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AN ANALYSIS OF LOCAL BENEFITS AND COSTS ASSOCIATED WITH HOG OPERATIONS IN MICHIGAN

By

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ABSTRACT

AN ANALYSIS OF LOCAL BENEFITS AND COSTS ASSOCIATED WITH HOG OPERATIONS IN MICHIGAN

By

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This report examines local benefits and costs associated with hog operations in Michigan. A regression analysis approach was used to determine the implicit costs of hog odors on property values. Property values were regressed against household and neighborhood characteristics of residential properties surrounding the hog farms. Local input purchases by hog operations are compared with reductions in property tax receipts as recorded by the local government. The benefit/cost ratios are positive in the case of 500 and 5000 head operations.

This study investigated over 300 residences surrounding eight hog operations that received multiple odor complaints. Results indicate that in a township with an SEV of $20 million, a 500 head hog operation purchases $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 purchase $229,347 locally in one year, while property tax receipts drop by $59,375.

to Lisa, Linda, Jeanette and Norman

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ISSUE IDENTIFICATION

1.1 Introduction

As far back as the 1400s in England, neighbors protested when nearby land owners began to raise pigs. Controlling odors from wafting across property lines was difficult. Lawsuits seeking abatement and damages flourished[1]. Today the situation has changed only slightly. While pigs and hogs are still associated with "noxious" odors, larger operations, urban sprawl, and increasing environmental awareness have revitalized this age old dilemma. In addition, local governments, under the authority of the township zoning act of 1943[2] and the Environmental Response, Compensation, and Liability Act[3] have begun enacting ordinances to control the size and

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[1]Roberts, E. F., The Law and the Preservation of Agricultural Land, Cornell University, Ithaca, New York, p. 7, 1982.

[2]Michigan Department of Agriculture, "Preliminary Report of the Animal Waste Resource Committee", p. 13, August 1987.

[3]Also known as Superfund.

location of hog operations. This thesis examines the benefits from hog operation purchases on local economies and the costs measured by impacts on property values. The information in this thesis may aid local government decision makers when considering specific zoning and planning situations involving livestock operations.

This chapter briefly outlines the circumstances affecting livestock operations in Michigan, including farming and environmental trends, legal actions and local government involvement. The chapter concludes with a statement of the research problem, hypotheses to be tested and an overview of the remaining chapters.

1.2 Farming Trends

The 1980s was a decade of change. Beginning in the early 1980s a major deterioration of farm finances occurred in Midwest Agriculture. Reductions in net farm incomes and land values led to increases in debt-to-asset ratios and accelerated farm bankruptcies. As a result of the farm debt crisis, the number of full time farmers has diminished and the number of part-time farmers increased. While this trend in farm numbers has been evident for over 50 years the 1980s saw unprecedented declines and significant structural changes in farm production. In the livestock sector, the emergence of some large, intensified farming operations characterized primarily by expert management and advanced technologies was the result. Slaughtering and processing plants have followed this same trend towards intensification. These larger operations utilize economies of size to provide expert management[4].

1.2.1 Livestock Operations

Like other farm enterprises, livestock operations have declined in number and increased in size. Nationwide trends reflect intensification of livestock farms and greater resource productivity. Intensification refers to higher levels and quality of management while increases in resource productivity suggests more animals per production unit. These two factors generally result in greater product standardization and lower costs of production per hog.

1.2.2 Michigan Livestock Operations

Over the five year period 1982-1987, the number of farms raising hogs and pigs in Michigan has declined from 7,433 to 5,577, a drop of 25%. Farm size has moved in the opposite direction as number of hogs and pigs increased 20% over the same five year period from 1,064,073 in 1982 to 1,277,069 in 1987[5]. The shift from smaller operations,

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[4]Iowa State University, "The Iowa Pork Industry: Competitive Situation and Prospects", p. 63, Ames, Iowa, December 1988.

[5]U.S. Department of Commerce, 1987 Census of Agriculture, Michigan State and County Data, Bureau of Census, Vol. 1, Part 22, p. 30, 1987.

with less than 500 head to large operations with over 500 head is important for this study. Since 1982, the percent of hogs produced from large operations in Michigan has increased from 60% to 69% of total production.

Larger operations are characterized by confinement systems. In 1987 there were 636 "large" operations over 500 head. Most are concentrated in the southern portion of the state, close to slaughtering plants in Detroit (Michigan), Indiana, Ohio and Pennsylvania.

More intensive land use in all livestock sectors has raised farm and field waste management issues. Confinement systems concentrate animal wastes within animal buildings, storage pits or lagoons instead of on the fields. Confinement systems use water to clean buildings adding additional volume to the quantity of manure that must be stored. Storing animal wastes can cause noxious odors, flies and the potential for groundwater contamination[6].

Proper disposal of large quantities of livestock wastes created by large concentrations of animals, requires proper storage facilities and calculated land applications to avoid nutrient overdoses and precautions against both water contamination and odor disturbances.

[6]For more information see: Barth 1984, Fenton 1988, Hamilton 1989.

1.2.3 Urban Sprawl in Michigan

Rural population increases and conversion of farmland to non-agricultural uses are issues straining local government revenues. As people move from urban population centers providing water and sewer, regular road maintenance and 24 hour police protection, to rural areas, many expect to receive these same services. Because the population in rural areas is less dense, economies of size are not attained. Increased distances between subscribers, further adds to service costs. The majority of Michigan townships are zoned. Most rural townships are zoned primarily agricultural but permit residential dwelling. The declining number of farms and urban-rural movement accounts for the loss in farm land. Since 1940, the number of acres in farm use in Michigan has dropped nearly in half, from 18 to under 10 million acres[7]. The conversion of farmland in Michigan to non-agricultural uses is one of the highest in the nation. Approximately 120,000 acres are removed from agricultural production annually[8].

1.2.4 Environmental Change and Citizen Concerns

Environmental consciousness affecting land use has swelled as has consumer product safety over the past decade.

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[7]Census of Agriculture, Michigan.

[8]Michigan Farmland Preservation Project, "Michigan's Land and Soil Resources: A Status Report", American Farmland Trust, October 1985.

Scientific findings regularly uncover new threats to health and safety. Radon gas, hazardous wastes, groundwater contamination and the use of pesticides and preservatives have aided in strengthening environmental legislation while Superfund statutes[9] "create powerful tools for local governments to protect the public and environment from problems posed by toxic and hazardous substances"[10].

Until the 1970s agriculture was exempt from many environmental regulations. In the late 1970s and early 80s, Michigan, along with 49 other states in the U.S., adopted "Right to Farm" legislation protecting agriculture against nuisance suits[11]. This was intended to reduce the barrage of complaints against agricultural operations. The act condones "generally accepted agricultural practices" but requires that farmers use "best management practices". In spite of the act, environmentally related agricultural complaints are increasing[12]. Michigan is not a unique case as environmental farm issues are gaining importance throughout the Midwest, however, Michigan's non-metro

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[9]Superfund statutes are supported by the national government and provide monies to clean up designated sites.

[10]Hanson, Kent E., and Babich, Adam, "Taking Charge: Local Governments and Hazardous Substances", in Zoning and Planning Law Handbook, edited by Mark S. Dennison, Clark Boardman Company, New York, NY, p. 560, 1989.

[11]Bahls, Steve, "Is Your Farm a Nuisance", Hog Farm Management, p. 16, March 1989.

[12]Conversations with the Michigan Department of Agriculture.

population density, at 105 people per square mile is the highest among the other lake states. This has some effect on the number of complaints.

1.3 Taking Action

This thesis examines odor complaints about hog operations. Reports cite periodic odors that are "noxious" and "severe", causing headaches and tearing, preventing children from playing outside. Lawyers use the term "nuisance", property assessors call it "economic obsolescence", economists refer to it as an externality. All three terms describe a market transaction that has not included or reimbursed all those affected. For example:

> In a market transaction there is a buyer and a seller. A crop farmer decides to sell his/her property to a livestock farmer. After bargaining the two farmers reach a mutually acceptable price.
>
> This agreement is considered "pareto efficient" if both parties are better off and no one is worse off and all costs are internalized. If, however, the buyer builds a facility to raise 50,000 hogs, there may be some external costs associated with the operation. Noise, odors and other environmental impacts may be experienced by neighbors that are reflected in reduced property values.

In this situation a market transaction's ability to create social pareto efficient outcomes is in doubt[13]. The figures on the following pages illustrate the situation.

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[13] Mandelker, Daniel R., Environment and Equity: A Regulatory Challenge, McGraw-Hill Inc., United States, p. 6, 1981.

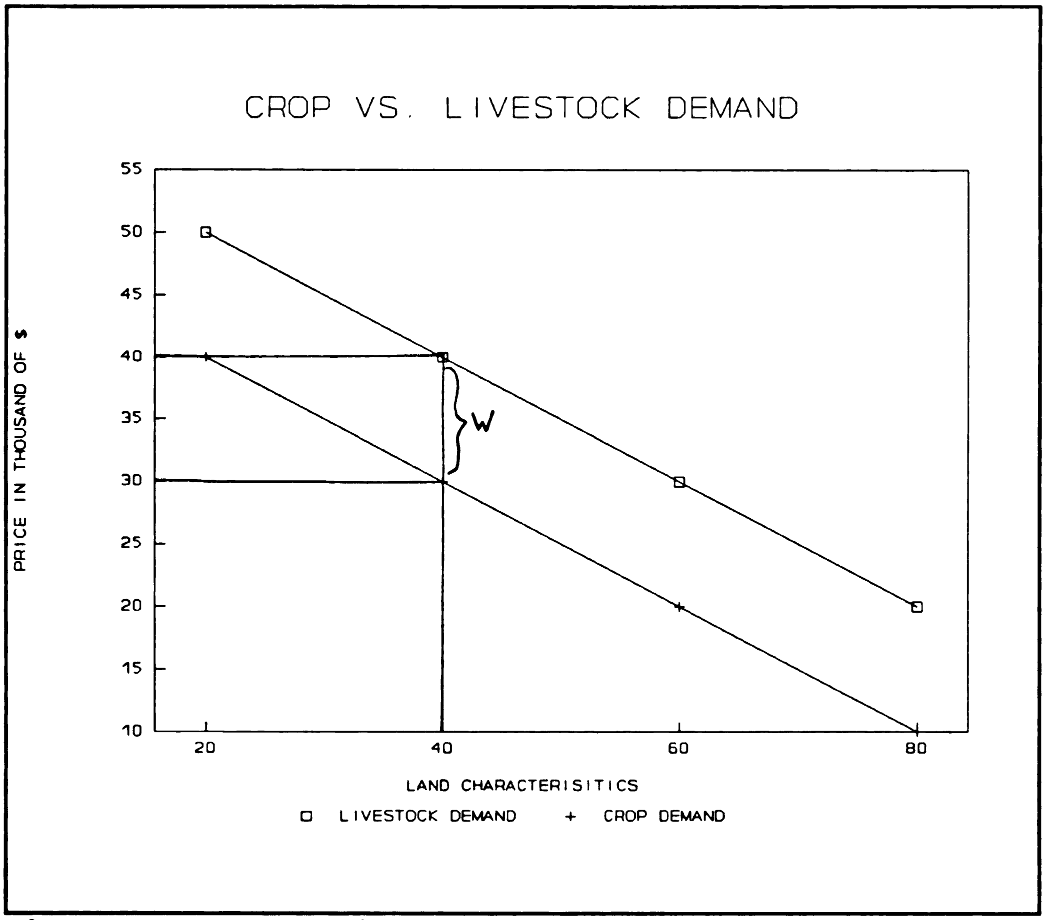

Figure 1 Crop vs. Livestock Demand

In Figure 1. the vertical supply curve refers to a fixed plot of land and its characteristics. D_l represents a livestock farmers demand for the land while D_c represents a crop farmers demand. Since the livestock farmer places a higher value on the land, he/she is able to purchase the land.

In Figure 2. demand for residential land, originally D_r, is now $D_{r'}$. While the seller gained W by selling to the livestock farmer, neighbors lost Q as a result[14]. If W is greater than Q the situation is a "potential" pareto solution, where an equitable distribution of benefits and costs would result in a pareto solution for both parties.

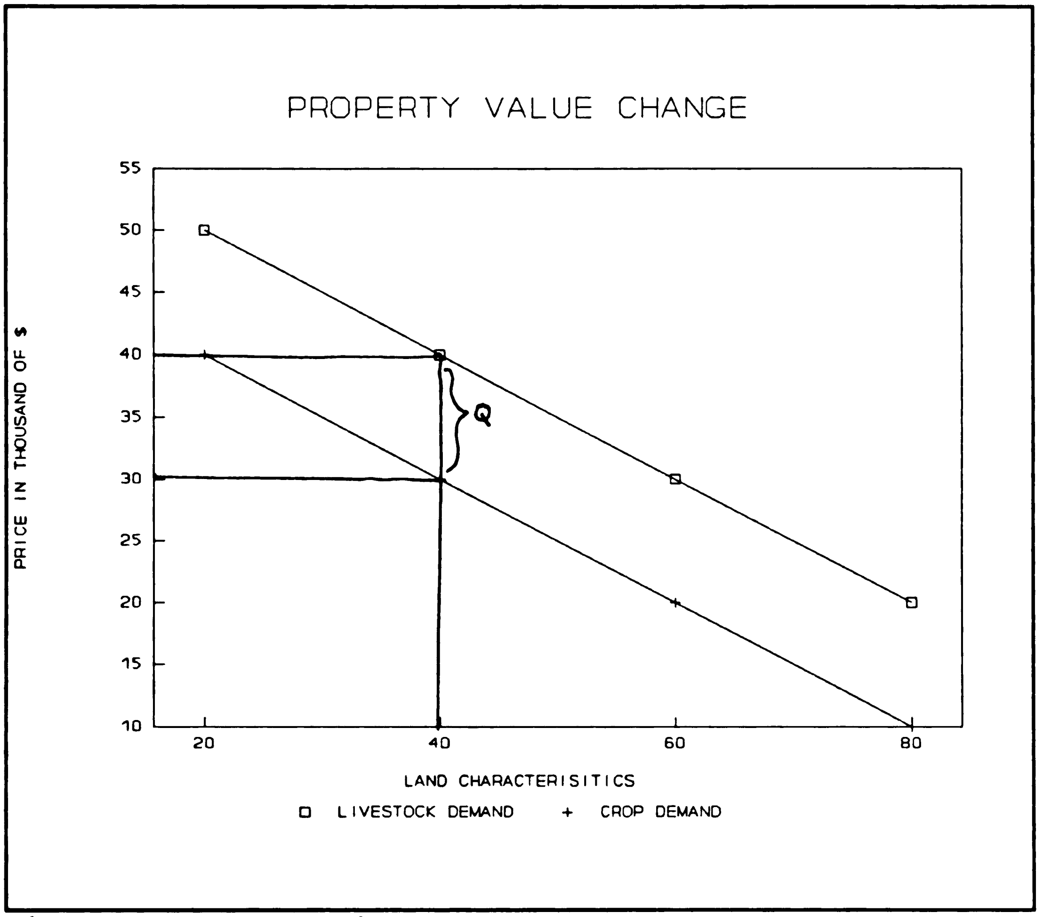

Figure 2 Crop vs. Livestock Impacts

There are three common ways of solving this problem; bargaining, adjudication and government regulation. Because of the joint impact characteristics of clean air, few people

[14]The township tax base is reduced when this happens.

will bargain with the farmer because there is no way to exclude those who do not participate in the bargaining. If the farmer was willing to be paid not to raise hogs, everyone would benefit, especially those who failed to pay.

Lawsuits are an option many are pursuing, although the process is long, expensive and not very encouraging to residential property owners[15].

Government regulation is an option that has traditionally attempted to prevent the problem from occurring, instead of minimizing it afterwards. In addition to state regulations for air and water pollution, townships have established zoning ordinances limiting the location and size of livestock operations. These ordinances reflect political pressures from township residents. The township, however, may be in an awkward situation as responsibility to respond to citizens demands of quality of life may conflict with its responsibility to generate revenue and maintain or improve service delivery.

1.4 Local Government Role

Economic fluctuations caused by an exodus of local enterprises and technological advances resulting in intensive management affect not only the sectors in which they occur, ie: automotive, agriculture, etc. but also the government jurisdictions where they are located.

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[15]See Bahls 1989, p. 34 and Fenton 1988, p. 50-55.

A study commissioned by Congress examined agriculturally dependent counties in seven regions in the United States and concluded that because of declines in the "real value of the agricultural tax base", tax delinquency rate increases and "declines in non-farm incomes, employment, and property values caused by lower farm incomes", local government revenues will fall[16]. Declines in revenues pose serious problems as monies from local government supports the operation of school districts, fire and police services, road maintenance, general local government administration and other local services.

Agricultural dependence is generally defined to be 20% of net revenues in a county. Michigan has only a few counties in this category and none in the region of this study. However, revenues from agriculture and agriculturally related industries are "Michigan's second leading industry and contributes approximately $15.5 billion annually to the state's economy"[17].

Understanding the structure and responsibilities of local governments in Michigan aides in analyzing the impacts of regulatory changes.

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[16]Stinson, Thomas, "Governing the Heartland: Can Rural Communities Survive the Farm Crisis?", Report of the Sub-Committee on Intergovernmental Relations, U.S. Government Printing Office, Washington D.C., p. 2, 1986.

[17]Michigan Department of Agriculture, "Michigan Agricultural Statistics", 1988.

1.4.1 Local Government Structure

Within each of Michigan's 83 counties, there exist township, city, village, school and special districts that depend on revenues from property taxation. In addition some units have authorities and special assessment districts that collect taxes. Within every county a taxpayer is listed as a resident of either a township or a city. Village properties are included on township tax rolls. The major common function of townships is assessing property and collecting property taxes.

Townships have "limited legal authority relative to that of cities and villages". Townships do however have considerable ordinance and service authority. These powers include: land and building use control, liquor and business licensing and control and service provision to name a few[18].

Location in a specific city, village, township and county will affect tax rates based upon the type of services provided.

[18]Sokolow, Alvin D., "Government Response to Urbanization", Agricultural Economic Report No. 132, Michigan State University, pg. 21, May 1968.

1.4.2 Revenue Sources

As townships cannot impose taxes on personal income[19], they must rely "upon property taxes as a major source of local income"[20]. Townships also receive revenue from the state in the form of state revenue sharing which is based upon local property taxation levels[21]. Taxes collected at the township level are allocated to township and county government operations, school districts, fire and special assessment sources.

Maximum operating millage rates are constitutionally established. The constitution provides a minimum township, county, intermediate school and K-12 school millage rate referred to as allocated millage. The combined operating millage (allocated and voted), for the four units cannot exceed 50 mills. This thesis focuses on townships as most agricultural lands come under their jurisdiction. All of the farms examined are found in townships accountable under township zoning ordinances.

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[19]VerBurg, Ken, Managing The Modern Township, Lifelong Education Programs, Michigan State University, East Lansing, Michigan, p. 119, 1981.

[20]ibid. The amount varies between 20%-50% of a townships budget.

[21]The distribution formula for state revenue sharing monies is: population x tax effort x relative income.

1.4.3 Township Ordinance Authority

The Township Planning Act, P.A. 168 of 1959[22], the Township Rural Zoning Act, P.A. 184 of 1943, and the Michigan County Zoning Act, P.A. of 183 of 1943 "are laws which authorize local units of government to enact ordinances regulating land uses"[23]. Both the U.S. and Michigan Supreme Courts have upheld their constitutionality. Particular agricultural practices can be encouraged, restricted or excluded through the use of ordinances"[24].

In the case of livestock operations these laws can be used to: require conditional or special use permits, determine setback standards, specify maximum number of animals per acre and other land use requirements[25].

1.5 Research Problem

Township ordinances affecting land use can influence quality of life levels measured by property values. These ordinances may increase or decrease property tax receipts thus affecting service delivery (unless millage levels are

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[22]Cooperative Extension Service, "Administering Township Zoning: A Basic Guide For Citizens and Local Officials", Michigan State University, Introduction, February 1987.

[23]Michigan Department of Agriculture, "Preliminary Report of the Animal Waste Resource Committee", pg. 13, August 1987.

[24]ibid.

[25]ibid.

also changed). In addition, land use decisions can affect employment, production and/or income opportunities for community members. This thesis will identify, measure and aggregate these diverse categories in a benefit/cost analysis. Comparing the benefits and costs resulting from a particular land use decision allows decision makers and community members to make more informed decisions.

The purpose of this study is to provide additional information to decision makers. This information however, is not likely to be used by itself. Political and social considerations must join with economic concerns when making decisions.

This study examines benefits and costs of hog operations. Impacts on the communities property values, income, employment and production are assessed. By regressing property values with household, neighborhood and farm characteristics, the impact per animal, if any, is determined. An estimation of **township impacts**[26] are provided, examining potential income, output and employment impacts. The importance of farm purchases such as feed, building materials, veterinary services, etc. for the

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[26]This is bolded to emphasize that benefits and costs will be assessed from a township government perspective. For example, if a particular house's property value declines by $1000, the **township impact** will be the resultant decline in property taxes received by the township, not the $1000 property value drop.

communities surrounding hog operations is included. The following hypotheses are addressed in this thesis.

1.5.1 Hypotheses

A. Livestock operations have a negative impact on property values. Damages increase as the size and concentration of the operation increases.

B. Local employment, income and output increase with the addition of hog operations.

C. Benefits to local governments from a hog operation exceed the costs of declining property tax receipts for that same unit of local government.

1.6 Thesis Overview

This chapter, introducing the issue and research problem is followed by Chapter II, introducing the conceptual framework, Chapter III, providing a regulatory analysis, Chapter IV, describing the methodology, Chapter V, examining research results and Chapter VI, summarizing the thesis.

CHAPTER II

CONCEPTUAL APPROACH

This chapter examines several methods that can be used to evaluate regulatory changes affecting livestock operations. Methods to value both benefits and costs are discussed, followed by a presentation of the methods chosen for this study.

2.1 Literature Review

Benefit/cost analysis can be used to examine benefits and costs associated with regulatory changes. As opposed to setting an output goal or expenditure ceiling and letting regulations develop to meet those limits, it considers impacts occurring as a result of different choices. Benefit/cost analysis is a tool to provide information to decision makers.

2.1.1 Perspectives

Benefit/cost analysis can examine alternative actions from a local, regional, national or global perspective, depending upon the issues involved. Choosing the unit of analysis, or perspective, is a crucial part of the study as it determines which benefits and costs are included.

Benefit/cost analysis challenges decision makers to examine the status quo and ask, "is it enough to make everyone better off and noone worse off" or are certain segments of society more deserving than others? The analysis raises social efficiency issues and contrasts them with distributional issues. The question of net gains versus who receives the gains is key.

This thesis posits, in this situation, that benefits must be assessed from the area in which costs occur. It emphasizes the importance of assessing costs and benefits at a local or county wide level, when, as in this case, the decision makers are within that area.

This may be seen in contrast to more common "local undesirable land uses" such as a hazardous waste sites, where state or national decision makers choose the location. Here, state-wide benefits are weighed against local costs. Since the decision makers represent residents from the entire state, the net benefit often outweighs localized costs.

In the case of townships, officers must weigh resident demands together with economic development in a community. Both of these categories have political, social and economic issues to consider.

2.1.2 Farm Studies

Benefit/cost studies are often used to assess the impacts of policy changes. Experimental farm projects are assessed with this method in order to make recommendations for project expansion or cancellation. Other studies, such as this thesis, examine impacts of future or emerging regulatory changes by comparing present benefits and costs with those predicted under different ordinances.

2.1.3 Environmental Impacts

The literature concerning agricultural environmental impact statements is growing. Leaching from chemical applications, runoff and soil erosion top the list of farm related environmental studies. In addition, harm to humans and wildlife are implicated when surface and groundwater contamination occur.

Past studies (Connor 1971, Forster 1975) focus upon state and federal air and water regulations. The economic studies estimate the cost of on farm improvements if more stringent regulations are enforced. Several of these studies addressed the possibility of increased regulation for livestock farms.

2.1.4 Livestock Farms

Several livestock studies discuss the concept of an "acceptably clean" environment[27]. 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 revealed additional capital outlays and increased annual costs per head[28]. Many early studies examined water pollution rules for livestock operations. Water quality concerns are not new to farm analysts. Testing and measurement standards determined by the Environmental Protection Agency and the Department of Agriculture have set permissible levels of nitrate and trace mineral content in watersheds for decades. The Department of Natural Resources still issues stiff fines and penalties when contamination occurs. Air quality, not a traditional farm issue, has invoked growing concern especially since livestock operations continue to expand.

Air and water pollution standards long applied to industries, where particulate emissions and odors are regu-

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[27]Connor, L.J., Maddex, R. L., and Leighty, L.L. "Environment Quality Legal Considerations For Michigan Livestock Producers", Michigan State University Extension Bulletin E-732, p.3, December, 1971.

[28]Forster, D. L., Connor, L.J., and Johnson, J.B., "Economic Impacts of Selected Water Pollution Control Rules on Michigan Beef Feedlots of Less Than 1,000-Head Capacity", Michigan State University Research Report, Agricultural Experiment Station, East Lansing and Economic Research Service, U.S.D.A., April, 1985.

lated, are now being applied to farming operations. Agricultural enterprises, once exempt, now face these same environmental regulations[29].

2.1.5 Air Quality and Hogs

Air emissions resulting from hog operations are well documented. Miner and Hazen identified "odor-producing amines... in swine manure"[30] over 20 years ago while over 75 other "odorous components of animal manure odor" have been identified since then. Research into swine odors have focused on odor transfer through particulate emissions. Removal of dust from pens resulted in reduced odors in several studies. Scientifically, particulate concentrations are measurable, however, "knowing the composition of manure odor along with the concentration of individual components does not explain the composite odor, qualitatively, or quantitatively"[31].

Research reveals that management is a key factor in odor control. The surface area as well as waste management system, weather and spreading area also affect odors.

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[29]Parnell, Calvin, B., ""Air Pollution Control For Agricultural Processing Plants", Agriculture and the Environment, American Society of Engineers, St. Joseph, Michigan, p. 107, 1984.

[30]Barth, C.L., and Melvin, S.W., "Odor", Agriculture and the Environment, American Society of Engineers, St. Joseph, Michigan, 1984.

[31]ibid, p. 100.

Implicit in this research is the relationship of manure quantity and number of animals.

Some attempts are being made to measure gases present at livestock operations. One township in Michigan has incorporated these gas measurements into their zoning ordinances. The ordinance states that "odors shall not create a nuisance...so that air quality standards are maintained of no more than one-half (1/2) part per million of hydrogen sulfide or ten (10) parts per million air borne ammonia average per hour at the site perimeters"[32]. The state of Iowa also regulates feedlot and lagoon odors.

2.2 Benefit/Cost Techniques

The following studies examine methods of valuing pollution impacts on the environment. In addition benefits associated with local expenditures on agricultural inputs are included.

2.2.1 Farm Pollution Controls

A study of agricultural non-point pollution control in Vermont investigated the impacts of high phosphorus concentrations in St. Albans Bay caused by wastewater treatment plant discharges and dairy farm runoff. These effects "impaired recreational and other amenity values of

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[32]From a township zoning ordinance.

the bay"[33]. The Rural Clean Water Program supported a manure storage project involving 62 dairy farms to "reduce the agricultural contribution"[34] to Bay pollution. Cost sharing enabled farmers to build 180-200 day storage structures. The study investigated farm costs and benefits, government costs, and water quality benefits. Farm level impacts of manure storage, including construction costs and benefits from labor and fertilizer savings were analyzed. Government costs included project and wastewater treatment. Benefits included property value increases, recreation enhancement and reduced water treatments[35].

Water quality benefits were measured using two methods. An hedonic model assessing changes in property values was used to calculate appreciating properties as water quality changed. Recreational benefits were found using a travel cost method.

The hedonic model calculated the reduction in property value as a result of increased pollution in the lake. From this estimate property values were re-estimated based upon lower levels of pollution. The travel cost method

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[33]Young, Edwin C. and Shortle, James S., "Benefits and Costs of Agricultural Non-point-source Pollution Controls: The Case of St. Albans Bay", Journal of Soil and Water Conservation, Vol. 44, #1, p. 64, January-February 1989.

[34]ibid.

[35]ibid.

calculated additional business and park fees generated by the less polluted lake.

The benefit-cost ratio of 1.2 was calculated over a 50 year period. A three year lag was assumed before project benefits would begin.

2.2.2 Multipliers in the Hog Sector

Benefits or costs of regulatory decisions that affect livestock operations must consider the forward and backward linkages associated with the industry. In the Michigan hog industry, backward linkages for inputs purchased including, corn, feed supplements, labor, veterinary services, fuel and machinery accounted for $153.3 million, 79% of producer receipts or an average of $87 per hog[36]. Forward linkages, including transportation, meat packing and processing accounted for an estimated 5600 jobs in 1986.

Otto combined farm and non-farm impacts associated with the hog subsector using input/output models to generate multipliers examining hog industry impacts on employment, income and output. He found multipliers in the Michigan hog industry to be:

Employment multiplier	=	1.86
Output multiplier	=	1.5
Income multiplier	=	1.68

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[36]Otto, Daniel, "Economic Importance of Michigan's Pork Industry", Unpublished Paper, Iowa State University, 1987.

For every job created in the hog sector, another .86 position is created. For every dollar generated in hog farm income, 68 cents is created off farm[37]. For every dollar of output created, 50 cents is generated outside the hog sector[38]. Combined these multipliers result in a total direct and indirect value to Michigan of $292.7 million[39]. This thesis attempts to expand this analysis and estimate resultant local impacts as operation size changes.

2.3 Finding Prices

Input-output models help find backward and forward linkages associated with an industry. This aides policy makers when considering changes affecting the industry. In cases where market values are not readily determined, cost and benefit information is difficult to find. When prices are not available two decision making situations follow. First, regulatory decisions can be made ad hoc, without the knowledge of costs or benefits. In the case of environmental goods, over or under production is likely since equilibrium production levels cannot be determined from

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[37]The income multiplier includes direct and indirect effects of a one dollar increase in final demand.

[38]Output is the producers value (what sellers receive for their goods).

[39]ibid.

prices[40]. By using enforcement "powers to assign and direct resources without compensation, the crucial role of prices as a metering device for efficiency is destroyed."[41]

In a second situation, where output levels (net benefits or costs) are difficult to measure, policy making will attempt to control inputs[42]. This may or may not have the desired effect depending upon the relationship between a set of inputs and the final output. For instance, regulations limiting the size of livestock operations may not be effective in reducing complaints if most of the complaints are the result of poor management practices.

2.3.1 Agriculture and the Environment

Classical economic rent theory supports differences in agricultural land values based upon environmental quality[43]. These quality differences can affect

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[40]Siegan, Bernard, H., Planning Without Prices, Lexington Books, Lexington, Massachusetts, 1977.

[41]ibid.

[42]Kilmer, Richard, L. and Armbruster, Walter, J., Economic Efficiency in Agricultural and Food Marketing, Iowa State University Press, 1987.

[43]Freeman, Myrick, A., The Benefits of Environmental Improvement, Resources for the Future, Johns Hopkins University Press, Baltimore, 1979.

productivity, thus net output. Alternate land uses also affect value. Raup categorizes these two components as:

A) The capitalized valuation of the income flow from the land, in agricultural use.

B) The value of the land in alternate non-farm uses[44].

An example of this distinction is seen in acts that entitle farmers to property tax assessments performed at use, not market value levels. By taxing according to "use" value it recognizes differences in land quality, and environmental as well as managerial factors.

Attempts are being made to extend this theory of an agricultural product's dependence upon environmental quality, to household properties. An agricultural product's value is seen as a bundle of goods comprised of seeds, fertilizers, management and environmental conditions. Likewise the value of a house is made up of a bundle of goods including, square footage, number of number of baths and fireplaces and environmental conditions as well.

This distinction arises because unlike agricultural land, utilized to produce consumer goods, a house is a durable good, with no tangible output, whose value was not thought to be affected by environmental differences.

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[44]Raup, Philip, M., "Structure and Performance of the Land Market in the United States", Staff Paper #P86-54, Department of Agricultural and Applied Economics, University of Minnesota, December 1986.

Contemporary studies refute this claim (Abelson, 1979, Freeman, 1979, Harris, 1981, Ridker, 1967). Researchers have found that a change in environmental quality does affect property values. Environmental quality in this context does not refer to locational characteristics such as proximity to a lakefront, park or forest. Instead, changes in environmental quality are considered. For example, if a lake became polluted, the change in water quality would likely have an impact on property bordering the shoreline. Or, as in this case, odors from livestock operations may affect property values.

2.3.2 Hedonic Price Studies

Hedonic studies look at the impacts of changes in environmental quality on property values. Air, water and noise pollution associated with industrial developments are the most common subjects of study (see Freeman, 1979, #3, for a survey of issues). In addition some studies involving soil conservation practices have attempted to quantify resultant changes in land values (Palmer, 1989). Figure 3 shows the hypothesized relationship between environmental quality and property values. As property values increase, so do environmental amenities.

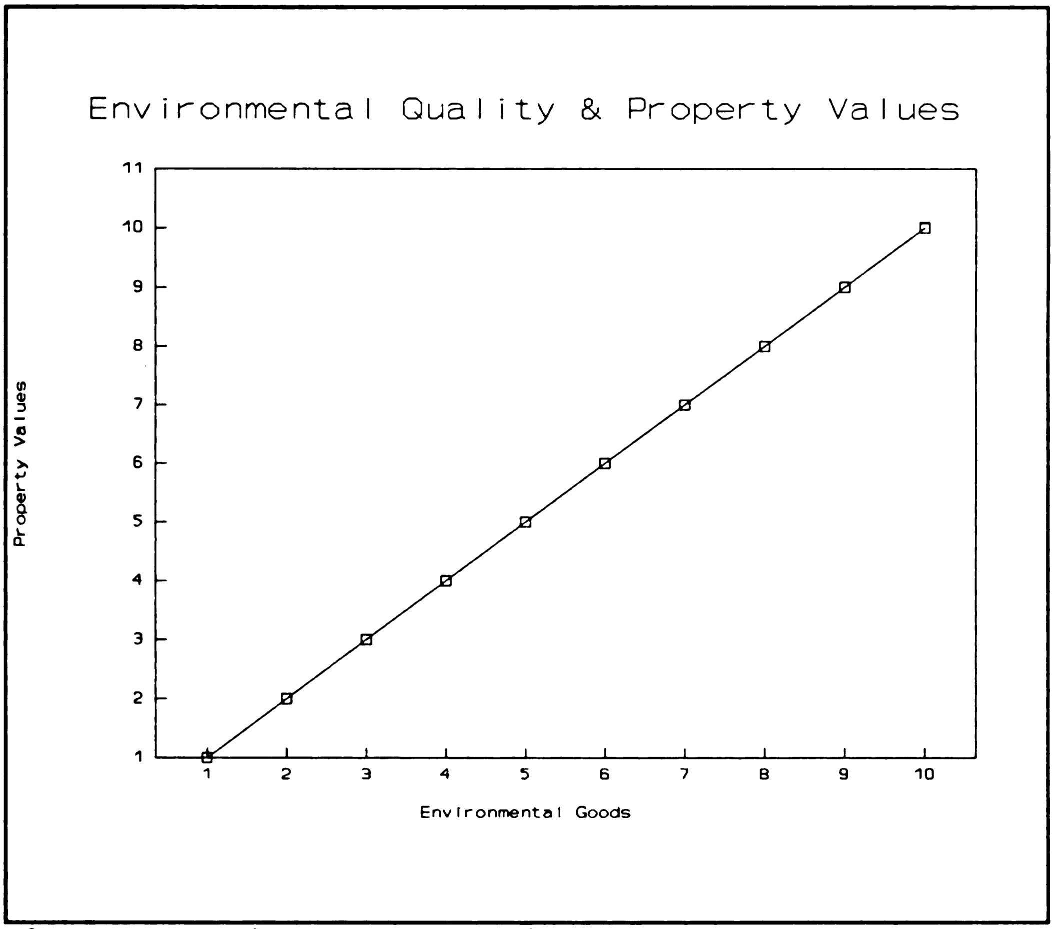

Figure 3 Environmental Quality and Property Values

2.3.3 Air Pollution Studies

In 1967, Ronald Ridker introduced the idea of using property values to measure the impacts of environmental quality changes. Ridker looked at property values and air pollution using cross sectional and time series regressions. Subsequent studies have included land, water, and noise as well as air pollution. In all cases the purpose is to measure the underlying prices associated with environmental change. When Ridker did his study he experimented with both a time series and cross sectional regression. Today the cross sectional analysis is used exclusively as property value fluctuations over extended periods confound measurements. Ridker's analysis was an urban study for the city of St. Louis. Except for the relatively few agricultural studies available, (Palmer 1989, Wellner) most hedonic studies are in concentrated population areas.

Ridker's air quality study examined the impacts of a factory emitting smoke in downtown St. Louis. He used two measures of pollution, sulfation levels at various sampling stations and a measure of suspended particulates gathered by high-volume air samplers. This method of measurement, using sophisticated air, water and land samplers is still common today.

Additional information including characteristics of household properties near the factory, the exact house location, type of neighborhood, as well as information on the occupations, taxes, submarket variables and median income of the residents were collected.

Results of the cross-sectional analysis indicated that "property values were adversely affected by pollution"[45]. If sulfate levels were reduced by .25 mg of $SO_3/110cm^2$/day the property value would increase at least $83 and up to $245. This result was for all houses in the metropolitan

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[45]Ridker, Ronald., "Property Values: A Cross-Section Analysis", Economic Costs of Air Pollution, p. 137, 1967.

area. The findings revealed that use of a low sulfur fuel could reduce sulfation levels, saving 10-15 million dollars in pollution costs[46].

Since Ridker's initial work, hedonic price analysis has gained popularity. Contemporary studies have applied the technique to evaluate noise pollution impacts in multiple regions.

2.3.4 Noise Pollution Studies

In 1981, Jon Nelson published an article on aircraft noise and hedonic prices[47]. The study examined residential property values in six U.S. metropolitan cities surrounding airports to see what affect noise had on property values.

Nelson obtained noise annoyance index calculation known as the Noise Exposure Forecast (NEF) from the cities and overlaid them upon census block maps around the airports. The author was careful to exclude sample areas that included other environmental features, major transportation facilities, community developments or other special neighborhood features.

The housing characteristics examined included physical accessibility, neighborhood, public sector and alternate use

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[46]Drops or increases in property values.

[47]Nelson, Jon, P., "Measuring Benefits of Environmental Improvements: Aircraft Noise and Hedonic Prices", Advances in Applied Microeconomics, Vol 1, p. 51-75, JAI Press, 1981.

characteristics. Results indicated that areas exposed to high NEF levels reported lower property values. Aggregating the six areas Nelson found that a house in a NEF=45 area, 20 points above normal levels, (the NEF range is 15-55, with little annoyance reported under 25) "would sell for $2675 less than a house exposed to only NEF=20."[48] ceteris paribus. Implicit prices per decibel ranged from $61 in Cleveland to $239 in San Diego.

Of particular interest in this study was Nelson's combination of cities and use of diverse and distant areas of study. By aggregating data across localities the assumption is that the markets for noise abatement are stable. Freeman refers to this as market segmentation. He cites Straszheim who argues "that the urban housing market really consist(s) of separate compartmentalized markets with different hedonic price functions in each". If this is the case, aggregating data would "provide faulty estimates of the implicit prices facing subsets of buyers in different market segments."[49]

The aircraft noise study by Nelson, in addition to one of his earlier studies tested for stability across markets.

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[48]Nelson, Jon, P., "Measuring Benefits of Environmental Improvements: Aircraft Noise and Hedonic Prices", Advances in Applied Microeconomics, Vol. 1, Jai Press, p. 62, 1981.

[49]Freeman, Myrick, A., The Benefits of Environmental Improvement, Resources For The Future, Johns Hopkins Press, Baltimore, p. 142-143, 1979.

In both cases the hypothesis that the hedonic price functions were the same in both markets was not rejected.

2.3.5 "Other" Pollution Studies

Air, noise and land studies similar to Ridker and Nelson's, in addition to water quality studies, predominate the literature. However, there are a number of other areas that are not well researched. In Myrick Freeman's book, The Benefits of Environmental Improvement, a list of "Types of Effects" of environmental quality changes is included. Under the topic heading "other" is listed "odor, visibility, (and) visual aesthetics." He explains that:

> "Since aesthetic effects are often not associated with direct use of environmental resources, they pose difficult measurement and valuation problems. But to the extent that they involve utility gains and willingness to pay, they are nevertheless every bit as real, in an economic sense, as the impairment of health."

One study in this category attempts to value country hedge rows admired by tourists passing on the road. Wellner investigated the maintenance and opportunity costs incurred by a land owner to determine the value, or what a countryside commission should pay in order to prevent a farmer from replacing the hedges with farmland. No studies involving the impacts of odors upon property are identified. These "aesthetic" effects are difficult to study due to measurement problems and the degree of subjectivity involved with measuring the environmental changes. In the past, contingent valuation has been used to evaluate "difficult measurement and valuation"[50] areas. Hedonic pricing techniques can also provide policy information for decision makers with specific feedback translated into monetary impacts.

2.4 Study Approach

A benefit/cost analysis is used in this study to measure the benefits associated with livestock operations on a local community with the costs imposed by hog odors.

2.4.1 Benefits

Backward and forward linkages, reflected in output, income and employment multipliers in the hog sector will be examined to determine the local impact of hog operations of various sizes. Discussions with industry participants and observers will generate estimated expenditure and production levels of two operation sizes. A small operation of 200 sows a year[51] will be compared with an operation of over 200 sows. Expected local benefits will be calculated based upon size of the operation. A regional benefit factor will also be generated for the statewide impact but this will not be used in the Benefit/Cost calculation.

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[50]Freeman, from above quote.

[51]This is the state average at present.

2.4.2 Costs

Externality costs associated with livestock operations are reflected in lower property values (environmental preferences are transferred to property). By recording residential property values in areas surrounding hog operations, together with characteristics of the property, neighborhood and farm/environmental conditions affected by farm location, implicit prices per hog will be determined. Cost estimates will be generated using the implicit prices for a particular farm size, multiplied by property densities in the farm area. Both the pecuniary costs shown as property value declines and the impact on township tax receipts will be presented. The purpose of this study is to examine annual impacts across an entire community, to do this the township tax loss will be used in the benefit/cost calculation[52].

2.5 Hypothesis

Hypothesis # 1: Livestock operations have a negative impact on surrounding property values. Hedonic studies have consistently found environmental disamenities to have a negative impact on property values. This hypothesis will be supported by examining the coefficients and significance of two key variables. The distance of the house from the

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[52]This does not ignore the pecuniary losses experienced by individuals but instead focuses upon costs experienced by township residents as a whole.

livestock operation and number of animals should have both positive and negative signs respectively. Prevailing winds, should have a positive sign. As distance away from the farm is increased, impacts should be lessened. In addition, the number of animals should be positively related to odor production and thus negatively affect property values.

Hypothesis # 2: Livestock operations provide revenues to local economies. A large portion of input costs used to raise and sustain hogs is spent in the communities surrounding the operation. While the percent of total input dollars spent locally declines as operations increase in size, a substantial portion of purchases remain within the locality.

Hypothesis # 3: Local benefits of livestock operations exceed costs. Monies spent within a township(s) by a hog operation, exceed township tax losses resulting from that hog operation.

2.6 Conclusion

This chapter reviewed literature concerning environmental factors affecting agricultural production practices. The second half of the chapter focused on various techniques used to determine the extent of environmental impacts both on and off of the farm.

The following chapter provides an analysis of the legal framework affecting livestock operations. It examines livestock producer responses, local government concerns and regulatory alternatives.

CHAPTER III

REGULATORY ANALYSIS

This chapter examines the legal status of livestock operations and the effects regulations have upon them.

3.1 Right to Farm Act

49 states have adopted Right to Farm legislation as a response to farmland conversion to non-agricultural use. The vast majority were enacted after 1978. Nationwide these statutes can be summarized as helping to ensure that "a farm cannot be considered a nuisance simply because the use of surrounding land has changed"[53].

The Right to Farm Act in Michigan had the same impetus as other state's. However, Michigan has added an additional requirement that certain best management practices be adopted before protection under the law is assured. For livestock operations this includes "manure management

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[53]Bahls, Steven C. and Bahls, Jane E., "Is Your Farm a Nuisance?", Hog Farm Management, p. 16, March 1989.

practices for land applications"[54]. Specifically, 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 best management practices pursuant to their guidelines.

3.1.1 Background

In 1981 the National Agricultural Land Study reported that agricultural land was being converted to non-agricultural uses at the rate of three million acres a year[55]. Michigan's farmland conversion rate of 120,000 acres a year is twice the national average. It is contrary to state plans expanding the role of agriculture and preserving existing farmland in the Michigan economy. PA 116, the Farmland Preservation Act, and the state's role in encouraging agriculture is evidence of this. In the early 1980s, despite opposition, the governor's office recruited large livestock operations to settle in the state. At the end of 1987, the hog and pig inventory for the state was the second highest ever, up 8% from 1986. University and livestock

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[54]Hamilton, Neil, "Environmental Pressures Are Going to Increase", Pork '89, p. 12, October 1989.

[55]Voth, Donald E., McCormic, Linda Grim, and Blair, Joanne S., "Right To Farm Legislation in Arkansas, Its Objectives and Its Applicability", Arkansas Agricultural Experiment Station, Bulletin 918, p. 1, March 1989.

association representatives throughout the state are eager to continue this upward trend in hog production.

3.1.2 Environmental Protection

The Right to Farm Act legalizes the special status long granted to agriculture. The following statutes in Michigan were established to protect the environment:

1. The Michigan Water Resources Act (PA 245) of 1929
2. The Michigan Air Pollution Control Act (PA 348) of 1965
3. The Michigan Environmental Protection Act (PA 127) of 1970
4. The Michigan Solid Waste Management Act (PA 641) of 1978
5. The Michigan Hazardous Waste Management Act (PA 64) of 1979

For many years prior to the passage of the Right to Farm Act, exemptions were granted and authorities were not fully exercised. Today, litigation involving livestock operations are becoming more numerous despite passage of Right to Farm Acts. According to agricultural law experts they will be on the rise in the 1990s.

3.1.3 National and State Cases

Experts across the nation disagree regarding the solution to agriculturally related environmental problems. Some are confident that new technologies and additional resources directed at the issues will solve the problem. Others are less optimistic. Neil Hamilton, an agricultural law professor, reports that:

> "The odorless pig is still a creature of the future. Well-designed facilities, good management

> and proper waste disposal help, but it is hard to escape the fact that hog manure stinks.[56]"

The following cases disclose the types of complaints encountered.

3.2 Nation-Wide and Michigan Complaint Cases

Nuisance suits are not uncommon in the United States. Several cases have attracted national attention due to media coverage. In response, trade journals suggest ways for livestock farmers to avoid litigation. A sample of several cases follows.

3.2.1 National Cases

A case in Colorado involves National Farms of Kansas City and some influential and wealthy neighbors. National Farms is constructing a farrow-to-finish operation valued at 40 million dollars for 300,000 to 350,000 head of hogs. 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 estimated by opponents is expected to reach 2.5 million gallons a day at full capacity. The Sierra Club, Audubon Society and neighbors, Colorado billionaire, Philip

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[56]Hamilton, Neil, "Environmental Pressures Are Going to Increase", Pork '89, p. 12, October 1989.

Anschutz and beer magnate, Peter Coors have joined opponents. These opponents were unsuccessful in their first attempt at stopping construction through legal channels.

In Missouri several smaller, family owned operations are contesting a series of nuisance cases filed against them. 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. The Missouri hog operations range in size from 2500-7000 head. These are smaller than the one in Colorado but larger than the average hog farm in Michigan, approximately 200 head.

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.

In the Colorado and Missouri cases as well as in Michigan, some of the more vocal opponents include hog farmers. They insist that confinement systems smell much worse. Observers suggest that they are worried about competing with corporate livestock enterprises.

3.2.2 Michigan Cases

Hog operations about which the Michigan Department of Agriculture has received complaints, range in size from one hog to over 10,000 hogs. 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 21 complaints reported in the first six months of 1989, at least ten of these were for operations over 500 head. There were approximately 670 large operations in 1987. This converts to 1.5% of all large operations receiving complaints. The remaining 11 complaints were directed towards smaller operations. .18% from a total of over 6200 smaller operations received complaints[57].

At least four of these 21 complaints have resulted in litigation. Lawsuits brought by community or environmental organizations are more common than those brought by individuals. Community interest may be based on the possibility of operations expanding or new ones moving into their areas. These groups are becoming more powerful as they obtain influential positions on township planning boards. Townships lacking well-documented planning guidelines to deal with nuisance abatement or refusing to issue building permits, risk charges of exclusionary zoning by the courts. Reluctance on the part of township governments to become involved in land use decisions is likely to be short lived, however. Litigation and rising concern often prompts township officials to establish a track record and basis for

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[57]Hog farm numbers are obtained from the 1987 Census of Michigan Agriculture.

opposing incompatible land uses. The result is more complete land use guidelines.

3.3 Local Government Concerns

As elected representatives, local government officials respond to citizen concerns. Unlike national and even state representatives, township officials are very much "in touch" with their constituents. Critics challenge local governments with accusations of ineffectiveness[58]. They demand consolidation of county government to do away with service repetition. Advocates describe "proximity to constituency, responsiveness, and flexibility" as advantages while noting that success depends upon "the quality of local leadership and the leadership agenda itself, volunteer action, multiple assignment to public employees and ad hoc--but effective--administration"[59].

Examining farming systems from a non-farm, rural development perspective has involved discussion of the agricultural recessions and their impacts upon "the financial health of state and local governments"[60]. Oddly

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[58]Schuh, Edward G., "Rural Development Issues", p. 8, University of Minnesota, Minneapolis.

[59]Sokolow, Alvin D., "Small Local Governments as Community Builders", National Civic Review, p. 363, September/October 1989.

[60]See The Agricultural Recession: Its Impact on the Finances of State and Local Governments" ACIR, June 1986 and "Agricultural Land Values an Assessments in Selective Counties in Michigan" by Lynn Harvey et al., November 1987.

enough, the current debate over livestock operations across the United States has not focused upon the economic impacts, positive and negative, when assessing the situation. Instead the focus is on quality of life standards. However, studies have shown that environmental quality standards increase with incomes. Vocal individuals, who do not depend upon the local economy for their employment, may have higher standards than others. The question becomes one of standard setting and whose preferences count?

The next section outlines the Benefit/Cost analysis used in this study. It begins with an introduction to local government revenue sources.

3.4 Property Value Change Impacts

Property taxes are the largest source of government revenue in the state of Michigan[61]. They accounted for 37.3% of "total state and local taxes in fiscal year 1985"[62]. Property taxes in 1985, accounted for 91.9% percent of local government tax revenue. Dependence on property tax revenues to support activities varies from 86%

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[61] Harvey, Lynn R., and Knudson, William, "Property Taxes and Relief in Michigan: Including The P.A. 116 Program", Staff Paper, Department of Agricultural Economics, Michigan State University, no. 88-98, pp. 1, December 1988.

[62] Taxation and Economic Policy Office, "Property Taxes in Michigan, Rates, Revenue and Relief 1986-1987", Department of Treasury, p. 1, September 1988.

for schools to 35.7% for municipalities[63]. Remaining funds are generated through fees and intergovernmental transfers. Residential real properties are by far the largest contributor to property tax revenues. They totaled 57.2% of property tax revenues in 1987[64].

Michigan property taxes are based on the state equalized value[65] multiplied by the township tax rate[66]. The total township tax rate is the sum of the millage rates for community colleges, schools, county and township (operation and debt, including fire, drain and special assessments)[67] located within the township boundaries. In 1986 the average millage rate was 48 mills. In addition to determining individual landowner property tax levels the state equalized value per pupil and millage rates are used to calculate state aid to school districts[68].

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[63]ibid, p. 8.

[64]ibid, p. 14.

[65]Equal to 50% of market value as determined by property tax assessors.

[66]Not to be confused with the 1 mill allotment to townships, this instead refers to total taxes paid to the township office.

[67]A mill equals ten dollars of taxes for every thousand dollars of SEV.

[68]Taxation and Economic Policy Office, "Property Taxes in Michigan, Rates, Revenue and Relief 1986-1987", Department of Treasury, p. 10, September 1988.

3.4.1 Local Government Impacts

Since township residents pay township, county, community college and school taxes, a decline in property values affects each of these units differently. The average distribution of property tax revenues amongst these units is shown below in table I along with the average degree of dependence on these revenues in 1984-1985[69].

Table I Property Tax Distribution and Dependence.

Property Tax:		Distribution	Dependence
Township	=	31.1%	48.4%
County	=	21.7%	40.4%
School	=	57.2%	86.0%

3.4.1.1 Townships: Townships by constitutional provision generally claim one mill to aid in operational expenses, however, voters may approve additional millage by a vote of residents. Additional revenues are obtained through state revenue sharing and service or user charge fees. Other township services that receive property tax revenues include fire districts, drain and other special assessments. Thus a decline in property value, as measured by the SEV directly

[69]Harvey, Lynn R., and Knudson, William, "Property Taxes and Relief in Michigan: Including The P.A. 116 Program", Staff Paper, Department of Agricultural Economics, Michigan State University, no. 88-98, p. 16, December 1988.

impacts the quality and quantity of services offered in a township.

3.4.1.2 Counties: An average Michigan county collected 6.14 mills in 1986. In return township residents receive a variety of county services including road maintenance, vital statistic registration, law enforcement, court services and register of deeds. Fees, intergovernmental transfers and additional services provided make up the remainder of the counties' funding.

3.4.1.3 School Districts: School districts are extremely dependent upon property value revenues. Eighty six percent of school revenues comes from property taxes. In an attempt to protect townships against extreme fluctuations in school funding the state guarantees a minimum funding support per pupil. A school district receiving funding via the state (membership aid) is known as "in-formula" while a district whose SEV/pupil ratio is greater than the state average is designated as an "out-of-formula" district. When "in-formula", a district receives state membership aid based upon the millage rate and the SEV per pupil. Property tax losses impact more heavily upon "out-of-formula" districts since they are above the state aid level, therefore bear 100% of the lost revenue. In a study of 29 counties in Michigan, declines in SEV per pupil have resulted in an increase of state membership aid from $381,356 in 1985-86 to $1.3 million in the 1987-88 school year[70].

3.4.2 Property Tax Stability

While property values are subject to substantial fluctuations depending upon the economy, safety mechanisms have been incorporated. Property values are stabilized because "assessed" values lag behind actual drops in land prices. Equalization offices use "sales studies" over a twelve to eighteen month period to lessen dramatic changes. In addition, certain taxation methods such as the "use" value assessment of farm land, are less vulnerable to economic downturns. Finally, in the short run, millage rates can be increased in order to offset property tax revenue resulting from declining agricultural land values[71].

3.5 Regulatory Options

Property tax revenues are important to support local services. Local governments are expected to protect the property values of its residents. In response to situations

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[70]Harvey, Lynn R., House, Al e., Cybulski, Karen K., and Walker, David R., "Agricultural Land Values and Assessments in Selective Counties in Michigan", Agricultural Economics Report, p. 32-33, No. 503, November 1987.

[71]Advisory Commission on Intergovernmental Relations, "The Agricultural Recession: Its Impact on the Finances of State and Local Governments", p. 17, Staff Information Report, Washington D.C., June 1986.

involving agriculture there are several mechanisms available to prevent declines in property values. These include ordinances, best management practices, technological improvements and regulatory alternatives described in the next four sections.

3.5.1 Ordinances

Zoning ordinances attempt to separate incompatible land uses. "Uses of land are typically incompatible if the characteristics of the use of the land may create negative consequences on adjacent land uses"[72]. Even though zoning ordinances are "legal, enforceable document(s)", they cannot predict future conflicts. The result is that new ordinances are adopted with the hope of preventing future conflicts.

Anne Fenton summarized a variety of these new ordinances in Michigan. Site requirements, involving "setbacks, (animal) density and prevailing winds are the typical criteria targeted" for livestock operations[73]. Fenton's summary cited conditional use permits distributed by townships requiring a minimum number of acres per operation, setbacks from residences and roads, direct access to county

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[72]Cooperative Extension Service, "Administering Township Zoning: A Basic Guide For Citizens and Local Officials", Michigan State University Extension Bulletin E-1408, p. 1, February 1987.

[73]Fenton, Anne M., "The Future of Intensive Swine Operations in Michigan" Plan B. Master's Paper, Department of Resource Development, Michigan State University, p. 46, March 1988.

or state roads and animal densities[74]. With the exception of maximum number of animals per farm restrictions, discussed next, compliance with these new ordinances is easily obtained. Fenton's summary cites two types of animal density requirements. One, adopted by the Michigan Animal Waste Resource Committee, sets a maximum number of animal units permissible per acre. Whether the owner uses a pasture or confinement feeding system is not important, instead the number of acres available where manure can be spread is the limiting factor. In the second case, limitations on the number of animals, regardless of acreage are imposed. The specific limits in the second case are:

300 cattle, horses, mules, or donkeys
600 swine, goad, sheep, ponies, or veal calves[75]

3.5.2 Best Management Practices

Best management practices have long been described as the most effective tools in preventing local conflicts. Careful thought given to barn location and timing of barn cleanup and manure spreading solve many of the problems. Agricultural engineers suggest moisture reduction to halt anaerobic biological decomposition, covered manure storage systems that "inhibit the interchange of odorous compound between the liquid surface and overlying atmosphere". They

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[74]ibid, p. 47.

[75]ibid, p. 48.

also discuss sprays that scrub odors from the air and finally barriers which aid in the dilution of odors[76]. A variety of other practices have been adopted by hog farmers in order to reduce the chances of nuisance suits. These include:

1. No spreading on Fridays, weekends or holidays
2. Informing neighbors before spreading
3. Spreading before it rains when possible to pull down odors

These practices involve extra time and consideration which may not be available to producers or thought of as necessary by them.

3.5.3 Technological Improvements

Technology exists to minimize, not eliminate odors. Most larger operations use anaerobic lagoons (as opposed to pits) with recirculating waste to cut down water usage. Lagoons with six month storage capacities allow for spreading only twice a year. This not only reduces the odors associated with spreading but also saves labor.

In some areas industrial odor management practices, such as floating lagoon aerators, are recommended. Costs for these technologies, when borne by the operator alone, often exceed the operator's perceived or realized benefits.

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[76]Miner, Ronald, J. and Barth, Clyde L., "Controlling Odors from Swine Buildings", p. 2, Pork Industry Handbook, Michigan State University Extension Bulletin E-1158, July 1979.

3.5.4 Regulatory Alternatives

Like commercial or industrial enterprises, livestock enterprises construct buildings, purchase inputs and spend money in their communities. Encouraging commercial or industrial enterprises to settle in an area sometimes involves tax easements and other incentives. If the benefits are great enough, townships might be able to use some of these same measures to encourage investment in both best management practices and technology which reduces odors and other environmental impacts.

Specifically, 12 year industrial tax easements, property tax waivers and local economic development associations can help secure low interest loans. Other more deliberate options include paving and plowing roads[77]. Looking at a livestock operation as an enterprise, important to the viability of the community, may perk community interest.

3.6 Summary

Accounting for the impact of environmental damages, be they cleanup costs from water contamination or lost revenues, is appropriate for decision makers. Regulatory options are one way of dealing with externalities created by livestock production. The next chapter presents the research methodology.

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[77] Discussion with Ken VerBurg, Michigan State University, Department of Continuing Education.

CHAPTER IV

RESEARCH METHODS

This chapter outlines the methods used in the thesis. The literature search, waste complaint survey, data collection and variables selected for the model are described.

4.1 Literature Search

The study began with a literature search focusing on state Right to Farm laws. The role of federal, state and local governmental units was explored in terms of interest and jurisdiction in addressing animal waste issues. A study of local ordinances affecting livestock farmers in Michigan led to an examination of local government decision making processes, waste management issues and finally a number of benefit/cost techniques used to evaluate environmental regulations.

4.2 Animal Complaint Survey

A study was performed to tabulate animal complaints filed with the environmental division of the Michigan Department of Agriculture. The purpose of the tabulation was to determine how livestock complaints were distributed across operation types and what kind of complaints were being made.

The tabulation categorized complaints by type of operation, (hog, dairy, beef, poultry and other), year (1986-1989), and type of complaint (air, water, other). Preliminary reporting in September of 1989 indicated a predominance of hog related complaints. 7.2 complaints per thousand farms were recorded for the hog sector as opposed to 4.3 for the next highest level in dairy cattle[78]. The tabulation is below in Table II[79] (see tabulation procedures in Appendix A).

The number of water related complaints across livestock types was nearly equal. The decision to focus on hog odor related cases was made based upon the preponderance of complaints in this category.

While this research focuses upon environmental concerns in Michigan, odor complaints are not unique to Michigan. In

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[78]Michigan Agricultural Statistics for 1988 report 26,000 cattle operations and 7000 hog farms.

[79]Abeles-Allison, Mark, "A Tabulation of Livestock Complaints in Michigan", Unpublished report, Department of Agricultural Economics, MSU, East Lansing, MI., September 1989.

Table II Complaint Tabulation Form.

COMPLAINT TYPE	Dairy	Cattle	Hogs	Poultry	Other	Totals
Odor						
1986	0	0	2	0	0	2
1987	2	1	8	0	0	11
1988	2	1	3	1	1	8
1989	5	6	18	4	6	39
Water						
1986	6	1	1	0	0	8
1987	2	0	2	1	0	5
1988	4	0	5	0	0	9
1989	11	4	11	2	3	31
Other						
1986	0	0	0	0	0	0
1987	0	0	0	1	0	1
1988	0	0	0	0	0	0
1989	0	1	0	0	0	1
TOTAL	32	14	50	9	10	115
% of Tot	27.83%	12.17%	43.48%	7.83%	8.70%	

Arkansas a mail survey recorded complaints against farmers using a random sample of 462 farmers in three counties over a five year period. Findings revealed that 10% of farmers reported complaints against them. The major complaint categories in Arkansas were chemical, odor and water. The top four complaint categories are shown below in Table III[80].

Table III Arkansas Complaint Survey.

Chemical Use	36%
Odors	18%
Water Use	16%
Water Pollution	10%

[80] Donald E., McCormick, Linda G., Blair, Joanne S., "Right to Farm Legislation in Arkansas, Its Objectives and Its Applicability", Arkansas Agricultural Experiment Station, University of Arkansas, March 1989.

4.3 Data Collection

There were five phases of data collection: 1) identification of farms; 2) houses and; 3) neighborhood, including environmental, characteristics for the property value study was followed by; 4) discussions with industry representatives and; 5) a literature search investigating local expenditures.

4.3.1 Property Value Study

This part of the study was intended to be a worst case scenario. This approach was used because community groups campaigning against undesirable land uses expect the worst. In order to incorporate this into the study, residential properties surrounding farms with odor complaints were used. In addition the farms in this study had received multiple complaints registered with the Michigan Department of Agriculture.

4.3.1.1 Identification of Farms: A total of 21 odor related complaints were registered for hog operations in the first nine months of 1989. Fourteen farms were selected using the criteria below. Eight of the fourteen were used in the final study. The other six were deleted because of insufficient data and/or lack of access to the data.

Farm selection was based on the following criteria:

1. Multiple complaints: Only farms with multiple

complaints against them were considered in this study. This included farms receiving more than one complaint in 1989 or several complaints over the three year period, 1986-1989 with at least one complaint in 1989. This criteria was designed to exclude situations involving neighborhood feuds, minor nuisances and/or individuals who complained in order to prevent the future expansion of an operation.

2. Availability of residential sales. Due to both PA 116 and poor recording procedures, several cases were removed because of insufficient residential sales or incomplete parcel card reporting.

3. Information on size of operation. When farm size information was not reported on the complaint forms, the farm was excluded from the survey.

4.3.1.2 Identification of Houses Surrounding Farms:

Residential properties were selected based upon several criteria. First, odor complaints are based upon concern for quality of life. Valuation of changes in quality of life can best be determined in areas where people live. Commercial or industrial properties do not function primarily as consumers of quality of life factors. Finally, in the case of agricultural properties, where both residences and production facilities coexist, several problems exist. First, relatively few farm sales take place as compared to residential sales. Second, valuation of a production unit is different than a residential unit. Including farm sales that have both might confound the results.

In order to insure that standard or "good" sales were used, "sales studies" provided by county equalization offices were used to identify recently sold houses and their prices. Houses on these studies are researched by the equalization office for use in their own studies to determine whether: personal property was included in the sale price, it was amongst family members and whether creative financing was used which could affect sale price.

4.3.1.3 Housing Characteristics: Structural characteristics of all buildings in townships are recorded on parcel cards. Maintaining these is the responsibility of the township supervisor. Once particular houses were identified from sales studies and their parcel numbers were recorded, trips to township offices were made to record the house characteristics used in this study.

4.3.1.4 Neighborhood Characteristics: Two locational variables were used in this study. Distance to the central business district was measured from the sale house to the nearest town with over 2500 people. In addition distance to the nearest highway from the house was recorded. Plat maps were used to make these measurements. The hypothesis is that proximity to a city or major highway allows for ease of access for rural residents who are likely to have urban jobs. Hedonic studies of urban areas support this claim as well.

4.3.1.5 Environmental Characteristics: Three environmental proxies were used to examine hog odors. These variables measure intensity and direction of odors. The variables are the number of hogs, wind direction and distance to the hog operation from the sale house.

4.4 Variables Selected for Property Value Study

Hedonic studies using property values to determine implicit prices utilize a wide range and number of variables. Freeman suggests that while house and neighborhood categories are almost always selected, the actual choice of variables within this grouping appears to be "haphazard". This recognizes the restrictions imposed by data availability. Some of the property and neighborhood variables used in previous studies are listed below.

Property Characteristics	Neighborhood Characteristics
Square footage	Distances to school, business areas and highways.
Number of rooms	Income levels
Type of construction	Tax rates
Year of Construction	Area Amenities
Heating system	Education level
Number of baths	Crime rate
Fireplace	Zoning
Classification	Population Density
Roof quality	
Improvements	

4.4.1 Dependent Variables: Property Sale Price

The dependent variable is the sale price of the house. Three years of sales were used in this study in order to obtain a large enough sample size. Use of the state equalized value (SEV) of the house prior to selling, normally 50% of the value of the house, was considered for the dependent variable, but due to variations in assessing methods across townships and within and between counties, sale prices were considered more consistent. It was interesting to find that even though equalization ratios[81] of individual plots varied between 30% and 70% of the sale price, when regressed against sale price, the coefficient of the independent variable, equalized values, was 49%, very close to the 50% state requirement.

It is hypothesized that property values are influenced by certain independent variables. Data on 19 independent

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[81] State equalized valuation divided by sale price.

variables were collected for this study. Descriptions of these variables are below.

4.4.2 Month of Sale

The month of sale, from 1-12, is included to capture the potential for lower sale prices in months associated with potent odors. Early spring and fall are the most common times for cleaning out lagoons and spreading manure.

4.4.3 Year of Sale

Three years of sales are recorded, March of 1986 through March of 1989. This should capture changes in interest rates and inflation. Expected sign of the coefficient is positive.

4.4.4 Road

This is a dummy variable for road surfaces. "One" = paved. "Zero" = unpaved. Expected sign of the coefficient is positive.

4.4.5 Age of House

Assessors depreciate houses year by year up to 35 years. This variable lists the age of the house in years. Expected sign of the coefficient is negative.

4.4.6 Plot

A large number of residential plots are vacant in rural areas. In order to include these plots in the study without having large numbers of observations with missing data, this variable is added allowing "zeros" to be entered on the remaining housing variables. "Ones" were recorded when there was just a plot of land with no building present. Expected sign of the coefficient is negative.

4.4.7 Brick or Stone Exterior

A dummy variable is designed to distinguish between brick and other types of houses. Any stone or brick on the house was recorded as a "one". Expected sign of the coefficient is positive.

4.4.8 Air Conditioning

A dummy variable is included for air conditioning. A "one" was recorded when it is present. Expected sign of the coefficient is positive.

4.4.9 Number of Baths

Quantity of full bathrooms is a variable. A full bathroom included a shower or bathtub, toilet and sink. Expected sign of the coefficient is positive.

4.4.10 Number of Fireplaces

Quantity of fireplaces is the variable. Expected sign of the coefficient is positive.

4.4.11 Garage

If a garage is present, attached or otherwise, it is recorded as a "one". Expected sign of the coefficient is positive.

4.4.12 Class Greater Than or Equal to "CB"

The state assessing system classifies houses by ranking them A through D. The classes reflect quality levels. A is an architecturally designed house while D is a below average house. C is average. All houses CB or better are recorded as a "one". Expected sign of the coefficient is positive.

4.4.13 Square Footage of House

The base footage of the house, not including porches, garages or terraces is recorded in square feet. Expected sign of the coefficient is positive.

4.4.14 Mobil Home

A dummy variable is included for a mobile home that sold with the property. "One" was recorded when a mobile home was present. Expected sign of the coefficient is negative.

4.4.15 Distance to Central Business District

Distance in one fifth mile segments is measured from the house to the nearest town over 2500 people. Expected sign of the coefficient is negative.

4.4.16 Distance to Highway

Distance in one fifth mile segments is measured from the house to the nearest four lane highway. Expected sign of the coefficient is negative.

4.4.17 Distance to Farm

Distance from the house to the hog operation is measured in fifth mile segments. Expected sign of the coefficient is positive.

4.4.18 Wind Direction

Wind direction is recorded to include any climate affects. A polar, 180 degree graph was used to assign measurements to houses in relation to the farm. Zero is directly upwind and 180 is directly downwind. Expected sign of the coefficient is negative. Prevailing wind directions were obtained at the Michigan Weather Service. Appendix 2 shows the map used for this study.

4.4.19 Wind x Distance Interaction

A wind and distance interaction variable is created to balance confounding distance measurements. This is included because there may be a relationship between the wind and distance variables. As distance from the operation changes, this should affect the dependent variable. However, this is dependent upon wind direction. For example, an upwind property, very close to the operation, may experience no impact. Expected sign of the coefficient is positive.

4.4.20 Animal Numbers

The number of animals, as recorded on complaint forms is recorded for each operation. Expected sign of the coefficient is negative.

4.5 Model Specification

$$PV = C + MON_1 + YrX_2 + ROADX_3 + YEARX_4 + ACREX_5 + PLOTX_6 + BRICKX_7 + AIRX_8 + BATHX_9 + FIREX_{10} + GARX_{11} + CLASSX_{12} + FEETX_{13} + MOBILX_{14} + CBDX_{15} + HWAYX_{16} + DISTX_{17} + WINDX_{18} + INTERX_{19} + ANIMALX_{20}$$

PV = Property sale value in nominal dollars
C = Constant
MON = Month of year house sold
Yr = Year house sold, 1986-1989
ROAD = Dummy, 1=paved road, 0=unpaved
YEAR = Age of house in years
ACRE = Acreage of plot, in acres
PLOT = Dummy, 1=just plot, 0=house
BRICK = Dummy, 1=brick or stone, 0=other
AIR = Dummy, 1=air conditioning, 0=none
BATH = Number of baths
FIRE = Number of fireplaces
GAR = Dummy, 1=garage, 0=no garage
CLASS = Dummy, 1=Class CB or better, 0=less than CB
FEET = Square footage of main house

MOBIL = Dummy, 1=mobile home, 0=not mobile home
CBD = Distance from house to central business district
HWAY = Distance from house to highway
DIST = Distance from farm to house
WIND = A vector reflecting odor intensity when downwind. The scale is 0-180. 0 = directly upwind, 180 = directly downwind.
INTER = WIND x DIST
ANIMAL = Number of animals at farm.

4.6 Variables Selected for Input Analysis

Calculations gathered from reports on hog farm input costs are integrated with expectations as to the degree of local spending.

4.6.1 Hog Input Costs

Backward linkages associated with raising pigs and hogs from birth to slaughter weight of 230 pounds represents expenditures of over $100 million dollars in Michigan[82]. Local communities benefit most from input purchases due to the structure of the livestock industry. Outputs are sold to slaughterer/processors which are more centrally located.

The amount spent to produce each hog goes towards feed, feed supplements, feed processing, labor, power and machinery, improvements, livestock expenses, land charges and other miscellaneous items. The figures below show total input expenses for hog operations under 200 and over 200 sows. The figures show that feed and feed supplement are

[82]Otto, Daniel, "Economic Importance of Michigan's Pork Industry", Iowa State University, 1987.

the two largest input items. Although total input costs are less for larger operations ($96.46 vs. $104.44), the distribution of expenses is similar.

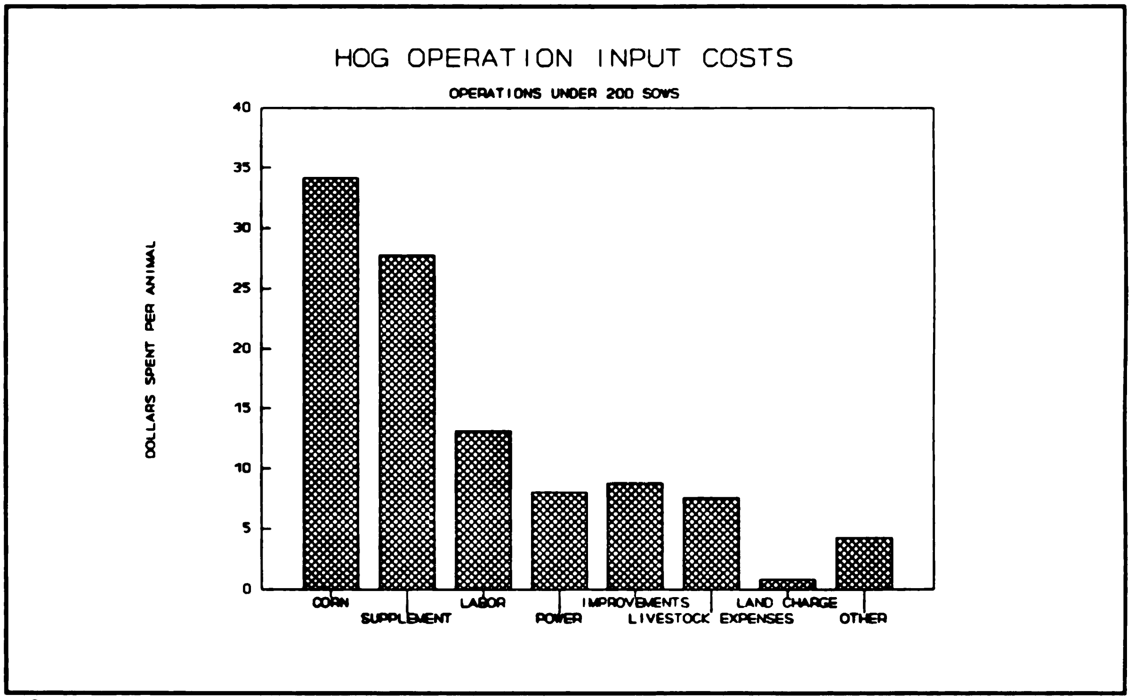

Figure 4 **Hog Operation Input Costs For Farms UNDER 200 Sows. Total input costs equal $104.44 per hog for this size operation (Schwab 1985).**

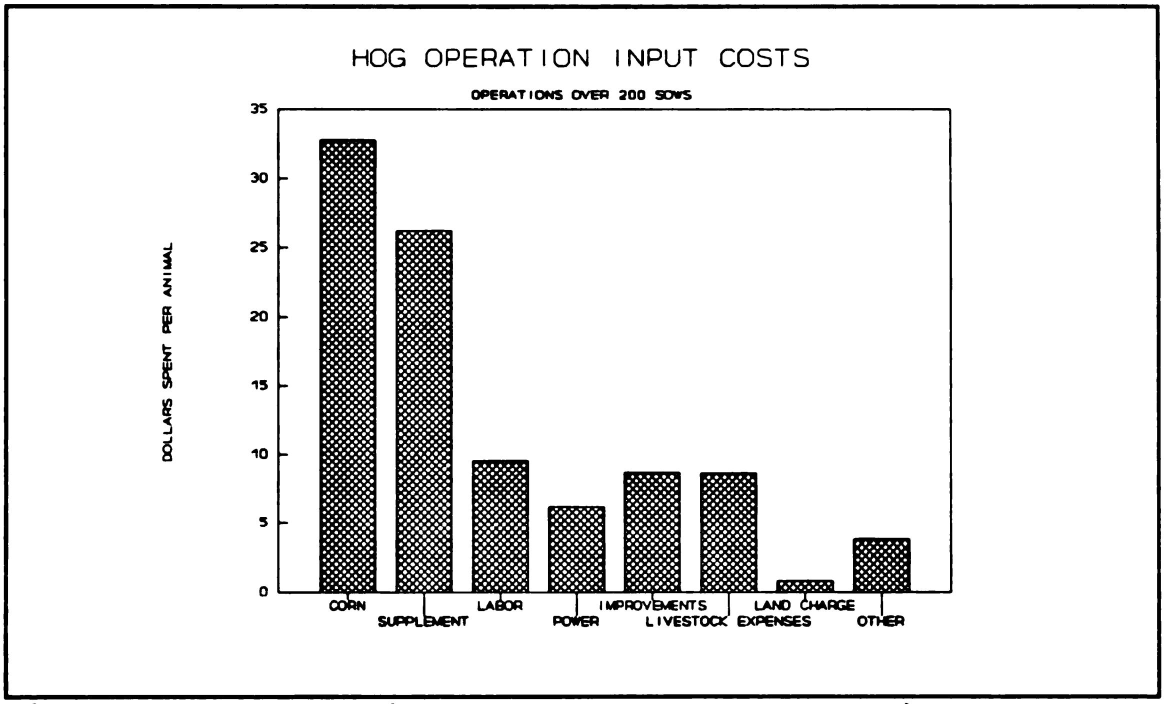

Figure 5 **Hog Operation Input Costs For Operations OVER 200 Sows. Total input costs equal $96.46 per hog for this size operation (Schwab 1985).**

4.6.2 Local Spending By Livestock Operations

Benefits associated with local (township or neighboring township) purchases by livestock operations are more relevant to land use decisions than are state wide livestock operation impacts. In part this is because land use decisions are decided by township governments. Because township ordinances are concerned with livestock densities, this section looks at the effects of larger operations on local input purchases.

As hog operations increase in size local spending per hog is hypothesized to decline. The following figures are based upon articles about hog farm purchasing practices and discussions with hog industry participants[83]. The figures show the relationship between size of operation and hypothesized local purchases. Eight categories of input purchases will be discussed. These categories are feed, feed supplements, labor, power and machinery, improvements, livestock expenses, land charges and other miscellaneous items. The categories are the same as those shown in Figures 4 and 5.

While little data is available documenting the location of purchases by livestock operations, purchasing practices and production information can be used to **estimate** the amount of local purchases. For example, the amount of own

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[83]Various articles in PORK magazine, 1981-86 and discussions with Dr. Jerry Schwab and Dr. Andy Thullen of Michigan State University.

grain grown by a hog operation may be a proxy for feed purchases foregone.

4.6.2.1 Feed Purchases

Hog operations grow a substantial portion of their own feed grain needs. However, Table IV shows that feed grain purchases increase substantially as the size of the operation increases[84].

Table IV Operator Grown Grain

FEED GRAIN NEEDS GROWN BY THE OPERATION	
Size of Operation	**National Average**
1,000-1,999	81%
2,000-2,999	69%
3,000-4,999	59%
5,000-9,999	45%
10,000-100,000	25%

In Figure 6, local feed grain purchases are hypothesized to rise as operations increase in size. Because top grain producing counties in Michigan are in the southern portion of the state where the majority of hog operations are located, most corn purchases will be local so as to minimize transportation costs. At present consumption of corn by hogs accounts for 11% of the corn produced in Michigan. Total feed purchases for small and large operations are $34.17 and $32.72 per head. Estimated local

[84]Rhodes, V.J., et al., "Basic Data on U.S. Mid/Large Size Hog Operations 1986-87", AEWP 1987-17, 1987.

feed purchases range between $5 and $15 for operations 500-5000 head in size.

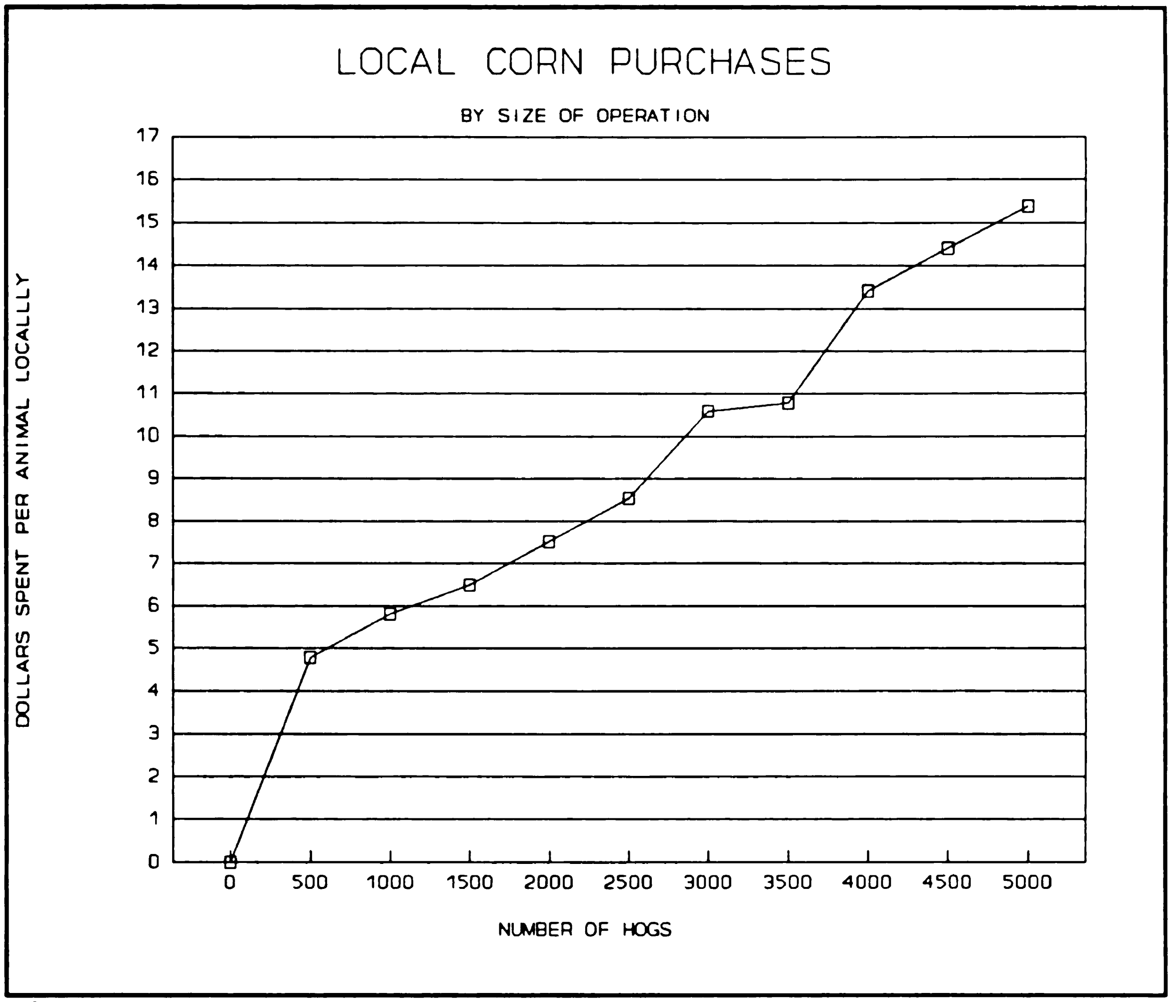

Figure 6 Local Corn Purchases

4.6.2.2 Feed Supplement Expenditures

Figure 7 shows local feed supplement purchases declining dramatically as operations grow. Feed supplement is a major portion of total expenses. For large operations, economies of size are obtained by purchasing truckloads from regional, often out of state manufacturers instead of the local elevator. Total supplement purchases for small and large operations are $27.78 and $26.17 per head. Estimated local supplement purchases range between $27 and $4 for operations 500-5000 head in size.

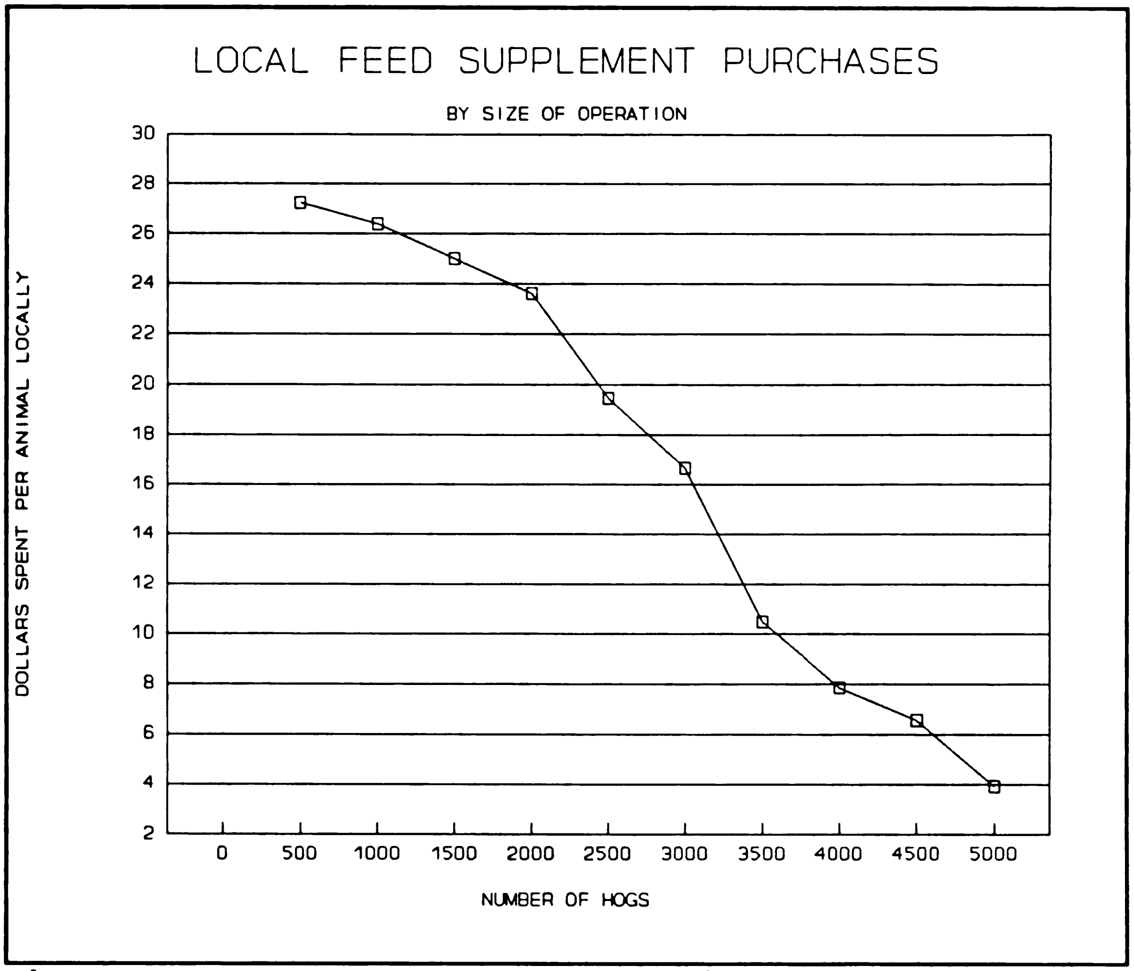

Figure 7 Feed Supplement Purchases in Local area.

4.6.2.3 Labor Expenditures

Labor expenses include, operator, family and hired labor. The amount spent locally per hog declines slightly with larger and larger operations as more specialized labor is brought in. Farm family labor is used primarily on smaller operations. Larger operations may have more staff, in addition to expert management, but it is likely that these individuals will live in the vicinity of the operation

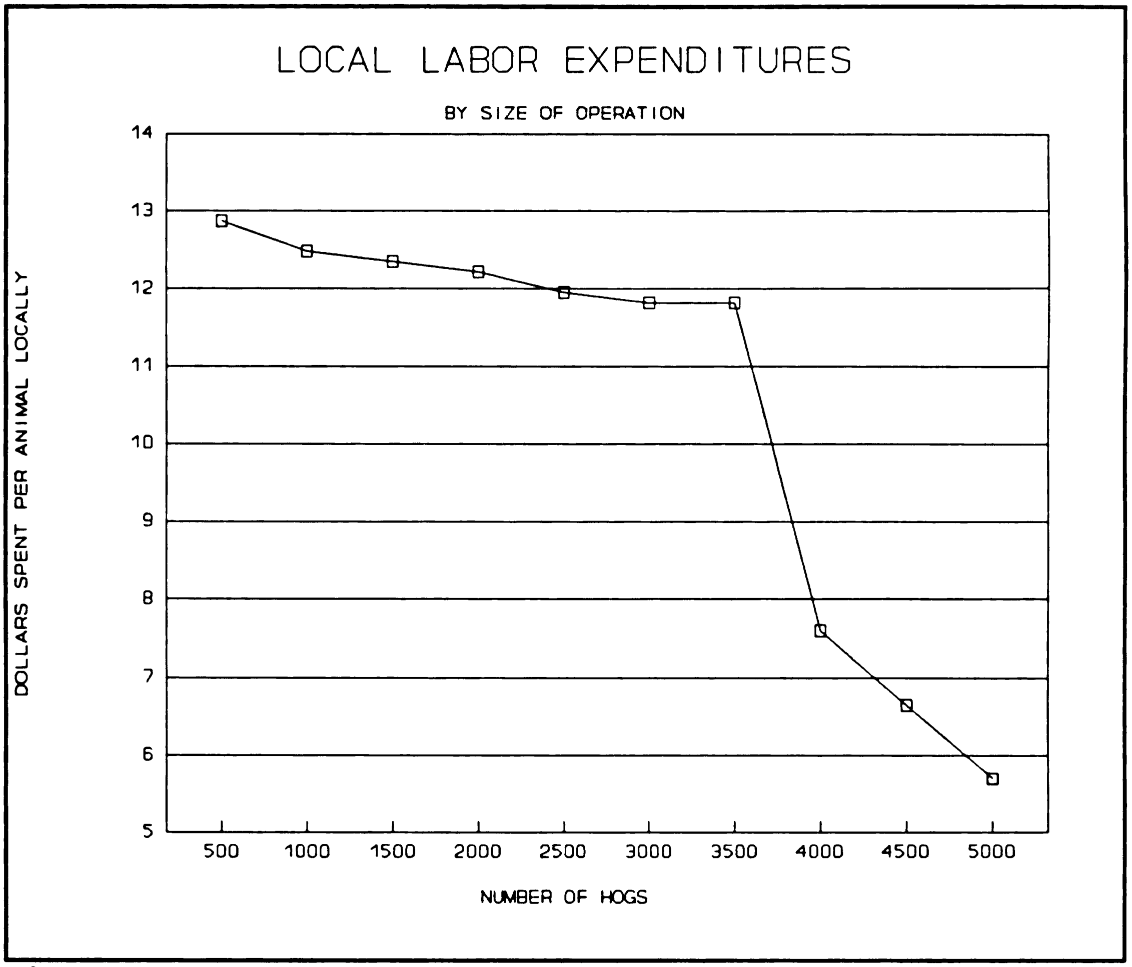

Figure 8 Local Labor Expenditures

as well. Total labor purchases for small and large operations are $13.1 and $9.49 per head. Estimated local labor expenditures as shown in Figure 8, range between $13 and $6 for operations 500-5000 head in size.

4.6.2.4 Power and Machinery Expenditures

Power and Machinery expenditures include repairs, fuels, depreciation and interest. Repairs and depreciation are the major categories. Most repairs will involve local labor and in some cases local parts. Depreciation on machinery is estimated to be over 50% local. Total power

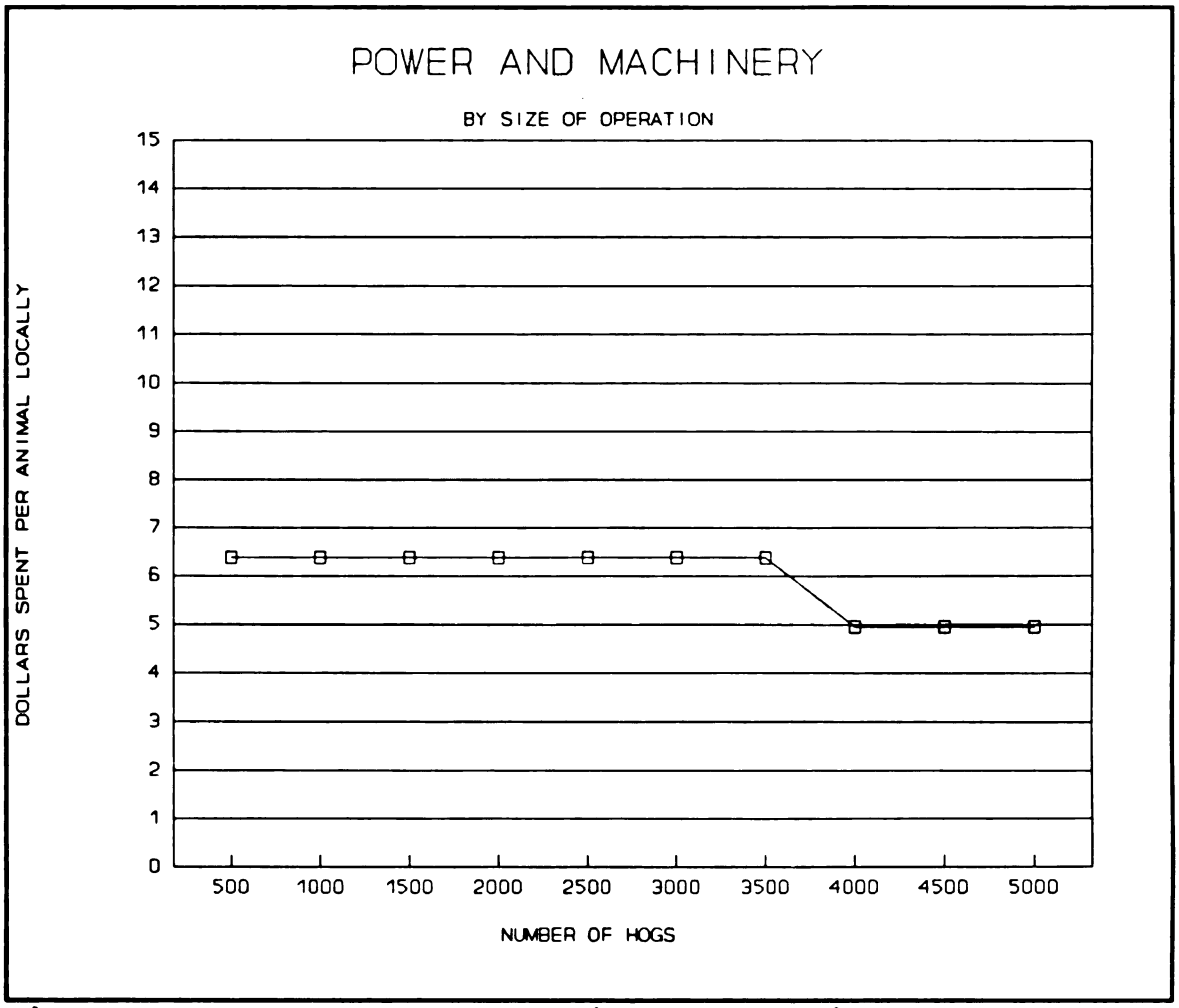

Figure 9 Local Power and Machinery Expenditures

and machinery purchases for small and large operations are $7.98 and $6.18 per head. Estimated local power and machinery purchases as shown in Figure 9, range between $6 and $5 for operations 500-5000 head in size.

4.6.2.5 Improvements

Improvements include repairs, insurance, depreciation and interest. Total improvement purchases for small and large operations are $8.74 and $8.64 per head. Estimated local improvement purchases as shown in Figure 10, are $8 for operations 500-5000 head in size.

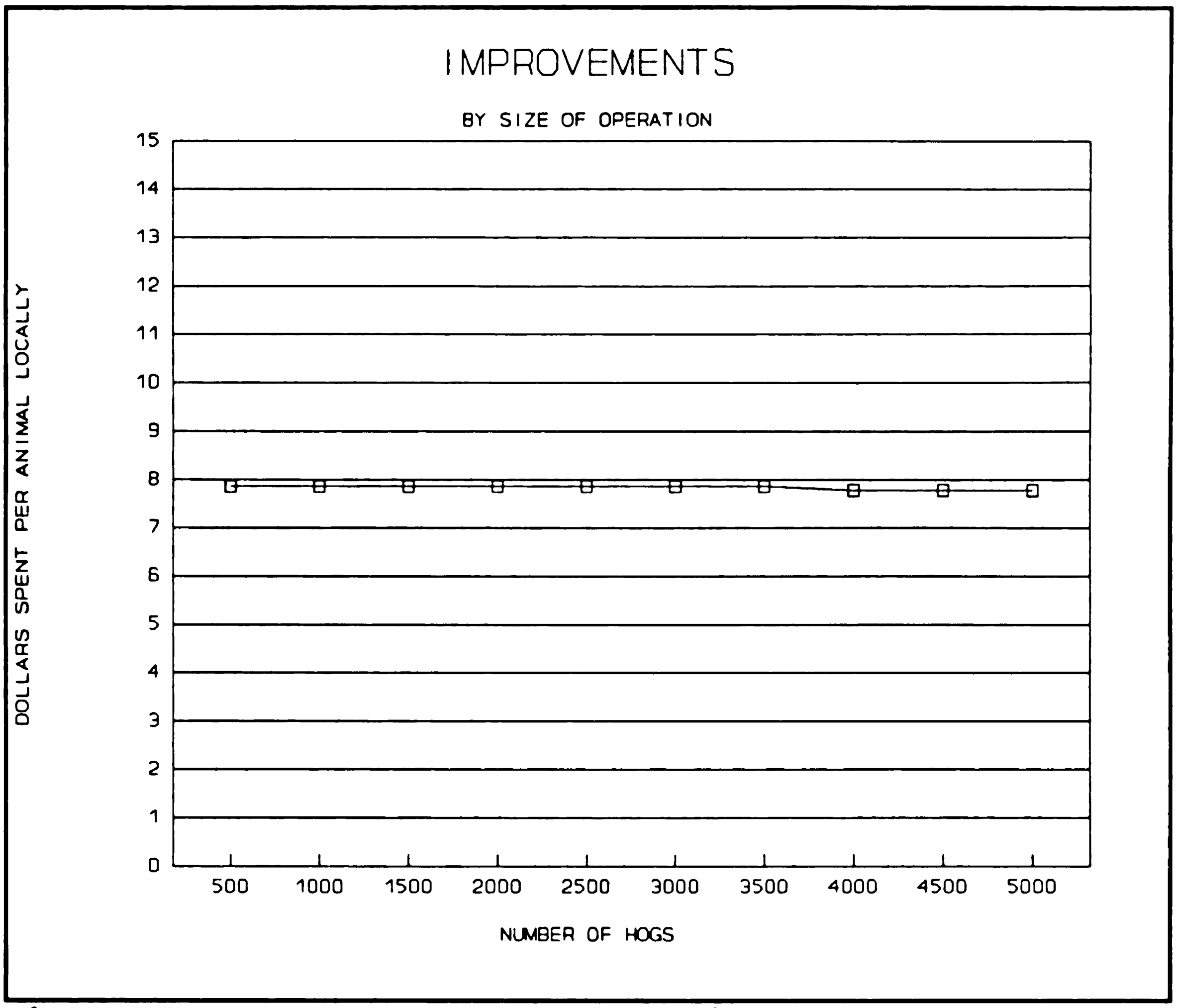

Figure 10 Local Improvement Expenditures

4.6.2.6 Livestock Expenditures

Livestock expenditures include semen and breeding, veterinary care, marketing, livestock supplies, other and interest expenses. Many medicines and drugs are produced outside the area while interest on loans will be paid outside the area as well. Total livestock expenditures for small and large operations are $7.56 and $8.57 per head. Estimated local livestock expense purchases as shown in Figure 11, range between slightly less than $4 and slightly more than $4 for operations 500-5000 head in size.

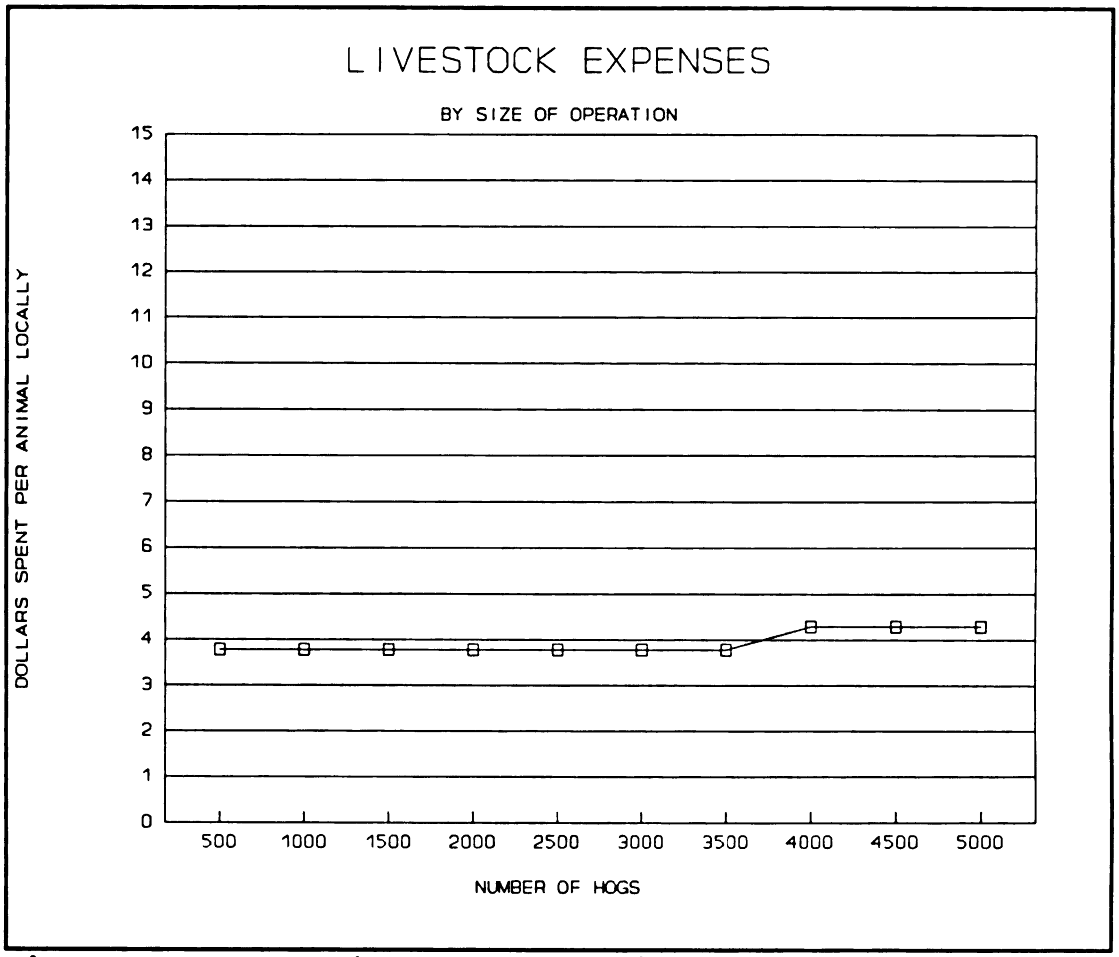

Figure 11 Local Livestock Expenditures

4.6.2.7 Land Charges

Land charges are primarily taxes which are returned to the local area. Total land charges for small and large operations are $.82 per head. Estimated local land expenditures as shown in Figure 12, are $.78 for operations 500-5000 head in size.

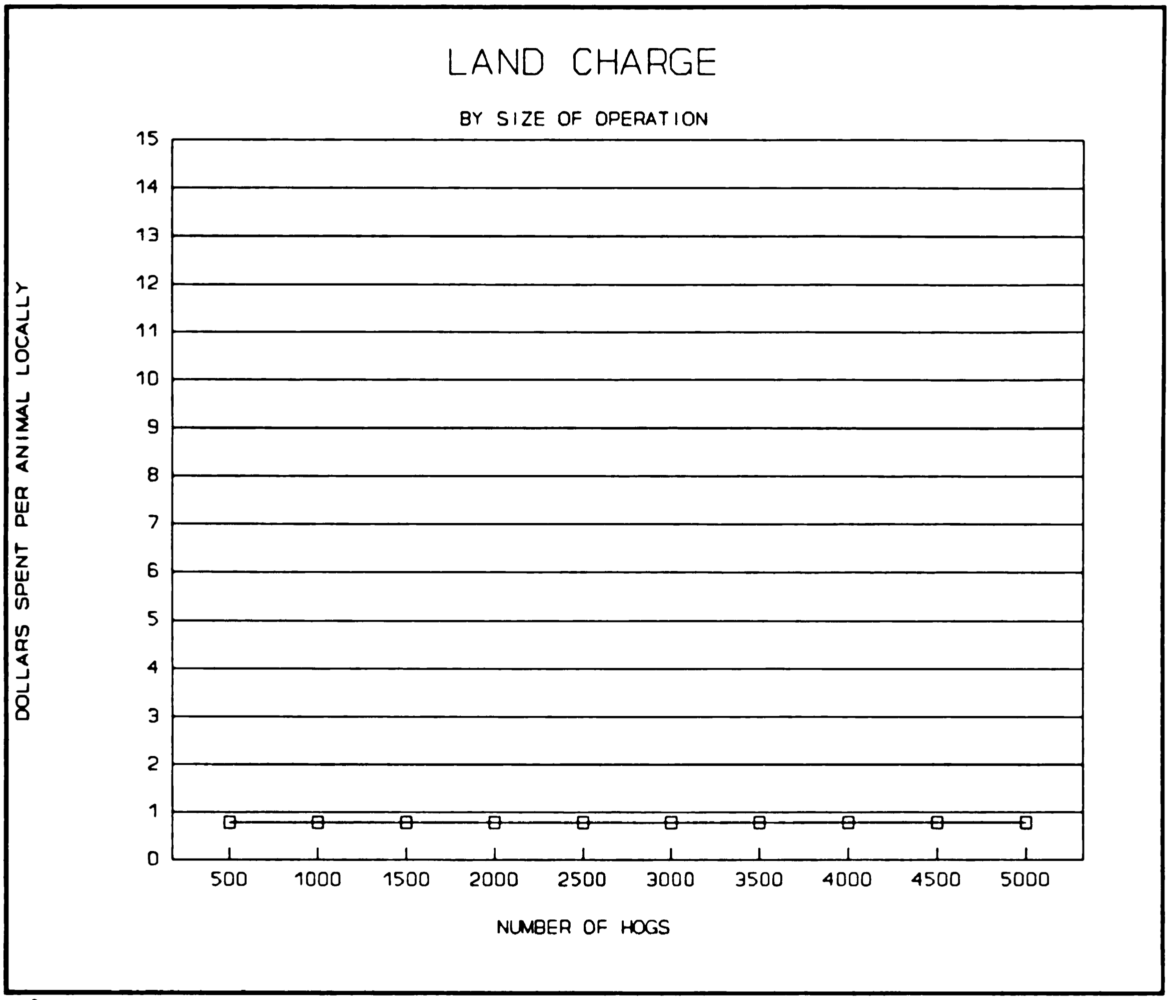

Figure 12 Local Land Charges

4.6.2.8 Other Expenses

Other local expenses include utilities and miscellaneous items. Most all of these are local expenses. Total other expenditures for small and large operations are $4.23 and $3.81 per head. Estimated local "other" expense

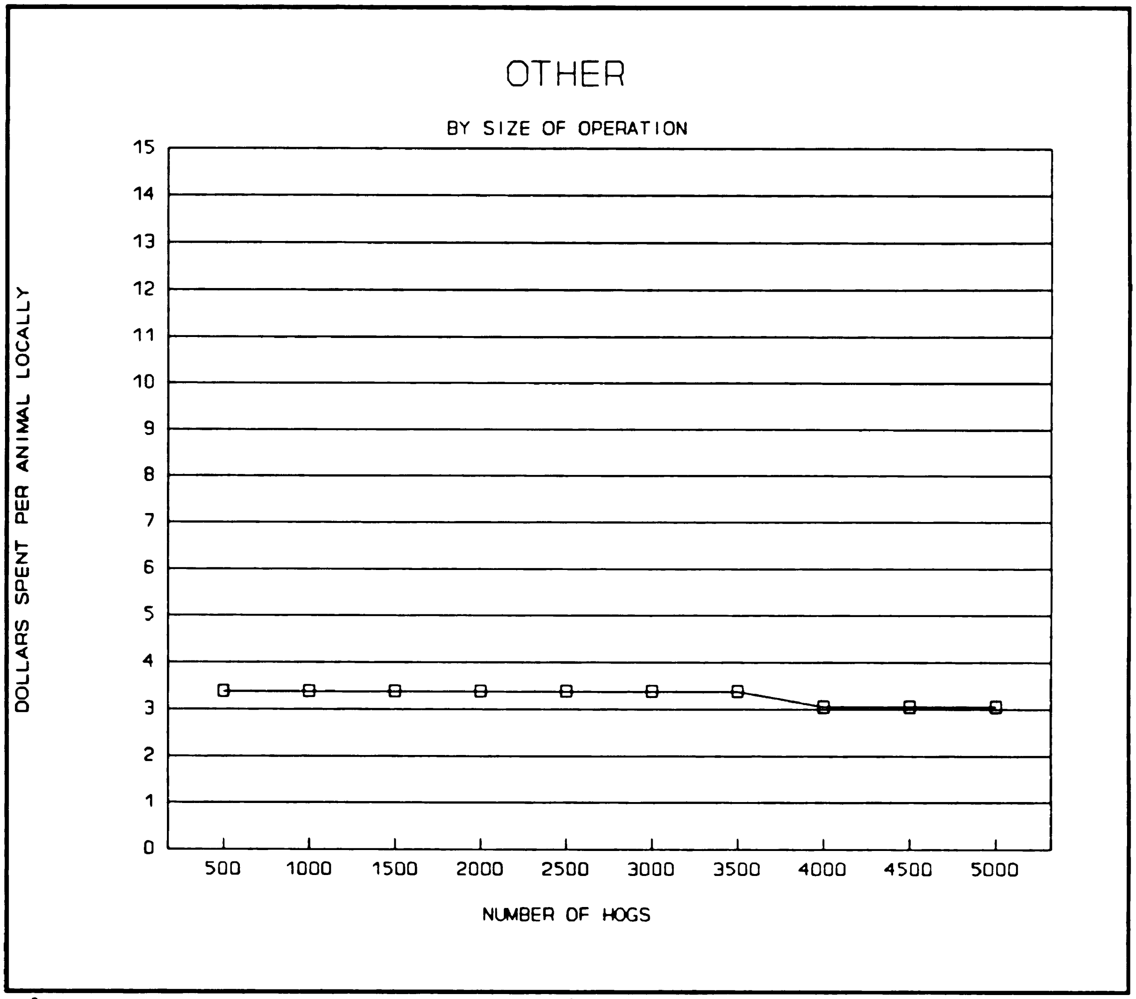

Figure 13 Other Local Expenditures.

purchases as shown in Figure 13, range between slightly more than $3 and $3 for operations 500-5000 head in size[85].

4.6.2.9 Total Local Expenditures

As operations increase in size, local expenditures steadily decline. This is especially true in the feed supplement category as economies of size make it profitable

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[85]These eight sections derived "local" purchases by multiplying the total cost by a percentage of purchases that were made locally. The 500 and 5000 head operation percentages are corn,14 & 47; supplement,98 & 15; labor,98 & 60; power,80 & 80; improvement,90 & 90; livestock,50 & 50; land,95 & 95; other,80 & 80.

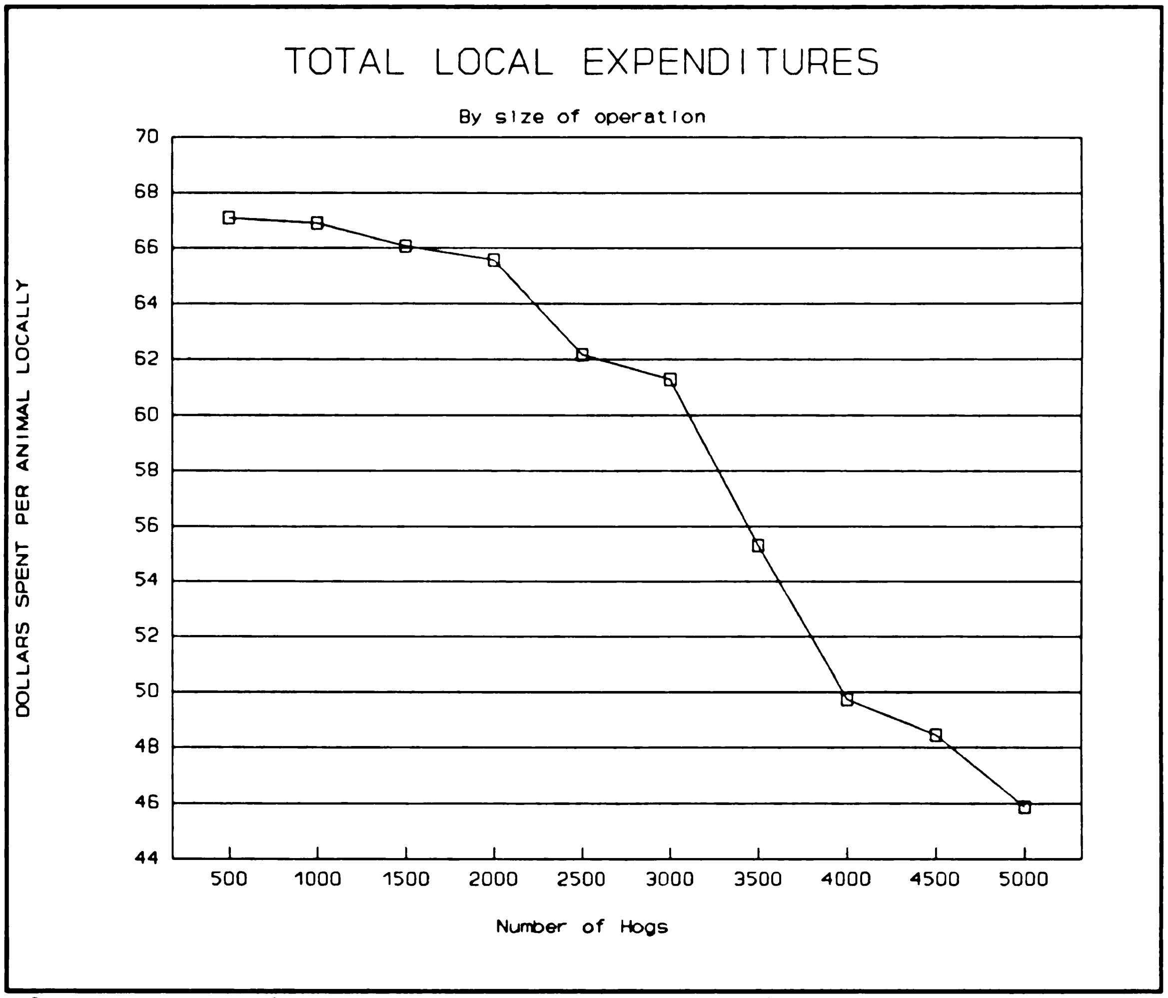

Figure 14 Estimated Total Local Expenditures Per Hog By Size of Operation.

to buy entire truck loads direct from manufacturers not located in the local area. Figure 14 shows estimated local expenditures to vary between $67 per hog for a 500 head operation, and $46 per hog for a 5000 head operation.

Because of limited data, the findings of this thesis will include a sensitivity analysis of local hog input purchases at a lower and higher level than that estimated above.

4.7 Comparing Benefits and Costs

In the following chapter benefits and costs are compared. Property tax receipt impacts[86] generated by the hedonic model will be determined. Property tax receipts are a percentage of the dependent variable, property value. Declines in property tax receipts are considered costs.

Local expenditures by hog operations are considered benefits. Benefit/cost ratios will be computed using two sizes of hog operations.

4.7.1 Scenarios

In Chapter V two scenarios are presented examining 500 and 5000 head hog farms. Benefits from local hog operation input purchases will be divided by costs measured as declines in property values.

Costs per property will be multiplied by property density in the affected region to generate total cost calculations. In order to compute local government impacts, the total cost calculation will be multiplied by an average township tax rate.

4.8 Summary

This chapter evaluated methods used for environmental benefit/cost analysis. The method used in this study combines regression analysis findings with local spending practices. The next chapter presents the research results.

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[86]The change in SEV is due to hog operations.

CHAPTER V

RESEARCH RESULTS

5.1 Findings

Hog operations benefit the communities surrounding them by purchasing inputs in the local area. Local purchases per hog, however, decrease as an operation increases in size. This chapter compares input purchases with the results of the regression analysis outlined in Chapter IV. An examination of the procedures used in determining benefits and costs, the benefit/cost ratio, significance of the findings, and a testing of hypotheses are below.

5.2 Livestock Operation Benefits

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[87].

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[87] Otto, Daniel, "Economic Importance of Michigan's Pork Industry", Iowa State University, 1987.

Revenues from processing hogs and selling pork do not usually benefit the community in which they are raised. However, a portion of input purchases, in addition to producer income, are returned to the communities where the animals originate. Because of odor and other problems associated with hog operations, hog producers make a conscious effort to purchase inputs locally.

5.2.1 Input Purchases

In 1985 input costs to raise a hog from birth to 230 lbs. was $104.44 for operations with under 200 sows and $96.46 for operations with over 200 sows[88]. The estimate of local purchases as a percent of these input costs are 64% and 46% respectively for a 500 and 5000 head operation[89]. Local expenditure estimates per hog are less for larger operations as economies of management and size are attained. The total dollar amount however is greater. Local expenditures per hog are estimated at $67.09 for small operations and $45.87 for larger operations[90]. Local expenditures for small and large hog operations are shown in Table V.

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[88]Schwab, Gerald D., "Business Analysis Summary For Swine Farms", Agricultural Economics Report, #485, Department of Agricultural Economics, Michigan State University, 1985.

[89] See Chapter IV of this thesis.

[90] See Chapter IV.

Table V Local Input Expenditures

Local Input Expenditures
By Size of Operation

# Of Head	Expenditures
500	$33,545
5000	$229,357

5.2.2 Output Multiplier

Otto's paper, "The Economic Importance of Michigan's Pork Industry", went beyond actual purchases in the hog sector to include indirect affects. He used an output multiplier to generate direct and indirect effects from all sectors needed to produce the output of the hog industry[91]. This output multiplier can be used to calculate the added impact of hog producer expenditures in local areas[92]. Using the producer output multiplier of 1.5, the additional revenues generated by small and large operations, are shown in Table VI.

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[91] Schmid, Allan, Benefit Cost Analysis: A Political Economy Approach, Westview Press, 1990.

[92] In a discussion with Dr. Otto, December 1989, it was determined that the multiplier used was from the producer level.

Table VI Local Input Expenditures with Multiplier

Local Input Expenditures With Multiplier
By Size of Operation

# of Head	Expenditures
500	$50,317
5000	$344,035

These calculations include the income and employment multipliers generated by producer spending on non-agricultural products. Figures 15 and 16 show the local input expenditures without and with the output multiplier.

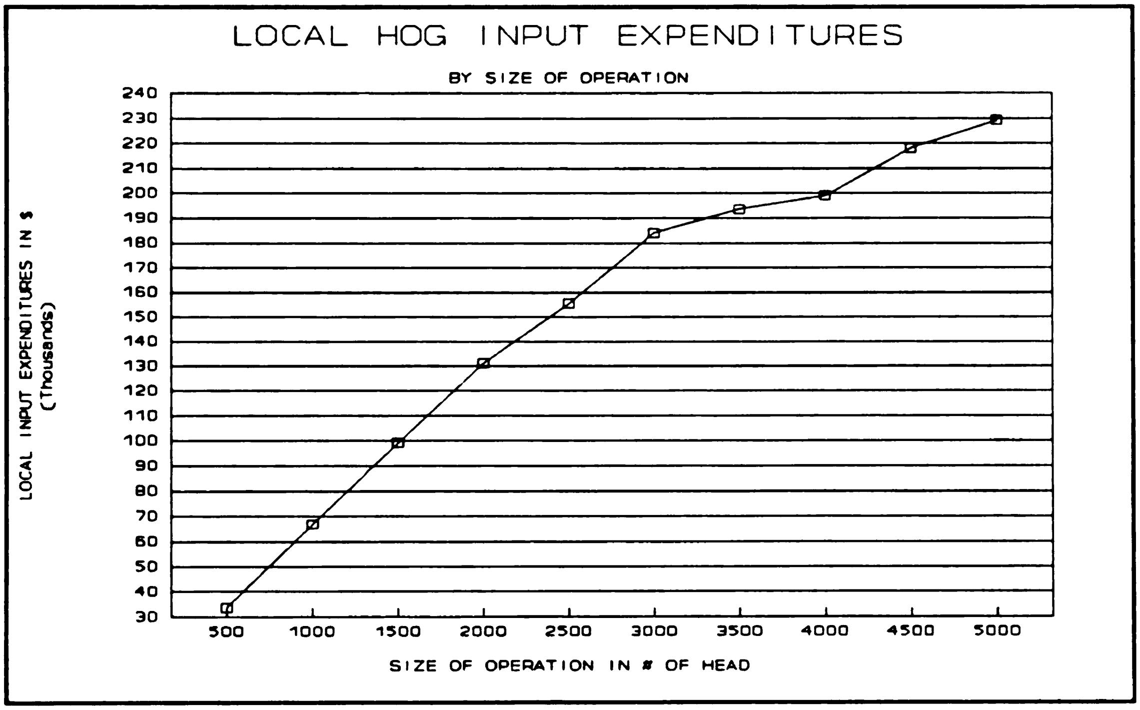

Figure 15 Estimated Local Hog Input Expenditures in thousands of dollars. For operations up to 5000 head.

In Figure 15 the slope of the expenditure line levels off somewhat as local expenditures, per hog, decline. In the Figure 16 the slope of the line is identical but the levels of expenditure are greater due to the output multiplier.

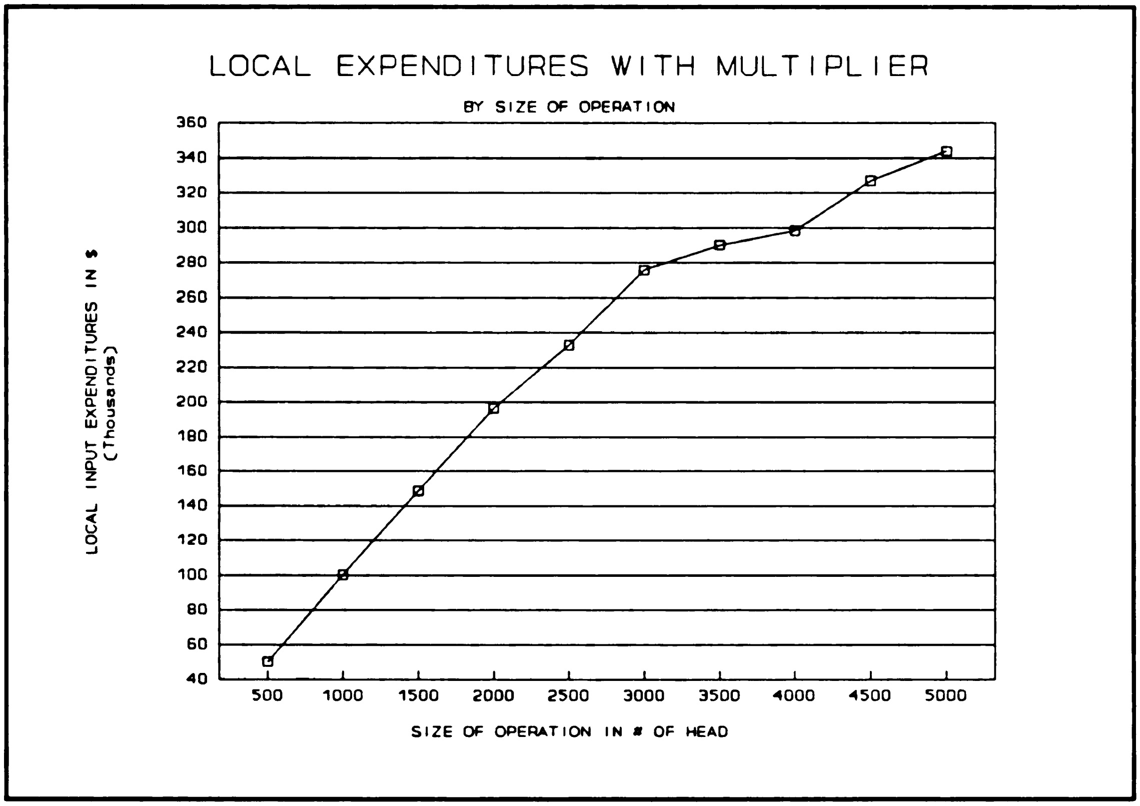

Figure 16 Estimated local input expenditures with output multiplier for operations up to 5000 head.

5.3 Livestock Operation Costs

An hedonic property value model is used to estimate losses in property tax receipts at the township level due to livestock operations. The regressions use property sale price as a dependent variable and property, neighborhood and environmental characteristics as independent variables. Linear and log-linear functional forms are used. The regression coefficients are used to calculate property value changes. This section discusses how these calculations were made.

5.3.1 Property Value Model

Four sets of regression equations are used in this analysis. The first set includes two regressions using the entire data set of 288 observations. The second set divides the dataset into small and large operations and examines each individually. In the third set, the data is sorted according to distance from the farm. Three regressions are then run for properties of close, medium and lengthy distances from the hog operations. The fourth and final regression set used a log-linear form with the entire dataset to determine how the independent variables are valued as a percent of property price. These four regression sets are described in detail below.

5.3.1.1 Set #1. Hog Impact on Property Price: The first regression in this set is used to generate the implicit cost of an additional hog on property value. The coefficient of the ANIMAL variable is the change in property value for every additional hog.

Several variables were removed from the original model specification[93] 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. The coefficients and statistical measures for SET 1., are shown in Table VII. Variables with significant t-tests at the 95% level are bolded. The key for the variable names follows the regression.

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93 See Chapter IV.

Table VII Hog Impact Model

Regression #1. Hog Impact Model
288 Observations

$PV = 5{,}505 + 297\ \mathbf{ACREX_1} + 17\ \mathbf{FEETX_2} + 1{,}855\ \mathbf{BRICKX_3} + 12{,}761\ \mathbf{BATHX_4} + 10{,}409\ \mathbf{FIREX_5} + 9{,}746\ \mathbf{GARX_6} - 20{,}184\ \mathbf{MOBILX_7} + 215\ \mathbf{CBDX_8} - 62\ DISTX_9 + 67\ WINDX_{10} - 2.62\ INTERX_{11} - .43\ \mathbf{ANIMALX_{12}}$

$R^2 = .65$ Adj. $R^2 = .64$ SER = 19,230 F-Statistic= 44.1

PV = Property sale value in nominal dollars
C = Constant
ACRE = Acreage of plot, in acres
BRICK = Dummy, 1=brick or stone, 0=other
BATH = Number of baths
FIRE = Number of fireplaces
GAR = Dummy, 1=garage, 0=no garage
FEET = Square footage of main house
MOBIL = Dummy, 1=mobile home, 0=not mobile home
CBD = Distance from house to central business district
DIST = Distance from farm to house
WIND = A vector reflecting odor intensity when downwind. The scale is 0-180. 0 = directly upwind, 180 = directly downwind.
INTER = WIND x DIST

Strengths
- *An R^2 of .65 compares well with other cross-sectional hedonic studies.
- *The F-Statistic is significant at .01 level.
- *The first eight variables are of the correct sign and significant at the .05 level.
- *The animal variable is significant at the .025 level.

Weaknesses
- *The standard error of the regression is 40%.
- *Wind, distance and central business district variables have unexpected signs.

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[94] declines 43 cents. Using this approach one thousand hogs results in a drop of $430 in property value on a single property.

Several other variables in the model are included for explanatory purposes. DIST and WIND are variables representing the distance from the property to the operation, and the prevailing wind direction. They are included because of their hypothesized importance in relation to odor transfer.

The coefficient of the variable DIST is expected to be positive. Property owners who live farther away should have higher property values, ceteris paribus. The coefficient for WIND is expected to be negative. Property owners located directly downwind of a hog operation are expected to have lower property values, ceteris paribus, than those upwind. Properties **directly** downwind were assigned a value of 180^{o}, while those directly upwind were assigned 0^{o}.

In this first regression both DIST and WIND had unexpected coefficient signs. These unexpected signs and insignificant t-statistics suggest that the relationship

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[94]A five mile block surrounding the farm.

between property value, distance from the farm and wind direction are not as important as earlier expected. The regression is shown in Table VIII.

Table VIII Regression #1, Hog Impact Model

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	5505.3277	5991.3188	0.9188841	0.358
ACRE	297.81103	167.10812	1.7821458	0.075
FEET	17.373255	3.7394666	4.6459179	0.000
BRICK	1855.3025	1117.8127	1.6597615	0.097
BATH	12761.338	2885.4824	4.4226012	0.000
FIRE	10409.632	2627.8144	3.9613268	0.000
GAR	9746.9120	3111.1214	3.1329256	0.002
MOBIL	-20184.337	6025.8750	-3.3496110	0.001
CBD	215.34303	86.254317	2.4966058	0.013
DIST	-62.703255	224.25020	-0.2796129	0.780
WIND	67.347925	65.370178	1.0302546	0.303
INTER	-2.6285560	2.5191474	-1.0434308	0.297
ANIMAL	-0.4322518	0.1923493	-2.2472237	0.025

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		

In order to re-test these relationships, a second regression included two additional variables, INTER and WIND^2. INTER is an interaction variable created by multiplying WIND times DIST. The combined effect of wind direction and distance from the farm can thus be measured. This variable is included because both wind direction and distance from the farm can affect odor transfer. In addition they can also affect the relation between odors and property value loss. The expected sign of the coefficient of INTER is negative. If the coefficient of INTER is negative, the effect of being more downwind wind on property price will decrease as distance increases or increase as distance decreases.

$WIND^2$ is the square of the wind variable. This emphasizes locations downwind. Properties downwind of the operation were assigned measures closer to 180°, while upwind locations were nearer to 0°. A negative sign is expected for this variable as property values should decrease for properties more downwind of hog operations because of odors. The regression is below in Table IX. Variables with significant t-tests at the 95% level are bolded.

Table IX Wind and Distance Model

FIGURE 21. Regression #2. Wind and Distance Impact Model
288 Observations

PV = 5,129 + 298 $\mathbf{ACREX_1}$ + 17 $\mathbf{FEETX_2}$ + 1,868 $\mathbf{BRICKX_3}$ + 12,762 $\mathbf{BATHX_4}$ + 10,443 $\mathbf{FIREX_5}$ + 9,763 $\mathbf{GARX_6}$ - 20,273 $\mathbf{MOBILX_7}$ + 214 $\mathbf{CBDX_8}$ - 64 $DISTX_9$ + 81 $WINDX_{10}$ -.08 $WIND2X^1{}_1$ - 2.59 $INTERX_{12}$ - .42 $\mathbf{ANIMALX_{12}}$

R^2 =.65 Adj. R^2 =.64 SER =19,264 F-Statistic=40.6

Results of Regression #2 in Table X, show negative signs for both variables. Neither variable however has a significant t-test at the 95% level.

Table X Regression #2, WIND and DIST impact model.

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	5129.0170	6330.4682	0.8102113	0.418
ACRE	298.67460	167.46584	1.7834956	0.075
FEET	17.384605	3.7465374	4.6401793	0.000
BRICK	1868.9946	1122.1723	1.6655149	0.096
BATH	12762.707	2890.5681	4.4152938	0.000
FIRE	10443.255	2638.5753	3.9579143	0.000
GAR	9763.1389	3117.8035	3.1314158	0.002
MOBIL	-20273.112	6055.1282	-3.3480896	0.001
CBD	214.28935	86.589721	2.4747666	0.013
DIST	-64.407856	224.82972	-0.2864739	0.775
WIND	81.057826	98.322385	0.8244087	0.410
WIND2	-0.0855147	0.4574634	-0.1869323	0.852
INTER	-2.5918655	2.5312007	-1.0239668	0.306
ANIMAL	-0.4286842	0.1936305	-2.2139287	0.027

R-squared	0.658575	Mean of dependent var	46506.55
Adjusted R-squared	0.642376	S.D. of dependent var	32214.51
S.E. of regression	19264.81	Sum of squared resid	1.02E+11
Durbin-Watson stat	1.952058	F-statistic	40.65534
Log likelihood	-3242.897		

The dependent variable is PRICE. The number of observations is 288.

Regression #1 supports the hypotheses that hogs are correlated with reduced property values. Regression #2 shows that no significant correlation exists between property value and the variables INTER and $DIST^2$.

5.3.1.2 Set #2. Large vs. Small Operations: As mentioned earlier in this thesis, odor complaints about hogs involve operations of all sizes. Many of the multiple complaint cases involving litigation are for larger operations. The eight cases in this thesis include three small operations, under 150 head, and five larger operations, over 3000 head. The regressions in Set #1 combine large and small operations together. While livestock specialists argue that poor management on any size of farm can cause environmental damages, the next section will examine whether small and large farm impacts on property value 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 #3 and #4 shown in Tables XI - XVI were run for the small and large operations. Variables with significant t-tests at the 95% level are bolded.

Table XI Small Hog Operation Model

Regression #3. Small Hog Operations
67 Observations

$$PV = 7{,}071 + 466\ ACREX_1 + 31\ FEETX_2 + 12{,}778\ BRICKX_3 + 5{,}140\ BATHX_4 - 20\ FIREX_5 + 3{,}083\ GARX_6 + 317\ CBDX_7 - 179\ DISTX_8 + 2\ WINDX_9 - .8\ INTERX_{10} - .55\ ANIMALX_{11}$$

R^2 =.66 Adj. R^2 =.59 SER =19,458 F-Statistic =9.9

Table XII Regression #3, Small Hog Operation Model.

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	7071.4985	37995.318	0.1861150	0.853
ACRE	466.41338	613.25547	0.7605532	0.450
FEET	31.163358	9.6411987	3.2323115	0.002
BRICK	12778.035	8496.0899	1.5039901	0.138
BATH	5140.5256	7603.0097	0.6761172	0.502
FIRE	-20.569418	6400.1497	-0.0032139	0.997
GAR	3083.6083	6848.1847	0.4502811	0.654
CBD	317.70723	180.97921	1.7554902	0.085
DIST	-179.72210	1337.6046	-0.1343612	0.894
WIND	2.3588291	463.07368	0.0050939	0.996
ANIMAL	-0.5582432	0.3639765	-1.5337342	0.131
INTER	-0.8334508	16.509932	-0.0504818	0.960

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		

The dependent variable is PRICE. The number of observations is 67.

Several significant changes occur when examining only the small operation areas. First, ACRE, BATH, FIRE, GAR and CBD variables are no longer significant. This is surprising because BATH, FIRE, GAR and CBD were robust variables that had significant t-test levels in all of the other regressions. Most important is the loss in significance of the t-test for the ANIMAL variable. The t-test dropped just below the 95% level significance level to -1.5. In addition the ANIMAL variable coefficient was unexpectedly large. The coefficient of .55 exceeds earlier estimates by .11. In this case the coefficient was expected to drop. The large operation regression is below. Variables with significant t-tests at the 95% level are bolded.

Table XIII Large Hog Operation Model

Regression 4. Large Hog Operations
221 Observations

PV = 5,433 + 307 $\mathbf{ACREX_1}$ + 14 $\mathbf{FEETX_2}$ + 1,451 $\mathbf{BRICKX_3}$ + 13,322 $\mathbf{BATHX_4}$ + 12,752 $\mathbf{FIREX_5}$ + 12,556 $\mathbf{GARX_6}$ - 16,946 $\mathbf{MOBILX_7}$ + 205 $\mathbf{CBDX_8}$ - .42 $DISTX_9$ + 74 $WINDX_{10}$ -3 $INTERX_{11}$ - .48 $\mathbf{ANIMALX_{12}}$

Table XIV Regression #4, Large Hog Operation Model.

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	5433.9196	6314.1740	0.8605907	0.389
ACRE	307.49570	180.48823	1.7036883	0.088
FEET	14.071166	4.3462261	3.2375597	0.001
BRICK	1451.8969	1154.6557	1.2574284	0.209
BATH	13322.437	3310.4066	4.0244109	0.000
FIRE	12752.374	3099.9669	4.1137129	0.000
GAR	12556.568	3641.5930	3.4480976	0.001
MOBIL	-16946.545	8041.7698	-2.1073154	0.035
CBD	174.77127	103.69530	1.6854309	0.092
DIST	-0.4267359	241.96962	-0.0017636	0.999
WIND	74.811294	68.013649	1.0999453	0.271
INTER	-3.0794351	2.6939970	-1.1430730	0.253
ANIMAL	-0.4859769	0.2372246	-2.0485938	0.041

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	33.55984
Log likelihood	-2490.871		

The Dependent variable is PRICE. The number of observations is 221.

Results of the large operation model are similar to the model with 288 observations presented in Regression #1. Differences include a drop in t-test significance levels for ACRE, FEET, BRICK, BATH, MOBIL, CBD, WIND and ANIMAL, a larger standard error of the regression and a drop in the F-Statistic. No coefficient signs changed. The ANIMAL coefficient of this sample is also higher than the total regression sample by .03.

5.3.1.3 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 is confusing. In order to re-test the importance of distance from the farm in determining damages, the 288 observations were sorted by DIST in ascending order. This permitted three regressions to be performed on the first, second and third group of observations corresponding to progressively greater distances from the farm.

Three regressions using the same variables as in Regression #1 were run, excluding distance since the observations were already sorted by distance. 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 three regression equations are below. The coefficient of the ANIMAL variable in Regression #5 (close properties) is -1.74. This is nearly four times the ANIMAL coefficient in Regression #1. The coefficients for ANIMAL in Regressions #6 (medium distance) and #7 (farthest), were -.53 and -.13, respectively. The reduction of the coefficients suggests that properties farther away from the hog operation are 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 in Regression #5 is -2.7, #6 is -1.6, #7 is -.59. These steady declines in t-test levels are evidence of the localized impacts of hog operations. Variables with significant t-tests at the 95% level are bolded. Regressions #5 - 7 are shown in Tables XV - XX.

Table XV Close Property Model

Regression #5. Close Properties
91 Observations

$PV = 10{,}115 - 1{,}040\ \mathbf{ACREX_1} + 25\ \mathbf{FEETX_2} + 1{,}588\ BRICKX_3 + 9{,}263\ \mathbf{BATHX_4} + 14{,}276\ \mathbf{FIREX_5} + 11{,}393\ \mathbf{GARX_6} - 6{,}097\ \mathbf{MOBILX^7} + 551\ \mathbf{CBDX_8} - 69\ WINDX_9 - 1.7\ \mathbf{ANIMALX_{12}}$

R^2 =.69 Adj. R^2 =.65 SER =23,229 F-Statistic =17.8

Table XVI Intermediate Distance Model

Regression #6. Intermediate Distance Properties
96 Observations

$PV = 7{,}467 - 455\ \mathbf{ACREX_1} + 20\ \mathbf{FEETX_2} + 12{,}326\ \mathbf{BRICKX_3} + 5{,}432\ BATHX_4 + 6{,}133\ \mathbf{FIREX_5} + 7{,}717\ \mathbf{GARX_6} - 16{,}197\ \mathbf{MOBILX^7} + 278\ \mathbf{CBDX_8} - 39\ WINDX_9 - .53\ \mathbf{ANIMALX_{12}}$

R^2 =.66 Adj. R^2 =.62 SER =17,389 F-Statistic =16.5

Table XVII Distant Property Model

Regression #7. Distant Properties
101 Observations

PV = 7,968 - 529 **ACREX**$_1$ + 12 **FEETX**$_2$ + 1,345 **BRICKX**$_3$ + 16,130 **BATHX**$_4$ + 9,268 **FIREX**$_5$ + 1,090 **GARX**$_6$ - 22,823 **MOBILX**^{7} + 36 **CBDX**$_8$ - 6.9 WINDX$_9$ - .13 **ANIMALX**$_{12}$

R^2 =.74 Adj. R^2 =.71 SER =15,116 F-Statistic =26.7

Table XVIII Regression #5, Close Property Model.

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	168.44071	7076.7234	0.0238021	0.981
ACRE	-1040.2219	540.49163	-1.9245848	0.058
FEET	25.644116	7.9784435	3.2141753	0.002
BRICK	1588.2631	9141.4121	0.1737437	0.863
BATH	9263.3730	5383.2678	1.7207713	0.090
FIRE	14276.892	6413.6231	2.2260261	0.029
GAR	11393.100	6804.2531	1.6744086	0.099
MOBIL	-6097.7873	18386.600	-0.3316430	0.741
CBD	551.24463	229.88759	2.3978877	0.019
WIND	69.470317	60.029378	1.1572720	0.251
ANIMAL	-1.7457668	0.6289852	-2.7755293	0.007

R-squared	0.691015	Mean of dependent var	47363.15
Adjusted R-squared	0.652391	S.D. of dependent var	39399.13
S.E. of regression	23229.07	Sum of squared resid	4.32E+10
Durbin-Watson stat	1.927806	F-statistic	17.89119
Log likelihood	-1038.099		

The dependent variable is PRICE. The number of observations is 91.

Table XIX Regression #6, Medium Distance Property Model.

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	7467.8171	5794.3811	1.2888032	0.202
ACRE	455.81950	194.35564	2.3452858	0.022
FEET	20.727822	6.5947381	3.1430850	0.002
BRICK	12326.464	5791.1098	2.1285150	0.037
BATH	5432.8119	5057.0837	1.0742974	0.286
FIRE	6133.2720	4235.9860	1.4478971	0.152
GAR	7717.4892	4896.6610	1.5760718	0.119
MOBIL	-16197.565	8616.7126	-1.8797847	0.064
CBD	278.75874	168.21429	1.6571644	0.102
WIND	-39.486028	49.788374	-0.7930773	0.430
ANIMAL	-0.5334500	0.3286039	-1.6233831	0.109

R-squared	0.660743	Mean of dependent var	44206.56
Adjusted R-squared	0.620831	S.D. of dependent var	28240.55
S.E. of regression	17389.61	Sum of squared resid	2.57E+10
Durbin-Watson stat	2.240214	F-statistic	16.55476
Log likelihood	-1067.685		

The dependent variable is PRICE. The number of observations is 96.

Table XX Regression #7, Distant Property Model.

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	7968.0359	5190.3444	1.5351652	0.129
ACRE	529.18792	283.02653	1.8697467	0.065
FEET	12.674263	5.3038512	2.3896340	0.019
BRICK	1345.8306	922.43371	1.4589998	0.149
BATH	16130.486	4535.8226	3.5562427	0.001
FIRE	9268.2839	3613.7263	2.5647443	0.012
GAR	10920.632	4557.1711	2.3963621	0.019
MOBIL	-22823.196	7543.9374	-3.0253692	0.003
CBD	36.303783	104.26429	0.3481900	0.729
WIND	6.9677968	33.700055	0.2067592	0.837
ANIMAL	-0.1382784	0.2317851	-0.5965804	0.553

R-squared	0.747942	Mean of dependent var	47920.87
Adjusted R-squared	0.719935	S.D. of dependent var	28564.54
S.E. of regression	15116.68	Sum of squared resid	2.06E+10
Durbin-Watson stat	1.598483	F-statistic	26.70603
Log likelihood	-1109.469		

5.3.1.4 Set #4. Log-Linear Form: In Regression #1, the coefficient on ANIMAL was -.43. 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. Figure 3. in Chapter II however, suggests that as income increases so does willingness to pay. This means that people with lower property values would discount property near a hog farm less (in dollar amounts) than would people with greater property values.

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, losses vary depending upon the value of the property. In the log-linear Regression #8 in Table XXI, the variables significant in Regression #1 stay significant. The only change is a slight drop in the adjusted R^2.

The coefficient for the ANIMAL variable is -.0000171. This is a .00171% percent impact of an additional hog on a property.

Table XXI Regression #8, Log-Linear Hog Farm Impact Model.

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	8.9075200	0.2094069	42.536908	0.000
ACRE	0.0118804	0.0058407	2.0340688	0.042
FEET	0.0008264	0.0001307	6.3226835	0.000
BRICK	0.0508212	0.0390695	1.3007905	0.193
BATH	0.3538208	0.1008526	3.5082975	0.000
FIRE	0.1010718	0.0918466	1.1004410	0.271
GAR	0.3395627	0.1087390	3.1227310	0.002
MOBIL	-0.4663255	0.2106146	-2.2141169	0.027
CBD	0.0059982	0.0030147	1.9896169	0.047
WIND	0.0010349	0.0022848	0.4529537	0.651
DIST	0.0007884	0.0078379	0.1005914	0.920
INTER	-5.359E-05	8.805E-05	-0.6086654	0.543
ANIMAL	-1.710E-05	6.723E-06	-2.5435662	0.011

R-squared	0.634597	Mean of dependent var	10.35054
Adjusted R-squared	0.618652	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		

The dependent variable is LOPRIC. The number of observations is 288.

5.3.2 Local Impact

Community impacts from declines in property values vary. Property owners who sell properties may experience a reduction in the amount they receive. For an individual this is a one time loss. Local governments, however, rely heavily upon property values to support services and other functions. The next section determines the loss due to a hog operation on township tax receipts.

5.3.2.1 Calculating Costs: In order to determine property tax losses, residential SEVs[95] 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 hog operation with 500 hogs in a 36 section township with a 20 million dollar SEV would be calculated as follows.

$$\frac{\$20{,}000{,}000}{36 \text{ sections}} \times 25 \text{ sections} \times 500 \text{ hogs} \times -.0000171$$

This produces a loss in residential SEV of $118,750. This must then be multiplied by the township tax rate, 50 mills. The resultant impact is $5,937 in lost revenues annually for

[95]Chapter 3 explains why residential properties were chosen.

the local government. A 5000 head operation in this same township would cause an annual loss in tax revenue of $59,375.

While these losses would occur annually, it would take several years for the full losses to affect equalized valuations. The pecuniary losses to the property owner are presented in the 500 animal case above but are not used in the benefit/cost calculations. The pecuniary losses would occur when a property owner sells the property. This study focuses upon annual costs as experienced by the township.

5.3.2.2 Township Cost Sharing: Because livestock operations do not always position their operations in the middle of a township, costs may be shared by as many as four townships near the operation. This reduces the costs an individual township must bear.

5.4 Livestock Operation Benefit/Cost Ratio

Table XXII summarizes the findings above by presenting the benefit/cost ratios of small and large hog 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.

Table XXII Benefit Cost Ratios

BENEFIT/COST RATIO FOR SMALL AND LARGE OPERATIONS

SIZE OF OPERATION	BENEFITS	PROPERTY TAX LOSS	BEN/COST RATIO	NET $ EFFECT
500	$33,545	$5,937	5.64	$27,607
5000	$229,347	$59,375	3.86	$169,982

Costs are determined by the number of animals and the amount of real property in the township. In Table XXIII Otto's output multiplier is used to examine the indirect effects of an operation on input purchases.

Table XXIII Benefit Cost Ratio with Multiplier

BENEFIT/COST RATIO FOR SMALL AND LARGE OPERATIONS
USING AN OUTPUT MULTIPLIER OF 1.5

SIZE OF OPERATION	BENEFITS	PROPERTY TAX LOSS	BEN/COST RATIO	NET $ EFFECT
500	$50,317	$5,937	8.47	$44,380
5000	$344,020	$59,375	5.79	$284,645

In order to see how sensitive the ratio is to declines in local input purchases by hog farmers, table XXIV examines what would happen if local input purchases dropped to 30 percent of total input purchases. When input purchases decline to 30% the benefit/cost ratio declines but 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

Table XXIV Benefit Cost Ratio with Low Local Purchases

BENEFIT/COST RATIO ASSUMING 30% LOCAL PURCHASES

SIZE OF OPERATION	BENEFITS	PROPERTY TAX LOSS	BEN/COST RATIO	NET $ EFFECT
500	$15,666	$5,937	2.63	$9,728
5000	$144,693	$59,375	2.43	$85,318

local input purchases. Table XXV 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 XXV Benefit Cost Breakeven Levels

BENEFIT/COST BREAKEVEN LEVELS

SIZE OF OPERATION	TAX LOSS EQUALS BENEFITS	SEV	BEN/COST RATIO	NET $ EFFECT
500	$33,545	$112 MILLION	1	0
5000	$229,875	$77 MILLION	1	0

The decreasing benefit/cost ratio as residential SEVs increase, supports locating hog operations in townships with low SEVs.

5.5 Ratio Formulation

An important part of Benefit/Cost analysis is to have common units to compare. Both benefits and costs to a local community are calculated in dollar amounts. Benefits are the total dollars spent on inputs locally. Costs are the total dollars lost in property tax receipts. Benefits are reflected in private consumption while costs are public services foregone. Both are important considerations in township decision making.

Alternate formulations of benefits might include: regional or statewide benefits or hog operation contributions to local tax receipts. The first alternative gets away from the local decision maker orientation stressed in this thesis. The second alternative presents technical problems, mainly data availability.

Alternate formulations of costs might include: declines in property value (as opposed to property **tax receipt** declines), or impacts on health or personal property. Because very few parcels are sold in any one year[96] and because people have the opportunity to move away from an operation, property tax receipts better measure the annual impact. Impacts on health or personal property are expected to be reflected in lower property values, thus lower tax receipts.

5.6 Significance of Findings

Estimates of benefits from local hog operation input purchases described in table XXII exceed property tax receipt costs by at least three and as many as five

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[96]Between 1% and 4% of parcels are sold in rural areas each year.

times[97]. As distance of houses from a hog operation increase, costs decline[98]. Larger operations appear to be more strongly correlated with property value costs than do smaller ones.

Township planners, officials and community members make deliberate decisions that affect the composition and success of their community when establishing informal policies or passing ordinances. These findings may aid a governmental unit in locating a new operation, or justifying the presence of an existing one.

5.7 Hypotheses Testing

Each one of the three hypotheses was affirmed. A brief explanation of each is below.

Hypothesis # 1: Hog operations have a negative impact on surrounding property values. The negative coefficient on the ANIMAL variable representing number of animals confirms this hypothesis. Validating this outcome is the finding that distance from the operation and number of animals also affects property price.

Odors are assumed to be the cause of declining property values. Lack of significance in the prevailing wind variable suggests that prevailing winds are not as important

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[97]In a township with 36 sections and an SEV of $20 million.

[98]Regressions #5-7.

as hypothesized or that odors may not be the primary cause of lower property values surrounding hog operations.

Hypothesis # 2: Hog operations provide revenues to local economies. Between 64% and 46% of input spending for hog operations is spent locally. Because hog operation owners make a concerted effort to buy locally and support the local economy when possible[99], hog enterprises may spend more locally than other types of enterprises. Even as operations increase in size and local purchases per hog decrease, local feed purchases, a substantial portion of total input costs, increase with the size of operation. This increase in local feed purchases helps balance diminishing local supplement and labor purchases by larger operations.

Hypothesis # 3: Local benefits of livestock operations exceed local property tax receipt costs. In a township with an SEV of $20,000,000 the benefit/cost ratios for a 500 head operation range between 2.63 and 8.47. The benefit/cost ratio for a 5000 head operation ranges between 2.43 and 5.79.

5.9 Summary

This chapter presents the results of the procedures described in Chapter III. An individual examination of both benefits and costs preceded the benefit/cost ratio section.

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[99] Conversation with Dr. Andy Thullen, Dept. of Animal Science, Michigan State University.

The significance of the findings and hypotheses testing followed. The final chapter comments on the study's strengths and weaknesses, presents future research needs and conclusions.

CHAPTER VI

CONCLUSION

This chapter presents the conclusions of this research, its strengths and weaknesses, in addition to future research needs.

6.1 Conclusions

The convergence of urban sprawl, growing environmental concerns and the intensification of livestock operations has the potential to create deep rifts between the agricultural and non-agricultural residents within a rural community. This thesis illustrates there are also economic ramifications.

As decisions are made affecting land use, local government tax receipts are affected. The purpose of this thesis is to provide additional information to local officials to aid in decision making. In addition the information should be valuable to livestock operators when considering expansion or a new location.

6.1.1 Summary of Findings

This thesis examined local input purchases and property tax losses from hog operations in Michigan. The study investigated eight livestock operations which received odor related complaints in the first 9 months of 1989.

Results indicate that the benefit/cost ratio of hog operations is positive until SEV levels within a township exceed $70,000,000. In addition the benefit/cost ratio increases as state equalized valuations (SEV) decrease. Potential damages are greater when SEVs are higher.

6.1.2 Distance and Size Impacts

Results also show that as distance from an operation increased property value losses declined. This supports the hypotheses that odors are a localized occurrence. The research also shows that while all sizes of livestock operations have a negative impact on property values, larger operations have a greater impact on property values than do smaller ones.

6.2 Regulatory Options

As the livestock sector continues to change, land use decisions will become more important. Livestock groups in the state of Michigan are preparing for a 1 million head increase in hog production in the next decade. This will come principally from an expansion of existing operations and new "large" operations. Being aware of benefits and costs allows local governments to make informed decisions on whether to "invest" or not in livestock operations.

Local zoning and land use ordinances are particularly crucial 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. As restrictions increase however, ordinance effects on communities should be examined. Information from this thesis allows a township to examine the impacts of an ordinance prohibiting operations over a certain size from entering their community. It is the communities responsibility to evaluate and act on these impacts. While zoning can be used as a preventative measure for resolving potential future conflicts.

6.3 Existing Conflict Solutions

Existing local conflicts pertaining to either operating hog farms, operations desiring to expand, or to new operations usually have to be resolved using other measures. These may include:

1. Referring hog farmers to the Cooperative Extension Service and/or the Soil Conservation Service for advice and council in better management 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. Application for the Air Pollution Control Tax Exemption Certificate (Act no. 250, P.A. 1965) to aid in financing pollution control equipment.

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

The resolution of manure management problems of hog farmers will impact the vitality of both the Michigan hog industry and of townships where they are located.

6.4 Thesis Strengths

This thesis used results from an input-output model of the pork sector together with an hedonic pricing method to determine the benefit/cost ratio of hog operations for local units of government. This in itself is not unique. Using the hedonic pricing method in a rural area is, however, a strength. Most hedonic studies occur in urban areas with sophisticated particle samplers. This study shows that where these measurements are not available, proxies can be used to determine environmental impacts.

A second strength of this thesis is its applicability for local government officials. Changes in the type of houses, tax base, size of operation and local input expenditures can be entered into the hedonic model to generate township specific results.

6.5 Thesis Weaknesses

Rural information collection is extremely time consuming and difficult. Multiple visits to county and township equalization and assessing offices revealed different reporting procedures in addition to large amounts of missing data. The result is limited observations in certain areas. Better information is also needed on local purchases of hog operations.

6.6 Future Research Needs

The following research needs should be explored.

1. An annual tabulation of livestock complaints in the state. This would permit an early identification of livestock complaints and their cause and origin. In addition it would allow individuals involved with the livestock sector to spot trends and react appropriately.
2. An examination of the political costs involved when making decisions affecting land use controls.
3. A study of purchasing practices by hog farmers.
4. A study of the impacts of good management practices on property value losses.

APPENDIX

Appendix A: Livestock Complaint Tabulation Procedures.

Livestock Complaint Tabulation

The Livestock Complaint Tabulation consisted of a review of livestock complaints on file with the Michigan Department of Agriculture (MDA). Information for the years 1986-1989 was available. Up until 1988 complaints were handled by the Department of Natural Resources (DNR). Since then MDA has handled all environmental complaints involving livestock. This transfer of authority should be considered when considering the increase in complaints over the four year period.

At present complaints come to the MDA from citizens, the DNR, The Soil Conservation Service and other public agencies including electrical companies and the local and state police.

Methods

An attempt was made to determine 1) the region 2) the year of the complaint 3) the animal species and 4) the type of complaint made.

1. The MDA regional breakdown was used to indicate where complaints were made. MDA breaks the state into seven regions.

2. The year is taken from the most recent complaint. In some cases complaints for the same livestock operation were made each of the four years. The most recent one was used to date the case.

3. The animals involved were listed as dairy, cattle, hogs, poultry (including turkeys) and other. In the "other" category, horses made up the bulk of complaints. Where more than one animal was raised on a farm, an attempt was made to determine which animal was in question. This was possible in most cases. One farm however, with over 10,000 hens and 3000 cattle was listed twice.

4. The type of complaint made was categorized as odor, water or flies. Some liberty was taken to fit complaints into the two major categories of odor and water. For example, a frequent complaint was un-disced manure spread on a field. If the spreading was not next to a stream or ditch, this was considered to be an odor complaint.

Gathering information on two other sections was attempted but not very successful. The first was location of the complaint, whether it was in the field or the farm lot. Any complaint involving manure that had been or was in the process of mechanical movement, such as spillage on a road, seepage into a ditch after spreading or odors from un-disced manure was considered field. Complaints based around the farm operation, lagoon or storage facility were considered lot. 55 lot, 43 field and 17 unknown complaints were recorded.

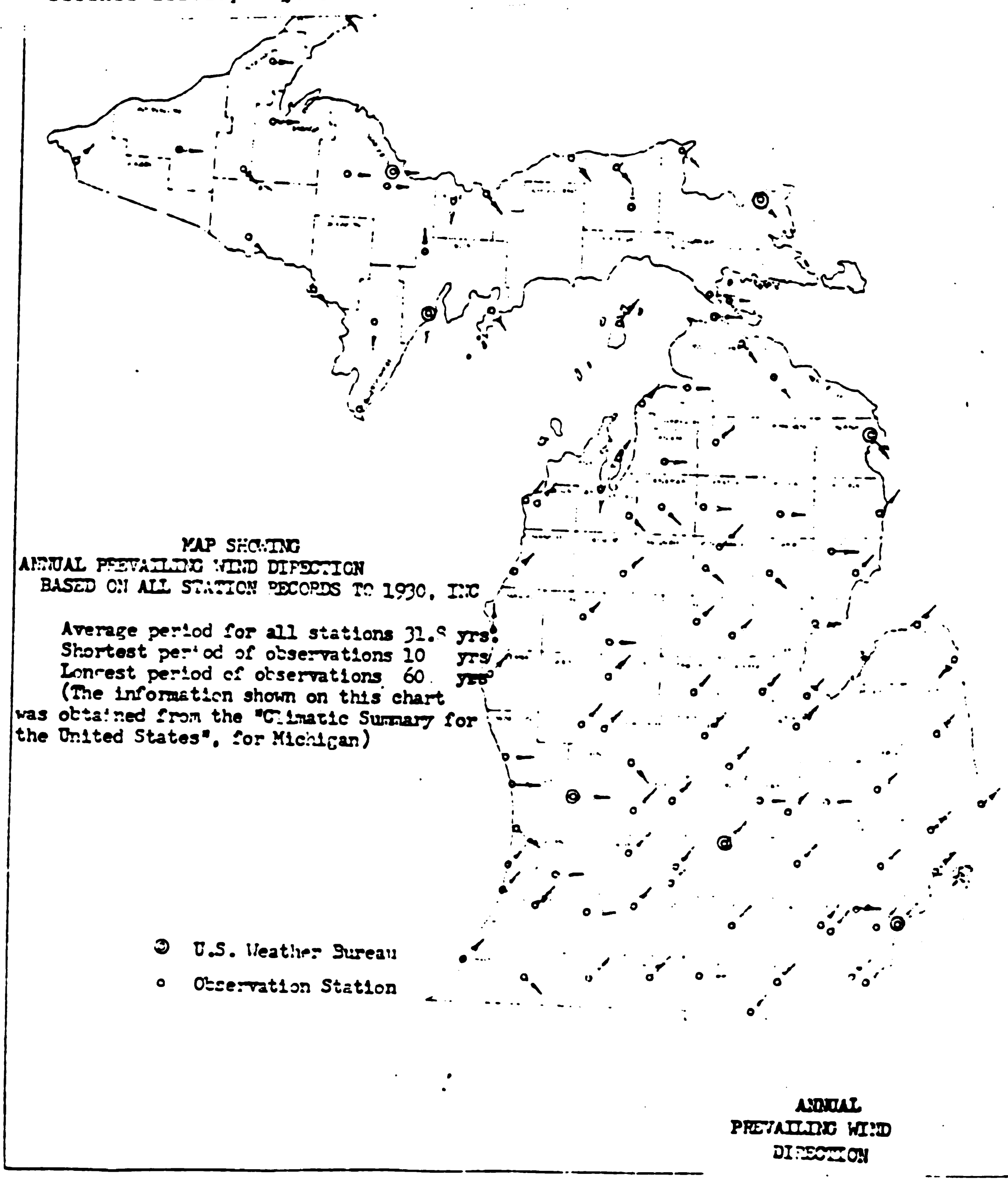
The second unsuccessful area was number of animals. Inconsistent and insufficient data on this prevents any discussion.

Appendix B: U.S. Weather Bureau Climatic Summary of The U.S.

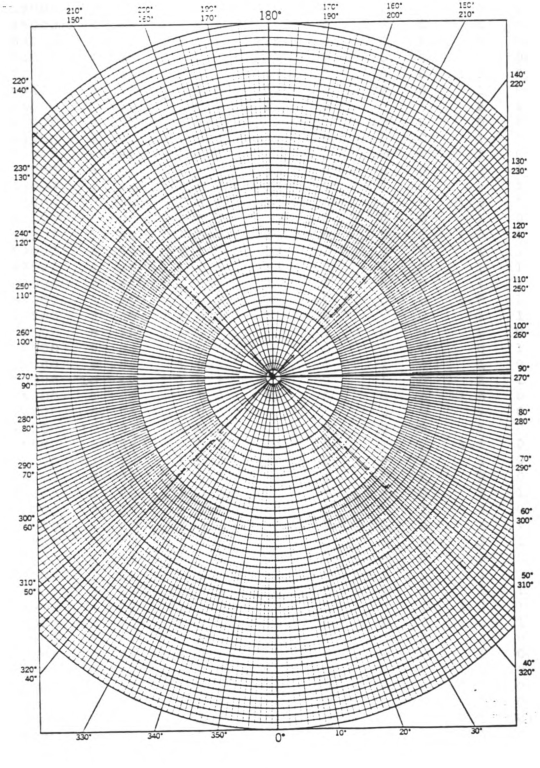
U.S. Weather Bureau
Climatic Summary of the U.S.
Washington: Government Printing Office
1932 - 1948

Supplement for 1931 - 1952

Science Library QC 983 .A35



Appendix C: Graph for Wind Plotting



Appendix D: Data Used in Regression Analysis

PRICE	MON.	Yr.	Road	ACRE	YEAR	PLOT	BRICK	AIR	BATH	FIRE	GAR
59900	10	87	1	3.5	29	0	0	0	1	1	1
95000	5	88	1	0.1		0	0	0	1	1	1
59000	8	88	1	0.1	74	0	0	0	1	0	0
74000	4	88	1		31	0	0	0	1	0	1
122500	9	88	1		13	0	0	0	1.5	0	1
59400	9	86	1	1.5	51	0	0	0	1	0	1
135000	12	88	1	0.4	37	0	0	0	2	1	1
10000	5	88	1	10.		1	0	0	0	0	0
45900	9	87	1	0.4	49	0	0	0	1	0	0
12500	6	88	1	10.	1	0	0	0	3	0	1
130000	6	86	1		23	0	0	0	2	2	1
135000	9	88	1	0.4	13	0	1	0	2	1	1
68000	7	86	1	0.5	18	0	0	0	1.5	1	1
62000	6	88	1	0.7	9	0	0	0	1	0	1
65900	8	86	1	0.4	29	0	0	0	1.5	1	1
69900	6	87	1	0.5	29	0	0	0	1	1	1
48500	8	86	1	0.6	13	0	0	0	1	1	1
63000	8	86	1	0.7	34	0	0	0	1	1	1
68000	5	88	1	0.7	25	0	0	0	1.5	1	1
78500	3	89	1	0.4	11	0	0	0	1	1	1
9500	6	86	1			1	0	0	0	0	1
79500	9	86	1			0	1	0	0	1	0
59900	9	86	1	0.3	13	0	1	0	1	0	1
60500	10	87	1	0.3	12	0	1	0	2	1	1
66000	3	89	1	0.3	13	0	0	0	1.5	0	1
44900	5	86	1	0.2		0	0	0	1	0	0
42500	10	87	1	0.2		0	0	0	1	0	0
56000	6	88	1	0.2	34	0	0	0	1.5	0	1
26700	12	86	1	0.2	14	0	0	0	1	0	1
8500	8	87	1	0.7		1	0	0	0	0	0
48000	8	86	1	0.5		0	0	0	1	1	1
11000	7	86	1	10	1	0	0	1	2.5	0	1
165000	5	87	1	0.4	12	0	0	0	2	1	1
119500	5	88	1	0.5	12	0	0	0	2	1	1
7000	11	87	1	3		1	0	0	0	0	0
62500	3	88	1	6.2	12	0	0	0	1	0	0
76000	8	86	1	2	14	0	1	0	2	1	1
89900	4	88	1	23	12	0	0	0	1.5	1	1
86000	12	86	1	5	18	0	0	0	2	1	1
11900	5	88	1	10.	1	0	0	0	2	0	0
52675	10	86	1	8.5		0	0	0	1	0	1
1000	10	88	1	6		0	0	0	0	0	0
55900	5	87	1	1.3	26	0	0	0	1.5	0	0
114900	10	86	1	5.5		0	0	0	2	0	1
34900	7	87	1	0.2		0	0	0	1	0	1
2000	4	87	1	0.3		0	0	0	1	0	0
18900	4	87	1	0.2		0	0	0	1	0	1
30500	8	88	1	0.2		0	0	0	1	0	1

PRICE	MON.	Yr.	Road	ACRE	YEAR	PLOT	BRICK	AIR	BATH	FIRE	GAR
46000	7	87	1	0.2		0	0	0	1	0	1
27500	7	86	1	0.2	24	0	0	0	1	0	0
23000	5	87	1	0.2	69	0	0	0	1	0	1
37900	10	87	1	0.3	29	0	0	0	1	0	1
42000	8	88	1	0.2	35	0	0	0	1	0	0
19350	12	87	1	0.2		0	0	0	1	0	0
58500	8	86	1	0.7	51	0	0	0	1.5	1	1
35500	1	88	1	0.2		0	0	0	1	0	1
29100	9	87	1	0.2		0	0	0	1	0	1
44800	1	88	1	0.1	11	0	0	0	1	0	1
2900	8	88	1	0.1	31	0	0	0	1	0	1
36000	4	88	1	0.2		0	0	0	1	1	1
31000	10	86	1	0.3		0	0	0	1	0	1
33000	11	86	1	1		0	0	0	1	0	0
43000	7	88	1	2.5	99	0	0	0	1.5	1	1
77900	12	86	1	4.8	17	0	1	0	1.5	1	1
85000	8	86	1	4.8	20	0	0	0	2	1	1
48500	3	88	1	0.7		0	0	0	1	0	1
39900	2	88	1	10		0	0	0	1	0	0
46000	8	88	1	0.7	31	0	0	0	1	0	1
38500	6	87	1	0.3	30	0	0	0	1	0	1
50000	11	86	1	0.6	42	0	1	0	1.5	1	1
73500	9	88	1	22.	119	0	0	0	2	0	1
64000	12	88	1	14.	10	0	0	0	1	0	1
59900	8	87	1	0.3	28	0	1	0	1	1	1
60000	4	87	1	1.6	12	0	0	1	1.5	1	1
3500	7	86	1	2	2	0	0	0	1	0	0
15000	9	87	1	10		0	0	0	0	0	0
85000	7	87	1	0.2	15	0	1	1	1.5	1	1
88500	9	86	1	0.2	32	0	0	0	2	0	0
28000	6	86	1	0.1	54	0	0	0	1	0	1
25000	8	87	1	0.1	54	0	0	0	0.5	1	0
62000	6	88	1	0.1	69	0	0	0	1	0	1
45000	5	86	1	0.0		0	0	0	0	0	0
54000	7	87	1	0.2	59	0	0	0	1	0	1
85000	11	86	1	0.2	13	0	0	0	2	1	1
58900	5	87	1	19.	109	0	0	0	2	1	0
53500	9	86	1	0.5	11	0	0	0	1	0	1
60000	6	88	1	0.5	10	0	0	0	1.5	0	1
65900	5	87	1	0.5	29	0	0	0	1.5	2	1
103000	12	88	1	12	10	0	0	0	2.5	1	1
65000	8	87	1	1	16	0	1	0	1.5	0	1
60000	8	88	1	16.	7	0	0	0	1	1	0
55000	11	88	1	10	8	0	1	0	2	1	0
87500	8	88	1	0.5	32	0	0	0	1	1	1
53000	8	88	1	0.2	18	0	0	0	1	0	1
7000	3	89	1	0.3		0	0	0	0	0	1
45000	8	86	1	0.5	32	0	0	0	1	1	1

PRICE	MON.	Yr.	Road	ACRE	YEAR	PLOT	BRICK	AIR	BATH	FIRE	GAR
50000	6	86	1	0.0		0	0	0	0	0	0
4000	5	86	1	0.2	35	0	0	0	0.5	0	1
89900	11	88	1	0.3	12	0	1	0	1.5	1	1
49800	7	88	1	0.4		0	0	0	2	0	0
75000	5	87	1	0.6	15	0	0	0	1.5	1	1
61500	4	86	1	0.7	11	0	0	0	1	0	1
65000	9	87	1	6.4	17	0	0	0	1	1	1
53500	11	86	1	1.8	20	0	1	1	2	0	1
55500	9	86	1	4	13	0	0	1	1.5	0	1
67000	11	86	1	5	31	0	0	0	1.5	1	1
42900	4	87	1	0.6	19	0	0	0	1	0	1
9000	12	87	0	10	7	0	0	0	1	0	0
77500	5	87	0	12.	16	0	1	1	2	3	1
36000	7	87	1	0.6	22	0	0	0	1	0	1
33900	9	87	1	0.3	39	0	0	0	1	0	1
35000	11	88	0	0.7		0	0	0	2	0	1
44000	9	87	1	9.7	2	0	0	0	1	0	0
22500	11	87	1	1.5	9	0	0	0	1	0	0
14000	7	87	0	2.8		1	0	0	0	0	0
13000	10	87	1	0.9	19	0	0	0	1	0	0
59900	12	87	1	1.5	15	0	0	0	1	0	1
8500	7	87	1	6.4		1	0	0	0	0	0
27000	5	87	0	1.4	19	0	0	0	1	0	0
47000	7	87	1	1.3	16	0	1	0	1	0	1
49500	12	87	1	0.9	28	0	0	0	1	0	1
7000	6	87	1	8	0	1	0	0	0	0	0
27500	11	88	1	0.8	49	0	1	0	1	1	0
46000	2	88	0	0.9	20	0	1	0	1	1	1
63000	6	88	1	3.3		1	0	0	0	0	0
23500	9	88	1	0.6	79	0	0	0	1	0	0
89900	8	88	1	1.6	29	0	1	0	2	1	1
7500	7	87	0	0.0		1	0	0	0	0	0
4000	11	87	0	0.1		1	0	0	0	0	0
72000	9	88	1	1.5		0	0	0	2		1
95000	8	88		0.0	10	0	0	0	2		1
88000	7	87	0	5	17	0	0	0	1	0	1
71000	8	88	1	10	39	0	1	0	1	0	1
15000	11	87	1	0.2	15	0	0	0	1	0	0
35000	10	88	1		14	0	0	0	1	1	0
2900	6	88	1	0.3		1	0	0	0	0	0
53500	10	87	1	4.5	7	0	1	0	1	1	1
3800	9	87	1	0.5		1	0	0	0	0	0
73750	8	87	1	9.0	89	0	0	0	1	1	1
2200	12	87	0	0.3		1	0	0	0	0	0
13000	5	87	1	5		1	0	0	0	0	0
7000	8	87	1	3.9		1	0	0	0	0	0
5500	5	87	1	1.2		1	0	0	0	0	0
49000	8	87	0	0.1	39	0	0	0	0	0	1

PRICE	MON.	Yr.	Road	ACRE	YEAR	PLOT	BRICK	AIR	BATH	FIRE	GAR
46000	9	87		0.4	39	0	1	0	0	0	1
8000	4	87	0	3.5		0	0	0	0	0	0
14000	9	88	0	3		1	0	0	0	0	0
70000	11	88	1	6	24	0	0	0	1.5	0	1
2000	11	86	1	0.4		1	0	0	0	0	0
94000	4	87	1	1.5	21	0	1	0	2	1	1
9000	5	87	0	10.		1	0	0	0	0	0
15000	10	87	0	14.		1	0	0	0	0	0
41000	8	88	0	10.	139	0	1	0	1	0	1
17000	10	88	0	25		1	0	0	0	0	0
12000	6	88	0	4.5	0	1	0	0	0	0	0
67900	6	87		10	11	0	0	0	1.5	0	0
20000	7	88	0	0.8		0	0	0	1	0	1
7000	3	87	1	2		1	0	0	0	0	0
73500	11	87	1	1.9		0	0	0	1	0	0
34000	7	86	0	1		0	0	0	1	0	0
129000	5	89	0	5.9	10	0	0	0	2	0	1
66000	8	88	0	1	31	0	0	0	1	0	1
135000	7	88	1	3.2	11	0	0	0	2	0	1
86000	7	88	1	3.2	12	0	1	0	1.5	1	0
62500	1	88	0	10	9	0	0	0	2	0	0
76000	8	88	0	10	11	0	0	0	1.5	1	1
78250	6	86	0	10	10	0	0	0	2	0	1
15000	6	87	0	10	0	1	0	0	0	0	0
10000	12	87	0	10		1	0	0	0	0	0
14900	5	87	0	10		1	0	0	0	0	0
7000	4	88	0	4		1	0	0	0	0	0
17500	3	88	0	10		1	0	0	0	0	0
50000	9	86	0	5	14	0	0	0	1.5	0	0
47000	9	86	0	10	16	0	0	0	1.5	0	1
94000	4	87	1	5	27	0	1	0	1	1	1
37500	1	87	1	0.9		0	0	0	1	0	1
78000	8	87	1	4.2	16	0	1	0	2.5	2	1
60010	8	87	1	4.2	10	0	0	0	1.5	0	0
14500	10	87	0	10		1	0	0	0	0	0
17500	4	88	0	10		1	0	0	0	0	0
72000	3	89	0	3.5	10	0	1	0	1.5	1	0
63900	12	87	0	2	10	0	1	0	1.5	0	1
63900	11	87	0	10		0	0	0	1	0	1
8000	4	87	0	2.4		1	0	0	0	0	0
6000	7	88	0	2.4		1	0	0	0	0	0
71000	5	87	0	2.4	17	0	1	0	1	0	1
82500	7	87	0	2.4	4	0	0	0	2	0	0
7800	1	88	0	2.4		1	0	0	0	0	0
92900	6	89	0	2.4	10	0	0	0	1.5	0	1
73500	7	86	0	2.4	15	0	0	0	2.5	1	1
9000	11	88				1	0	0	0	0	0
7000	11	87				1	0	0	0	0	0

PRICE	MON.	Yr.	Road	ACRE	YEAR	PLOT	BRICK	AIR	BATH	FIRE	GAR
80000	10	86	0	10.	19	0	0	0	2.5	1	1
16900	8	88	0	10.		1	0	0	0	0	0
52000	4	86	0	4.7	11	0	0	0	2	0	1
60000	7	86	0	4.6	11	0	1	0	2	1	1
37900	6	89	1	2	49	0	0	0	1	0	0
6000	6	88	1	0.1		0	0	0	1	0	0
17000	4	88	1	0.6		0	0	0	1	0	0
13000	10	87	1	0.4		0	0	0	1	0	1
28500	5	87	1	0.7		0	0	0	1	0	1
41500	10	88	1	2.5	16	0	0	0	1	0	1
51000	1	89	1	5.5	20	0	0	0	1	0	1
4000	10	88	1	5		1	0	0	0	0	0
22000	11	86	1	1	10	0	0	0	1	0	1
18000	10	86	1		29	0	0	0	1	0	0
16500	7	88	1	1	89	0	0	0	1	0	0
33000	6	88	1	1	103	0	0	0	1	0	0
13000	9	87	0	1	109	0	0	0	1	0	0
8500	6	88	0	0.2		1	0	0	0	0	0
7000	7	88	1	0.4		1	0	0	0	0	0
6000	6	88	1	0.2		1	0	0	0	0	0
17200	10	86	1	0.5		0	0	0	1	0	0
12000	12	88	0	0.4		0	0	0	1	0	1
36000	5	87	0	1.4		0	0	0	1	0	0
2200	5	88	0	0.3		1	0	0	0	0	0
1000	2	89	0	0.3		1	0	0	0	0	0
605	4	88	0	0.3		1	0	0	0	0	0
1100	8	87	0	0.3		1	0	0	0	0	0
2000	10	88	0	0.3		1	0	0	0	0	0
1000	2	89	0	0.2		1	0	0	0	0	0
1300	7	87	0	0.2		1	0	0	0	0	0
7000	4	86	1	0.4		1	0	0	0	0	0
9000	6	86	1	0.3		1	0	0	0	0	0
10000	6	87	0	0.8		1	0	0	0	0	0
58000	12	86	0	0.2	20	0	1	0	1	0	1
48000	11	86	0	0.2	28	0	0	0	1	0	0
38000	6	87	0	0.6	16	0	0	0	1	0	0
57000	5	88	0	0.2	20	0	0	0	1	0	1
26000	1	89	0	0.3		0	0	0	1	0	0
20000	2	88	1	0.2	10	0	0	0	1	0	1
6500	5	86	1	0.2		0	0	0	1	0	0
4500	5	87	1	0.1		1	0	0	0	0	0
10000	5	86	1	0.2		0	0	0	1	0	1
6500	7	88	1	0.3		0	0	0	1	0	0
17000	12	86	1	0.1		0	0	0	1	0	1
68500	5	88	0	10		0	0	0	2	0	1
72000	7	87	0	10.	11	0	0	0	1	0	1
54900	3	88	0	0.9	18	0	0	0	1	0	0
10000	9	87	1	0.2		0	0	0	1	0	0

PRICE	MON.Yr.		Road	ACRE	YEAR	PLOT	BRICK	AIR	BATH	FIRE	GAR
53500	3	88	1	1.3		0	1	0	2	0	1
8000	12	88	1	0.4		1	0	0	0	0	0
8000	9	87	1	0.4	2	0	0	0	1	0	0
21500	1	89	1	4.2		1	0	0	0	0	0
7144	3	89	1	0.6		1	0	0	0	0	0
29288	10	88	1	0.5		0	0	0	1	0	0
20000	3	88	1	3.0		0	0	0	1	0	1
22000	1	87	1	0.2		0	0	0	1	0	0
7500	9	88	1	0.8		1	0	0	0	0	0
5000	1	89	1	7.6		1	0	0	0	0	0
35000	5	88	0	1.0		0	1	0	1	1	0
30500	4	88	1	1.2	45	0	0	0	1	0	0
28130	12	87	0	0.5		0	0	0	1	0	0
89000	4	87	1	1.1	16	0	1	0	1.5	1	1
24500	6	87	1	0.8	49	0	0	0	1	0	1
63500	9	86	1	2.5	11	0	0	0	2	0	1
70000	9	86	1	1.7	19	0	0	0	1	1	1
55300	9	87	0	1.7	27	0	0	0	1.5	1	1
18000	10	87	1	10		1	0	0	0	0	0
79000	6	88	1	2		0	0	0	1	1	1
19258	1	89	1	10.		1	0	0	0	0	0
9000	12	88	1	22.		1	0	0	0	0	0
45500	9	88	1	1.1	70	0	0	0	1	1	1
56000	12	87	1	36	39	0	0	0	1	1	1
95000	8	86	1	13.	17	0	0	0	1.5	1	1
16000	9	86	1	9.2		1	0	0	0	0	0
72000	8	87	1	0.9	25	0	0	0	1.5	0	1
74000	11	88	1	89		0	0	0	1	0	0
50000	6	87	1	0.9	37	0	0	0	1	0	1
68000	1	89	1	1.8	12	0	0	1	1	0	1
78000	4	86	1	0.3	11	0	0	0	2	1	1
15000	9	87	1	1.4	1	0	0	0	1	1	1
82000	10	87		11.	10	0	0	1	2	1	1
56875	6	88	1	0.2	17	0	0	0	1	1	1
70000	7	86	1	0.3	17	0	0	0	2	1	1
159000	12	86	1	6	25	0	1	0	2	2	1
64500	3	87	1	0.4	24	0	1	0	2	2	1
78000	10	87	1	0.3	19	0	0	0	1.5	0	1
74900	5	86	1	0.3	20	0	1	0	1.5	0	1
73900	10	86	1	0.5	16	0	1	0	1.5	0	1
89000	9	87		1.3	14	0	0	0	1.5	1	1
90000	5	88		1		0		0	1.5	1	1
73000	6	86		0.3	17	0	1	0	1	1	1
88000	6	88	1	0.4	16	0	0	0	1.5	1	1
76000	9	86	1	0.4		0	0	1	1	1	1
69000	11	86	1	1.2	14	0	1	0	1.5	0	1
76300	11	88	1	0.5	18	0	0	1	1.5	1	1
78000	3	88	1	0.5	12	0	0	0	1	1	1

PRICE	MON.	Yr.	Road	ACRE	YEAR	PLOT	BRICK	AIR	BATH	FIRE	GAR
69000	7	87	1	4	26	0	0	0	1	0	1
37500	3	88	1	1.4	33	0	0	0	1	0	0
64500	11	87	1	6.3	53	0	0	0	1	1	0
117500	9	88	1	16	12	0	1	0	2	1	1
51000	6	88	1	1.5	120	0	0	0	1	1	0
133500	5	88	1	10.	5	0	0	0	1	1	1
56000	8	88	0	1.2	109	0	0	0	1	0	1
12000	5	88	1	2.5		1	0	0	0	0	0
82500	10	88	1	4	30	0	1	0	1.5	2	1
55000	10	88	1	7.8	18	0	0	0	1	0	0
63000	8	87	1	2	6	0	0	0	2	0	1
66900	6	87	1	2.4	17	0	1	0	2	1	1
89750	12	88	0	9.9		0	0	0	2.5	1	1
89900	3	88	1	1	20	0	0	0	1.5	0	0

>= CB	FEET	MOBIL	CBD	DIST	HWAY	WIND	ANIMAL
0	1096	0	51	25	123.	140	1500
0	1080	0	27	17	110.	113	1500
0	1039	0	27	17	110.	113	1500
0	704	0	43	10	102	102	1500
0	1252	0	43	10	102	102	1500
0	956	0	39	13	110	122	1500
0	1120	0	39	13	110	122	1500
0	0	0	28	18	93.5	55	1500
0	0	0	32	16	99.5	71	1500
1	1062	0	25	16	93.5	45	1500
1	1569	0	25	16	93.5	45	1500
0	1272	0	25	16	93.5	45	1500
1	1470	0	27	23	87.5	42	1500
0	1040	0	21	25	81.5	25	1500
1	1480	0	14	24	77	10	1500
1	1344	0	14	24	77	10	1500
1	1428	0	14	24	77	10	1500
0	1220	0	14	24	77	10	1500
1	1218	0	14	24	77	10	1500
0	1144	0	9	24	77	2	1500
0	1522	0	9	24	77	2	1500
0	1368	0	9	24	77	2	1500
1	1092	0	9	24	77	2	1500
0	1092	0	9	24	77	2	1500
0	1092	0	9	24	77	2	1500
0	960	0	9	24	77	2	1500
0	864	0	9	24	77	2	1500
0	1104	0	9	24	77	2	1500
0	960	0	9	24	77	2	1500
0	0	0	20	12	16	20	1500
0	1377	0	20	12	16	20	1500
0	992	0	20	12	16	20	1500
0	1200	0	24	8	95	40	1500
1	1344	0	24	8	95	40	1500
0	0	0	30	5	102	95	1500
0	1196	0	36	8	108	148	1500
0	1292	0	34	7	108	170	1500
0	1264	0	56	34	133	157	1500
0	1524	0	56	34	133	157	1500
0	1320	0	45	23	120	145	1500
0	1071	0	45	23	120	145	1500
0	0	0	14	14	90	27	1500
0	872	0	14	14	90	27	1500
0	1409.	0	20	15	97	70	1500
0	1375	0	3	24	78	19	1500
0	858	0	3	24	78	19	1500
0	1404	0	3	24	78	19	1500
0	900	0	9	22	84	36	1500

>= CB	FEET	MOBIL	CBD	DIST	HWAY	WIND	ANIMAL
0	1080	0	9	22	84	36	1500
0	1157.	0	9	22	84	36	1500
0	1246	0	9	22	84	36	1500
0	1428	0	9	22	84	36	1500
0	648	0	9	22	84	36	1500
0	960	0	9	22	84	36	1500
0	1724	0	9	22	84	36	1500
0	900	0	11	31	78	40	1500
0	792	0	11	31	78	40	1500
0	884	0	11	31	78	40	1500
0	0	0	11	31	78	40	1500
0	696	0	11	31	78	40	1500
0	832	0	11	31	78	40	1500
0	882	0	13	27	88	47	1500
0	1407	0	17	23	90	60	1500
1	1248	0	17	23	90	60	1500
1	1668	0	17	23	90	60	1500
0	1259	0	25	26	97	78	1500
0	964	0	29	20	90	92	1500
0	1008	0	37	36	90	50	1500
0	1008	0	37	36	90	50	1500
0	1560	0	37	36	90	50	1500
0	1464	0	37	36	90	50	1500
0	768	0	37	36	90	50	1500
0	1304	0	32	32	90	43	1500
0	1092	0	38	23	90	78	1500
0	864	0	38	23	90	78	1500
0	0	0	38	23	90	78	1500
0	1144	0	47	28	85	92	1500
0	1504	0	47	28	85	92	1500
0	944	0	47	28	85	92	1500
0	432	0	47	28	85	92	1500
0	760	0	47	28	85	92	1500
0	0	0	47	28	85	92	1500
0	816	0	47	28	85	92	1500
0	1008	0	47	28	85	92	1500
0	918	0	47	28	85	92	1500
0	1120	0	47	28	85	92	1500
0	879	0	47	28	85	92	1500
0	1176	0	50	28	85	102	1500
1	2547	0	50	28	85	102	1500
0	960	0	50	28	85	102	1500
0	616	0	50	28	85	102	1500
0	1064	0	50	28	85	102	1500
0	1380	0	50	28	85	102	1500
0	1040	0	42	23	90	92	1500
0	0	0	42	23	90	92	1500
0	1380	0	45	23	90	105	1500

>= CB	FEET	MOBIL	CBD	DIST	HWAY	WIND	ANIMAL
0	0	0	45	23	90	105	1500
0	780	0	45	23	90	105	1500
0	1368	0	45	23	90	105	1500
0	1064	0	45	23	90	105	1500
0	875	0	63	37	85	134	1500
0	1242	0	63	37	85	134	1500
0	1040	0	63	37	85	134	1500
0	1104	0	68	41	85	138	1500
0	888	0	68	41	85	138	1500
0	1344	0	68	41	85	138	1500
0	1232	0	57	35	48	175	25000
0	784	1	58	27	101	155	25000
0	2392	0	58	27	101	155	25000
0	2088	0	71	30	39	74	25000
0	1008	0	63	20	39	90	25000
0	1400	0	63	20	39	90	25000
0	960	0	50	30	42	179	25000
0	924	1	50	34	40	172	25000
0	0	0	39	23	29	155	25000
0	672	1	51	15	21	30	25000
0	1620	0	25	28	16	128	25000
0	0	0	20	29	10	116	25000
0	728	0	11	31	1	90	25000
0	960	0	20	22	7	90	25000
0	1092	0	22	24	3	70	25000
0	0	0	22	24	3	70	25000
0	800	0	52	30	40	1	25000
0	1200	0	44	37	9	24	25000
0	0	0	38	30	4	30	25000
0	1536	0	38	30	4	30	25000
0	1657	0	25	25	8	110	15000
0	0	0	49	8	9	20	15000
0	0	0	49	8	9	20	15000
0	1050	0	25	25	8	110	15000
0	980	0	13	32	21	88	15000
	1650	0	73	28	34	83	15000
0	1000	0	71	27	28	65	15000
0	1440	1	73	34	28	44	15000
0	1050	0	73	34	28	44	15000
0	0	0	73	34	28	44	15000
0	950	0	70	28	26	47	15000
0	0	0	64	18	21	62	15000
0	1300	0	64	18	21	62	15000
0	0	0	51	14	9	21	15000
0	0	0	58	34	4	0	15000
0	0	0	58	34	4	0	15000
0	0	0	58	34	4	0	15000
0	950	0	42	18	4	20	15000

>= CB	FEET	MOBIL	CBD	DIST	HWAY	WIND	ANIMAL
0	650	0	42	18	4	20	15000
0	240	0	42	18	4	20	15000
0	0	0	42	18	4	20	15000
0	1100	0	40	62	13	30	15000
0	0	0	40	62	13	30	15000
0	1450	0	32	34	21	42	15000
0	0	0	51	40	7	15	15000
0	0	0	51	40	7	15	15000
0	1150	0	49	42	13	22	15000
0	0	0	17	30	61	113	90
0	0	0	17	30	61	113	90
0	800	0	17	30	61	113	90
0	850	0	3	22	66	142	90
0	0	0	16	30	67	166	90
0	1050	0	11	25	73	171	90
0	1000	0	11	13	75	180	90
0	1950	0	11	13	75	180	90
0	1300	0	25	15	89	42	90
0	1150	0	20	3	85	70	90
0	864	0	20	3	85	70	90
0	1200	0	21	7	85	110	90
0	1050	0	21	7	85	110	90
0	1400	0	21	7	85	110	90
0	0	0	21	7	85	110	90
0	0	0	24	13	85	120	90
0	0	0	24	13	85	120	90
0	0	0	24	13	85	120	90
0	0	0	25	21	80	138	90
0	960	0	25	21	80	138	90
0	1300	0	27	21	85	122	90
0	1600	0	33	27	85	125	90
0	700	0	27	8	95	45	90
0	1100	0	27	8	95	45	90
0	1150	0	27	8	95	45	90
0	0	0	27	8	95	45	90
0	0	0	27	8	95	45	90
0	1200	0	37	20	102	5	90
0	816	0	38	28	108	28	90
0	900	0	38	28	108	28	90
0	0	0	38	20	108	42	90
0	0	0	38	20	108	42	90
0	1050	0	38	20	108	42	90
0	900	0	38	20	108	42	90
0	0	0	38	20	108	42	90
0	1100	0	38	20	108	42	90
0	1150	0	38	20	108	42	90
0	0	0	38	20	108	42	90
0	0	0	38	20	108	42	90

>= CB	FEET	MOBIL	CBD	DIST	HWAY	WIND	ANIMAL
0	1100	0	43	28	102	85	90
0	0	0	43	28	102	85	90
0	1005	0	43	28	102	85	90
0	1050	0	43	28	102	85	90
0	1000	0	50	37	102	85	90
0	700	0	0	14	48	25	8400
0	0	0	0	14	48	25	8400
0	720	1	0	14	48	25	8400
0	970	0	0	14	48	25	8400
0	1620	0	36	22	23	172	8400
0	950	0	32	23	16	125	8400
0	0	0	27	18	21	122	8400
0	950	1	31	26	17	111	8400
0	1250	0	10	17	39	51	8400
0	1300	0	18	31	48	28	8400
0	950	0	25	22	57	75	8400
0	1026	0	30	22	52	110	8400
0	0	0	35	23	20	165	8400
0	0	0	35	23	20	165	8400
0	0	0	35	23	20	165	8400
0	624	1	29	25	20	97	8400
0	840	1	29	25	20	97	8400
1	1400	1	29	25	20	97	8400
0	0	0	29	25	20	97	8400
0	0	0	29	25	20	97	8400
0	0	0	29	25	20	97	8400
0	0	0	29	25	20	97	8400
0	0	0	29	25	20	97	8400
0	0	0	29	25	20	97	8400
0	0	0	29	25	20	97	8400
0	0	0	34	42	16	88	8400
0	0	0	34	42	16	88	8400
0	0	0	34	42	16	88	8400
0	1092	0	34	42	16	88	8400
0	960	0	34	42	16	88	8400
0	950	0	34	42	16	88	8400
0	1450	0	34	42	16	88	8400
1	1344	1	34	42	16	88	8400
0	1020	1	34	42	16	88	8400
1	700	1	34	42	16	88	8400
0	0	0	34	42	16	88	8400
0	778	0					8400
0	999	0					8400
0	1150	0					8400
0	1450	0	16	10	9	179	100
0	1250	0	6	10	9	100	100
0	700	0	10	8	9	135	100
0	600	0	2	7	3	65	100

>= CB	FEET	MOBIL	CBD	DIST	HWAY	WIND	ANIMAL
0	1200	0	2	7	3	65	100
0	0	0	2	7	3	65	100
0	960	0	2	7	3	65	100
0	0	0	2	7	3	65	100
0	0	0	9	15	9	80	100
0	1100	0	9	15	9	80	100
0	1016	0	11	18	3	55	100
0	1150	0	5	13	3	55	100
0	0	0	24	31	9	64	100
0	0	0	9	13	3	30	100
0	701	0	18	21	9	18	100
0	1050	0	8	7	3	11	100
0	1150	0	13	12	9	11	100
0	1850	0	33	24	3	122	100
0	850	0	41	34	21	90	100
0	1144	0	56	31	15	175	60
0	1248	0	37	27	26	115	60
0	1218	0	64	40	16	172	60
0	0	0	58	36	21	169	60
0	1334	0	64	40	16	172	60
0	0	0	56	31	15	175	60
0	0	0	56	31	15	175	60
0	1248	0	46	25	17	155	60
0	1344	0	45	10	43	170	3000
0	1446	0	29	12	37	80	3000
0	0	0	29	12	37	80	3000
0	1768	0	14	22	25	46	3000
0	1008	0	14	22	25	46	3000
0	966	0	20	19	24	10	3000
0	768	0	30	8	36	10	3000
0	760	0	30	8	36	10	3000
0	1228	0	25	15	30	8	3000
0	1510	0	25	15	30	8	3000
0	1040	0	39	18	39	52	3000
0	936	0	39	18	39	52	3000
0	2592	0	32	19	34	30	3000
0	1274	0	25	28	21	10	3000
0	1100	0	25	28	21	10	3000
0	788	0	25	28	21	10	3000
0	1144	0	25	28	21	10	3000
0	1040	0	25	28	21	10	3000
0	946	0	25	28	21	10	3000
0	1140	0	25	28	21	10	3000
1	1248	0	25	28	21	10	3000
0	1232	0	25	28	21	10	3000
0	576	0	25	28	21	10	3000
0	1100	0	25	28	21	10	3000
0	816	0	25	28	21	10	3000

>= CB	FEET	MOBIL	CBD	DIST	HWAY	WIND	ANIMAL
0	832	0	57	30	40	154	3000
0	1056	0	27	20	35	85	3000
0	955	0	27	20	35	85	3000
0	1672	0	56	29	42	144	3000
0	1120	0	48	25	46	142	3000
0	1671	0	30	24	38	95	3000
0	826	0	27	20	35	85	3000
0	0	0	27	20	35	85	3000
1	1310	0	42	13	53	150	3000
0	1152	0	36	28	39	104	3000
0	1345	0	58	30	40	162	3000
0	1060	0	49	23	52	175	3000
1	1850	0	60	40	38	170	3000
0	1200	0	58	30	40	162	3000

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