Table 4 : Hog Regression Estimates with t-Ratios and Variance Inflation Factors (VIF)

	MODEL 1					MODEL 2			
Variable	Para-meter Estimate	t – Value	P-Value	VIF		Para-meter Estimate	t – Value	P-Value	VIF
CONSTANT	-120.12	-3.13	0.0020	0		-120.25	-3.13	0.0020	0
LFD	14.20	2.30	0.0221	9.64		15.20	3.54	0.0005	3.39
YLFD	-1.05	-1.11	0.2678	2.23		-1.01	-1.10	0.2714	2.15
LFDN	1.06	0.37	0.7092	1.69		1.05	0.37	0.7112	1.69
ETH	2.33	0.52	0.6044	1.36		2.30	0.51	0.6073	1.35
ETHN	-2.83	-0.97	0.3319	1.57		-2.81	-0.97	0.3319	1.56
CPLANT	-3.79	-0.59	0.5572	1.55		-3.79	-0.59	0.5574	1.55
CPLANTN	-4.41	-1.53	0.1266	1.66		-4.41	-1.53	0.1267	1.66
PHOG	4.11	4.29	<.0001	1.85		4.11	4.29	<.0001	1.85
PCORN	-4.71	-1.95	0.0527	1.80		-4.74	-1.97	0.0499	1.79
POPDENS	-0.01	-2.23	0.0264	1.64		-0.01	-2.24	0.0260	1.64
CATDENS	0.16	4.17	<.0001	2.31		0.16	4.17	<.0001	2.31
CATSHARE	0.04	3.15	0.0018	1.93		0.04	3.15	0.0018	1.93
INCOME	0.12	0.32	0.7511	2.87		0.12	0.33	0.7440	2.85

CRD1	-31.45	-5.20	<.0001	2.52		-31.22	-7.25	<.0001	2.15
CRD2	-30.21	-5.59	<.0001	2.42		-30.11	-6.79	<.0001	2.33
CRD3	14.07	2.63	0.0091	2.28		14.15	2.20	0.0284	2.21
CRD4	-26.04	-4.42	<.0001	2.01		-25.96	-6.38	<.0001	1.97
CRD5	-19.04	-2.96	0.0034	2.15		-18.95	-3.54	0.0005	2.11
CRD6	7.70	1.46	0.1465	2.63		7.78	1.58	0.1151	2.57
CRD7	-31.47	-5.13	<.0001	1.96		-31.39	-5.86	<.0001	1.93
INTER1	1.43	0.10	0.9225	5.98					
INTER2	-1.01	-0.04	0.9677	1.49		-1.99	-0.27	0.7909	1.25
INTER3	-27.75	-1.55	0.1219	2.26		-28.81	-2.64	0.0088	1.42
INTER4	-5.50	-0.33	0.7401	3.22		-6.58	-1.22	0.2253	1.79
INTER7	-0.93	-0.05	0.9570	2.82		-2.02	-0.31	0.7543	1.64
F Value	14.44		<.0001			15.10	<.0001		
R-Square	0.59					0.59			
Adj-Rsq	0.55					0.55			

Summary and Conclusions

This paper draws on the theory of long-run competitive equilibrium and uses county level census data to assess the impact of the LFCP on cattle and hog farms in Nebraska. The LFCP is an optional program that counties in Nebraska can request designation for. Results for both cattle and hogs farms show that the LFCP had a positive and significant association with cattle and hog farm numbers. The result is based on models estimated with heteroscedasticity-consistent standard errors and correction for multicollinearity using the variance inflation factor procedure.

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. Another limitation is not accounting for the details of zoning regulations for each county and the strictness of the regulations. Such details would give more definitive result and could be useful in evaluating the interplay between NDA LFC zoning guidelines and county zoning regulations.

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 in the state. 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.

References

Aiken, J. D. (2015). *2015 Legislative Wrap-Up.* Cornhusker Economics. Retrieved July 2015, from http://agecon.unl.edu/2015-legislative-wrap-up

Azzam, A., & Schoengold, K. (2014). Hog industry structure and the stringency of environmental regulation. *Canadian Journal of Agricultural Economics, 13*(31), 1-26.

Bartik, T. (1988). The effects of environmental regulation on business location in the United States. *Growth and Change*(19), 22-44.

Bartik, T. (1989). Small business start-ups in the United States: estimates of the effects of characteristics of states. *Southern Economic Journal, 55*, 1004-1018.

Belsely, D. A., E. Kuh, and R. E. Welsh. *Regression Diagnostics: Identifying Influential Data and Sources of Collinearity*. Wiley Series in Probability and Statistics, 1980.

Feinberg, R. M. (2014). State antitrust enforcement in the US and implicaions for small business entry and relocation. *Applied Economics, 46*(7), 769-779.

Gray, W. B. (1997). *Manufacturing plant location: does state pollution regulation matter?* US Bureau of the Census. Washington DC: Working Paper 97-8.

Helms, L. J. (1985). The effect of state and local taxes on economic growth: a time series-cross section approach. *The Review of Economics and Statistics, 67*(4), 574-582.

Isik, M. 2004. Envrionmental Regulation and the Spatial Stucture of the U.S. Dairy Sector. American Journal of Agricutural Economics 86:949-962.

Montgomery, D. C., E. A. Peck, and E. A. Vining. *Introduction to Linear Regression Analysis*. New York: Wiley, 2001.

Nebraska Department of Agriculture. (2015a). *Livestock Friendly County.* Retrieved February 2015, from http://www.nda.nebraska.gov/promotion/livestock_friendly/index.html

Nebraska Department of Agriculture. (2015b). *Nebraska Agricultural Fact Card.* Retrieved July 2016, from http://www.nda.nebraska.gov/facts.pdf

Nebraska Department of Agriculture. (2015c). *Livestock Friendly County Regulations.* Retrieved June 2015, from http://www.nda.nebraska.gov/regulations/promotion/tilp.pdf

Nebraska Department of Economic Development. (2015). *Nebraska Crop Reporting Districts.* Retrieved from http://www.neded.org/business/data-a-research/agriculture

Nebraska Department of Environmental Regulation. (2015). *Livestock Waste Control Regulations.* Retrieved January 2015, from http://deq.ne.gov/RuleAndR.nsf/RuleAndReg.xsp?documentId=4552C6A35D290D8C862568970059A367&action=openDocument

Nebraska Ethanol Board. (2015). *Nebraska Ethanol Plants.* Retrieved from http://ethanol.nebraska.gov/wordpress/about/nebraska-ethanol-plants/

Nebraska Farmer. (2014). Counties put out livestock welcome mat. *Nebraska Farmer*. Retrieved July 2014, from http://magissues.farmprogress.com/NEF/NF06Jun14/nef006.pdf

Roe, B., E.G. Irwin and J.S. Sharp. (2002). Pigs in Space: Modeling the Spatial Structure of Hog Production in Traditional and Nontraditional Production Regions. *American Journal of Agricultural Economics,* 84(2): 259-278.

Schroeter, J. R., Azzam, A. M., & Aiken, J. D. (2006). Anti-Corporate Farming Laws and Industry Structure. *American Jounal of Agricultural Economics, 88*(4), 1000-1014.

US Bureau of Economic Analysis. (2015). Retrieved May 2015, from http://www.bea.gov/iTable/iTable.cfm?reqid=70&step=1&isuri=1&acrdn=5#reqid=70&step=1&isuri=1

USDA National Agricultural Statistics Service. (2002). Census of Agriculture. Retrieved from http://www.agcensus.usda.gov/Publications/2002/Volume_1,_Chapter_2_County_Level/Nebraska/

USDA National Agricultural Statistics Service. (2012a). *Census of Agriculture.* Retrieved April 2015, from http://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_2_US_State_Level/st99_2_045_045.pdf

USDA National Agricultural Statistics Service. (2012b). *Census of Agriculture.* Retrieved February 2015, from http://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_2_County_Level/Nebraska/st31_2_011_011.pdf

USDA National Agricultural Statistics Service. (2015). *Quick Stats.* Retrieved from http://quickstats.nass.usda.gov/

Wasylenko, M. (1997). Taxation and economic development: the state of economic literature. *New England Economic Review*(March), 37-52.

White, H. (1980). A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. *Econometica*, 48(4).

Appendix

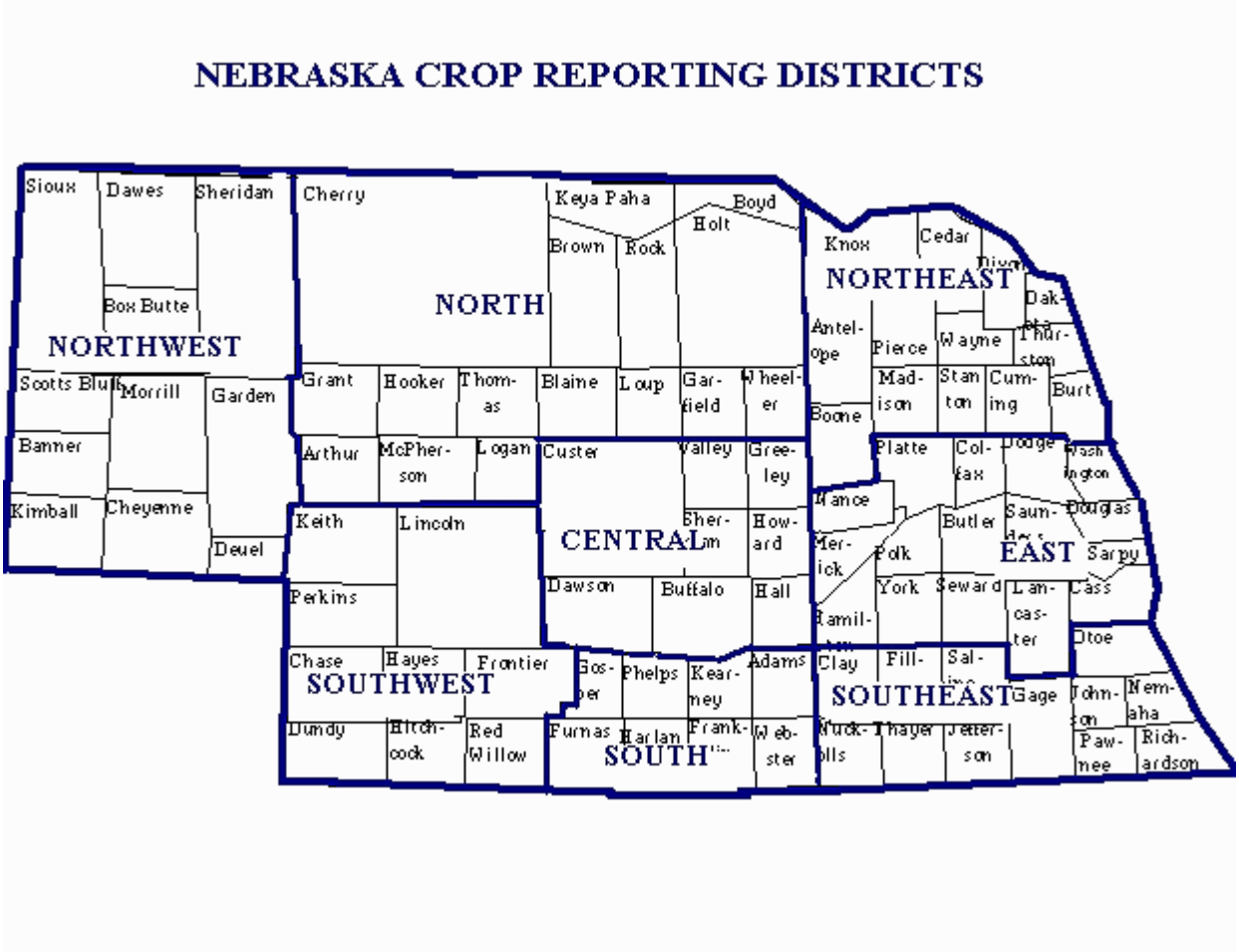


Figure 2: Nebraska Crop Reporting Districts.
Notes: Northwest=1, North=2, Northeast=3, Southwest=4, Central=5, East=6, South=7, Southeast=8.