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THE MONITORING AND ENFORCEMENT OF
ANIMAL HEALTH IN THE MICHIGAN
SLAUGHTER HOG MARKET

By

George James Galasso

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ABSTRACT

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Records of the Food Safety and Inspection Service, USDA, indicate that in 1984, 15% of the barrows and gilts slaughtered in Michigan exhibited symptoms of clinical health problems. The purpose of this study is to examine the incentives and disincentives for marketing diseased hogs, and to assess how these incentives and disincentives may be affected by market conditions. The methods of analysis include interviews with market participants and the use of the ordinary least squares regression to assess the role of market factors in explaining variations in disease rates. The results of the study indicate that the lack of an animal identification system in the Michigan slaughter hog market distorts the incentives and disincentives relating to the production and marketing of diseased animals in a deleterious manner. Accordingly, it is suggested that the implementation of animal identification be considered.

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CHAPTER ONE: PROBLEM STATEMENT AND STUDY OBJECTIVES

1.1. The Problem

Recent statistics indicate that there may be high rates of disease in the hogs slaughtered in Michigan. Inspection data collected by the U.S. Food Safety and Inspection Service (FSIS) show that in 1984 approximately 15% of barrows and gilts slaughtered in Michigan exhibited some symptoms of disease problems [1]. Studies recently completed by the Elanco research group of Eli Lilly, with the cooperation of local veterinarians in 12 midwestern states, indicate that 71% of the hogs slaughtered in the region exhibited signs of atrophic rhinitis, and 70% displayed signs of pneumonia [2]. The findings in a 1981 study conducted by the Slaughter Check Group at Michigan State University for a particular county in Michigan indicated that 42% of the the hogs examined exhibited symptoms of atrophic rhinitis, and 58% displayed pneumonia lung lesions [3].

The high prevalence of disease in slaughtered swine presents a possible health hazard to the public and may

cause real economic losses to market participants. Pathogens may be transmitted from diseased animal products to the consumer. H. Riemann and E.L. Bryan's Food-Borne Infections and Intoxications [4] describes several livestock diseases affecting swine that can be contracted by humans upon consumption of pork. Nevertheless, it is emphasized that the risk of contraction is negligible if proper handling is practiced. A recent study prepared by the National Research Council [5] concludes that the pathogens Salmonella, Campylobacter, Clostridium, and Staphylococcus may be transmitted from animal products to consumers, and pose a particular hazard in that they are not readily identifiable at slaughter.

Economic losses may be incurred by market participants as a result of the disease problem. Although the subject is often a matter of contention among veterinary researchers [6], it is commonly believed that high morbidity is associated with lowered daily rates of gain and lowered feed gain efficiency. The specifics behind this association, such as the identity of a given causative pathogen, and the extent to which any given pathogen may contribute to decreased performance, are currently the subject of debate. Studies such as those conducted by Braude, et., al. [7], Muirhead [8], and Straw, et., al. [9] & [10] indicate that pneumonia can

decrease average daily gain as much as 5.6%, and decrease feed efficiency by as much as 4.6% . However, other researchers have concluded that pneumonia has an insignificant effect on the rate of gain [11] & [12].

The ambiguity of the veterinary record with respect to the effects of specific pathogens upon animal performance illustrates the complexity of the relationship between disease and animal performance. This relationship is contingent upon numerous environmental and pathological interrelationships. Nonetheless, it is commonly agreed that morbidity impedes hog performance, necessitating increased production expenditures for feed, space, and veterinary care. However, swine producers may be unaware of this possible effect because disease may be subclinical and, thus, only observable at slaughter. Only if their animals identified according to producer at the slaughter level can the information be returned to them.

Economic losses associated with disease may also be incurred by any participant in the slaughter hog market as a result of livestock death and condemnation loss. Hog deaths which occur in the marketing chain most often result in absolute losses to the marketer. Furthermore, animals displaying symptoms of disease may be discounted or re-routed to 'inferior' markets with lower price offerings. Due to the lack of identification in the

Michigan slaughter hog market, direct losses associated with discounting and 're-routing' are often borne by marketers rather than producers. Marketers may attempt to regain their losses by decreasing the average price offered to producers. This practice acts to spread the costs associated with diseased animals over all producers, not just those who contribute to the disease problem.

Condemnation losses may result in the loss of an entire hog, or may consist of partial carcass losses. In 1984, 7223 slaughter hogs were condemned in Michigan's federally inspected slaughter plants [1], representing a direct loss of approximately \$876,540 [13] to slaughter plants operators. Only an estimated \$722 of this total could be regained in the form of rendered products [14] (these figures do not include losses due to partial condemnations of carcasses). Once again, it is possible that average prices offered may consequently decrease as slaughterers attempt to offset costs of condemnation, or, they might increase prices charged to the consumer.

1.2. Study Objectives

The high rate of disease in hogs slaughtered in Michigan raises questions concerning its causes.

Obviously, production and climatic factors have a central role in the determination of the level of health in any given group of slaughter hogs. Proper nutrition, sanitation, separation of animals into discrete units, care in the selection of breeding stock, and effective veterinary care all influence herd health. Climatic conditions such as temperature and the extent of rainfall also have an affect upon animal health.

However, market factors may also play an important part. The market is responsible for generating and disseminating signals and economic sanctions associated with market participants' preferences, and if it were optimally organized, it would act to discourage the production of diseased stock. Economic theory suggests that health problems may be in part due to inadequate signals and economic sanctions between the points of production and slaughter. It is hypothesized that preferences concerning disease are not being adequately communicated among market participants.

This study addresses the manner in which such preferences are articulated in the Michigan slaughter hog market. More specifically, the study describes the process by which information about animal health is discovered and disseminated in the Michigan slaughter hog market, and examines how this process may be affected by

changing market conditions. The primary hypothesis to be tested is that the economics of the slaughter hog market frequently discourage selectivity in the hog marketing process. Essentially, it is alleged that the means by which the terms of sale, including the health criteria, are monitored and enforced, become increasingly lax as the supply of hogs declines. If this is true, inconsistent signals are being sent to market participants, and the overall level of animal health may thus be expected to be lower than it would have been had more consistent signals been sent.

The specific study objectives are as follows:

- (a) Describe the process by which terms of sale relating to diseased hogs are monitored and enforced throughout the Michigan slaughter hog market.
- (b) Identify how this process may be influenced by conditions of supply and demand in the Michigan slaughter hog market.
- (c) Offer prescriptions for more effective monitoring and enforcement of the terms of sale with respect to diseased hogs.

This study's emphasis on marketing rather than production factors affecting animal health reflects the fact that it is part of a larger project being conducted at Michigan State University which seeks better understanding of the nature of violations of FSIS food safety standards in the livestock industry. Previous research has addressed the effectiveness of the current structure of inspection and enforcement, particularly with respect to residue control [15]. Future research is intended to illuminate those factors influencing producer behavior concerning animal health. This study acts as a link between these two research areas.

This study's focus on Michigan should not be taken to imply that the problem of disease in slaughter hogs is greater in Michigan than elsewhere. Rather, the focus reflects the fact that the research was undertaken at Michigan State University. It also reflects the costliness of undertaking a nation-wide investigation of the hog marketing process.

The potential implications of this study for improving animal health in the Michigan slaughter hog market are significant. The outcome of this study will increase our understanding of the procedures used to

prevent the marketing of diseased hogs and the potential role of market factors in the determination of the level of disease among Michigan's slaughter hogs. The resulting prescriptions could lead to a more consistent set of market procedures and incentives for improving animal health. The implications of this study become even more important when considered in light of recent legislation proposed in Congress to ban the subtherapeutic use of antibiotics in feed [16]. Should the fear expressed by producers that such a ban would increase losses from animal disease become a reality, the effectiveness of the market in discouraging the production and purveyance of hogs with health problems would gain increased importance.

1.3. Thesis Plan

The study is organized into six chapters. Chapter 2 develops an economic framework for analyzing the process by which market mechanisms act to monitor and enforce the terms of sale relating to disease in Michigan slaughter hogs. Chapter 3 outlines the methods utilized to examine this monitoring and enforcement process. Chapter 4 offers a description of the Michigan slaughter hog market, with emphasis upon the mechanisms utilized in the market to monitor and enforce the terms of sale with

respect to disease. Chapter Five examines how the performance of this system may vary with changing market conditions. Several hypotheses are tested in an attempt to substantiate the primary hypothesis that market selectivity, and consequently the level of slaughter hog health, is contingent upon market conditions. The concluding chapter summarizes the findings of this study and offers several suggestions for further research.

CHAPTER TWO: CONCEPTUAL APPROACH

2.1. Introduction

The task of this chapter is to develop a conceptual framework for identifying what and how signals and economic sanctions concerning animal health are being communicated throughout the Michigan slaughter hog market, and how they may vary with changing market conditions. The first part of this task is accomplished by examining the incentive structures pertaining to the articulation of demand for physical attributes, with particular attention to animal health, throughout the slaughter hog market from inspection at the slaughter level through to farm level production. The second part of the task is accomplished by examining how these incentive structures are influenced by changing market conditions.

2.2. Demand for Animal Health

The demand for animal health, among other attributes of slaughter hogs, is articulated from consumers to producers. These consumer demands for disease free pork are articulated by regulatory agencies. This analysis begins by looking at regulatory signals and sanctions. Incentives to slaughterers, marketers, and producers are

then discussed.

2.2.1. Government Regulatory Agencies

Governmental regulatory agencies are concerned with ensuring a wholesome food supply, i.e. one not presenting a health risk to consumers. The agencies demand that the hog-pork subsector provide wholesome products, inspecting animals at slaughter and levying sanctions for unwholesome animals in the form of condemnations. The agencies exist partially as a result of the high information cost of animal health discovery. Often disease problems lack overt symptoms in the live animal, requiring the attention of veterinarians or costly chemical and/or biological testing to identify. To a certain extent, animal health is a public good, and requires some intervention in the market.

The regulatory agencies act to set a minimal permissible level of animal health by means of continuous inspection at the point of slaughter. This minimal demand level is considered to be constant, and it is enforced by the condemnation of animals. The costs of condemnation are often equivalent to the cost of the condemned hog as it must be relegated to a rendering process, which yields a net return of approximately \$0.10 per animal [14]. The

rationale for inspection is that these condemnation costs will be transmitted through the marketing chain, somehow sanctioning the producers and the marketers of the diseased hogs. However, it must be recognized that such sanctions are contingent upon proper identification of the animal with its producer [15]. Should proper identification be lacking, as it is in the Michigan slaughter hog market, the slaughterer may simply offer lower average prices for hogs to offset condemnation losses, therefore spreading costs associated with unhealthy animals to all market participants, and not just to those responsible for such animals.

2.2.2. Slaughterers

Slaughterers may demand more rigorous standards than those set by regulatory agencies. In an effort to avoid condemnation losses, the economically rational slaughterer would be likely to purchase from only those sources providing healthy hogs -- providing lots unlikely to contain those animals suffering from health problems of the dimensions to warrant condemnation. Furthermore, it is likely that conscientious slaughterers would also wish to avoid unhealthy animals to maintain a good business reputation, and are likely to have stricter

standards than merely 'sick enough to pose a human health risk'. Also, evidence of disease among slaughter hogs may slow down inspection, and consequently, the disassembly process may slow, increasing costs to the slaughterer.

Slaughterers articulate their demand for healthy animals principally by means of sorting and pricing practices. Sorting facilitates the culling of live animals with health problems. These animals may then be either shipped back to the marketer, with the slaughterer refusing payment, or they may be discounted in price, or the animals will be slaughtered subject to inspection, i.e., identification is maintained and payment is contingent upon the animal passing inspection. However, sorting is costly, and the extent to which a slaughterer pursues sorting is conditioned by such costs. These costs include sorter wages, 'handling shrink' (hog weight loss associated with the stress of being handled), and the opportunity costs associated with a possible slowing of animal processing by sorting time requirements, and possibly, foregoing more inexpensive hogs because of health problems.

Other means by which slaughterers may articulate animal health demand include direct and indirect communication. Slaughterers can specify their health

demands directly to sellers during negotiation of terms of sale. With continued business, slaughterers may comment upon the health of previous shipments from particular sellers, issuing whatever verbal sanctions or praises are deemed appropriate. If adequate identification is available, the slaughterer may even discuss health matters with producers. Indirect means of communication may include the simple association of one or more seller's hogs with specific levels of animal health based upon past experience.

2.2.3. Marketers

Marketers must provide hogs to the slaughterer which meet the slaughterer's demand for healthy animals, and other attributes as well. There is a derived demand, and one that is driven by a desire to avoid losses associated with discounts and rejection of their stock. Their incentive structure with respect to animal health monitoring and enforcement is similar to that of slaughterers. Marketers wish to minimize the costs of sort, including handling shrink, slowed movement of hogs through the channels, and having to overlook more inexpensive animals because of certain undesirable attributes. Yet they must maintain certain standards, and

have incentive to purchase their animals from more reliable sources, to avoid the disease related losses, and damage to their reputations. However, the need to procure certain quantities may pressure the marketers to procure from less reliable sources at times, and sort less carefully. They must weigh the benefits of avoided rejections and discounts against the costs associated with sorting and the consequences of operation at lower volumes and higher per unit costs.

2.2.4. Producers

The incentives a producer faces concerning the marketing of animals with respect to animal health differ from those of marketerers and slaughterers. Although, like the marketers, the producer faces a derived demand for a certain level of animal health, other considerations factor into the producer's market decisions. The producer must market his hogs irrespective of their health. In fact, marketing may provide an opportunity to cull diseased animals out of a herd. Given market sort and discount practices, it may prove economically rational for a producer to market his hogs with animal health problems early, thereby reducing the risk of further spread of contagion, reducing costs of veterinary care, and

preventing death loss. The costs of doing so may include discounting, possible re-routing of hogs to inferior markets, damage to the producer's reputation, and possibly the costs of transporting rejected animals back to the farm.

2.2.5. Summary

This discussion of the incentive structures associated with the monitoring and enforcement of animal health emphasizes the fact that the extent to which market participants guard against unhealthy animals is contingent upon a tradeoff between costs and benefits of sorting. The focus upon the costs and benefits associated with the sorting process raises questions concerning the processes by which animals get from the farm to the slaughter plant; what are the methods of sale?, how do hogs move through the market?, who are the participants involved?, and how are the terms of sale determined and enforced? Before a discussion of the monitoring and enforcement of animal health may be pursued, recognition of the organizational context within which it operates must be made. Those participants to whom costs and benefits accrue must be identified, and the nature of those costs and benefits illuminated. Only then may the process by which animal

health is influenced by the market be addressed.

2.3. Animal Health and Conditions of Supply and Demand

The level of health realized at the slaughter level has been hypothesized to be a function of monitoring and enforcement practices of governmental regulators and market participants. The major participant groups' incentive structures behind monitoring and enforcement have been discussed in terms of the various costs and benefits associated with animal health. However, the discussion has been limited in that no mention has been made concerning how these costs and benefits may vary with market conditions.

The primary hypothesis to be tested in this study is that conditions of supply and demand affect the manner in which the market acts to discourage the purveyance of diseased stock. Conditions of supply and demand weigh heavily upon the incentive structures of market participants, with the exception of governmental inspectors as their incentive structure is assumed constant and not subject to market conditions. The effect

is to create a situation in which animal health criteria are monitored and enforced by market participants on an inconsistent basis. Inconsistency consequently compromises the market's ability to discourage diseased animals.

Essentially, as supply conditions change, corresponding changes in the market participants' perceived tradeoff between the costs and benefits of animal health monitoring and enforcement may take place. During periods of short supply, buyers may find it more economically rational to lessen the extent to which they pursue monitoring and enforcement of physical attributes, including animal health, accepting increased risk of condemnation, discounting, or rejection losses in an effort to procure more hogs. Such lessening of standards acts to increase the number of available hogs in the premium markets, as hogs previously deemed unacceptable and relegated to inferior markets may now be purchased at a price comparable to that of other market hogs.

Slaughterers' demand for hogs during periods of short supply may take precedence over strict enforcement of animal health criteria. Slaughterers may decrease their effective demand for animal health, and face a higher risk of condemnation losses, in an effort to cover costs.

Slaughterers have considerable levels of fixed costs, and it is conceivable that, at times, the only way to cover those costs and ensure a reasonable profit is to ensure that the line operates at a constant, near capacity level. The lessening of slaughterers' standards is given added impetus when the product prices received increase. The assurance of an adequate, stable supply may rely upon lax animal health monitoring and enforcement.

The decreased slaughterer demand for the animal health attribute in periods of short supply is reflected in marketer demand. If the risk of discounts and rejections at the slaughter level lessen, the marketer's perceived costs of lax monitoring and enforcement diminish, and health standards are likely to be reduced. It then follows that producers' perceived costs associated with the marketing of unhealthy hogs decreases, and consequently, the health of slaughter hogs will be lower than it might have been had more rigid standards been enforced.

In periods of short supply, as slaughterers diminish their sorting standards, and marketers respond with diminished standards of their own, producers may perceive a decreased risk of discount or rejection losses, and may market hogs they would have normally held back. Sick

animals may be marketed when, under conditions of more ample supply, they may have otherwise been kept for convalescence, or have been shipped directly to 'inferior markets'. Also, during periods of short supply, the price received by producers increases, thus providing more incentive to market as many animals as possible. The perceived costs of discounting or rejections are reduced relative to the perceived benefits from marketing.

2.3.1. Summary

The above discussion can be summarized in three hypothetical relationships:

- a) As quantity supplied decreases, and/or product prices received by slaughterers increase, the emphasis upon health criteria in choosing hogs for slaughter decreases.
- b) The decreased emphasis upon animal health criteria at the slaughter level will result in corresponding changes in the emphasis of health criteria by marketers.
- c) Consequently, producers will be induced to market hogs they would normally hold off the market, particularly if producer prices rise above the historical average. Thus, disease rates recorded by Food Safety and Inspection Service can be expected to be higher during periods of short supply.

CHAPTER THREE: METHODOLOGY

3.1. Introduction

The research required two major tasks. The first was to develop a general description of the Michigan slaughter hog market, including a description of the terms of sale with relevance to disease and the means by which those terms are monitored and enforced. The second task was to determine whether disease-related monitoring and enforcement in Michigan's slaughter hog market was influenced by market conditions.

3.2. Description of the Hog Marketing System and the Monitoring and Enforcement of Animal Health

The description of the Michigan slaughter hog market was undertaken to orient the rest of the analysis, providing a context for discussion and identifying key market factors influencing the monitoring and enforcement of the terms of sale with respect to disease.

The methodology of description was guided by the results of a Michigan slaughter hog market study conducted in 1975 by Tom Bloomer [17], market descriptions including J. McCoy's Livestock and Meat Marketing [18], among others [19] & [20], and consultation with both members of the

Michigan State University faculty knowledgeable about Michigan's slaughter hog market [21] & [22], and state swine extension specialists [23].

Data collection was organized into four parts; description of (a) market participants, (b) market channels, (c) methods of sale, and (d) terms of sale. This approach was used so that benefits and costs of marketing diseased animals, and how these benefits and costs might change over time, could be better discussed in the analysis.

The available literature identified market participants with respect to market channels. Bloomer's study [17] provided a detailed description of the market channels and methods of sale. Agricultural statistics were used to substantiate and update Bloomer's findings, particularly those provided in the Packers and Stockyards Statistical Resume [24]. Unfortunately, only very general information was available relating to the terms of sale in the market. Specific information pertaining to the terms of sale, particularly concerning animal health, was obtained through interviews and on-site visits.

Interviews and on-site visits were used to build upon the information provided in Bloomer's study, and to describe the process of sale, both identifying the terms of sale and the manner in which the terms are monitored

and enforced. Interviews were conducted on two different levels. The first level concerned the organization of the market, and the second concerned the process of sale. The first level was oriented by the following questions; (a) from where and how do you obtain slaughter hogs?, (b) to whom and how do you sell slaughter hogs?, and (c) what is the process by which you physically move animals through your establishment?. The second level of interviewing consisted of three major questions; (a) how is price established?, (b) what is the 'type' of hog desired?, i.e. what are the attributes sorted and/or priced for?, and (d) how is the sorting performed?

After these questions had been asked, the respondents were asked whether they considered disease to be a problem in the market. They were then asked to describe the manner in which they dealt with diseased animals and whether or not they distinguished diseased animals from healthy. If the respondents answered in the affirmative, they were asked on what basis was such a distinction made, and what was the subsequent treatment or disposition of diseased hogs. Finally, with respect to the second part of the analysis, respondents were asked whether or not they perceived any changes over time in the identification and disposition of diseased hogs. This question was asked to examine the hypothesis that health

monitoring and enforcement may change as market conditions change. If an affirmative answer was provided, they were asked to describe such changes, and answer why they felt such changes occurred.

As a result of the predominance of a relatively small number of market participants, the availability of market statistics, and the detailed study by Bloomer, little attempt was made to design a rigorous sampling strategy. Instead, each of the major marketing and slaughtering organizations were subjected to repeated interviews, and an effort was made to interview representatives with different roles within each of the major organizations. Administrators, market managers, plant managers, and animal sorter/handlers were interviewed from each of the major organizations. In addition to the interviews conducted with the major market participants, smaller market participants were also interviewed. Market managers from six of Michigan's nineteen livestock auction markets which deal in slaughter hogs were interviewed. The six were chosen randomly from a list provided by the Michigan Department of Agriculture. Several truckers, involved in the transportation of hogs to the two major slaughter plants in Michigan, were also interviewed. Interviews relating to producers' marketing concerns included the secretary and spokesman for the Michigan Pork

Producers Council [25], and an interview with a producer from St. Johns, Michigan [26].

Interviews were followed up by several visits to Michigan slaughter hog facilities. Production, market, and slaughter facilities were visited in the course of research. One production unit located in St. Johns, Michigan was visited, whereupon the farm owner was interviewed informally about his marketing concerns [26]. A buying station in Pewamo, Michigan was also visited [27], as was an auction market in Howell, Michigan [28]. In addition to the marketplaces, the two largest slaughter facilities, Frederick and Herruds, Detroit, and Utica Packing, Utica, Michigan, were also visited. Sorting and pricing techniques were observed first hand at the marketplaces and slaughter facilities, and facility personnel were interviewed informally concerning the manner in which they 'controlled' for diseased animals. Food Safety and Inspection Service ante- and post-mortem inspections were also observed at the slaughter facilities. The veterinarian on-duty at Frederick and Herruds was interviewed briefly, and was asked to describe the post-mortem inspection.

3.3 Market Conditions and Animal Health

In addition to interview data, statistical methods were used to test the hypothesis that market conditions affect the level of animal health in the Michigan slaughter market. As described in Chapter 2, market conditions may affect market participants' behavior, and consequently have repercussions for the general level of health in the hogs marketed. Market conditions may encourage inconsistencies in the processes by which terms of sale relating to disease are monitored and enforced. These inconsistencies are expected to consist of varying degrees of selectivity in the sorting process. Specifically, when supply of slaughter hogs declines, selectivity on the part of slaughterers in the sorting process diminishes, bringing about a more lax sort throughout the marketing system, thus resulting in an increased incidence of health problems in slaughter hogs. This hypothesis is tested using statistical techniques to determine whether disease rate, as indicated by FSIS inspection records, is correlated with conditions of supply and demand.

3.3.1. The Dependent Variable

The principle dependent variable in the analysis was animal health at slaughter. Animal health was proxied by the rate of disease, including parasitic infestation,

found in Michigan slaughtered hogs. Although animal health is a general term, which includes factors other than disease, such as drug and chemical contamination, the analysis was restricted to disease rates because of limitations in the available data. Although the FSIS pursues a monitoring program for chemical contaminants on a national level, the data is not available on a state by state basis. However, the FSIS maintains records of disease rates at the individual slaughter plant level, and made the records for Michigan plants in 1984 available for this study. Unfortunately, the FSIS data does not include sub-clinical disease rates, i.e. those not readily indicated during ante- and post-mortem inspection.

A disease rate was determined for two of the major slaughter facilities processing grade #1 and #2 barrows and gilts on the basis of the results of FSIS continuous inspection records. Together, the two plants slaughtered 94% [29] of the state's federally inspected slaughter of barrows and gilts. The numbers of hogs receiving FSIS CONDEMNED, RESTRICTED, and PASSED categorization on the basis of disease problems were summed on a weekly basis, and divided by the number of animals slaughtered weekly by the two facilities. The FSIS recognizes four different groups of animals; those that display no symptoms of disease, or those receiving any of the three

categorizations mentioned above. CONDEMNED refers to those animals deemed by a FSIS veterinarian to present a health risk to consumers, and are subsequently destroyed or otherwise precluded from human consumption. RESTRICTED refers to those animals deemed by the FSIS veterinarian to present a potential health threat to consumers unless processed in a specific manner, i.e. those animals exhibiting symptoms of tuberculosis restricted to processing involving cooking. PASSED refers to those animals exhibiting symptoms of disease or parasite problems, but not of the type nor extent to which the FSIS veterinarian feels a human health risk is being presented [30].

The CONDEMNED, RESTRICTED, and PASSED categories were aggregated into a single variable, DISEASE, in the analysis. The PASSED rate is of principle importance herein as it represents the proportion of animals exhibiting outward symptoms of health problems ante-mortem, or post-mortem yet before evisceration, and only later deemed fit for human consumption. This category consequently relates most directly to the theory presented in Chapter 2 about the slaughterer's sorting decisions. The slaughterers' decisions concerning the disposition of animals held to be of suspicious animal health, yet not certain to be condemned, are those that

are most likely to result in the changes in the rate of disease. These 'borderline' cases of animal health problems are likely to be refused during periods of high supply, yet accepted during periods of short supply, thereby altering the disease rates indicated by FSIS inspection.

The topic of interest is the general level of hog health, and for the purposes of this study, there is little analytical value to disaggregation according to the FSIS categorizations. The decisions on the part of the FSIS concerning whether a particular hog health problem poses a direct threat to human consumers is only indirectly of importance to this study, what is important is the overall incidence of health problems in the hog subsector. Furthermore, disaggregation would yield only inconclusive results as there was not be enough variation in either the CONDEMNED or RESTRICTED categories alone for any conclusive correlations. In 1984, only about(.14%) of the Michigan slaughtered hogs were CONDEMNED, and only about (.01864%) were RESTRICTED, whereas approximately (15.58%) were PASSED [1].

The health statistics obtained were considered representative of the Michigan slaughter as 94% of the state's federally inspected barrow and gilt slaughter was performed by the two plants from which the FSIS statistics

were derived. It should be noted, however, that this variable represents the level of health in those hogs slaughtered in Michigan, and cannot be interpreted as indicative of the level of health in hogs produced in Michigan per se. This is a limitation, particularly since approximately 85% [31] of hogs slaughtered in Michigan are derived from out-of-state sources, and constrains the analysis. The problem of changing proportions of in-state to out-of-state hog procurement for Michigan slaughter facilities may compromise the analysis. Should the proportion of animals procured by Michigan slaughterers from out-of-state be correlated with the quantity supplied, and if out-of-state hogs have different levels of health than in-state hogs, the testing of the hypothetical relationships discussed in Chapter 2 may be biased. Although an attempt was made to determine if changes do in fact take place in the proportion of out-of-state to in-state animals, and to what extent over what period of time, it was found that the data base simply is not disaggregated sufficiently for such an analysis. Nevertheless, this study is intended to draw relationships between market practices and conditions, and animal health in Michigan, not between Michigan production conditions and animal health.

3.3.2. Explanatory Variables

The explanatory variables used in the analysis include quantity supplied, product prices received by slaughterers, prices received by hog producers, and season. The significance of these variables, and the relationships between them and the dependant variable are discussed below.

Quantity of hogs supplied represents a measure of the extent to which Michigan slaughterers were under pressure to procure hogs. Quantity supplied consists of the quantity of barrows and gilts supplied by producers to slaughterers in Michigan, and in neighboring states from which Michigan slaughterers procured hogs, on a weekly basis for 1984. The rationale for this variable is based upon the fact that the slaughterers' profit margins are relatively small, and they must maintain high capacity production to cover fixed costs. Therefore, slaughterers' compete actively with one another to obtain the available supplies. Consequently, during conditions of short supply, competition among slaughterers is most intense, and they may lessen the 'selectivity' of their sorting process, and are more likely to accept the increased risk associated with animals of questionable health. Consequently, producers may market animals that might otherwise have held back from the marketing process, and disease rates reflected in FSIS inspection at slaughter may increase. The weekly quantity supplied data for 1984

was obtained from Livestock, Meat, Wool Market News [32], and was proxied by the federally inspected slaughter of barrows and gilts in the region encompassing Michigan, Ohio, Indiana, Illinois, Wisconsin, and Minnesota. This proxy variable was called Supply in the analysis. The limitation of the use of Supply is that it is an indirect measure of the extent to which slaughterers are under pressure to obtain hogs. A more direct measure is product prices obtained by slaughterers.

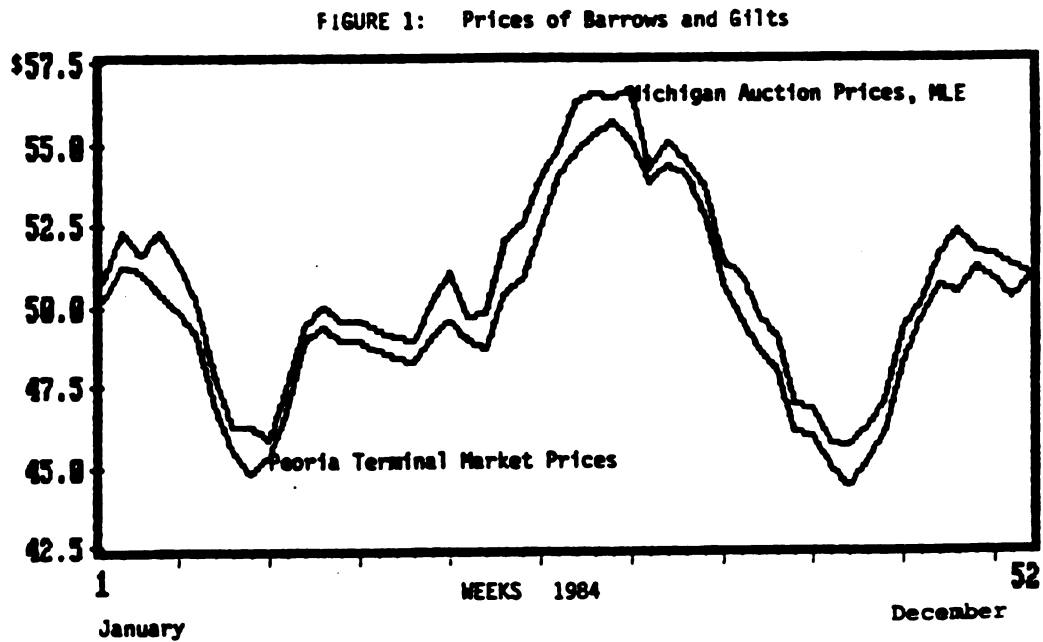
Product prices received by slaughterers is also intended to proxy the extent to which slaughterers compete with one another to obtain available supplies of hogs. As product prices rise, the net return slaughters may receive on each animal may also rise. Their competition for supply intensifies, and their sorting standards may ease, resulting in higher disease rates as recorded by the FSIS. Sorting standards may ease with respect to animal health in an effort to procure more hogs, and also because the perceived benefits of buying an animal of 'borderline' health may offset the perceived risk of added costs from condemnation. Product prices received by slaughterers consisted of the average weekly wholesale prices received by slaughterers for their products. The proxy variable chosen to represent such prices, Pork Price was the

average weekly price of loins/cwt., Central U.S., FOB Omaha. The prices were obtained from the Livestock, Meat, Wool Market News.

Prices received by producers, i.e., those that are paid out by slaughterers, also indicate the degree of competition between slaughterers, with the same implications as discussed above. Additionally, changes in prices received may alter producer's perceived relationship between the benefits and costs of marketing diseased animals. Higher prices, particularly when combined with eased sorting standards, may prompt producers to market animals of questionable health which they would have held back under historical average prices and sorting standards. Accordingly, higher disease rates can be expected when prices received by producers are higher.

Prices received by producers were estimated using average weekly prices received by Michigan producers for grade #1 barrows and gilts ranging from 230 to 245 pounds. This variable consisted of data obtained from the Michigan Livestock Market Letter [33]. The data was derived from each of the MLE's four major auction markets through the weekly selection of one to two 'representative' sale lots of grade #1 barrows and gilts, chosen by the market manager to be indicative of the sales occurring during each week. The prices obtained for the

lots were then averaged to obtain Hog Price. Although the price data was limited to #1 hogs, Figure 1 indicates that Hog Price behaves in a similar manner to Peoria prices estimated for #1 and #2 grade hogs.



The Season variable represents a series of three dummy variables, each representing a different season. The fourth season is considered by default. The dummy variables allow for the seasonal factors influencing animal health to be separated out in the regression analysis.

3.3.3. The Statistical Analysis

The statistical analysis consisted of the estimation of regression coefficients, or measures of the extent to which two or more variables vary together. The statistical package 'micro TSP' was utilized in the estimation of the coefficients. The package calculated Ordinary Least Squares.

As the regression coefficients could only measure the extent to which two or more variables varied together, the above hypothesized relationships were used to determine the causal relationships between variables. The relationships are summarized below.

Expected Relationship	Sign of the Coefficient
a) Disease = f(Season, Supply)	(-)
b) Disease = f(Season, Hog Price)	(+)
c) Disease = f(Season, Pork Price)	(+)

To reiterate, these relationships are used to test the primary hypothesis that disease problems in the Michigan slaughter hog market are influenced by market conditions.

CHAPTER FOUR: THE MONITORING AND ENFORCEMENT OF ANIMAL HEALTH

4.1. Introduction

This section describes how animal health is monitored and enforced in the Michigan slaughter hog market. The chapter begins with a discussion of meat inspection and the disease data. In turn, each of the major market participants are addressed with respect to the means by which each monitor and enforce animal health. However, before each of these means are discussed, the setting, or context in which each operate is described. The participants are first described, then the manner in which they transfer ownership of hogs is discussed, followed by an examination of the general terms of sale and the manner in which those terms are ensured by market participants. Once this background information has been presented, animal health monitoring and enforcement is then discussed. The section is concluded by a discussion of the incentives and disincentives to market animals with disease in Michigan.

4.2. Disease Rate and the FSIS

The Food Safety and Inspection Service sets the minimum level of acceptable animal health at the slaughter plants. The FSIS serves to both monitor and enforce animal health at the slaughter plant level, ensuring that slaughterers have an incentive to maintain certain standards of animal health, as will be discussed below. The primary function of the inspection service is to prevent hazardous products, i.e., those which pose a public health risk, from reaching the consumer.

The responsibilities of the inspection service are outlined in the Federal Meat Inspection Act of 1967 (21 U.S.C. 601 et. seq.). The Act requires the Secretary of Agriculture to ensure, at the plant level: (a) sanitary production conditions, (b) product wholesomeness, (c) product free of adulteration, and (d) 'proper' marking, labeling, and packaging of product. The requirement of this Act with the most relevancy to this study is (b). Wholesomeness is an elusive term, but may be addressed in terms of the FSIS condemnation and restriction guidelines. Wholesomeness is the quality of being free from indications of 'metabolic, toxic, nervous, or circulatory disturbances, nutritional imbalances, or infectious or

parasitic diseases' (Code of Federal Regulations 1985, 9:107), and being free of signs of putrification. Adulteration is defined as the quality of bearing any 'poisonous or deleterious substance which may render it injurious to health' (Code of Federal Regulations 1985, 9:82).

The Act specifies that both ante-mortem and post-mortem inspection of slaughter hogs must be pursued at the slaughter plant level. Both inspection activities consist of the organoleptic examination of animals and carcasses, respectively. Organoleptic examination consists of the examination of an animal or carcass, through the senses of sight, touch, and smell, for indications of health problems.

The ante-mortem inspection includes such an examination for indications of disease, contamination, and other abnormalities. Rashes, localized and generalized infections, tumors, swollen glands, body conformation, respiratory problems, lameness, stupor, and injection sites (indicative of possible drug violations), etc. are sought out. Should an inspector detect symptoms of clinical illness, contamination, or other signs of abnormality, the animal exhibiting such signs is isolated, held in a U.S. SUSPECT pen, until it may be examined by the circuit veterinarian who may then make the final

decision as to the disposition of the animal.

Post-mortem inspection involves the examination of the carcass for similar signs of illness as ante-mortem, but is more exhaustive. The carcass is examined from the initial preparation to the point of evisceration. The range of symptoms presented to the inspectors is much greater than in the live animal. Greater efficiency is enabled as individual organs may be inspected directly for parasitic infestation, cancer, signs of infection, etc. (after Shriver 1984 [15]). For a more detailed discussion of inspection practices and regulations, see the Code of Federal Regulations 1985, #9:Part 309-10.

On the basis of the inspection results, a SUSPECT animal may be labeled one of three different FSIS classifications: (a) PASSED, (b) RESTRICTED, or (c) CONDEMNED. PASSED refers to those animals/carcasses possessing symptoms of disease, parasite, or chemical problems, but deemed by a FSIS veterinarian to present no potential threat to human health, and may consequently be processed with the rest of the slaughter. RESTRICTED refers to those animals/carcasses determined to be of potential hazard, yet of such dimensions as to avert any danger upon specified processing; ex. tuberculosis infected animals must be cooked before marketing. CONDEMNED refers to those animals/carcasses determined to

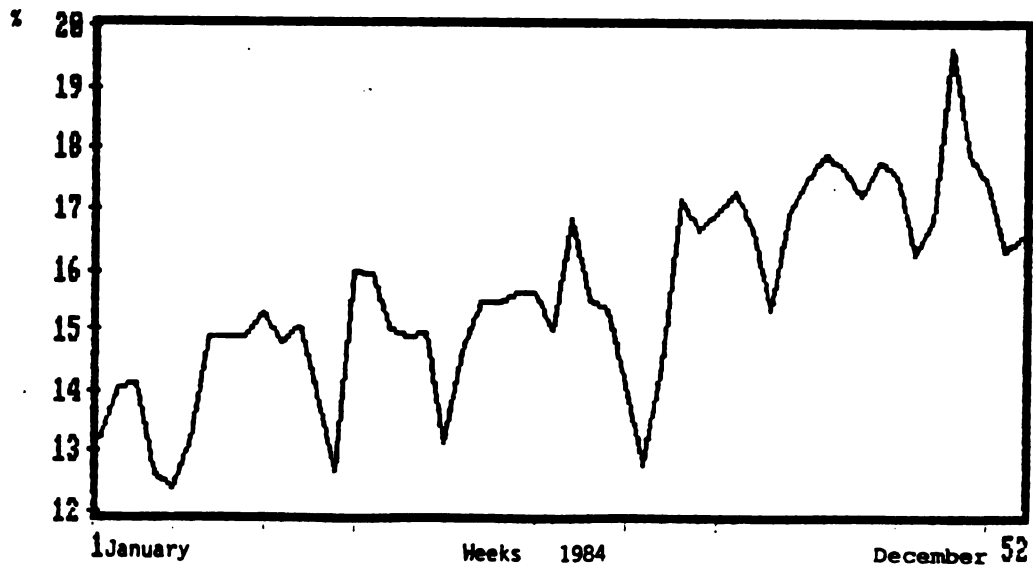
be of unavoidable hazard to the consumer, and are therefore destroyed, or rendered for non-food purposes [30].

The FSIS disseminates the results of plant-specific monitoring and enforcement only to the particular plant inspected, and to the agency's central office. Each plant is given an account of all its violations. However, the accounting is not released to the public, nor is any given to other market participants unless the plant itself provides such an account. Frederick and Herrud was the only plant in the state found to reveal FSIS data to its clients. Yet, the data it communicated, by way of a computer print-out sent only to the larger marketers (MLE and Heinold), included only market weight and number of condemnations. Although it does not release plant-specific data, the FSIS does publish the national condemnation rates in its annual report entitled "Federal Meat and Poultry Inspection".

The results of the FSIS continuous inspection in Michigan for 1984 were used to estimate the variable Disease. Disease is the primary dependant variable in this analysis. It is indicative of the disease rate in barrows and gilts slaughtered in Michigan, and not simply those hogs produced in the state. The

specific diseases considered in the FSIS inspection, those that are aggregated to determine the disease rate, are listed in Appendix 4. The rate ranges from 12.38% to 19.67%, with a mean of 15.58%. As can be seen in Figure 2, the rate fluctuates systematically. A pattern of oscillation, of alternating increases and decreases, is evident. When this variable is disaggregated into its three separate components, PASSED (Figure 3), RESTRICTED (Figure 4), and CONDEMNED (Figure 5), the pattern of sub-monthly, alternating increases and decreases are still apparent.

FIGURE 2. DISEASE Rate



(43)

FIGURE 3. PASSED Rate

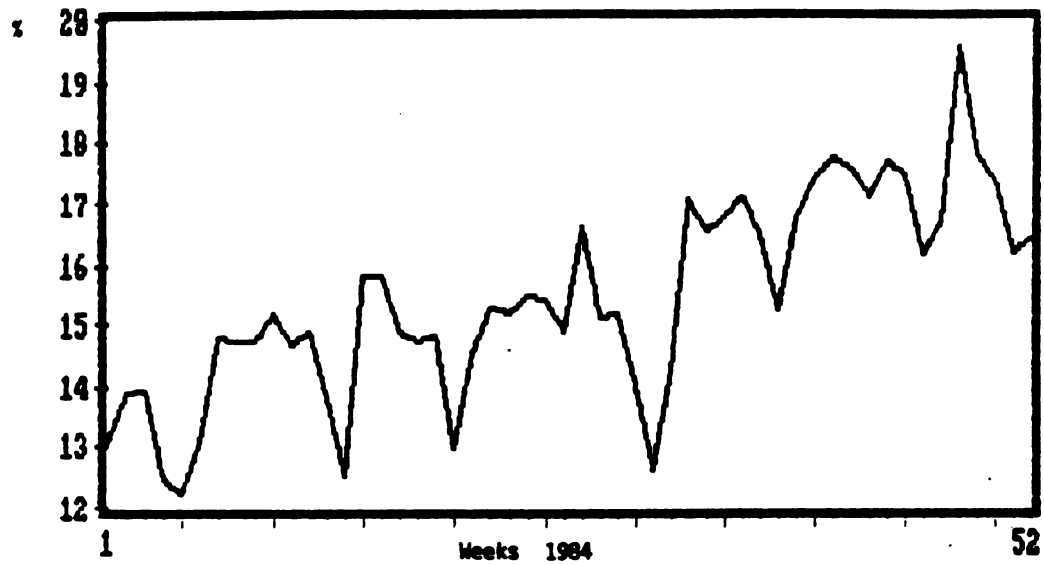


FIGURE 4. RESTRICTED Rate

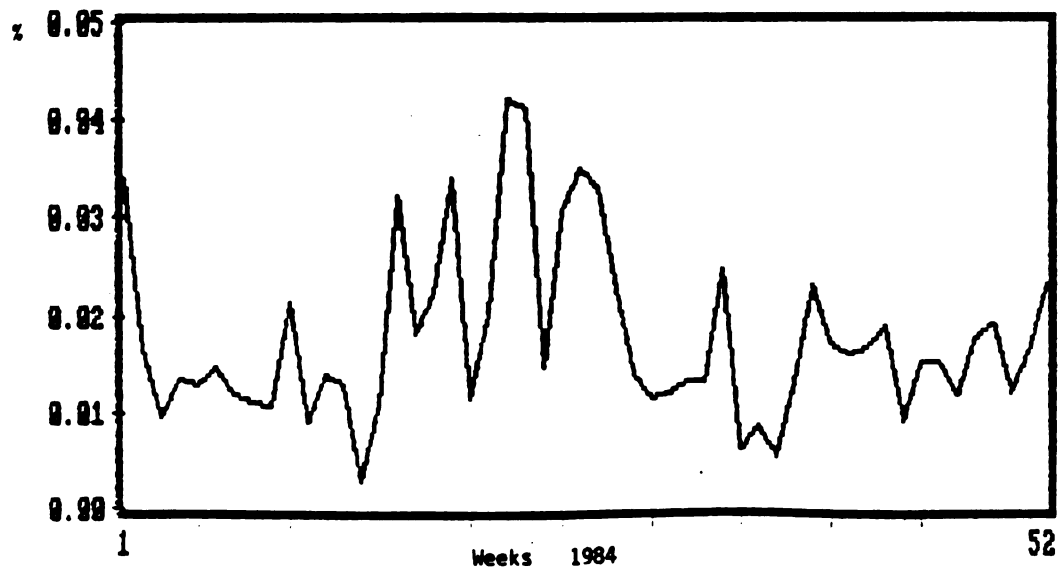
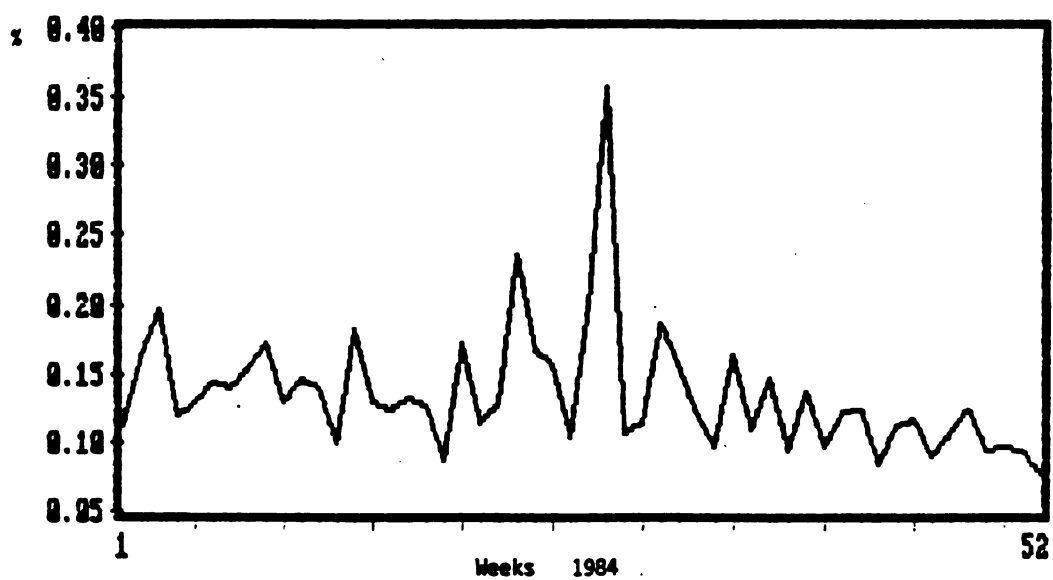


FIGURE 5. CONDEMNED Rate



Although the patterns of fluctuation in the rates are similar, they do differ in magnitude across seasons. The PASSED rate exhibits a steady upward trend from January to December. The RESTRICTED rate suggests higher rates in the winter and summer, with lower rates in the spring and fall. The CONDEMNED rate indicates a sudden increase in mid-summer. The Disease rate is dominated by the PASSED rate, which averages around 15%, of total slaughter, and consequently exhibits no clear seasonal patterning. However, the reader must be cautioned in the interpretation of these generalizations about rates as the data covers only one year, and does not provide an adequate statistical basis for any conclusive arguments. Furthermore, the RESTRICTED and CONDEMNED rates are based upon a limited range of fluctuation; between (.013%) and (.021%) of the total Michigan slaughter for the former, and (.078%) and (.357%) for the latter.

4.3. Slaughterers

Slaughterers consist of individuals engaged in the slaughter and processing of slaughter hogs. They interact with both producers and marketers in the procurement of livestock. Michigan slaughter is dominated

by two companies, Frederick and Herruds, and Utica Packing. Together, these two slaughterers account for approximately 94% of the Michigan slaughter. Michigan slaughterers procure at least 85% of their animals from out-of-state according to the slaughter buyers and swine extension specialists interviewed. Interviews with slaughterer representatives from both Frederick and Herruds and Utica indicated that the bulk of these animals came from Ohio, Illinois, and Indiana.

Michigan slaughterers procure their animals from three major marketing channels; terminal markets, auction markets and buying stations. Approximately 34.9% of the hogs slaughtered in Michigan were obtained from terminal markets, 16.3% from auction markets, and 48.8% from buying stations [24].

Interviews with various market participants and one regulatory official, distinguished between two basic types of slaughterers. They insisted that both 'quality' and 'price' buyers existed. The quality buyers purchased only those animals they believed to be grade #1 or #2, and to be healthy. These buyers most often sold pork cuts or carcasses. On the other hand, the price buyers sought to purchase animals solely on the basis of price, accepting animals of questionable health, and accepted the consequent condemnations on the part of the FSIS. These

buyers generally sold processed pork products such as sausage or frozen dinners. Two Michigan-based price buyers and seven others which were based outside of Michigan, but purchased Michigan hogs, were identified by the market participants interviewed. These price buyers account for only a small proportion of the total buyers of hogs.

4.3.1. Methods of Sale

Michigan slaughterers purchase on a liveweight basis, with indirect sales predominating. Animals are delivered to the plants, they are sorting and weighed, though not necessarily in that order, and payment is then offered immediately. Payment is most commonly performed by means of a billing process; claims are made by the major marketers against the slaughterer's account. Slaughterer's rarely purchase directly from producers, although a few exceptions are made. In such instances, the producer receives a check from the plant.

4.3.2. Terms of Sale

Slaughterers negotiate terms of sale with marketers over the telephone. In Michigan, the slaughterers generally negotiate prices and quantities with either Heinold's or MLE's central offices on a daily basis. Prices are generally in accordance with those quoted for Peoria, with probable adjustments for transportation costs

as the prices received by the marketing organizations float above the Peoria prices (see Figure 1, p.36). The specific physical attributes desired by the plants are not usually mentioned during such negotiations. As the three parties have daily contact, an implicit understanding exists between them concerning the type of animal desired by the plants. However, disputes do arise, as will be discussed below.

At the slaughter plant, the animals are unloaded and sorted. Federal law requires an FSIS inspector to conduct ante-mortem inspection, and this procedure is performed as the animals are being off-loaded and sorted. The sorting culls are then loaded back onto the truck, and the remaining animals are purchased by the plant by means of a receipt/billing to account process. The sorting process which ensures that the physical specifications of the terms of sale (weight, body conformation, leanness, and health) mirrors that described below for buying stations, with two major exceptions. Hogs arriving at the plant are sorted only once; no other buyers are considered in the sorting process. Furthermore, as the hogs are unloaded, they are hammer tattooed at Frederick and Herruds to identify each shipment. On-site observation of the process indicated that animals not meeting the plant's attribute specifications are re-routed back onto the

vehicle from which they arrived, unless the animals suffer from acute health problems. In such instances, these animals are supposed to be labeled U.S. SUSPECT by the FSIS ante-mortem inspector, and they are slaughtered accordingly, with negligible payment to the marketer should the animal be condemned. However, should an animal only be condemned post-mortem, only Frederick and Herruds, with its tatooing system, may discount marketers' bills for the amount of loss.

The tatooing system also enables Frederick and Herruds to operate a computerized system whereby marketers receive a print-out specifying the number of their animals condemned by FSIS, as well as weight data and the price received for their animals. Unfortunately, the print-out provides no details concerning the condemnations, and does not include partial condemnation losses or listings of disease problems not requiring condemnation.

Interviews revealed that the sort performed by the slaughterers is often contested by marketers. Approximately half of the marketers interviewed who negotiated directly with slaughterers commented on how they felt it was necessary to argue with slaughterers during sales negotiations concerning the sort their animals received at the slaughter facilities. They felt that the slaughterers were not consistent in their sort.

Several of the marketers suggested that animals that would normally be accepted, would sometimes be rejected when supply was long. This matter will be addressed in more depth in the following chapter.

4.3.3. Monitoring and Enforcing Animal Health

Interviews and on-site visits revealed the live sorting process to be the major mechanism of animal health monitoring and enforcement. In terms of the live animal, both plant sorters and FSIS inspectors attempt to cull animals exhibiting the signs of health problems discussed above. The plant sorters have an incentive to sort against sick animals before payment is made and the animals enter the slaughter process. However, they must weigh the potential costs of such condemnations against the costs associated with a slowed disassembly line. The on-site visits indicated that the sorting process is accomplished very quickly, essentially while the hogs are on the run. Slaughterers are extremely concerned with line speed; maintaining a rapid kill rate is viewed as essential to the maintenance of net profits.

Should the sorters detect suspect animals, they may refuse purchase, and return the animals to the vehicle from which they came, thus avoiding condemnation losses. However, should the sick animals be brought to the attention of the inspector on duty, and should s/he

determine that the problem may be serious enough to warrant slaughter/destruction, the animal must be slaughtered U.S. SUSPECT at plant expense. The sorters therefore have an incentive to cull the suspect animals before the inspector does so.

If the suspect animal is identified with a particular marketer, and should that animal be condemned, the marketer will often not receive payment for that animal. In the case of the hog that gets past the sorting and initial inspection process, only to be condemned post-mortem, the loss is incurred by the slaughterer, unless the animal can be identified by tatoo. Tatooing serves to transfer the potential losses associated with condemnation from the slaughterer to the marketer. However, the slaughterer may still incur a cost from having to process the animal, and then only obtain the equivalent of \$5.00 gross return per animal in rendered products [14].

4.4. Marketers

Marketers consist of agents who facilitate the exchange of livestock between producers and slaughterers. Many different types of marketers exist in the slaughter hog subsector. They may be associated with terminal

markets, auction markets, buying stations, marketing cooperatives, or may be self-employed. Furthermore, slaughter houses may employ marketers to purchase livestock from any available market. Marketers may take ownership title to hogs, or may operate on a commission basis. Michigan marketers are dominated by two interests, the Michigan Livestock Exchange, a cooperative marketing organization, and Heinold, a subsidiary of DeKalb which operates numerous buying stations throughout the state.

Michigan slaughterers procure their hogs from essentially three basic types of marketers; those associated with auction markets, terminal markets, and buying stations.

4.4.1. Auction Markets

An auction is a private or cooperatively owned market point where producers bring consignments of animals to be bid upon in response to an auctioneer's chant, generally by slaughterer representatives. The auction may offer the service of aggregation and sorting, or seller consignments may be bid upon directly without any sort or commingling. In Michigan, the auction market rarely takes title to the animals; ownership is transferred from producer to slaughterer. Approximately 16.3% of the hogs slaughtered in Michigan were obtained through auction markets [24], although only 5.8% of the total slaughter was obtained

from Michigan auctions [34].

Auction markets in Michigan can be broken down into two major groups; the autonomous, privately owned market, and that owned and operated by MLE, the marketing cooperative. Both types of auction markets generally market numerous species of livestock in addition to hogs. In 1983, slaughter hogs comprised anywhere from 4% to 55% of the annual livestock volume in various Michigan auction markets, with an average of 25% of all species marketed in Michigan auctions [34].

4.4.1.1. Methods of Sale

In most cases, the auctions serve as conduits of exchange between producers and slaughterers; no title of ownership is taken by auction market representatives. Auctions most commonly involve the issuance of a 'consignment ticket' to the producer. Consignment tickets specify number of head, an average weight determined by weighing the entire consignment and dividing by number of head, and a general description. The animals are then sorted and commingled irrespective of the identity, or producer affiliation. However, sort usually corresponds to the consignment ticket description. Once all animals have been bought, the producer may 'cash in' the consignment ticket.

Auctions take place one, sometimes two times a week

in Michigan, and are generally attended by two or three slaughter hog buyers who place bids for specific slaughterers. The buyers are commonly order buyers who operate on a commission basis. They purchase in the name of a specific slaughterer, receiving remuneration on a commission basis, and generally do not take title to the animal.

4.4.1.2. Terms of Sale

Terms of sale consist of the specification of slaughter hog weight, body conformation, leanness, health, price, and date of delivery in negotiated agreements. Ultimately, the buyer must rely upon visual inspection of the animals to ensure the physical attributes match those demanded by the slaughterer. Price is directly negotiated in the auctioning process, and the buyer must transport his hogs upon purchase; Michigan auctions generally do not perform a holding service.

The buyer is often assisted by a sorting and aggregation service provided by Michigan auctions. Although some auctions put a particular seller's hogs on the block without any further sorting, most of the larger auctions sort hogs irrespective of producer identity. Sorting provides the primary mechanism for monitoring the terms of sale. It consists of disaggregating animals into more homogeneous groupings with respect to physical

attributes. The attributes sorted for in the Michigan market at any given date are (a) weight, (b) 'leaness', (c) body conformation, and (d) health.

Upon arrival at the auction market, a producer's/seller's hogs are subjected to an initial sort as they are unloaded. This sort is accomplished by channeling the producer's/seller's hogs into a chute through which no more than one or two animals may pass at a single time, and routing those animals displaying attributes in accordance with buyer demand onto a scale, and an average weight is determined. Interviews with auction market personnel indicated that this initial sorting process is conducted rapidly, sometimes with hogs passing through the chutes at a rate of 30 animals a minute. Those animals exhibiting attributes at odds with buyer demand are culled from the rest, and processed separately. The producer/seller is then given a consignment ticket with a summary description of his hogs, based on the aforementioned attributes. Further sorting may take place after the animals have been weighed, in an effort to 'fine tune' the sort. After the hogs have been sold, the seller may then cash in the consignment ticket for the amount obtained in the sale for animals matching the consignment description, less the commission charge levied by the auction market for its services. The

identification of animals is commonly lost in the process of re-sorting.

Sorting attribute categories are determined by the specific requirements of the slaughterer to which the animal is likely to be sent; i.e. the particular combination of specifications for each of the attributes demanded by the purchasing slaughter facility.

Essentially, auction markets rely upon a knowledge of the specific attribute combinations sought by each slaughterer to guide the sorting process. For example, Utica Packing desires a 230-245 lb., long, straight-bellied hog with big loins, approximately a U.S. Grade #1 hog. The weight range of hogs desired by Frederick and Herruds is greater, 220-260 lbs., with heavier hogs preferred. Frederick and Herruds also desire at least 1/2 " of backfat, and make no distinction between what they consider to be an U.S. Grade #1 or #2 equivalent hog. Like Utica, Frederick and Herruds seeks a well muscled animal. The sorters at the auction markets must make estimations as to expected quantities of equivalent grade #1 hogs and grade #2 hogs, weigh the estimations against expected sales , and sort accordingly.

One auction manager described the situation as posing a dilemma. Although one slaughterer may not pay any more for grade #1 hogs than #2 hogs, the auction market cannot

separate out all of the #1's in the sort exclusively for the other slaughterer as the market must maintain sales to both interests to remain in business.

4.4.1.3. Animal Health Monitoring and Enforcement

Hogs exhibiting overt symptoms of serious health problems, such as staggering, stupor, acute respiratory difficulty, extreme skin conditions or rashes, or other indications of severe illness, are separated out from healthier animals in the sorting process, and are either refused and returned to the seller, or are penned with other animals in similar condition for special bidding by 'price buyers', or shipment to specific slaughter facilities specializing in such animals. The consignment tickets note the presence of such animals, and in the case of shipment to specialized slaughterers, indicate their value.

State inspectors employed by the State Veterinarian's office of the Michigan Department of Agriculture are generally present at auction sales, and are instructed by state law to assist in the identification and labeling of hogs exhibiting health 'abnormalities' such as those listed above, and ensure that such animals are not sold for human consumption. The inspectors may also label hogs as SUSPECT, or CONDEMNED, and in the case of either categorization, it is required that identification be maintained

4.4.2. Terminal Markets

Terminal markets, also known as public markets, are a form of auction market. The two major terminal markets serving Michigan slaughter houses are the Peoria and Joliet markets. Approximately 34.9% of the hogs slaughtered in Michigan were derived from terminal markets [24]. However, interviews with representatives from these markets indicated that few, if any, Michigan-produced hogs were passed through terminal markets. These markets differ somewhat in both scale and organization from typical auction markets. More than two to three bidders compete for consignments, and the volume of animals bid upon is far greater. The terminal market participants include the market personnel, commission agents, and order buyers. Market personnel are responsible for the handling of the animals, and the bidding process. Commission agents, or firms, operate as professional selling representatives for producers. Order buyers operate as buying representatives for slaughterers.

4.4.2.1. Methods of Sale

The methods of sale in the terminal market differ little from those described for Michigan auction markets. A sorting service is performed, in a similar manner to

that described above, and consignment tickets are issued. Hogs are then openly bid upon, and the holders of the consignment tickets are remunerated after the animals have been purchased. However, unlike the Michigan auctions, often no central ring exists, and bids may be offered by order buyers on the basis of description alone, without visual inspection. Furthermore, commission agents are often responsible for the sort that is performed.

4.4.2.2. Terms of Sale

The terms of sale in the terminal markets differ from those at Michigan auctions primarily in that producers must commission marketing agents to sell their animals, and these commission agents then attempt to achieve the highest price from order buyers representing slaughterers. Neither the commission agents nor the order buyers take title to the animals. Instead, the commission agent holds consignment tickets in the name of producers, paying the producers the amount obtained in the bidding process for animals matching the consignment description, deducting a commission charge as determined by the Packers and Stockyards Administration, USDA. Additionally, the order buyer acts on behalf of a slaughterer, and is enabled to purchase animals against a slaughterer's account.

As was the case in the Michigan auctions, the sorting process serves as the primary means by which the terms of

sale are monitored and enforced. The sort is performed as it is described above. The difference is that the market representatives do not perform the sort, but allow commission agents to do the sorting.

4.4.2.3. Animal Health Monitoring and Enforcement

Like the auction markets, the animals determined to be unhealthy in the sorting process are generally relegated to an inferior bidding unit, or are shipped to a price-buying slaughterer at a drastically reduced price. Additionally, like the auction markets, the terminal markets are subject to state inspection. However, unlike the auction markets, the costs associated with the labling of an animal as SUSPECT or CONDEMED may be borne by the the commission firms performing the sort. Should an animal in a commission firm's possession be found to be condemned by an inspector, the commission firm deducts the cost of the animal from the producer's consignment ticket, providing that identification is available. Interviews with two different terminal market managers revealed that if the animal is merely labled SUSPECT, the commission firm generally does not pursue such deductions, but accepts the risk of condemnation at slaughter.

Should a disease problem only be discovered after an animal has been purchased by an order buyer, the order buyer may contest the purchase with the commission agent,

who may or may not refund the purchase price.

4.4.3. Buying Stations

The buying stations operate autonomously, purchasing consignments from producers and selling to slaughterers in an effort to maximize price spreads. Buying stations take ownership title to the animals transacted. In Michigan, buying stations are operated by either Heinold or MLE. Together, they market 48.8% of the hogs slaughtered in Michigan [24]. Heinold operates five markets across Michigan, and MLE operates seven. In all buying stations, individual market managers are given approximate price ranges and quantity ranges from a central office, yet must operate under the constraints set by the local markets, and are consequently allowed a wide margin of discretion. Upon sorting and weighing, buying station personnel pay the producer and take title to hogs. The animals are then re-sorted and transported to the slaughter plant.

4.4.3.1. Method of Sale

The method of sale at the buying stations differs very little between Heinold and MLE. Producers bring their hogs to the markets where a daily price is quoted. The markets must take all comers at the quoted price, less any discounts. Upon arrival at the buying station, the animals are unloaded through a chute. As they pass

through the chute, hogs not meeting the attribute requirements of the market are culled, and isolated into a pen. Those meeting the range of attribute criteria are gathered by the truckload onto a scale, and weighed. The total weight is divided by the number of head, and the producer is paid on the basis of the average weight. The producers' hogs are discounted if they are above or below a specified weight range. As was the case for the Michigan auction markets, the attribute criteria are set by the slaughterer to receive the hogs, and the same tradeoffs apply.

The purchased hogs are then sorted according to the intended slaughterer to whom they will be sold. Identification is often lost at this point, although several of the buying station personnel interviewed stated that they could sometimes associate their hogs with specific producers, particularly if the producers supply a distinctive breed. The animals are then loaded into trucks contracted by the buying station organizations, and transported to the slaughter houses. The slaughterer is then billed to an account for the hogs received.

4.4.3.2. Terms of Sale

The terms of sale at the buying station are generally dictated by the demand being faced by the station operators. As was the case with the other markets,

sorting provides the primary mechanism of monitoring and enforcing the terms of sale; weight, body conformation, leanness, and health factor into the sort. The specific attribute bundles the buying station personnel use as criteria in their sort are determined by the slaughterer to whom they intend to sell. For instance, if they expect to obtain some grade #1 hogs, but not enough to send a full trailer load to Utica, they will sell to Frederick and Herruds, and offer no premium for grade #1 hogs. However, should they expect to procure a full load of grade #1 hogs, they will offer a premium for such hogs.

Price offered by the buying station, in both the privately and cooperatively owned enterprises, is based upon a daily quotation received by a central office. This price represents the highest negotiated price obtainable from buyers and, in the case of the privately operated stations, the lowest possible offer price required to procure the estimated demands. In the case of the cooperatively operated station, they are acting as agents for the producer, and accordingly do not try to minimize the price paid to the producer. In both station types, central office buyers call numerous packers daily, and determine what prices are being offered at Peoria and Joliet to 'get a feel for the market', then negotiate over the phone with slaughterers and establish verbal contracts

for delivery to various packers. The buying station central office buyers consequently instruct local station buyers of packer demands, and the station manager is entrusted with the local offer price determination, quantity adjustments, and that the animals shipped not be unacceptable to the slaughterers. Should the animals be deemed by the purchasing slaughterer as unacceptable, for health problems or any other reason, the buying station must transport the animals to other potential customers.

4.4.3.3. Animal Health Monitoring and Enforcement

The monitoring and enforcement of animal health is accomplished primarily by means of the sorting process. As was the case with the auction markets, only those hogs with the more extreme health problems are sorted out. Essentially two categories are recognized; normal and abnormal enough to warrant condemnation or rejection at the plant level. Although state inspectors have the same jurisdiction over the buying stations as they do the auction markets, limitations in inspection resources preclude them from systematic and intensive efforts directed at discouraging the marketing of unhealthy animals [35].

When buying station sorters cull 'abnormal' animals from sellers' lots, the animals are either refused and loaded back onto the vehicle from whence they came, or are

purchased at decidedly lower prices, and penned apart from the other animals. The prices offered for such animals range considerably, and can be as low as \$1.00 according to one marketer, although several marketers put the price around 1/2 of that offered for healthy animals. These abnormal animals are generally aggregated in a separate pen at each market until a truck specified for such a purpose collects these animals from the markets. Such trucks often visit the markets more than once a week, delivering the hogs to 'price buyer' slaughter facilities.

4.5. Producers

Producers are defined herein as those individuals who raise hogs to maturity and then attempt to either sell them on the open market, or deliver them to fulfill a forward contract. Approximately 8,500 hog producers operate in Michigan. Together, they produced 1,250,000 slaughter hogs in 1983 [31]. The proportion of Michigan production coming from various size farms is summarized in Table 1.

**Table 1. Annual Sales of Michigan-produced
Hogs and Pigs, by Size of Operation, 1978**
(Source: [19])

Farm Size (# Head on-farm at any given time)						
1-99	100-199	200-499	500-999	1000-1900	2000-4999	5000+
12.8%	9.6%	19.3%	18.3%	19.2%	13.9%	6.9%
% of Total Michigan Annual Production Sales						

As previously stated, approximately 85% of the hogs produced in Michigan are marketed and slaughtered in state. Michigan producers bring their hogs to either auction markets or buying stations for sale. No terminal markets exist in Michigan, and interviews with managers from terminal markets in neighboring states indicated that a negligible number of Michigan producers used the markets [36] & [37]. Local traders, on-farm slaughter, and custom slaughter are relatively insignificant in the Michigan slaughter hog market, capturing only 1-2% of total production [24] & [31]. Forward contracting is extremely rare in the state, with only one contract being identified in the course of the interviews. Furthermore, direct sales between producers and slaughterers are limited to

less than one percent of the total slaughter in Michigan according to Michigan slaughterers.

The monitoring and enforcement of animal health faced by producers upon marketing their animals may influence their marketing decisions. Although interview data suggests that no statements can be made concerning the relative 'selectivity' of sort between market channels, practices concerning diseased animals do differ between market channels. Marketers unanimously suggested that the proportion of animals they cull for disease ranges from 1-10% of the total number of animals they process.

The marketing decisions faced by the producer who is attempting to sell 'sick' animals are tempered by both the relative likelihood that the animals will be culled, and the subsequent treatment of the animals. Although producers enjoy a certain degree of anonymity once their animals have been initially sorted and re-sorted, irrespective of the market (i.e., identification measures are not systematically practiced at any of the markets), the disposition of diseased animals differs between the different market channels. While the price obtained for 'sick' animals may be determined by competitive bidding in the auction markets, the price obtained at buying stations is set non-competitively by the station manager, if, indeed, the animals are not rejected outright. The

producer who is attempting to market diseased animals must also weigh the chances of having his animals condemned by inspectors. Buying stations are regulated far less extensively than auction markets, as discussed previously. A tradeoff exists for the producer attempting to market sick animals; whether to market where the prices are competitively bid upon, or market where the animals are less likely to be condemned.

4.6. Conclusion

The sorting process has been identified as the predominant mechanism of monitoring and enforcing disease problem standards. The demand for animal health may be perceived as originating at slaughter, at the point where hogs are subjected to post-mortem inspection. Post-mortem inspection is more comprehensive than ante-mortem inspection and is consequently the critical factor determining slaughterer demand for animal health. The slaughterer attempts to select out the animals with questionable health before the slaughtering process in an attempt to avoid condemnation costs. In doing so, the

slaughterer may reject a marketer's animals or discount them severely. The cost of condemnation is therefore carried forward into the marketing system. In the case of actual condemnations, the slaughterer is enabled to transfer such costs only if marketer identity is maintained. At only one plant, where a tattooing process is practiced, can animals be identified post-mortem.

As the slaughterer transfers the costs of FSIS regulation by identifying the condemned animal with a specific marketer, and then deducting the cost of that animal from the marketer's bill, the demand for animal health is carried through to the marketer. Consequently, the marketer demands a sufficient degree of animal health from the producer in an effort to avoid such losses. The marketer is given incentive to sort with attention to animal health, rejecting or discounting any animals of questionable health. The marketers also desire to avoid animals with animal health problems as they are sometimes subjected to state inspection, and may suffer losses due to condemnation.

The driving force behind the monitoring and enforcement of animal health is the FSIS inspection process. FSIS inspection sets the standards for animal health, and ultimately drives the sorting process throughout the market. However, interviews and on-site

visits revealed that market participants are only given incentives to control those health problems of such severity as to warrant condemnation, and no concerted efforts are made to control sub-clinical health problems, or even those problems which do not warrant condemnation. In fact, the market participants were found to actually have disincentives to control such problems.

The disincentives for controlling health problems differ between participants. Slaughterers rely upon rapid slaughter rates for a margin of profit, and the careful sorting required for animal health would slow the kill line. Additionally, individual slaughterers may find it desirable under certain circumstances to increase their quantity supplied by easing their sort standards somewhat, and accept the increased risk of condemnations.

At times, marketers are also under pressure to process large numbers of animals rapidly. Marketers have another disincentive to control for animal health in that they compete for producers' hogs, and if any one marketer takes it upon himself to discourage the marketing of diseased hogs, producers may take their animals elsewhere. Both marketers and slaughterers indicated during interviews that they were concerned about the implications of rigid enforcement of sorting standards as they sometimes showed favor to particular purveyors of hogs by

letting some questionable animals slip through. Furthermore, interviews revealed that they are very much concerned about handling shrink, and thus have a disincentive to sort extensively for disease.

The producer's disincentive to control animal health from a marketing standpoint is that the animals must be sold, and there is always the possibility that failure to notify marketers of health problems will result in animals receiving full price in contrast to a discount or rejection, provided that the animal can 'slip through' the first stage of marketing. The lack of a producer identification system in the Michigan slaughter hog market permits a producer to be little concerned about marketings beyond the first stage.

CHAPTER FIVE: THE INFLUENCE OF MARKET CONDITIONS ON ANIMAL HEALTH MONITORING AND ENFORCEMENT

5.1. Introduction

This chapter presents the results of interviews and quantitative data analysis directed at the examination of the relationship between disease rates and market conditions in the Michigan slaughter hog market. The interviewing was used to determine whether the 'selectivity' of the sorting process, particularly with respect to animal health, varied over time. Since the interviews suggested that 'selectivity' with respect to animal health actually varied over time, an attempt was then made to determine whether this phenomena could be associated with market conditions of supply and demand. The variability in the disease rate, as discussed in the previous chapter, was compared with supply and demand conditions using linear, least squares regression techniques.

5.2. The Interview Results

Eighteen market participants were interviewed in an effort to examine the relationship between the primary means of animal health monitoring and enforcement, the sorting process, and conditions of supply and demand. Seven buying station operators, four from MLE and three from Heinold, nine auction market managers, five from MLE

and four from private auctions, and terminal market managers from both Peoria and Joliet were asked whether they perceived any changes in the general sorting process over time. None of the respondents admitted that their own sorting process was subject to inconsistency. They unanimously contended that their sorting standards and practices, including those relating to animal health, were not subject to change.

However, of the respondents who must face slaughterers' sorting practices, namely the buying station personnel who sell directly to the slaughter facilities, five out of seven contended that they faced inconsistencies in the sort their animals experienced at the slaughter plant. They suggested that animals which would normally pass the sort practiced at the slaughter plant, would be rejected at times, sometimes on the basis of what the marketers considered to be exaggerated animal health problems. Three of the buying station personnel stated without any prompting that they noticed a pattern in the practice; most contested rejections would occur during periods of abundant supply. Two other buying station personnel, upon being asked if they noticed any pattern in the sorting inconsistencies they faced, stated that they did, and repeated the observation that rejections were related to supply conditions. One of the

buying station operators was very specific in his response. He contended that at one particular plant to which he sold, two sorters operated on different shifts, and that while one gave his animals a relatively consistent sort, the other, whom the operator suggested knew very little about hogs, would sort very inconsistently. The inconsistent sorter would take into consideration the number of hogs coming into the plant on any given day, and sort accordingly.

Slaughterer representatives from three slaughter houses were also questioned concerning the consistency of sort. Ten slaughter personnel were interviewed; two plant managers, one company administrator, three buyers, three sorters, and one 'quality control' employee. They all claimed that their sort was consistent. However, they did complain that the hogs sent to them by marketers would be more poorly sorted during conditions of low supply. They suggested that marketers would deliver more 'junk' animals, which they contended to have higher rates of disease, in periods of short supply.

In the course of the interviews, the question was asked, 'Do you believe there is a health problem in the MI slaughter hog market?'. Respondents unanimously denied that any serious problem existed. However, most agreed that a few sellers would invariably attempt to 'slip in a

few' animals with health problems. None of the interviewed marketers admitted to recognizing any patterning in this practice, and all suggested that their sorting procedures prevented most of the 'sick' animals from being marketed. However, sorters from the two largest slaughter facilities admitted that 'sick' animals sometimes got past them, and noted that higher proportions of 'sick' animals were encountered in mid-summer and mid-winter.

5.3. Results of the Statistical Analysis

The crux of the statistical testing is to determine whether a relationship exists between market conditions of supply and demand, and the rate of disease observed in barrows and gilts slaughtered in Michigan. The testing results associated with each of the hypothetical relationships developed in Chapter 2 will be presented accordingly.

5.3.1. Disease Rate and Quantity Supplied

The analysis indicated a statistically significant relationship between the disease rate and the quantity of barrows and gilts supplied to Michigan slaughterers. However, the relationship was suggested to be contrary to that hypothesized. Instead of the expected negative

relationship, a positive one was indicated. The results indicated that as quantity supplied increases, the disease rate increases.

The correlation of Disease with Supply yielded a correlation coefficient of 0.34 . The regression of Disease on Supply, dummy variables for season, and a constant yielded an F-statistic of 18.17, significant at the 95% confidence level. The t-statistic for Supply was estimated at 1.73, significant at the 90% confidence level. The regression results indicated two weaknesses. The Durbin-Watson statistic suggested a measure of serial correlation at 1.32, and the adjusted R-squared statistic, indicative of the variation in the dependant variable 'explained' by the variation in the independant variables, was relatively low at .57 . See Table 2.

TABLE 2. DISEASE = f(C, SEASON, SUPPLY)

SMPL 1 - 52

52 Observations

LS // Dependent Variable is DISEASE

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	10.977794	1.8331431	5.9885088	0.000
SPRING	0.8201072	0.4165522	1.9687979	0.085
SUMMER	1.8788639	0.4244611	4.4287049	0.000
FALL	3.0788619	0.4388300	7.0161147	0.000
SUPPLY	0.0088040	0.0088173	1.7300190	0.090
R-squared	0.607329	Mean of dependent var	15.58363	
Adjusted R-squared	0.573910	S.D. of dependent var	1.625740	
S.E. of regression	1.061211	Sum of squared resid	52.92998	
Durbin-Watson stat	1.320877	F-statistic	18.17325	
Log likelihood	-74.24568			

Possible explanations for a positive relationship between disease rate and quantity supplied include seasonal effects, changing procurement areas, and, perhaps, sorting constraints. If disease rate should peak in mid-winter and mid-summer, decreasing in spring and fall, due to seasonal factors, and coincidental increases and decreases in supply follow the pattern, a problem of intercorrelation would be indicated. The effects of season could be confused with the influence of supply conditions in the determination of the disease rate.

The regression results showed that the relationship between season and disease was positive and significant at the 95% confidence level. The regression coefficients of the season variables increase in both size and statistical significance over time, indicating a cumulative influence of seasonal factors on disease rate as recorded by the FSIS at Michigan slaughter plants. The DISEASE graph, Fig. 2, supports the cumulative effect interpretation, indicating an upward trend in the disease rate from January to December. Thus, seasonal factors appear to be important in explaining disease rates, however, the overall effect cannot be determined here since the data covers only one year.

Assuming that hogs from different areas may exhibit different rates of disease, changes in the procurement

areas could affect the rate of disease evidenced at Michigan slaughter facilities. It is possible that the proportion of in-state to out-of-state hogs procured by Michigan slaughterers varies throughout the year. Although insufficient data exists for determining the proportions of in-state to out-of-state hogs slaughtered in Michigan throughout any given year, a case may be made for changes in such proportions. The proportion of seasonal pasture to year-round confinement production operations is relatively high in Michigan; approximately 80% are pasture operations according to those market participants and hog specialists who hazarded a guess. Accordingly, the proportion of Michigan-produced hogs is likely to vary significantly with season. As described above, the effect of seasonally changing variables on disease rates was found to be significant. Consequently, the statistical results suggest that the phenomena of changing proportions of inshipments into Michigan should be examined further.

Sorting may also factor into the explanation for the positive correlation of disease rate and supply. On-site visits to marketing facilities and slaughter plants revealed that the speed at which hogs flow through the sorting chutes is variable. When the quantity supplied is high, it is likely that the rate at which animals pass

through the chutes increases. An increase in the speed of sorting is likely to result in less careful sorting, increasing the likelihood that proportionately more animals with disease problems get through without being culled. The problem with this interpretation is that the opportunity cost associated with sorting is lowest during conditions of high supply. In a relative sense, the market participants have more of an incentive to be selective.

5.3.2. Disease Rate and Prices Received by Producers

The testing of the relationship between the disease rates and the prices received by farmers indicated a statistically significant correlation. However, the correlation was contrary to that hypothesized. The analysis suggests that a negative correlation exists. As prices rise, disease rates decrease. This relationship is theoretically consistent with that previously discussed; as quantity decreases, prices rise, and disease rate decreases. The results did not support the hypothesis that producers were inclined to market hogs they would normally hold off, in an effort to obtain a higher price. Once again, Season was found to be significant, following the same pattern as that previously discussed.

The correlation of Disease on Hog Price yielded a correlation coefficient of -0.17 . The regression of

Disease on Hog Price, dummy variables for season, and a constant yielded an F-statistic of 19.28, significant at the 95% confidence level. A t-statistic of -2.2 was estimated for Hog Price, significant at the 95% confidence level. The Durbin-Watson statistic, estimated at 1.33, indicated a low level of serial correlation, and the adjusted R-squared statistic indicated a relatively poor 'fit' at .62 . See Table 3.

TABLE 3. DISEASE = f(C, SEASON, HOG PRICE)

SPL 1 - 52

52 Observations

LS // Dependent Variable is DISEASE

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	20.431261	2.8877140	7.0752369	0.000
SPRING	1.0303830	0.4170882	2.4708828	0.017
SUMMER	2.2274625	0.4858088	4.7804080	0.000
FALL	3.3023543	0.4088184	8.0778025	0.000
HOGPD	-0.1282084	0.0582337	-2.2007350	0.033
R-squared	0.621344	Mean of dependent var	15.58363	
Adjusted R-squared	0.589118	S.D. of dependent var	1.825740	
S.E. of regression	1.042101	Sum of squared resid	51.04082	
Durbin-Watson stat	1.334708	F-statistic	19.28078	
Log likelihood	-73.30074			

One possible explanation for the indicated negative relationship between price and animal health violations is that slaughterers are indeed paying more for healthy animals. However, the results of the interviews and on-site visits do not support this conclusion.

Slaughterers and marketers both expressed a marked preference for the rejection of unhealthy animals over their discounting, as both market participants distrusted the other's judgement in the matter. The marketers did not want to allow the slaughterer to discount with impunity, which would be the case as shipments are sorted and discounted at the plant without the marketer, or a third party, present. Consequently, animals were only infrequently discounted by slaughterers on the basis of health.

A more likely explanation for the negative correlation between prices and animal health violations is that as prices change, procurement areas may also change, and such changes in procurement areas may be associated with the changes in disease rates. It is quite likely that as prices of slaughter hogs increases, higher proportions of hogs are shipped in from more distant sources. More inshipments of hogs from other states may occur. First of all, high prices may indicate increased effective demand, or decreased local supplies, and since

Michigan producers alone do not meet the slaughterers' demand, increased inshipments are required to keep slaughterers at some minimal level of capacity. Additionally, since the prices of local hogs are largely based upon those offered by the terminal markets (see Figure 1.), when the prices received by producers rise, the cost of transportation is reduced in a relative sense, making the procurement of out-of-state hogs by slaughterers more economically rational.

If proportionately more inshipments are occurring during periods of high prices, the negative relationship between prices and health violations may also indicate that transportation stress is not as important a factor as other factors such as production practices in determining hog health violations. However, it should be remembered that the majority of hogs slaughtered in Michigan are from out of state.

5.3.3. Disease Rate and Prices Received by Slaughterers

The analysis indicated a statistically significant correlation between the disease rate and prices received by slaughterers for their products. However, as in the case of the correlation between disease and prices received by producers, the relationship was contrary to expectations. As prices rise, the disease rate decreases. The explanation of this phenomena has been discussed

above. Economic theory suggests that prices received by slaughterers are highly correlated with those received by producers, and consequently, the correlation of producer prices and disease rates can be explained accordingly. As was the case in the first two regressions, seasonal variables proved to be significant, and the same interpretation of seasonal influence applies here as was discussed above.

The correlation of Disease with Pork Price yielded a correlation coefficient of -0.39. The regression of Disease on Pork Price, dummy variables for season, and a constant yielded an F-statistic of 23.65, significant at the 95% confidence level. A t-statistic of -3.48 was obtained for Pork Price, significant at the 95% confidence level. The Durbin-Watson statistic was estimated at 1.36, indicating a small degree of serial correlation. See Table 4.

more 'picky' during periods of long supply. Although no market participants admitted to sorting inconsistently themselves, the majority accused their sellers and/or buyers of such inconsistencies. The marketers accused slaughterers of inconsistency with respect to sorting for animal health, while slaughterers accused marketers of the same.

The statistical analysis failed to provide strong correlative relationships between market conditions and disease rates as indicated by FSIS inspection. The adjusted R-squared statistics ranged from .57 to .63, and the Durbin-Watson statistic ranged from 1.32 to 1.36 . Furthermore, the results contradicted the findings of the interviews and the hypothesized relationships. The inability to control for the effects of changing proportions of in-state to out-of-state animals at Michigan slaughter plants constitutes a major flaw in the analysis.

The conclusions that can be drawn from the analysis are limited. Due to the contradictions between the interview results and those of the statistical analysis, no strong statements may be generated from these results concerning the relationship between the extent to which disease is monitored and enforced in the Michigan slaughter hog market and market conditions of supply and

demand. It can only be surmised that market conditions have no influence upon disease rates as recorded by FSIS inspection at slaughter.

However, a number of the interviews did suggest that the extent to which market participants contest the sort they face varies under different market conditions. Specifically, slaughterers claimed that marketers provided them with proportionately more 'junk' hogs during periods of low supply than at other times, and they contended that 'junk' hogs were associated with a higher likelihood of disease than other hogs. Consequently, relationships between the incidence of disease problems and market conditions should not be ruled out.

CHAPTER SIX: SUMMARY AND RECOMMENDATIONS

6.1. Summary of Findings

The examination of the means by which animal health is monitored and enforced in the Michigan slaughter hog market indicated that both disincentives and incentives existed for the marketing of diseased animals. The disincentives were derived directly, or indirectly, from regulatory inspection, principally through condemnation of animals by the Food Safety and Inspection Service at the plant level. However, the study results indicate that insufficient identification of hogs exists in the Michigan slaughter hog market for disincentives generated at the slaughter plant level to be communicated directly to the production level. Consequently, it is unlikely that individual producers of diseased animals will be directly affected by such disincentives. Nevertheless, the study results do indicate that disincentives are transmitted indirectly through the marketing system; slaughterers demand a minimal level of animal health from marketers, using discounting and rejection to articulate their demand, and marketers, using similar means, consequently demand a minimal level of animal health from producers.

The incentives associated with the marketing of diseased animals may be viewed in terms of the costs of ensuring that diseased animals are not marketed. First of all, animal health has been associated with high information costs. Furthermore, high standards of animal health result in high opportunity costs. From a slaughterer's standpoint, maintaining a rapid line speed is of paramount importance, and a comprehensive sort against health problems is very time consuming. Additionally, a rigidly comprehensive sort with respect to animal health would impede an individual slaughterer from using variation in sorting standards to dampen supply shocks. From the marketer's perspective, added sorting measures to ensure that diseased animals are selected out might result in additional handling shrink losses, and added labor costs for more sorting personnel. From the producer's perspective, the costs of not marketing diseased animals include added veterinary bills and the costs of keeping an animal on-feed beyond the point where it is usually marketed.

The fact that market-oriented incentives and disincentives concerning the marketing of diseased animals were found to exist indicates that marketing considerations factor into the determination of animal

health. Additionally, the findings of this study indicate that animal identification is a key to the overall effect of such incentives and disincentives upon animal health. The production farm is generally the locus of disease origin. The slaughter plant is the most likely point of disease detection, and the primary point where condemnations occur. This study determined that condemnations serve as the predominant disincentive to purvey diseased animals. Accordingly, should hogs at slaughter not be identified by producer, the disincentives to producers, those most responsible for disease conditions, are weakened. Consequently, the relatively high proportions of indirect marketing in Michigan undoubtedly contributes to the state's slaughter hog disease rates.

The analysis failed to conclusively associate changing market conditions with variations in the rate of disease indicated at Michigan slaughter plants. Nevertheless, the conclusions drawn in Chapter Five do not rule out the possibility of such a relationship.

6.2. Recommendations

The recommendations that may be derived from this

study are limited. The relatively inconclusive nature of the statistical findings, the analysis of only one year of data, the failure to adequately survey producer marketing strategies, and the inability to adequately control for extra-regional inshipments of hogs compromise the prescriptive value of the analysis. The restriction of one year of data casts suspicion upon the claim that seasonal influences have a cumulative influence upon the relationship between disease rates and market conditions as statistically estimated in the analysis. The failure to adequately survey producers narrows the analysis and resulted in an inability to assess the impact of drug use in the marketing process. It is possible that producers use drugs to mask the symptoms of disease in their market hogs in an effort to avoid rejections, lower prices, or condemnations of their animals. This possibility is important as it may result in biased analysis; the Disease variable measurements could be distorted by changes in drug use through the year. Furthermore, the failure to control for inshipments may have also biased the statistical testing.

Another limitation of the study for general prescriptive purposes is the fact that the Michigan slaughter hog market is relatively unique in the North

Central region in that the majority of its hog slaughter is composed of hogs shipped in from other states. Furthermore, while the proportions of hogs marketed through the various marketing channels in the North Central region have been estimated at 81% for direct marketings (including buying station marketings), 13% for terminal markets, and 6% for auction markets, the market channel proportions of hogs slaughtered in Michigan are 49% for 'direct' marketings (Packers and Stockyards Administration category including buying stations), 35% for terminal markets, and 16% for auction markets [26]. In contrast to the rest of the North Central region, Michigan relies heavily upon indirect marketing. Accordingly, inadequate identification may not be as pronounced in surrounding states as it is in Michigan, and consequently, the trade-offs between the incentives and disincentives associated with animal health may differ between Michigan's slaughter hog market and those of other states.

In light of the above limitations, it must be concluded that the hypotheses tested in Chapter Five require more and better data. Nevertheless, despite the limitations, the subjective findings derived from interviews provide a sufficient basis for recommending

that the implementation of animal identification be considered. The difficulty with which hogs are identified with producers at the slaughter plant level was found to severely impede the extension of sanctions and signals to producers. Furthermore, it was found that virtually no slaughter information is passed from slaughterers to producers. Consequently, producers may be unaware of animal health problems which only show up at the slaughter plant. Thus, the lack of animal identification compromises producers' ability to address animal health problems.

Further research is recommended because of the important ramifications of this study. Should market conditions be found to actually affect the variation in the disease rate, inspection resources could be more effectively allocated. For example, if violations of health standards were found to increase during periods of low supply, more inspectors could be employed during such periods, and, perhaps, fewer may need be employed during periods of long supply. Also, additional sanctions might be found to be necessary during periods of short supply to ensure animal health.

Recommendations for continued research based upon

this study include inquiry into producer marketing strategies and drug use, a more detailed analysis of the effect of animal identification upon animal health, and an extension of the data sampled to several years and to encompass regional or national levels. More detailed analysis of the role of identification with respect to animal health can be pursued using comparative analysis. Areas with relatively high proportions of direct sale marketing, particularly those with high proportions of grade and yield purchases, may be compared with those areas having higher proportions of indirect marketings. Based upon the findings of this study, it is expected that such a comparison would indicate fewer violations of FSIS health standards in those areas of direct marketing predominance. Identification would be facilitated by direct marketing, and disincentives for producing a sick animal could thus be better targeted at the producers at fault. Producers selling grade and yield would also be far more likely to get slaughterer feedback on the state of the slaughter animals' health, than those selling in an indirect market. Comparative analysis, however, would necessitate controls for differences in weather/climatic factors and production practices impinging upon animal health.

Analysis of several years worth of data would enable more reliable assessments of potential seasonal influences. Regional or national level analysis would avoid biases resultant from changing proportions of inshipments.

6.3. Concluding Remarks

In conclusion, this study has illustrated the importance of market behavior in the explanation of animal health problems recognized at slaughter. The incentives and disincentives associated with the marketing of diseased animals have been discussed. The study's findings indicate that the lack of animal identification in the Michigan slaughter hog market is a significant problem. Disincentives associated the marketing of diseased animals only indirectly filter through the market structure. Consequently, this study indicates that the implementation of an animal identification system be considered for the Michigan slaughter hog market.

FOOTNOTES

1. 1984 FSIS continuous inspection records concerning diseased hogs recognized in Michigan slaughter plants. Obtained April, 1985.
2. Feedstuffs, January 7, 1985. p.8 and p.25.
3. Data provided by Jerry Shurson, MSU Slaughter Check Coordinator, February 6, 1985.
4. Riemann, H. and F.L. Bryan. Food-Borne Infections and Intoxications. Second Edition, Academic Press, N.Y.. 1979.
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a \$0.10/head net value in rendering offered by rendering
manager, Frederick and Herruds. Bob Alexander of Globe
Engineering Co., a Chicago-based rendering equipment
supplier, stated that in 1984, a rendered 240 lb. hog
could be expected to gross only \$5.00. With this
estimate, Michigan slaughterers were likely to have
regained only \$2835 (7223*5)-(2 rendering employees *
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APPENDIX 2: FSIS INSPECTION RATES FOR TWO MAJOR
PLANTS IN MICHIGAN. (% of Total Plant Slaughter)
WEEKLY RATES FROM 1/1/84 - 12/31/84.

obs	RESTRICTED	CONDEMNED	PASSED	TOTAL
1	0.034054	0.112300	13.06999	13.21634
2	0.016207	0.164300	13.86881	14.04932
3	0.009690	0.197200	13.91874	14.12563
4	0.013615	0.120300	12.46767	12.60158
5	0.012622	0.130000	12.24045	12.38308
6	0.014408	0.144800	13.05869	13.21790
7	0.011760	0.139700	14.76229	14.91375
8	0.011100	0.155000	14.74040	14.90650
9	0.010541	0.171400	14.71850	14.90044
10	0.021171	0.128300	15.14974	15.29921
11	0.008917	0.147100	14.64297	14.79898
12	0.013803	0.140300	14.90629	15.06039
13	0.012826	0.098600	13.81974	13.93117
14	0.003005	0.181600	12.51052	12.69512
15	0.010901	0.130000	15.81487	15.95578
16	0.032378	0.123300	15.77540	15.93108
17	0.017917	0.132800	14.88110	15.03182
18	0.022424	0.127200	14.72472	14.87435
19	0.034068	0.086600	14.84387	14.96454
20	0.011174	0.170400	12.94101	13.12258
21	0.020137	0.113500	14.54544	14.67907
22	0.042334	0.129600	15.29291	15.46484
23	0.040967	0.236000	15.17259	15.44955
24	0.014550	0.166800	15.45995	15.64130
25	0.030817	0.156400	15.41877	15.60599
26	0.034965	0.104600	14.87200	15.01156
27	0.032921	0.197800	16.61604	16.84676
28	0.022752	0.357100	15.13268	15.51253
29	0.013838	0.108000	15.20085	15.32268
30	0.011181	0.114400	13.98641	14.11200
31	0.012160	0.186600	12.60519	12.80395
32	0.013015	0.156200	14.29112	14.46034
33	0.013173	0.121900	17.04630	17.18137
34	0.024780	0.096300	16.54493	16.66601
35	0.006067	0.163800	16.76395	16.93381
36	0.008453	0.110600	17.13283	17.25189
37	0.005259	0.147100	16.47279	16.62515
38	0.013275	0.093500	15.22685	15.33363
39	0.023040	0.136100	16.75198	16.91112
40	0.017126	0.098000	17.36661	17.48174
41	0.015867	0.122300	17.74358	17.88174
42	0.016693	0.125000	17.55601	17.69771
43	0.018724	0.085800	17.09062	17.19514
44	0.009238	0.111500	17.68499	17.80573
45	0.015393	0.118100	17.42155	17.55504
46	0.015204	0.090800	16.13910	16.24511
47	0.011769	0.107700	16.72983	16.84930
48	0.017753	0.123300	19.53394	19.67499
49	0.019201	0.095700	17.78625	17.90115
50	0.011991	0.096600	17.34830	17.45689
51	0.016145	0.095600	16.18311	16.29485
52	0.023156	0.078200	16.41468	16.51604

APPENDIX 3: OBSERVATIONS ON VARIABLES USED IN THE
REGRESSION ANALYSIS. WEEKLY OBSERVATIONS FOR 1984.

obs	AVGWT	SUPPLY	HOG PRICE	PORKPRICE
1	242.0000	403.5000	50.79000	106.7500
2	238.0000	490.3000	52.26000	106.4000
3	244.0000	470.0000	51.55000	104.9800
4	240.0000	463.6000	52.30000	99.31000
5	241.0000	449.5000	51.28000	98.10000
6	242.0000	471.7000	50.14000	97.17000
7	243.0000	454.6000	47.86000	94.50000
8	240.0000	460.1000	46.24000	94.19000
9	240.0000	444.7000	46.19000	89.42000
10	242.0000	529.1000	45.82000	87.94000
11	243.0000	501.2000	47.47000	85.65000
12	241.0000	502.9000	49.29000	90.50000
13	241.0000	520.7000	49.98000	90.90000
14	244.0000	505.3000	49.52000	90.25000
15	246.0000	510.1000	49.54000	91.50000
16	237.0000	480.1000	49.18000	93.15000
17	238.0000	482.7000	49.02000	92.55000
18	240.0000	500.5000	48.85000	90.80000
19	239.0000	514.4000	50.01000	94.70000
20	241.0000	484.2000	51.04000	98.69000
21	242.0000	482.5000	49.60000	94.88000
22	242.0000	411.4000	49.72000	97.50000
23	239.0000	481.5000	51.96000	99.50000
24	239.0000	468.9000	52.48000	96.71000
25	236.0000	446.9000	53.93000	93.83000
26	237.0000	448.2000	54.82000	100.3300
27	236.0000	349.0000	56.30000	111.1700
28	238.0000	445.7000	56.59000	119.3800
29	233.0000	424.8000	56.42000	119.3100
30	236.0000	405.4000	56.62000	109.8300
31	234.0000	428.5000	54.19000	109.0000
32	238.0000	449.3000	55.09000	106.3300
33	237.0000	448.5000	54.44000	100.0000
34	238.0000	476.4000	53.65000	99.88000
35	239.0000	466.1000	51.36000	96.83000
36	236.0000	448.5000	50.96000	100.3100
37	236.0000	503.7000	49.61000	101.3300
38	236.0000	522.6000	48.98000	100.0500
39	234.0000	510.3000	46.88000	88.60000
40	238.0000	531.6000	46.71000	89.67000
41	243.0000	528.9000	45.72000	86.50000
42	244.0000	543.3000	45.63000	84.94000
43	242.0000	538.0000	46.16000	86.05000
44	239.0000	531.9000	47.02000	83.17000
45	245.0000	529.7000	49.16000	85.92000
46	244.0000	499.7000	50.01000	87.41000
47	241.0000	432.8000	51.50000	88.67000
49	238.0000	542.1000	51.60000	87.35000
50	239.0000	518.0000	51.87000	92.50000
51	240.0000	512.1000	51.23000	98.60000
52	240.0000	386.2000	50.90000	103.1700
	Lbs/Head	1,000 Head	\$/Cwt.	\$/Cwt.

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