An Analysis of Local Benefits And Costs of Michigan Hog Operations Experiencing Environmental Conflicts

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PREFACE

This report was based on an M.S. Thesis by Mark Abeles-Allison in the Department of Agricultural Economics at Michigan State University. The study was made possible through the support of various individuals and organizations. Financial support was provided through the Michigan Agricultural Experiment Station. Christine Lietzau of the Michigan Department of Agriculture assisted in providing information on livestock farms. Township governments provided information on property and neighborhood characteristics relating to areas associated with hog operations. Christine Lietzau, Gerald Schwab, Howard Person and Maynard Hogberg reviewed the initial draft of the report and offered constructive comments. The results and conclusions of the study remain the responsibility of the authors.

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SUMMARY

This report examines local benefits and costs associated with hog operations for which odor complaints had been received in Michigan. A regression analysis approach was used to determine the implicit prices of hog odors on property values. Property values were regressed against household and neighborhood characteristics of residential properties surrounding these hog farms. The benefit/cost ratios for a 500 and 5,000 head hog operations in a township with a $20 million State Equalized Valuation (SEV) are 5.64 and 3.86 respectively. The study indicates that the ratio of benefits to costs increase (improve) as SEV declines. This means that damages are dependent upon property value. As the amount of property value in the area declines, damages decline.

This study investigated over 300 residences surrounding eight hog operations that received multiple odor complaints in the first 9 months of 1989. Results indicate that in a township with an SEV of $20 million, a 500 head hog operation spends an estimated $33,545 in hog operation inputs locally in one year. That same 500 head operation will reduce property tax receipts by $5,937. A 5,000 head hog operation will spend $229,347 locally in one year, while property tax receipts drop by $59,375.

Results further indicate that locating residential properties further away from hog operations reduces property tax losses substantially. The study also shows that while all sizes of problem livestock operations have a negative impact on property values, larger hog operations have a greater impact than do smaller ones.

This report's focus on local benefits and costs recognizes both township jurisdictions and the localized nature of many livestock manure management cases. It does not however, attempt to determine what level of benefits and costs is acceptable to a community. The report concludes with some suggestions for local governments and livestock operators.

An Analysis of Local Benefits and Costs of Michigan Hog Operations Experiencing Environmental Conflicts

By
Mark Abeles-Allison
Larry J. Connor (1)
INTRODUCTION

Since the 1970's, environmental legislation impacting current livestock farming practices has been slowly developing. Stricter state and federal environmental regulations affecting all sectors of the economy have passed legislatures. Agriculture was less affected by these laws, in part because of its decentralized nature, location in more sparsely populated areas, and it's role of providing a basic necessity - food.

Over this same period of time, technological advances in the livestock sector have become more widely used. Intensive livestock operations, characterized by higher animal densities, confinement systems, and higher volumes of animal manures per site are today more common. They have also successfully maintained relatively stable meat prices for the consumer. Intensive livestock production has clashed with an already high and rapidly expanding rural population level in some areas of Michigan, due in part to urban sprawl.

Some township governments are attempting to stop some new or expanding livestock operations in their communities in response to complaints about odors, flies, potential water contamination and manure on the road. In the past decade, township governments have begun to exercise land use controls guaranteed under the state constitution. These controls or ordinances can prohibit new livestock operations from entering a township or an existing operation from expanding.

(1) The authors are former graduate assistant and Professor respectively, in the Department of Agricultural Economics, Michigan State University, East Lansing, MI.

Land use decisions involve political, social and economic considerations. As this method of controlling livestock operations becomes more popular, it is important to understand the ramifications of these decisions. This report examines only the economic benefits and costs of hog operations. This research investigated 8 hog farms in Michigan and their impact on local communities. These farms had multiple odor complaints filed against them over a period of several months and, in some cases, years.

OBJECTIVES

The objectives of this research were to investigate the local economic benefits and costs of hog operations subjected to complaints. The focus on local benefits and costs recognized both townships' jurisdictions and the localized nature of livestock manure management cases. The following questions are addressed in this report:
1. Do hog operations with multiple odor complaints have a negative impact on residential property values? If so, how much?

2. Do communities surrounding hog operations receive economic benefits? If so, how much?

3. Do the benefits communities receive from a hog operation outweigh the loss in local taxes resulting from a decline in property values?

LITERATURE REVIEW

This study involved benefit/cost analysis and the use of a hedonic price model to determine cost estimates for hog operations. These topics are discussed below.

Benefit/Cost Analysis

Benefit/cost analysis can be used to examine benefits and costs associated with regulatory changes. It considers numerous impacts occurring as results of different decisions. Benefit/cost analysis is a tool to provide information to decision makers. Many environmental studies use this tool.

Past studies (Connor 1971, Forster 1975), involving livestock and the environment have focused upon state and federal, air and water regulations. These economic studies estimate the cost of on-farm improvements for the farmer, balanced with the benefits of a "cleaner" environment, if more stringent regulations are enforced.

Several livestock studies discuss the concept of an "acceptably clean" environment (Connor 1971). Choosing a particular level of "clean" will influence producer costs and thus consumer prices. Selected pollution control measures including runoff control and increased manure storage capacity required additional capital outlays and increased annual costs per head of livestock (Forster 1975).

Finding Prices

The regression analysis used in this study, known as hedonic price analysis, attempts to find prices for non-market goods. In this study, environmental factors, specifically odors, are hypothesized to affect residential property values. Hedonic studies look at the impacts of changes in environmental quality on property values. Past studies of this type generally show that there is a positive relationship between environmental quality and property values.
REGULATORY ANALYSIS

Forty nine states have adopted Right to Farm legislation in response to farmland conversion to non-agricultural use. The vast majority were accepted after 1978. These statutes help to ensure that "a farm cannot be considered a nuisance simply because the use of surrounding land has changed" (Bahls 1989).

Michigan has added an additional requirement that certain generally accepted management practices be adopted before protection under the law is assured. For livestock operations this includes "manure management practices for land applications and odor control and water quality protection measures" (Hamilton 1989). When responding to a livestock complaint, the Environmental Division of the Michigan Department of Agriculture will investigate the farm in question to determine whether the farm is in compliance with generally accepted agricultural management practices pursuant to their guidelines.

Nation-Wide Cases

Nuisance suits are not uncommon in the United States. Several cases have attracted national attention due to media coverage.

Colorado

A case in Colorado involves National Farms of Kansas City and some influential and wealthy neighbors. National Farms is constructing a 300,000-350,000 head farrow-to-finish hog operation valued at 40 million dollars (Hog Farm Management; "National Farms Proceeds," p. 34-35, September, 1989). A local conservation organization along with the Farmers Union object to potential water and odor impacts in addition to corporate farming in the state. Opponents site environmental issues as their key concern, despite compliance by National Farms with state and local laws. The quantity of liquid waste generated is estimated by opponents to reach 2.5 million gallons a day when the operation is running at full capacity.

Missouri

In Missouri several smaller, family owned operations are contesting a series of nuisance cases filed against them (Hog Farm Management; "Bad Blood at Concord Hill," p. 10-20, March, 1989). The Missouri hog operations range in size from 2,500-7,000 head. In one case problems began when the hog operators switched to a confinement system. Five neighbors located one mile from the operation have complained about "intolerable" odors. The complaints have resulted in litigation to solve the problem. Missouri farmers have formed a support group called the Producers Rural Protection Association. Farmers pay membership dues
of 10 dollars a year and 25 cents per hog sold to assist other farmers with nuisance suits.

Michigan

The Michigan Department of Agriculture has received complaints about operations ranging in size from one to over 10,000 hogs (See Table 1). As might be expected, the number of odor complaints about operations over 500 head is greater than for those less than 500 head. Of the 29 odor and water complaints reported in the first six months of 1989, at least 10 were for operations over 500 head. According to the Michigan Census of Agriculture there were approximately 670 operations with over 500 head in 1987 (Census of Michigan Agriculture 1987). These 10 complaints equal 1.5 percent of all large operations. The remaining 19 complaints amounted to .03 percent of operations under 500 hogs.

METHODOLOGY

Information on costs and benefits were gathered from a variety of sources. The following sections summarize these sources.

Benefits

Hog farm benefits were based on information from a "Business Analysis Summary For Swine Farms" (Schwab 1985). The percentage of hog farm input purchases made locally was estimated based upon industry practices and discussions with industry participants.

The amount spent to produce each hog includes feed, feed supplements, feed processing, labor, energy, machinery, improvements, livestock expenses, land charges and other miscellaneous items. Figure 1 (Vis. 1) and Figure 2 (Vis. 2) show input expenses for hog operations under 200 and over 200 litters. The graphs show that feed and feed supplement are the two largest input items. Although total input costs are less for larger operations, the distribution of expenses is very similar.

Figure 3 (Vis. 3) is also based upon discussions with hog industry participants (extension specialists and marketing magazines). It shows the relationship between size of operation and hypothesized local purchases. The figure includes the eight categories of input purchases. Since little research is available documenting the location of purchases by livestock operations, purchasing practices and production information were used to estimate the amount of local purchases.

As operations increase in size, local expenditures per hog steadily decline. This is especially true in the feed supplement category as pecuniary economies of size make it
advantageous to buy entire truck loads direct from the manufacturers, in most cases not located in the local community. The graph in Figure 3 (Vis. 3) shows local expenditures to vary between $67 per hog for a 500 head operation, and $46 per hog for a 5000 head operation.

Costs

A livestock complaint tabulation for the first nine months of 1989 was compiled with the assistance of the Michigan Department of Agriculture (Table 1). This tabulation revealed what types of livestock operations received what complaints and what complaint types were most common (2). From this tabulation, 8 hog farms receiving odor complaints were chosen based upon the number of animals, the number of complaints registered and the availability of sales information in order to determine the impact upon property values and, thereby property taxes. A five square mile block was marked on plat maps surrounding each of these farms. A listing of residential sales over the years 1986-1989 in these marked areas was obtained from county equalization offices. Visits to township offices in the selected areas were made to collect property and neighborhood characteristics of the property sold (see the following pages).

(2) Michigan Department of Agriculture, 1989

The individual house sale prices were then regressed against hog farm, property and neighborhood characteristics. The purpose was to determine whether the farm characteristics, number of animals, distance of the house from the farm or wind direction influenced sale price of houses. In total, information on over 300 house sales was collected.

Property Characteristics:
Square footage
Type of construction
Year of Construction
Air Conditioning
Number of baths
Fireplace
Classification
Month of sale
Year of Sale
Vacant lot
Garage
Mobile Home

Neighborhood Characteristics:
Distances to central business district
Distance to highway
type of road
Wind direction
Distance to farm
LIVESTOCK OPERATION BENEFITS

<table>
<thead>
<tr>
<th>COMPLAINT TYPE</th>
<th>TYPE OF FARM</th>
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<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>DAIRY</td>
<td>BEEF</td>
<td>HOGS</td>
<td>POULTRY</td>
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<td>TOTALS</td>
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<td>32</td>
<td>14</td>
<td>50</td>
<td>9</td>
<td>10</td>
<td>115</td>
</tr>
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</table>

Table 1. Livestock Complaint Tabulation for Michigan

In 1986 hog operations in Michigan purchased over $153 million in inputs, employed 5,600 meat packing workers in pork related activities and generated $292.7 million in direct and indirect outputs (Otto 1987).

Revenues from processing hogs and selling pork do not usually benefit the community in which they are raised. However, a portion of input purchase dollars, in addition to producers income, are returned to the communities where animals originate.

Local Input Purchases

In 1985, input costs to raise a hog from birth to 230 lbs. were $104.44 for operations with under 200 litters and $96.46 for operations with over 200 litters (Schwab 1985). The estimate of local purchases as a percent of input costs are 64 percent for a 500 head operation and 46 percent for a 5000 head operation respectively. As operations increase in size, off-farm service requirements diminish as do fixed costs per hog. Larger operations will spend more in total dollars in their community. The input expenditure per hog declines as economies of management and size are attained (See Figure 4)(Vis. 4). Local expenditures per hog are estimated at $67.09 for small operations (under 200 litters) and $45.87 for larger operations (over 200 litters). Estimated local
expenditures for small and large hog operations are as follows:

<table>
<thead>
<tr>
<th>Operation</th>
<th>Total Expenditures</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Head</td>
<td></td>
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<tr>
<td>500</td>
<td>$33,545</td>
</tr>
<tr>
<td>5000</td>
<td>$229,357</td>
</tr>
</tbody>
</table>

Table 2. Local Input Expenditures by size of Operation

LIVESTOCK OPERATION COSTS

An hedonic property value model was used to estimate losses in property tax receipts at the township level due to hog operations. Regressions with property sale price as the dependent variable and property, neighborhood and environmental characteristics as independent variables were run. Linear and log-linear functional forms were used. Regression coefficients were used to calculate property value and township tax receipt losses. Three sets of regression equations were used in this analysis. These are briefly discussed below.

Impact on Property Price

The first regression in this set is used to generate the implicit cost of an additional hog on property value (See Table 3). The coefficient of the ANIMAL variable indicates the change in property price for each additional hog. Several variables were removed from the original model specification due to lack of significance. Specifically, these include month of sale, year of sale, type of road, age of house, whether the land has a house on it, air conditioning and property classification. Regression #1 coefficients and statistical measures are shown in Table 3. Variables with significant t-statistics at the 95 percent level are bolded. The key for the variable names follows the regression.

The important explanatory variable in this model is ANIMAL. The negative .43 coefficient means that for every hog added to the area, value for each property in the entire survey area declines 43 cents (3). Using this approach, one thousand hogs result in a drop of $430 in property value on a single property.

Several other variables in the model were utilized for explanatory purposes. DIST, distance from the house to the operation, and WIND, prevailing wind directions, were put in the model because of their relation to odor transfer.

(3) A five mile radius around the farm.
Table 3. Hog Impact Model Set #1.

The coefficient of distance from the hog farm was expected to be positive. According to this hypothesis, property owners who lived farther away should have higher property values, all other things held equal. The coefficient for wind direction was expected to be negative. Property owners located directly downwind of a hog operation were expected to have lower property values, assuming all other things are held constant than those upwind. Properties directly downwind were assigned a value of 180 degrees, while those directly upwind were assigned 0 degrees. All of these variables except WIND had the expected signs. Explanations for why WIND was positive might be because prevailing wind directions have changed, that odor is not the effect being detected or that property value declines are the result of perceived as opposed to actual odor damages.

Log-Linear Modification

In the regression above the coefficient on ANIMAL suggests that for every additional hog, property values decline 43 cents. This assumes that impacts are constant across all properties regardless of the value of the property. The log-linear form allows for the property, neighborhood and environmental characteristics to be valued as a percent of property price. While the percent is fixed, the total damages will vary depending upon the value of the property. In the log-linear regression (see Appendix Table 2) the variables significant in regression set # 1 stay
significant. The only change is a slight drop in the adjusted $R^2$. The coefficient for the ANIMAL variable is -.000171. This is a -.00171 percent impact of an additional hog on a property. For example: a property valued at $100,000, would be impacted $1.7 for each hog.

Set #2. Large vs. Small Operations

Odor complaints about hogs involve operations of all sizes. Many of the serious complaints, involving litigation and multiple complaints, are against operations over 500 animals. The eight cases in this study include three small operations, under 150 head, and five large operations, over 3000 head. Both regressions in Set #1 combined large and small operations. While livestock specialists argue that poor management at any size of farm can cause environmental damages, the next section examines whether small and large farm impacts on property price are the same.

Of the 288 observations, 67 were from small operations and 221 were from larger operations. Using the same variables as those used in Regression #1, Regressions #2 and #3 were run for the small and large groups. Several interesting changes occur when examining only the small operation areas. First, several of the more robust variables, BATH, FIRE, GAR and CBD are no longer significant. Most noteworthy is the loss in significance of the t-statistic for the ANIMAL variable. The large operation regression is very similar to regression #1 with all 288 observations (see Appendix Table 3).

Set #3. Distance Calculations

Based on the fact that the majority of hog odor complaints come from neighbors, the negative coefficient on the DIST variable found in Regression #1 is confusing. In order to re-test the importance of distance from the farm in determining damages, the observations were sorted by DIST in ascending order. This permitted three regressions to be performed on the first, second and third hundred observations corresponding to progressively greater distances from the farm.

Three regressions using the same variables as in Regression #1 were run. The first regression included properties up to 1.6 miles away from the farm, the second regression included properties between 1.6 and 2.3 miles away and the last regression included properties between 2.3 and 3.5 miles away.

The results confirmed the importance of distance in measuring impacts on property values. The coefficient of the ANIMAL variable in the regression with the closest properties is -1.74. This is nearly four times the ANIMAL coefficient in Regression #1. The coefficients for ANIMAL
in the second two regressions were -.53 and -.13, respectively. The reduction of the coefficients value suggests that properties values farther away from hog operations are clearly less affected than those nearby. Of particular interest is the progressive decrease in the ANIMAL coefficient significance level as distance increases. The significance level of the ANIMAL coefficient moves from -2.7, to -1.6, to .59, as distance increases. These steady declines in t-statistic levels are evidence of the very localized impacts of hog operations.

CALCULATING LOSSES

In order to determine property tax losses, residential State Equalized Valuations (SEVs) in a township are multiplied by the log-linear ANIMAL coefficient, -.0000171. In this case the residential SEV for the township is divided by the number of sections in the township and multiplied by 25 sections, the survey area in this study. This averages the residential SEV for each section based on the total residential SEV in the township.

For example, the impact of a new hog operation with 500 hogs in a 36 section township with a 20 million dollar SEV would be calculated as follows.

\[
\frac{20,000,000}{36 \text{ sections}} \times 25 \text{ sections} \times 500 \text{ hogs} \times -0.0000171 = 118,750
\]

This produces a loss in residential SEV of $118,750. This must then be multiplied by the given township tax rate, 50 mills(4). The resultant impact is $5,937 in lost revenues for the local government. A 5000 head operation in this same township would cause a loss in tax revenue of $59,375.

LIVESTOCK OPERATION BENEFIT/COST RATIO

Table 4 summarizes the above findings by analyzing the benefit/cost ratios for two sizes of operations. Calculations are for a 36 section township with an SEV of $20 million and tax rate of 50 mills. The benefit/cost ratio means (in the case of a 500 head operation) that for every five dollars and sixty four cents in community benefits, one dollar of lost property tax receipts is incurred. The net dollar effect is the benefits minus costs.

(4) This includes K-12 intermediate school districts, township, county and special assessments. 50 mills is an average.
Table 4. Benefit/Cost Ratio for two Sizes of Operations.

Costs are determined by the number of animals and the amount of real property in the township. In order to see how sensitive the ratio is to declines in local input purchases by hog farmers, Table 5 examines what would happen if local input purchases dropped to 30 percent of total input purchases from the 47 percent and 64 percent levels used above.

Table 5. Benefit/Cost Ratios Assuming 30% Local Purchases

Even when input purchases decline to 30% as in Table 5, the benefit/cost ratio remains positive. The point where benefits equal costs (where the benefit/cost ratio = 1) occurs when property values in a township are high enough so that property tax losses surpass local input purchases. Table 6 shows this occurring at SEV levels far above what would typically be found in an agriculturally oriented township. Calculations are for a 36 section township with an SEV of $112,000,000 and $77,000,000 and a tax rate of 50 mills.

Table 6. Benefit/Cost Breakdown Levels

SIGNIFICANCE OF FINDINGS

Estimates of "benefits" from local hog operation input purchases exceed property tax receipt "costs" by at least two and as many as five times.(5) The benefit/cost ratio would undoubtedly be higher for hog operations for which no odor complaints had been received. As distance of houses from a hog operation increase, costs decline. Larger operations appear to be more strongly correlated with reductions in property receipts than do small ones.

(5) In a township with 36 sections and an SEV of $20
Township officials and community members make deliberate decisions that affect the composition and success of their community when establishing informal policies or passing ordinances or regulations. Hog operations may make important economic contributions to rural townships. They may also create problems for township officials because of increased local apprehension about odors, potential water contamination, and so forth. Hence, important tradeoffs must often be made when evaluating the contribution of these operations to the well-being of the community. Local zoning and land use ordinances are important in minimizing potential conflicts between hog farmers and their farm and non-farm neighbors. They may prevent potential conflicts by limiting or minimizing the contacts and interactions between these groups. However, zoning is a preventative measure for potential future land use conflicts. It is a relatively ineffective measure for resolving existing conflicts between hog farmers and their neighbors. Existing local conflicts pertaining to operating hog farms, operations desiring to expand, or to new operations usually have to be resolved using other measures. Township officials may:

1. Refer hog farmers to the Cooperative Extension Service and/or the Soil Conservation Service for advice and counsel on farming practices and facilities.

2. Negotiate community support for hog operations in exchange for appropriate manure handling technology adoption by farmers.

3. Serve as a moderator and facilitator in getting hog farm operators and complainants together to solve their problems.

4. Help producers secure low interest loans for adopting manure handling technology.

5. Refer the problems to the state level (Michigan Department of Agriculture) for review and handling.

How townships handle these manure management problems of hog farmers will impact the vitality of both the Michigan hog industry and of townships in many areas of Michigan.
### Appendix Table 1. Regression of Hog Impact Model.(1)

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>STD. ERROR</th>
<th>T-STAT.</th>
<th>2-TAIL SIG.</th>
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<td>0.9188</td>
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R-SQUARED          0.658532 Mean of dependent var 46506.55
Adjusted R-squared 0.643631 S.D. of dependent var 32214.51
S.E. of regression 19230.98 Sum of squared resid 1.02E+11
Durbin-Watson stat 1.951999 F-statistic 44.19547
Log likelihood    -3242.915

(1) Dependent Variable is PRICE. Number of observations equals 288

### Appendix Table 2. Regression of Log-Linear Hog Farm.(2)

<table>
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<tr>
<td>FEET</td>
<td>0.0008264</td>
<td>0.0001307</td>
<td>6.3227</td>
<td>0.000</td>
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<tr>
<td>BRICK</td>
<td>0.0508212</td>
<td>0.0390695</td>
<td>1.3008</td>
<td>0.193</td>
</tr>
<tr>
<td>BATH</td>
<td>0.3538208</td>
<td>0.1008526</td>
<td>3.5083</td>
<td>0.000</td>
</tr>
<tr>
<td>FIRE</td>
<td>0.1010718</td>
<td>0.0918466</td>
<td>1.1004</td>
<td>0.271</td>
</tr>
<tr>
<td>GAR</td>
<td>0.3395627</td>
<td>0.1087390</td>
<td>3.1227</td>
<td>0.002</td>
</tr>
<tr>
<td>MOBIL</td>
<td>-0.4663255</td>
<td>0.2106146</td>
<td>-2.2141</td>
<td>0.027</td>
</tr>
<tr>
<td>CBD</td>
<td>0.0059882</td>
<td>0.0030147</td>
<td>1.9896</td>
<td>0.047</td>
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<td>WIND</td>
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<td>0.0022848</td>
<td>0.4529</td>
<td>0.651</td>
</tr>
<tr>
<td>DIST</td>
<td>0.0007884</td>
<td>0.0078379</td>
<td>0.1006</td>
<td>0.920</td>
</tr>
<tr>
<td>INTER</td>
<td>-5.359E-05</td>
<td>8.805E-05</td>
<td>-0.6086</td>
<td>0.543</td>
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<tr>
<td>ANIMAL</td>
<td>-1.710E-05</td>
<td>6.723E-06</td>
<td>-2.5435</td>
<td>0.011</td>
</tr>
</tbody>
</table>

R-SQUARED          0.634597 Mean of dependent var 10.35054
Adjusted R-squared 0.624351 S.D. of dependent var 1.088452
S.E. of regression 0.672156 Sum of squared resid 124.2431
Durbin-Watson stat 1.917618 F-statistic 39.79945
Log likelihood    -287.5906

(2) Dependent variable is LOPRIC. Number of observations equals 288
Appendix Table 3. Regression of Small Hog Operations.

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>STD. ERROR</th>
<th>T-STAT.</th>
<th>2-TAIL SIG.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>7071.4985</td>
<td>37995.318</td>
<td>0.1861150</td>
<td>0.853</td>
</tr>
<tr>
<td>ACRE</td>
<td>466.41338</td>
<td>613.25547</td>
<td>0.7605532</td>
<td>0.450</td>
</tr>
<tr>
<td>FEET</td>
<td>31.163358</td>
<td>9.6411987</td>
<td>3.2323115</td>
<td>0.002</td>
</tr>
<tr>
<td>BRICK</td>
<td>12778.035</td>
<td>8496.0899</td>
<td>1.5039901</td>
<td>0.138</td>
</tr>
<tr>
<td>BATH</td>
<td>5140.5256</td>
<td>7603.0097</td>
<td>0.6761172</td>
<td>0.502</td>
</tr>
<tr>
<td>FIRE</td>
<td>-20.569418</td>
<td>6400.1497</td>
<td>-0.0032139</td>
<td>0.997</td>
</tr>
<tr>
<td>GAR</td>
<td>3083.6083</td>
<td>6848.1847</td>
<td>0.4502811</td>
<td>0.654</td>
</tr>
<tr>
<td>CBD</td>
<td>317.70723</td>
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<td>DIST</td>
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<td>1337.6046</td>
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</tr>
<tr>
<td>WIND</td>
<td>2.3588291</td>
<td>463.07368</td>
<td>0.0050939</td>
<td>0.996</td>
</tr>
<tr>
<td>INTER</td>
<td>-0.5582432</td>
<td>0.3639765</td>
<td>-1.5337342</td>
<td>0.131</td>
</tr>
</tbody>
</table>

R-SQUARED 0.666568 Mean of dependent var 42733.78
Adjusted R-squared 0.599882 S.D. of dependent var 30761.84
S.E. of regression 19458.38 Sum of squared resid 2.08E+10
Durbin-Watson stat 1.632711 F-statistic 9.995563
Log likelihood -750.1515

(3) Dependent Variable is PRICE. Number of observations equals 6

Appendix Table 4. Regression of Large Hog Operations.

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>STD. ERROR</th>
<th>T-STAT.</th>
<th>2-TAIL SIG.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>5433.9196</td>
<td>6314.1740</td>
<td>0.8605907</td>
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<tr>
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<td>307.49570</td>
<td>180.48823</td>
<td>1.7036883</td>
<td>0.088</td>
</tr>
<tr>
<td>FEET</td>
<td>14.071166</td>
<td>4.3462261</td>
<td>3.2375597</td>
<td>0.001</td>
</tr>
<tr>
<td>BRICK</td>
<td>1451.8969</td>
<td>1154.6557</td>
<td>1.2574284</td>
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</tr>
<tr>
<td>BATH</td>
<td>13322.437</td>
<td>3310.4066</td>
<td>4.0244109</td>
<td>0.000</td>
</tr>
<tr>
<td>FIRE</td>
<td>12752.374</td>
<td>3099.9669</td>
<td>4.1137129</td>
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</tr>
<tr>
<td>GAR</td>
<td>12556.568</td>
<td>3641.5930</td>
<td>3.4480976</td>
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<tr>
<td>MOBIL</td>
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<tr>
<td>CBD</td>
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<td>103.69530</td>
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</tr>
<tr>
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<td>241.96962</td>
<td>-0.0017636</td>
<td>0.999</td>
</tr>
<tr>
<td>WIND</td>
<td>74.811294</td>
<td>68.013649</td>
<td>1.0999453</td>
<td>0.271</td>
</tr>
<tr>
<td>INTER</td>
<td>-3.0794351</td>
<td>2.6939970</td>
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<td>0.253</td>
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<td>0.2372246</td>
<td>-2.0485938</td>
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</tr>
</tbody>
</table>

R-SQUARED 0.659417 Mean of dependent var 47650.33
Adjusted R-squared 0.639768 S.D. of dependent var 32623.43
S.E. of regression 19580.36 Sum of squared resid 7.97E+10
Durbin-Watson stat 1.892945 F-statistic 9.995563
Log likelihood -2490.155

(4) Dependent variable is PRICE. Number of variable equals 221.
BIBLIOGRAPHY


Bahls, Steven C. and Bahls, Jane E., "Is Your Farm a Nuisance?", Hog Farm Management, March 1989.


Michigan Agricultural Statistics Service, Michigan


Figure 1. Hog Operation Input Costs For Farms UNDER 200 Litters. Total input costs equal $104.44 per hog for this size operation (Schwab 1985).

Figure 2. Hog Operation Input Costs For Operations OVER 200 Litters. Total input costs equal $96.46 per hog for this size operation (Schwab 1985).
Figure 3. Total Local Expenditures By Size of Operation (Abeles-Allison 1990).

Figure 4. Estimated Local Hog Input Expenditures in thousands of dollars. For all operations up to 5000 head (Abeles-Allison 1990).