AJAE appendix for

‘Does Animal Feeding Operation Pollution Hurt Public Health? A National Longitudinal Study of Health Externalities Identified by Geographic Shifts in Livestock Production’

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Note: The material contained herein is supplementary to the article named in the title and published in the American Journal of Agricultural Economics (AJAE)

Appendix A1: Description of Data Sources

Information on livestock numbers comes from a proprietary dataset created by Robert Kellogg at the National Resource Conservation Service (NRCS). "Livestock" in this study include beef, dairy, swine, and poultry. Sheep, goats, horses, and other animal types are excluded. Dr. Kellogg created this dataset using the 1982, 1987, 1992, and 1997 Censuses of Agriculture. Public-use data by county from the Census of Agriculture is censored when it is possible to discern specific farms within the county. As livestock operations have become increasingly concentrated, the observations by county have been increasingly censored. In this situation, "censoring" means that the data is denoted as censored and "blacked out." The observation is not omitted from the sample. When data cells can be used to identify individual operations, these cells are marked with a "D." Unfortunately, there is no described top-code over which data cells are censored, making extrapolation complicated at best. The data from Dr. Kellogg does not suffer from this impediment. A full description of this appears in Kellogg, Lander, Moffitt, and Gollehon (2000). In order to provide more anonymity for individual farms, the data I have received has units of observation that sometimes contain more than one county.

Because they arise from birth records, the natality data also include demographic and medical use variables. I use the 1980, 1990, and 2000 U.S. Censuses to account for the percentage of a county that is Hispanic and the percentage of counties with various education levels. Hispanic origin is recorded on natality records for 99 percent of all cases starting in 1990, and in all states starting in 1993. Maternal education is recorded on the birth record for all states only beginning in 1992. Between 1980 and 1991, four highly-populated states (Texas, California, Washington, and New York) had intermittent or incomplete coverage of this variable. Because of the lack of information in the first two periods, I do not use this information from the birth record. Results using the sample for which I have data on these covariates are remarkably similar to those shown in the paper.

I use U.S. Census and Bureau of Economic Activity data to control for per capita income and farm employment by county. Variables for population density, well water usage, and septic tank usage variables come from the Census of Housing. Building permit information comes from USA Counties, a publication of the U.S. Census Bureau.

Hydro-geologic factors and land use practices may mitigate any correlations between livestock farming, health, and pollution. The National Resource Inventory (NRI), created by the NRCS, provides a statistically representative sample of soils and groundcover in the U.S. The inventory is performed every five years, corresponding to the years of the Census of Agriculture. A complete description of this dataset can be found in NRCS (2001). I use monthly precipitation and temperature data from the National Climactic Data Center. CWA permit information was obtained via the EPA's online Envirofacts Data Warehouse.

Data on physicians and hospitals per capita arise from various releases of the Area Resource File.

Data on the number of establishments in 15 different industries come from County Business Pattern (CBP) data. The 15 industries are the following: accommodation and food services; administrative support and waste management and remediation services; agricultural, forestry, fishing, and hunting support; arts, entertainment, and recreation; finance and insurance; information; construction; health care and social assistance; management of companies and enterprises; manufacturing; utilities; wholesale trade; professional, scientific, and technical services; retail trade; transportation and warehousing.

CBP data changes from SIC to NAICS industry codes in 1987. Therefore, constructing a coherent series for 1985 to 2005 requires converting pre-1987 data from SICs to NAICs. This was done using the Census Bureau's SIC to NAIC correspondence tables. In the cases where individual SIC categories are not entirely assigned to a single NAICS, this correspondence table provides the percentage of the SIC that was assigned to individual NAICS codes.

Table A1 provides additional information on data sources, years covered, and modifications to the data to make comparable county-period units.

Table A1 Summary of data sources, years available, and method of making compatible

Variable	Source	Years	Modification
Livestock numbers	Proprietary dataset created by Robert Kellogg at the National Resource Conservation Service (NRCS) from the Census of Agriculture	1982, 1987, 1992, 1997	No modification
Infant mortality, Mean age of mother, mean number of prenatal visits, percent of births occurring in hospitals, percentage of mothers who are African-American, percentage of mothers that are foreign-born, month of birth, percentage of mothers who are married	Restricted-use birth and death data from National Center for Health Statistics (NCHS)	Annual 1980-1999	Means taken for periods
Per capita hospital beds, per capita physicians	Area Resource File	Annual 1980-1999	Means taken for periods
Percent Hispanic, mean education levels	U.S. Census	1980, 1990, 2000	Linear extrapolation by county between Censuses, then means taken for Periods
Per capita income, farm employment	Bureau of Economic Analysis	Annual 1980-1999	Means taken for periods
Population density, percent of houses using well water, percent of houses using septic tanks	Census of Housing	1980, 1990, 2000	Linear extrapolation by county between Censuses, then means taken for Periods
Building permits	USA Counties, a publication of the U.S. Census Bureau	Annual 1980-1999	Means taken for periods
Percent of land	National Resource Inventory	1982, 1987, 1992, 1997	No modification
Temperature, precipitation	National Climactic Data Center	Annual 1980-1999	Means taken for periods
Clean Water Act permit	EPA's online Envirofacts Data Warehouse	Annual 1980-1999	Means taken for periods
Number of establishments in 15 other industries	County Business Patterns	Annual 1980-1999	Means taken for periods

Periods: 1980-1984, 1985-1989, 1990-1994, 1995-1999

Appendix A2: Supporting Figures and Regression Results

Figure A1:
Number of Livestock Farms, by Animal Type, 1930-1997

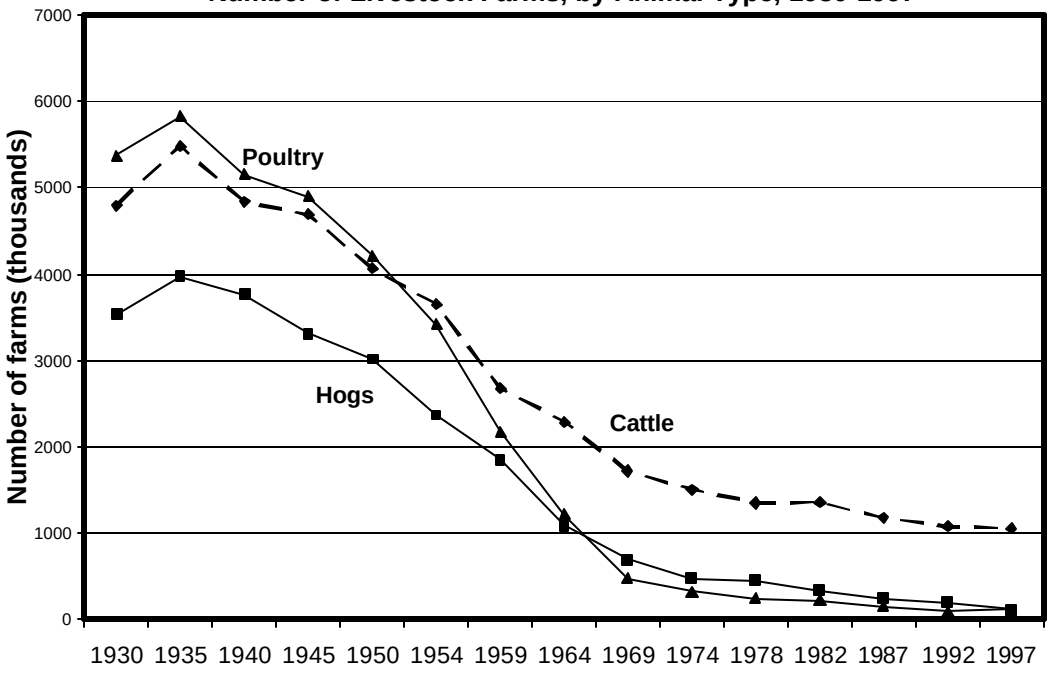

Figure A2:
Number of Livestock in Inventory, by Animal Type, 1930-1997

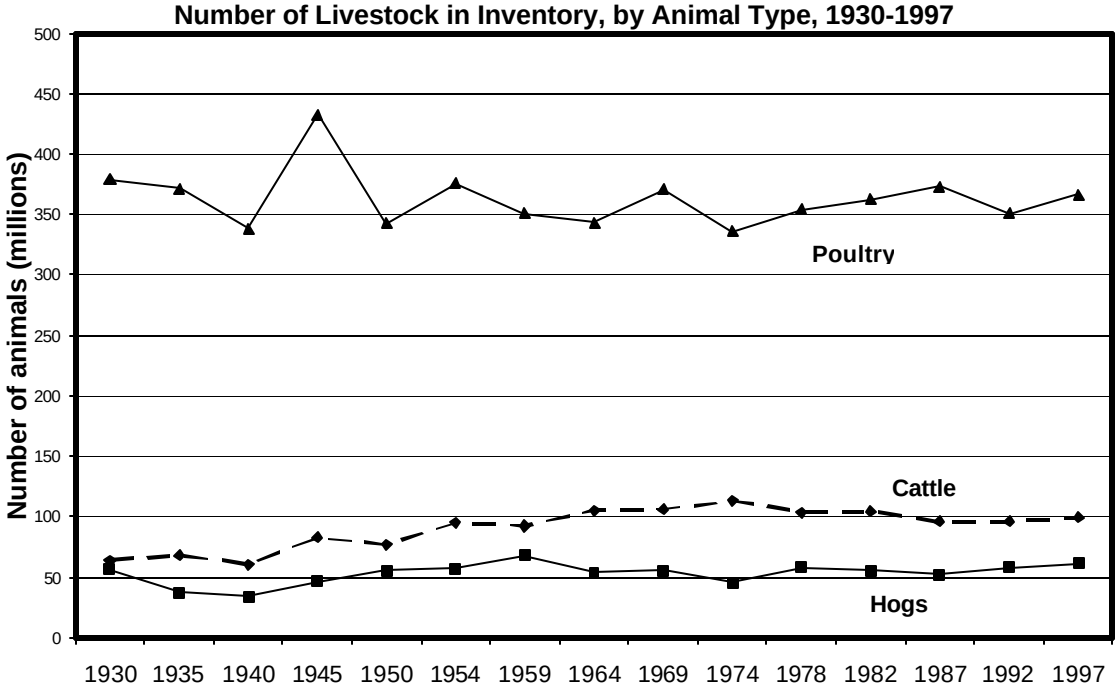

Table A2.1: Fixed Effect Regressions of Animal Units and IMR on Other Industries

	Dependent Variable	
Independent Variable	**Number of animal units (100,000)**	**IMR**
Accommodation and food services	-0.375	-3.839
	(0.139)*	(2.051)
Administrative support and waste management and remediation services	-0.427	-2.023
	-0.22	(3.140)
Agricultural, forestry, fishing, and hunting support	0.267	-1.072
	(0.325)	(4.300)
Arts, entertainment, and recreation	-0.088	-6.218
	(0.377)	(4.100)
Finance and insurance	-0.090	0.050
	(0.063)	(1.006)
Information	-0.107	-0.545
	(0.406)	(4.676)
Construction	-0.027	-0.113
	(0.038)	(0.605)
Health care and social assistance	0.267	0.796
	(0.099)*	(1.848)
Management of companies and enterprises	0.253	-1.228
	(0.159)	(3.678)
Manufacturing	-0.058	-1.106
	(0.043)	(0.465)*
Utilities	-1.093	-23.142
	(0.944)	(16.864)
Wholesale trade	-0.121	3.691
	(0.085)	(1.412)*
Professional, scientific, and technical services	0.090	1.664
	(0.067)	(0.852)
Retail trade	0.160	0.699
	(0.060)*	(0.867)
Transportation and warehousing	0.114	-4.903
	(0.284)	(3.745)
Controls for mother and birth? [a]	N	Y
County-level controls? [b]	Y	Y
Period, county, and state*time fixed effects?	Y	Y

Notes: Industry variables are thousands of establishments. IMR regression observations weighted by number of births. Robust standard errors shown in parentheses. Standard errors clustered by county. * refers to significance at the 5% level.

[a]Refers to percentage of mothers that are foreign-born, mother's race, mother's marital status, mother's age, mother's age squared, month of birth, percent of births occurring in hospitals, and average number of prenatal care visits.

[b]Refers to controls for log of per capita income, farm employment, county education levels, percentage of county that is Hispanic, population density, percentage of homes with well water, percentage of homes with septic tank, hospital beds per capita, physicians per capita, CWA permits, building permits, percentages of county in cultivated cropland, forest, rural transportation land, and other rural land, prcipitation, and temperature.

Table A2.2 Correlation between Log of Number of Animal Units and Log of Infant Mortality

Observations weighted by number of births in the county. Standard errors clustered by county.

	Dependent Variable					
	Model I	**Model II**	**Model III**	**Model I**	**Model II**	**Model III**
	Log(IMR)	**Log(IMR)**	**Log(IMR)**	**Log (Neonatal IMR)**	**Log (Neonatal IMR)**	**Log (Neonatal IMR)**
Log of animal units	0.207	0.078	0.074	0.233	0.095	0.074
	(0.034)*	(0.036)*	(0.030)*	(0.043)*	(0.047)*	(0.039)*
Average # prenatal visits		0.015	0.01		0.009	0.006
		(0.009)*	(0.009)		-0.011	(0.013)
Physicians per capita (1000)		-0.386	-0.384		-0.421	-0.417
		(0.167)*	(0.159)*		(0.215)*	(0.202)*
Log of per capita income		-0.261	-0.244		-0.314	-0.299
		(0.080)*	(0.084)*		(0.094)*	(0.098)*
Farm employment (/1000)		0.068	0.05		0.085	0.060
		(0.022)*	(0.022)*		(0.033)*	(0.036)*
Population density (/1000)		-0.297	-0.445		-0.314	-0.526
		(0.087)*	(0.132)*		(0.100)*	(0.157)*
% of homes with septic tank		0.174	0.144		0.348	0.255
		-0.172	(0.173)		-0.232	(0.234)
% of homes with well water		-0.826	-0.802		-1.044	-1.013
		(0.199)*	(0.198)*		(0.258)*	(0.260)*
Demographic controls?[a]	N	Y	Y	N	Y	Y
Controls for month of birth?	N	Y	Y	N	Y	Y
Other medical use controls?[b]	N	Y	Y	N	Y	Y
Land use covariates?[c]	N	Y	Y	N	Y	Y
Precipitation and temperature covariates?	N	Y	Y	N	Y	Y
CWA permits and building building permits covariates?	N	Y	Y	N	Y	Y
Other industry levels?[d]	N	N	Y	N	N	Y
Period fixed effects?	Y	Y	Y	Y	Y	Y
County fixed effects?	Y	Y	Y	Y	Y	Y
State*time controls?	N	Y	Y	N	Y	Y
R2	0.685	0.761	0.770	0.647	0.723	0.734
N	8,882	8,823	8,742	8,514	8,458	8,395

Notes: Observations weighted by number of births in the county. Robust standard errors shown in parentheses. Standard errors clustered by county. * refers to significance at the 5% level.

[a]Refers to controls for county education levels, percentage of county that is Hispanic, percentage of mothers that are foreign-born, mother's race, mother's marital status, mother's age, and mother's age squared.

[b]Refers to hospital beds per capita and percent of births occurring in hospitals.

[c]Refers to percentages of county in cultivated cropland, forest, rural transportation land, and other rural land.

[d]Refers to the number of establishments for 15 different industries; for listing see appendix.

Table A2.3: Sensitivity Analyses: Fixed Effect Regressions of Infant Mortality on Number of Animal Units

	Dependent variable					
	IMR	**IMR**	**IMR**	**Neonatal IMR**	**Neonatal IMR**	**Neonatal IMR**
Panel I: Sensitivity analysis 1 (One-year intervals)						
Number of animal units (100,000)	2.232 (0.614)*	1.598 (0.750)*	2.134 (0.731)*	1.732 (0.443)*	1.394 (0.587)*	1.712 (0.590)*
Demographic and socio-economic controls?[a]	N	Y	Y	N	Y	Y
Housing controls?[b]	N	Y	Y	N	Y	Y
Land use, precipitation, temperature, and permit covariates?[c]	N	Y	Y	N	Y	Y
Other industry levels?[d]	N	N	Y	N	N	Y
County fixed effects?	Y	Y	Y	Y	Y	Y
Period fixed effects?	Y	Y	Y	Y	Y	Y
State*period controls?	N	Y	Y	N	Y	Y
R-squared	0.581	0.675	0.688	0.569	0.664	0.678
Observations	9,860	9,141	8,881	9,860	9,141	8,881
Panel II: Sensitivity analysis 2 (Three-year intervals)						
Number of animal units (100,000)	1.84 (0.519)*	1.02 (0.637)	1.52 (0.625)*	1.396 (0.408)*	0.959 (0.481)*	1.244 (0.493)*
Demographic and socio-economic controls?[a]	N	Y	Y	N	Y	Y
Housing controls?[b]	N	Y	Y	N	Y	Y
Land use, precipitation, temperature, and permit covariates?[c]	N	Y	Y	N	Y	Y
Other industry levels?[d]	N	N	Y	N	N	Y
County fixed effects?	Y	Y	Y	Y	Y	Y
Period fixed effects?	Y	Y	Y	Y	Y	Y
State*period controls?	N	Y	Y	N	Y	Y
R-squared	0.618	0.714	0.731	0.601	0.7	0.716
Observations	9,860	9,142	8,970	9,860	9,142	8,970

Notes: Observations weighted by number of births in the county. Robust standard errors shown in parentheses. Standard errors clustered by county. * refers to significance at the 5% level.

[a]Refers to average number of prenatal visits, physicians per capita, hospital beds per capita, percent of births occurring in hospitals, log of per capita income, farm employment, population density, controls for county education levels, percentage of county that is Hispanic, percentage of mothers that are foreign-born, mother's race, mother's marital status, mother's age, mother's age squared, and month of birth.

[b]Refers to percentage of county with well water and percentage with septic tank.

[c]Refers to mean county temperature, mean county precipitation, existence of Clean Water Act permit in county, number of average annual building permits, cultivated cropland, forest, rural transportation land, and other rural land.

[d]Refers to the number of establishments for 15 different industries; for listing see appendix.

Table A2.4 Fixed Effect Regressions of Infant Mortality Rate on Number of Animal Units, by Size of County

Dependent variable: Infant Mortality Rate

	Entire sample	Small counties	Large counties
Number of animal units (100,000)	1.232	2.516	0.698
	(0.485)*	(1.591)	(0.469)
Demographic and socio-economic controls?[a]	Y	Y	Y
Housing controls?[b]	Y	Y	Y
Land use, precipitation, temperature, and permit covariates?[c]	Y	Y	Y
Other industry levels?[d]	Y	Y	Y
County fixed effects?	Y	Y	Y
Period fixed effects?	Y	Y	Y
State*period controls?	Y	Y	Y
R-squared	0.759	0.771	0.795
Observations	9,012	4,487	4,525

Notes: A "small county" refers to a county of less than 610 square miles. A "large county" refers to a county of 610 or greater square miles. Observations weighted by number of births. Robust standard errors shown in parentheses. Standard errors clustered by county. * refers to significance at the 5% level.

[a]Refers to average number of prenatal visits, physicians per capit a, hospital beds per capita, percent of births occurring in hospitals, log of per capita income, farm employment, population density, controls for county education levels, percentage of county that is Hispanic, percentage of mother's that are foreign-born, mother's race, mother's marital status, mother's age, mother's age squared, and month of birth.

[b]Refers to percentage of county with well water and percentage with septic tank.

[c]Refers to mean county temperature, mean county precipitation, existence of Clean Water Act permit in county, number of average annual building permits, cultivated cropland, forest, rural transportation land, and other rural land.

[d]Refers to the number of establishments for 15 different industries; for listing see appendix.

Table A2.5 Fixed Effect Regressions of Infant Mortality Rate on Number of Animal Units per Square Mile

Dependent variable: Infant Mortality Rate

	Model		
	(I)	**(II)**	**(III)**
Number of animal units per square mile	0.029	0.020	0.019
	(0.005)*	(0.005)*	(0.005)*
Demographic and socio-economic controls?[a]	N	Y	Y
Housing controls?[b]	N	Y	Y
Land use, precipitation, temperature, and permit covariates?[c]	N	Y	Y
Other industry controls?[d]	N	N	Y
County fixed effects?	Y	Y	Y
Period fixed effects?	Y	Y	Y
State*period controls?	N	Y	Y
R-squared	0.677	0.752	0.759
Observations	9,208	9,134	9,012

Notes: Observations weighted by number of births. Robust standard errors shown in parentheses. Standard errors clustered by county. * refers to significance at the 5% level.

[a]Refers to average number of prenatal visits, physicians per capita, hospital beds per capita, percent of births occurring in hospitals, log of per capita income, farm employment, population density, controls for county education levels, percentage of county that is Hispanic, percentage of mothers that are foreign-born, mother's race, mother's marital status, mother's age, mother's age squared, and month of birth.

[b]Refers to percentage of county with well water and percentage with septic tank.

[c]Refers to mean county temperature, mean county precipitation, existence of Clean Water Act permit in county, number of average annual building permits, cultivated cropland, forest, rural transportation land, and other rural land.

[d]Refers to the number of establishments for 15 different industries; for listing see appendix.