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CHANGES IN COST STRUCTURE OF SWINE PRODUCERS IN THE UNITED STATES AFTER IMPLEMTATION OF A BAN ON SUBTHERAPEUTIC ANTIBIOTIC GROWTH PROMOTANTS

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CHANGES IN COST STRUCTURE OF SWINE PRODUCERS IN THE UNITED STATES AFTER IMPLEMENTATION OF A BAN ON SUBTHERAPEUTIC ANTIBIOTIC GROWTH PROMOTANTS

By

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ABSTRACT

CHANGES IN COST STRUCTURE OF SWINE PRODUCERS IN THE UNITED STATES AFTER IMPLEMENTATION OF A BAN ON SUBTHERAPEUTIC ANTIBIOTICS

By

Michael Gordon Hogberg

Recently there has been much controversy and speculation drawn to the potential impact of a ban on the use of subtherapeutic antibiotics on the livestock industry. Much previous research has determined the impact on producers as a homogeneous group. In reality, swine producers are a heterogeneous group, and a ban on antibiotic growth promotants could affect producers of different sizes, cost structures, and management styles in various ways. One of the hypothesis of the study was that high-cost producers gaining efficiency as the economies of scale are shifted away from the low-cost producers. This study used average cost data to model how a ban on subtherapeutic antibiotics would affect high, middle, and low-cost producers. This was done using a set of equations that linked production data to the cost structure.

This study finds the change in costs do not seem to be great enough for high-cost producers to compete with the low-cost producers. It is apparent that the ban would limit or reduce economies of scale in the swine industry. The change in the economies of scale are sufficient to change cost minimizing (productivity maximizing) from previously low cost to middle-cost producers for the wean to finish phase. If prices are held constant, a ban on AGP would make many producers unprofitable, most likely leading to an exit from the industry. This research suggests that high-cost producers and breed to wean farms are most likely to exit the industry with a ban on Antibiotic Growth Promotants.

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CHAPTER ONE

INTRODUCTION

1.1 Background

Recently there has been much speculation regarding the potential impact on the livestock industry from imposing a ban on the use of subtherapeutic antibiotics in animal production. Since the Swann Committee released its report to the English Parliament in 1969, subtherapeutic antibiotic use has been an issue of global importance. The response to the Swann Committee report has been as diversified as the number of countries that have taken up the matter. Reponses have ranged from Denmark and Sweden banning the use of subtherapeutic antibiotics in livestock to the United States, which has not yet taken legislative action (Barlam, 2001).

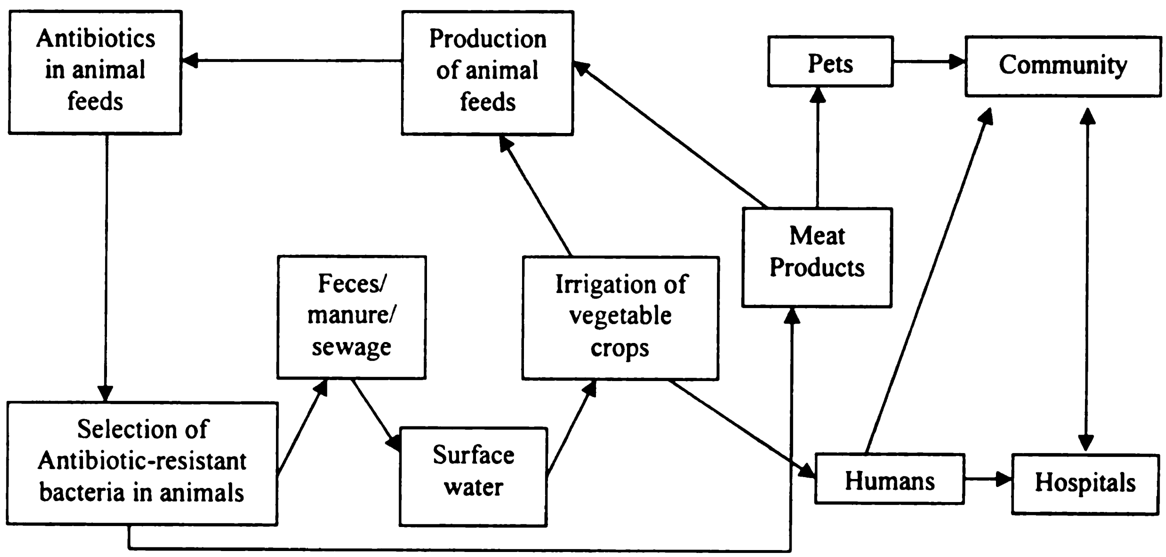
The use of subtherapeutic antibiotics in livestock started over 50 years ago when it was discovered that the waste made when fermenting chlortetracycline enhanced the growth of livestock (United Kingdom, 1969). The growth and intensification of agriculture at that time was aided by the addition of antibiotics in the feed. The antibiotics not only helped increase animal growth, but also controlled diseases, mainly respiratory and enteric diseases. Such diseases are common when intensifying animal production.

The Swann Committee report caused growing concern over the health risks associated with feeding subtherapeutic antibiotics to animals. Such animals are at a higher risk of developing bacteria that are resistant to the antibiotics and of passing those bacteria on to humans (Mathew et al., 1998). Since the same antibiotics used to treat animals are often used to treat humans, this could cause health concerns in the future as commonly used antibiotic treatments become less effective. The European Union will cease use of all subtherapeutic antibiotics in the livestock industry by the year 2006 (Barlam, 2001). Denmark (2000) and Sweden (1986) have already completed the ban and England is slowly phasing out the use of subtherapeutic antibiotics. Antibiotic use continues to be a concern of many countries around the globe, especially in the United States, which has yet to perform any action on the subject other than gaining information on approximate costs of implementation.

Recent research linking mutated strains of antibiotic resistant bacteria to feeding and use in livestock production (Aarestrup, 1999; Davies and Roberts, 1999; Shryock, 1999) have sparked the United States government to examine the problem more thoroughly. Modern food production presents favorable conditions for bacteria to develop a resistance to antibiotics. Animals are presented with low dosages of antibiotics over long periods of time, giving the bacteria time to mutate and develop resistance to those antibiotics. The resistant strains may then be passed on to consumers through contamination at the packing plant and improper cooking. While resistance to common antibiotics is still relatively rare, there are reported incidences of such (Wegener et al., 1999). There is still some confusion of the amount of risk that is imposed to humans concerning antibiotic resistance. However, making linkages may become easier in the future with increasing traceability of food animals. George Khachatourians (1998) discussed the linkage between the evolution of antibiotic-resistant bacteria and the increasing resistance to a number of drugs. In one of his examples, salmonella showing a multi-drug resistance increased from 39% to 97% in a ten-year period.

Antibiotic resistant bacteria from animal agriculture that infects humans can come from a number of different places. Figure 1.1 shows possible routes that the bacteria can take from production to consumption, ultimately leading to human health risk. There are three different ways humans can be exposed including vegetable consumption, meat consumption, and pets. This health concern has led to the recent interest, especially in the United States, in the effects of disallowing the use of preventative antibiotics in agriculture.

Figure 1.1 Linkage between the use of antibiotics in animal agriculture and human health.



Source: Khachatourians, 1998.

The choice of the government ultimately turns out to be a political economy problem. There are financial benefits to the producers and consumers of utilizing more cost effective ways of producing pork products and passing some of the savings on to the consumer. However, this lower cost production increases the social risks because of the greater health risk. Policy makers need to decide where they stand on the issue. Some governments, as the European Union, have taken the stance of zero risk for their citizens and banned AGP use. Others, as the United States, have favored the financial return of producers, and do not currently ban subtherapeutic antibiotics.

1.1.1. Summary of the Swann Committee Report

The Swann Committee was set up in 1968 by the British Parliament to examine the growing concern over the use of antibiotics in animal agriculture and the risk involved to humans. The Swann report, submitted in November of 1969, utilized the expertise of many university researchers and specialists. It included 12 sections ranging across the use and value of antibiotics in animal production, possible dangers, transfers, and recommendations to the houses on what action should be pursued. One of the main problems that they encountered was in defining the antibiotics classification. It was easy to identify the theoretical difference between therapeutic and subtherapeutic use of antibiotics, but identifying the difference in terms of practical use was more problematic. As they stated in the report, "Since it is impossible to determine the level at which these antibiotics have only a purely growth promotional effect and the level at which they take on a preventative role as well, the definition of such use depends on what is in the mind of the user" (United Kingdom, 1969, 11). This would have consequence in determining policy implications.

Originally, the committee looked at the pros and cons of antibiotic use in man and animals. They found great benefit to individual farmers as well as animals in using these antibiotics. One example is "This recently published estimate of benefit from present usage amounted to about £1,000,000; if growth promoting agents were used to the full, the potential benefit was estimated to be over £3,000,000 annually." (United Kingdom. Minister of Agriculture, Fisheries, and Food 1969, 15). The committee then pointed out health risks for the general public from using antibiotics in animals. These included antibiotic residues passed on, resistance of bacteria to antibiotics and spread of disease from animal to man, either through contact or consumption (United Kingdom. Minister of Agriculture, Fisheries, and Food 1969, 17). So the social welfare of the citizens was higher than the impact on producers, thus adding to the argument for banning the use of antibiotics. Identifying dangers from continued use of antibiotics was the joint committee's primary goal. Once they had established the pros and cons of using antibiotics, they moved on to suggesting some courses of action.

Some of the major courses of action that the Swann Committee recommends are as follows:

- Permission to supply and use antibiotics without prescription should be limited to antibiotics which:
    - i. are of economic value in livestock production
    - ii. have little or no application as therapeutic agents in man or animal
    - iii. will not impair the efficacy of a therapeutic antibiotic
- The use of certain antibiotics (including tetracycline's, and penicillin) should be prescription only
- Feed antibiotics should not be fed to breeding stock
- A committee should be created that would be in charge and regulate all use of antibiotics, both human and animal.

This report was a catalyst for other countries to examine antibiotic use, resulting in many countries adapting at least some of the committee's recommendations.

1.2 Problem Statement

While government officials in the United States debate which course of action to take, industry officials and researchers are working to assess what the impact of subtherapeutic antibiotics removal would be on the various livestock industries. Of particular interest are the swine and poultry industries as they are the most reliant on the use of antibiotics to control growth and disease, due in part to their concentrated horizontal market structure. The United States swine industry uses antibiotics for growth promotion and disease prevention in 80.1 percent of swine feed rations (NAHMS, 2000). Additionally, pigs may receive preventative medication in their water, by injection, or orally. Much research has been done to date on the cost of subtherapeutic antibiotics removal in the swine industry as well as its impact on prices at consumer level. But along with production costs, there may also be a change in the market structure.

The question of whether to use Subtherapeutic Antibiotic Growth Promotants within a country is truly subject to benefit-cost analysis. Some governments choose a no risk policy for their citizens, like that of European countries. And other countries, like that of the United States, prefer to support their farmer amidst inconclusive science on the effects of AGP on humans.

Lawmakers are often faced with the following question: Do the advantages to the producer outweigh the consequences to the consumer? For the issue of an AGP ban, governments first have to calculate the impact on costs to the swine industry and producers. This would include cost of unemployment for those farmers that would have to exit the industry, added costs, and loss of productivity. Next they have to determine the Social Cost (impact) of leaving Antibiotic Growth Promotants in production. Some social costs would be changes in health care costs, food costs, and drug research and development among others. Then the two costs are compared and a decision is made based on which stakeholder has the higher costs. Often the social welfare problems are influenced by the government's protection policies and favor for either industry or the citizens. For a country like the United States, the decisions by lawmakers are more based on conclusive scientific research; thus, passing health care type of legislation is often a difficult process without scientific certainty. Whereas, countries like those of the European Union take more of a zero-risk stance when it comes to protecting their citizens. If there is any scientific proof that something can be harmful to citizens, then legislatures do not hesitate to change the law to ensure safety of their citizens. The outcome of social welfare problems is determined by where the protection lies and the value governments place on their citizens.

1.3 Justification for the Study of the Change in the Cost Structure

Antibiotics have had a great role in production of swine over the past 50 years. They have contributed to the growth and ability of the United States producer to meet the demand both nationally as well as globally for pork products. Antibiotics have increased the growth and production efficiency of the animals as well as decreasing production risk stemming from slow growth rates and higher disease-related mortality rates. Because of this, the industry has been able to increase the efficiency of production by gaining economies of scale in both production and slaughter facilities. These economies of scale along with more vertical relationships have decreased transportation costs, input costs, and risk. Antibiotics are not the sole cause of this increase in economies of scale; however, subtherapeutic antibiotic use has a big role in maintaining economies of scale.

The first step in assessing the changes to cost from a ban on subtherapeutic antibiotics is to assess the impact at the farm level. Previous studies (Brorsen, et al. 2001, Hayes, et al. 2001, and Miller, et al. 2003) have presumed an 'average producer', implying homogeneity across producers or farms. Realistically, however, producers may be heterogeneous with regards to different management styles and size of operations. Producers that have well managed farms may be affected differently from those producers with relatively poorer managed farms. Also, some producers may utilize different technological advantages compared to some producers. Some examples are risk of disease, dependency on antibiotics, cost of labor, etc. that vary with the different management styles. Many researchers have looked at the cost either to the industry at a whole or the cost per head or to the average producer, but none of them allowed for a change in the market structure. Changes to the market structure can be dependent on the changes that are incurred with the changes in costs.

1.4 Objectives of the Study

The general objective of this study is better to understand the impact of a subtherapeutic antibiotics ban on the swine industry. This includes analyzing the benefits of subtherapeutic antibiotics and the effects of removal. The basic question is how such a ban would affect the costs structures of various types of swine producers.

1.4.1 Specific Objectives

The specific objectives of this study are:

a) To provide an overview of impacts of the European ban on subtherapeutic antibiotics

b) To look at the United States swine market structure and determine what effect antibiotics have on the current structure, conduct and performance

c) To identify what effect removal of antibiotics will have on United States swine producers of varying size and management styles.

d) To identify policies that could help smooth the transition for producers as they eliminate the use of subtherapeutic antibiotics.

1.5 Methodology

1.5.1 Identifying Effects of Subtherapeutic Antibiotics

The effect of subtherapeutic antibiotics on the swine industry of the United States involves three characteristic needs: production values, management styles, and the type of animal housing that is used. In order to understand how the removal of growth promoting subtherapeutic antibiotics would affect the industry, the first step is to identify how antibiotics affect these three characteristics needs. All three of these characteristics affect the market structure of the industry. How market structure would be influenced by the removal of subtherapeutic antibiotics is yet to be seen; however, it is crucial in determining the overall costs of the ban.

Because the ban could have different implications for different management styles, the impact was examined for 3 different cost structures. For example, in response to a ban producers can influence growth rates, conception rates, and mortality just by taking proper precautions or following proper standard operating procedures. The individual producer's response is likely to depend on the cost structure that producer faces. For the purposes of this study the cost structure is a measurement of the farms management capacity. Farms with lower costs are assumed to be better managed.

1.5.2 United Feeds Data

Cost data was collected by United Feeds Inc., a Midwestern feed company in Indiana. It includes farms that they service and surveyed, and will be used in this thesis to determine how the ban will affect top performing, average performing, and low performing management. The performance was based on cost levels. The production data provided by United Feeds gives ample opportunity to look into the potential responses that management has in growing hogs within different types of operations. There are three different types of production operation for which data are provide: farrow to finish, wean to finish, and breed to wean. There are 133 farrow to finish, 37 wean to finish, and 18 breed to wean producers that participated in the survey and were reported. A full list of the summary data is provided in the Appendices starting on page 82. The summary provides average cost data and production data specific to that style of operation and averages for all farms, top third and bottom third performing farms. From these numbers, the average for the middle third can be extrapolated for an average management style. To define the top and bottom producers, average costs per head were calculated and the low cost producers were considered the top producers. According to the data, the top (bottom) producers for wean to finish and farrow to finish farms are also the larger (smaller) farms in number of head sold per year. In the breed to wean, the lowest cost farms are the smaller firms.

1.5.3 Analysis of Change

To determine the impact that antibiotics have on management, changes from a ban on cost levels will have to be identified. To identify these changes, determining how the production traits affect the total cost structure has to first be identified. Then determining how the use of AGP affects these production traits and applying them to the data helps to gain insight into how removal of subtherapeutic antibiotics affects US producers cost structures. These results will project how the United States producers will change given that their production style can be determined by the cost structure of the producer.

For this thesis, a total of 24 simulations were run and the cost and profit levels of each were recorded. Two simulations were run with all the variables changing to their "post-ban" level for a partial ban and a full ban. Then holding all other variables constant at the experimental value, a sensitivity analysis was run on the 11 variables (high and low values for each) to determine which variables have the highest influence on the profit.

1.6 Organization of Thesis

This thesis is organized into five chapters. Following the introductory chapter, chapter two is an overview of what has happened in Europe in regards to the ban on antibiotics. Because researchers commonly believe that what has happened in Denmark gives insight into what is going to happen in the United States (Hayes et al., 2003; Waddell, 2003), sections 2.1.2 and 2.3 deal with the history of the Denmark situation and how it compares to the United States situation. Also discussed are the effects of the ban on two countries that have finished using subtherapeutic antibiotics, Sweden and Denmark, as well as what aided in the transition to no subtherapeutic antibiotics. In section 2.2, trade between the United States and European Union is analyzed to determine the effect that the antibiotic issue may have on trade between these two major trade partners.

The third chapter deals exclusively with the United States hog sector. It starts out with section 3.1 looking at the characteristics of the swine industry including the recent history of antibiotic use as well as the development of the current market structure. This is followed in section 3.2 by a discussion of how the antibiotics and in particular how subtherapeutic antibiotics have influenced the current market structure.

Section 4.1 develops an economic model to understand changes in the cost structures that will result from full or partial bans of subtherapeutic antibiotic use. Section 4.2 deals with changes that will happen in market structure due to the changes in the cost structure for a full ban, including a discussion of the results of the change in the cost structure on the market structure of the industry.

Chapter five is a summary of the results as well as some policy implications and limitations to the study, and recommendations for future studies.

CHAPTER TWO

SUBTHERAPEUTIC ANTIBIOTICS IN EUROPEAN UNION

2.1 Antibiotic Use

2.1.1 Past through the Present

Both European Swine producers and their American counterparts started using subtherapeutic antibiotics in the mid 1950's. This management practice was adopted to help control disease. However, producers quickly found that there were other unexpected benefits. In addition to incurring less disease problems, the time from weaning to market weight of 230 pounds was decreased, feed efficiency improved, and the mortality rate was lower for the herd when antibiotics were included in the feed. (Miller et. al, 2003) The antibiotics that were most commonly used were given the name Antibiotic Growth Promotants (AGP). AGP are generic antibiotics used to treat many common diseases. When they were first introduced, they were fairly expensive and not very widely used. However, by the mid 1960's, the price of AGP was a tenth of that in the 1950's. Hence, they grew in popularity as they became affordable to more farmers. Before when there was an extremely high price, the benefit did not exceed the cost. But in the 1950's, this changed as antibiotic costs decreased dramatically, causing the benefit of using them to exceed the cost. A combination of lower costs, increasing knowledge about the optimal amount of antibiotics to be fed, and improved understanding of how AGP affect production helped propel the use of subtherapeutic antibiotics into farm production. This trend continued until 1969 with the release of the Swann Committee Report.

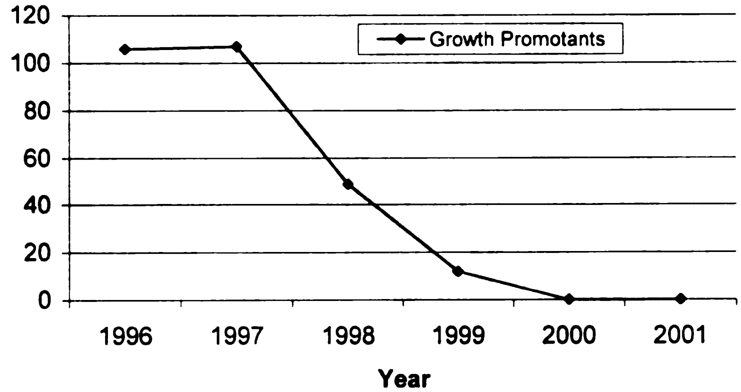
Following the Swann report, the public in Europe and to a lesser extent in the United States became concerned about the health effects of AGP use in livestock production, and eventually about the environmental effects as well. There is concern that antibiotic resistant bacteria could potentially get into the environment, specifically ground water. Humans and other animals and plants would then consume the antibiotic resistant bacteria. Another concern was that with antibiotics, farms could get large and concentrated. In a country like Denmark, land is limited. So an increase in farm size was a concern because it may lead to soil and groundwater pollution; the fecal run-off from the farms could get into the streams. (Barlam et. al, 2001) This heightened concern in the public as well as with the producers who were concerned with their sustainability in the future.

With all this negative publicity and farmers and the public agreeing, subtherapeutic antibiotics were beginning slowly to be phased out of use in livestock production. This started in 1986 when Sweden became the first country to stop using AGP under pressure from the Swedish Farmers Union and consumers. In addition, at this time (1988) Sweden enacted animal welfare legislation requiring a change in management practices and housing requirements. (Hayes et. al, 2003) These management practice changes likely aided in the transfer of a ban of AGP use. This will be discussed in section 2.1.3. Other countries have been phasing out the use of AGP following Sweden's lead. This has been met with mixed results. Demark banned selected antibiotics in the 1970s, started to phase out the use of all subtherapeutic antibiotics in 1995, and has completed the phase-out period. (Barlam, et. al, 2001) Denmark started by banning AGP used within the finishing segment of production, and eventually moved to a complete ban of antibiotics within the entire production system by January 1, 2000. Denmark is the example that most researchers are using to determine the effects of the cost of a ban on the United States pork industry (references). However, the next section draws lessons from both Sweden and Denmark

2.1.2 Banning AGPs in Denmark and Sweden

Denmark banned penicillins and tetracyclines in the 1970's in reaction to the Swann Committee Report. In 1998, the Danish government enacted a voluntary ban on the use of all AGP in the grower and finishing phase of production. The government added a national tax on all AGP in order to stop and effectively phase out the use of these antibiotics at this level. This tax was levied to the producers that chose to use the antibiotics (Hayes, 2003). These producers eventually were able to change to no AGP in livestock diets. Then in late 1998, the plan was extended to all phases of production. The use of antibiotics as growth promotants is shown in figure 2.1. When the legislation was passed in 1998, there was a dramatic drop in the use of AGP. By January 1, 2000, Denmark completed the ban; there has been no use of AGP in the country since.

Figure 2.1 Use of Antibiotics as Growth Promotants in Denmark



Source: DANMAP, 2000

2.1.3 What Aided the Transfer to no-AGP Production

There are some characteristics of the industry in Denmark and Sweden that aided producers in eliminating Antibiotic Growth Promotants. Market structure of the two countries has aided in the rapid removal of antibiotic growth promotants in the diets. The greatest advantage was from the way that the government mandated changes to management practices.

2.1.3.1 Market Structure

The market behavior of Denmark and Sweden is similar to that of the United States in that there is great consolidation between market segments. The main difference is that markets in the United States are mainly privately held corporations, where Sweden and Denmark are mainly cooperatives. Swedish Meats is a farmer owned cooperative, representing 50,000 farmers, which accounts for two-thirds of the hog slaughter in Sweden. The Danish Bacon and Meat Council comprise ninety-five percent of the total swine producers in the country. Denmark exports 80 to 85 percent of the pork produced in the country (Barlam et al., 2001). The countries are similar in that the vast majority of producers belong to a cooperative, and are under contract to supply their whole production to their cooperative markets. Since the early 1990's, each country's industry has followed this trend and is moving toward greater and greater vertical coordination. There is also a movement toward greater horizontal integration as larger farms are buying smaller firms. This has continued despite the elimination of antibiotic growth promotants. Joining these cooperatives is voluntary for the producers, but market conditions make it almost necessary for producers to join in a collaborative effort. In these countries, market structures may have helped ease the transition into the elimination of antibiotic growth promotants, as discussed below.

In Sweden, the Swedish Federation of Farmers is the umbrella organization that supports and represents almost all of Swedish agriculture. Much of the pork production in the country is controlled by cooperatives. These cooperatives in turn have formed associations and businesses to market their products. This means that the cooperatives own or are in control of much of the pork industry from farm to the plate. As mentioned previously, membership is voluntary; however, most producers join to decrease risk created by economic situation of the industry, such as market access. Swedish Meats is the largest food group in Sweden. The difference between Swedish Meats and U.S. firms is that Swedish Meats is owned by four regional farmers' cooperatives, whereas mainly large corporations vertically control the U.S. system. This means that the farmers really govern the overall business practices of the organization in Sweden. This unilateral organization aided in the switch to the ban on AGP (Hayes, 2003). In Sweden, the farmers as well as the public led the fight to ban the use of Antibiotic Growth Promotants in livestock production (Barlam et al., 2001). The perceived benefits were that it would increase the worldwide market viability of Swedish pork products and be healthier for the environment and humans. By having the farmers be proponents of the ban, this allowed for a smoother transition without having producers protesting the move. One of the major cultural differences between the European producers and U.S. producers is that often the large groups of the livestock production sectors in Europe try to stay ahead of the government and enact voluntary bans before they become law. This eases the transition for the producers due to setting timelines themselves, and gives the large food group cooperatives a bargaining position for their sales. In Sweden, a strong vertically organized market structure, that is producer owned, saw the change and was able to make adjustments before a mandated change occurred, and this eased the impact on the producers to change on their own timeline (Barlam et al., 2001).

Denmark produces 400% of their national demand, so the pork industry is largely dependent on exports (Barlam et al., 2001). To assure a place in the market, the government chose to ban the use of subtherapeutic antibiotics to gain share in the international pork market. The internal market structure of the pork industry is similar to Sweden in that large marketing groups or cooperatives control much of the countries' pork production. Thirty percent of the farmers produce 80 percent of the supply of hogs. The larger farms have multiple sites for production due to the intense environmental regulations placed on them. The farmers that belong to cooperatives are required to provide their entire production to the cooperative, and conversely, the cooperative is required to buy the whole supply from the farmer (Barlam et al., 2001). These cooperatives are democratically governed, meaning one farmer counts for one vote. The farmers act as board members and stakeholders in addition to suppliers of the cooperative. While this releases the participating farmer from having to do the marketing of his product, farmers that are not part of these cooperatives are often forced to find a place to market their products outside the country. This is due to the fact that between 1970 and 2000, the number of slaughterhouses decreased from 70 to three (Barlam et al., 2001). These three slaughterhouses are run by The Danish Bacon and Meat Council.

The Danish Bacon and Meat council is made up primarily of smaller cooperatives, which represent 95 percent of the farmers in the country. The other five percent primarily have to market their hogs to German Processors (Barlam et al., 2001). As in Sweden, cooperative membership is voluntary, but almost economically essential. These cooperatives mainly compete against themselves in marketing of their products. However, they work together to set standards, deal with issues facing the industry, and trade associations. Most of the market channel is made up of different mini-cooperatives that make up one or two segments that work with other mini-cooperatives to capture supplies to reduce risk and ensure a steady supply stream. Also, as in Sweden, Denmark's antibiotics are controlled and sold by a government agency, the Danish Integrated Antimicrobial Resistance Monitoring and Research Programme (DANMAP), which does not have direct oversight from the Danish Government (Smith, 2003). Denmark has a tightly coordinated and integrated market system in their pork industry, which has aided in the transition through a ban on antibiotic growth promotants by controlling management practices and increasing the information structure throughout the industry.

Through the tight market coordination system that Denmark and Sweden have in place, they were able slowly to adjust to impeding governmental legislation before it was mandated. In many cases the laws were put into place because the cooperatives lobbied for them, allowing producers to set their own timelines. In the case of Sweden, both producers and public were worried about health and environmental concerns, while Denmark wanted to create a niche in the international pork market and establish sustainability. In both countries it was easier to pass and implement a ban because of the overwhelming support and encouragement of the producer cooperatives (Barlam et al., 2001). Both countries seem to be heading in the same direction in terms of greater vertical coordination and market integration.

2.1.3.2 Management Practices

Management practices are important in lessening the impact removal of subtherapeutic antibiotics could have on swine production, since management practices can often promote better herd health. Using subtherapeutic antibiotics can make up for poor management practices, causing management to have a smaller overall effect on the herd health and growth rates. Management practices have not only been a concern for the health of the animals, but public concern and outcry have also had an effect on how herds are managed as well as what is considered proper welfare for the animals. This has led both the producers and the governments to enact strict guidelines and laws to ensure that producers are following the proper management plans that the consumer has set forth (Barlam, 2001). Both Sweden and Denmark have government controlled management plans that aid in removing antibiotic growth promotants from pork production (Barlam et al., 2001). These government mandated management practices, which lower the chance of spreading disease, force producers to implement practices, which cause better swine health and improve animal husbandry. These animal husbandry practices gave the producer a more cost effective transition into the ban, and lessened the monetary burden of the ban.

Many of the management practices that are required by law were put in place to improve the welfare of the animals. These management styles also have the advantage of decreasing the susceptibility of the animals to diseases, for example legislated practices concerning animal space allocation and the type of housing that can be used for each species. In the case of swine, the European Union currently requires an average of two square meters per head for breeding sows and gilts. (National Committee for Pig Production, 2004) Denmark and Sweden require that sows farrow in open stalls, which worsens the laid on death rate, but decreases sow injuries. In Denmark, the government had the advantage of observing the Swedish transition to no AGP's. Industry Leaders and scientists realized that Sweden had to change management practices when they took subtherapeutic antibiotics out of the system (Hayes, 2003). This led to more welfare regulations, which controlled the animal density, farm size, and use of slatted floors. In controlling the animal density and the size of farms, it is normally easier to control disease as there is a smaller chance of cross contamination both by pigs and humans.

Another management change in Denmark was that the producers had to delay weaning until 4 weeks of lactation. This allows piglets' digestive tract to develop so that they can better digest a soybean meal diet (Harper et al., 2001). Producers have increased the number of days of nursing to an average of twenty-eight. This means that they sacrifice litters per year to increase the viability of the freshly weaned pigs. In addition, they also leave the piglets in the farrowing area until they are ready to be moved into growing pens. This limits the stress that the baby pigs experience at weaning. These two practices help decrease the stress, thus decreasing the negative impact on the young pig's immune system (Ensminger, 2001).

Since the introduction of the ban, these two management changes have aided in a decrease in morbidity and an increase in producer profits (Hayes, 2003). In changing management styles and animal welfare requirements, Denmark was able to ease the transition through their ban and experienced less problems and costs than did Sweden.

2.1.4 Effects of the Ban on Sweden and Denmark

The AGP ban in Sweden and Denmark had consequences that were known ahead of implementation as well as others that were unknown by producers and policy makers until full implementation. Removal of antibiotics from hog diets in finishing operations did not have major consequences However, when nursery pigs were deprived of antibiotics at the subtherapeutic level, producers incurred higher health problems and greater costs (Hayes et al., 2003). Some of the bans' impacts on productivity in Sweden and Denmark are listed in Table 2.1. It was said that when Denmark imposed the partial ban, they received eighty percent of the benefits with twenty percent of the costs from the use of growth promoting antibiotics. However, when instating the complete ban, that fell to twenty percent of the benefits at eighty percent the cost. (Hayes et al, 2003) This suggests there is a greater health benefit to using subtherapeutic antibiotics at the nursery phase.

Table 2.1 Productivity impacts in Denmark and Sweden from AGP Ban.

	Sweden	Denmark
Age at Weaning	+ 1 week	a
Days From Weaning to reach 25 kg	+ 5 Days	a
Feed Efficiency from 50 to 250 lbs	-1.5%	-1.5%
Piglet Mortality	+ 1.5%	a
Fattening-finishing Mortality	+ 0.04%	+ 0.04%
Piglets per Sow	-4.82%	-4.82%
Veterinary and Therapeutic Costs (per pig)		+ $ 0.25
net of costs for feed grade antibiotics		+ $ 0.25
Lawsonia Vaccine		$ 0.75

[a] These costs totaled $1.25 per animal in Denmark and were not broken down into specific productivity impacts

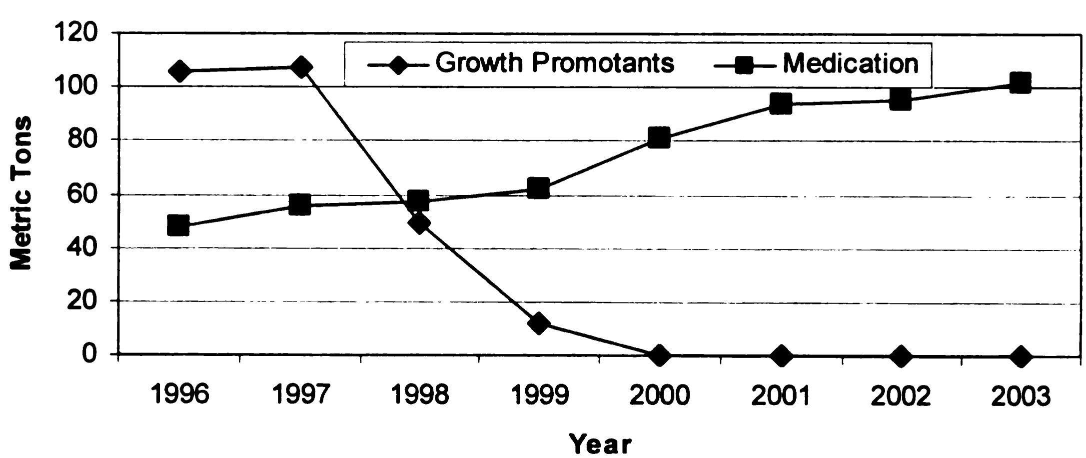
Source: Hayes, D, H. Jensen, and L. Backstrom, 2003

As shown in Table 2.1, when the ban was enacted in Sweden, the swine industry experienced an increase in post-weaning diarrhea. Also, post weaning mortality increased by 1.5% (Hayes, 2003). This can be attributed to stress caused by weaning as well as the relatively high susceptibility of piglets to disease. Post-weaning diarrhea is one of the main causes of post-weaning death in nurseries (NAHMS, 2000). As is evident by Table 2.1, another immediate effect of the ban in Sweden is that the number of days necessary for the pigs to stay in the nurseries was increased by five to six days. This was most likely caused by the increase in illness and post-weaning diarrhea, which cause decreased appetites, slower growth rates, and poorer feed to gain ratios (Casewell, 2003). In order to combat this, zinc oxide can be used along with other treatments. Zinc oxide, along with other trace minerals, has been proven to have a positive impact on the health of the animal. (Lawrence and Hahn, 2001) Due to the concern over higher dosages affecting the environment zinc oxide became prescription in 1998 in Sweden. However, changes in animal management, hygiene, and feed have helped decrease post-weaning mortality and other health problems (Barlam et al., 2001). But even with the change in management, post-weaning death is still 0.5% higher than it was before the ban (Waddell, 2003).

Denmark experienced many of the same results with their version of the ban. There was one major difference when Denmark acted on their ban: they did not incur the early costs like those of Sweden's ban. Animal welfare laws were put in place before they started the ban, whereas Sweden wrote the laws at the same time as their ban. In both countries the laws governed management, housing, and feeding styles that producers were allowed to use. In Denmark the laws helped the farmer ease in to the ban as they provided for less stress on the animals and decreased the spread of disease between pigs. However, Denmark incurred its own problems in discontinuing the use of AGP. Even though they were able to learn from the Swedish experience, they still had problems with post-weaning diarrhea. The diarrhea led to an increase in mortality and slower growth at the same time for the post-weaning piglets (Hayes, 2003). However, the trouble and cost was not to the same extent that was occurred in Sweden. The Danish producers only experienced a 0.7% increase in post-weaning mortality and an increase in days to 30 kg of 2.4 days (Hayes, 2003). An unforeseen effect of the ban was the large increase in the number of cases of Lawsonia intracellularis infections, more commonly known as failure-to-thrive disease (Hayes, 2003). The producers that have problems with Lawsonia now need to vaccinate the young piglets to control the disease.

Denmark has a unique position in that they have a government agency that is in charge of distribution of antibiotics within the country. With this system, they are also able to document when, where, and why the antibiotics were used (Barlam et al., 2001). The data collected showed that after the ban in antibiotics took place, therapeutic antibiotic use increased as can be seen in figure 2.2. This would be expected due to the rise in disease that would have otherwise been controlled with subtherapeutic antibiotics. As can be seen, the use of therapeutic antibiotics has risen continuously since the ban took place. One of the major concerns of the increase in therapeutic antibiotics is again the growing resistance of bacteria to the antibiotics. The resistance to therapeutic antibiotics is of greater concern than the growth promoting antibiotics because therapeutic antibiotics are often the same drugs as what are used in human treatments (Hayes, 2003, Waddell, 2003). The bacteria then grow resistance to these antibiotics, which is a greater risk to human health than the subtherapeutic antibiotics.

Figure 2.2 Use of AGP and Therapeutic Antibiotics in Denmark



Source: DANMAP 2003

2.2 Friction concerning Trade with the US

Europe and the United States have had long-standing disagreements on agricultural exports and imports. Both governing bodies demonstrate a protective policy with their agriculture products on the international market (Emerson, 2001). The two trading partners have had a tumultuous past, especially within the agriculture sector. In 1998, The Transatlantic Economic Partnership (TEP) was created from the preceding New Transatlantic Marketplace. This partnership was developed between the United States and European Union as a limited agreement for working out key issues, particularly in agriculture, audiovisual services, and culture (Bach, 1999). Recent issues have arisen with the emergence of biotechnology and food safety and the different political stances for the two partners in the TEP (Burney, 2000).

The disagreement regarding food safety between the United States and European Union is over one hundred years old. In the 1880's, the European governments of the time chose to ban U.S. meat products due to concerns about the slaughter methods being unsafe and unhealthy. (Leonard, 1999) It was not until Upton Sinclair's novel "The Jungle" came out in 1905 that the United States government chose to react.

There are still issues with biotechnology in plants, the use of hormones in beef, and now with the use of subtherapeutic antibiotics in food animals. These issues have at times shut down trade between the Transatlantic Treaty partners (Leonard, 1999). Other issues that have arisen deal with welfare standards of livestock and environmental concerns. The United States has responded to these regulations as being trade barriers because they do not have a scientific basis. This leads to large trade barriers that are hard to dissolve, and cause less international trade and a less effective global marketplace

(Bach, 1999). A good example of this is the ban that the European Union has on hormone-injected beef. The European Union banned US beef imports because of American producers' use of growth hormones in production, due to health concerns that hormone injected beef can have residual effects. The US refuses to accept this as a reason for a ban because there is no scientific evidence to support the theory. Examples such as this have led the US and EU to the edge of an all out trade war (Taylor, 2002).

A ban on animals that are fed antibiotic growth promotants has yet to be included because the whole European Union has not yet completed their ban. However, they are hoping to complete the ban by 2006 (Food Safety Authority, 2002). This means that animals fed subtherapeutic antibiotics could soon be banned from the EU.

2.3 Using Denmark as a Case Study

Many researchers believe that Denmark may be the best model to determine the effects if the United States bans the use of subtherapeutic growth promoting antibiotics. Denmark was the first country with a similar type of market structure actively to phase out the use of AGP. Though many similarities exist between Denmark and the United States, there are far more differences that suggest that the Danish model is not going to provide accurate or applicable answers to the question: What is going to happen to the swine industry in the United States if subtherapeutic antibiotics are banned from use? Much of the previous research tried to answer the question of how much it would cost United States producers to quit using Antibiotic Growth Promotants. Many of these studies used the Danish model to determine costs. The results from the Danish ban have provided us with some valuable information, but cannot be applied directly to the US swine industry due to major differences that would change the cost structure of the industry. Some of the more common differences are oversight agencies, contracting between the vertical components of the industry, the management practices already used within the country, and the thought process of producers.

One of the biggest problems that the United States has run into is their form of government and the checks and balances that are in place. In 1970, the Food and Drug Administration tried to follow the rest of the world and ban subtherapeutic use of penicillin and tetracyclines in food animals because of the results of the Swann Committee report. In response, Congress threatened to cut back the FDA's funding if they followed through with the ban. (Barlam et al., 2001) In Denmark and Sweden, the parliament does not get involved with how the Ministry of Agriculture is run or any issues that pertain to policies implemented. The United States government could cause more of a challenge to implementing a ban on AGP depending on how different agencies or branches of the government react. Additionally, the FDA is responsible for the approval of the drugs, not regulating or licensing the use of the drugs. In Sweden and Denmark, their Ministries of Agriculture are in charge of everything from the approval to the regulation and licensing of the drugs. This makes it easier to monitor consumption and means of administration to assure adherence to the ban. The United States has no current way of tracking this information.

Another big roadblock that the United States has to face, unlike Sweden and Denmark, is that producers perceive that a ban will negatively affect their profits. In many cases, the Danish farmers did whatever the government told them to do, while in the United States, farmers may believe that their profitability would be reduced from using less antibiotics and lobby congress to resist such an action (Barlam et al., 2001).

This is also true from the standpoint of the consumers. American consumers, on average, do not know where their food comes from and are rather uneducated about food issues. They feel that the government will take care of any food problems that may arise. In Denmark and most of Europe, the consumers are extremely aware of what is happening in the food industry. One of the aspects that helped the ban on antibiotic growth promotants in Denmark to work was a large market of consumers that demanded the antibiotic free product and were willing to pay extra to receive it (Hayes, 2003). The United States consumer wants a safe, cheap food supply. It is unclear whether the US consumer views antibiotic free pork as safer (are there any studies on this), and if so, how much they would be willing to pay for pork produced without AGP. The profit that is driven within small margins in the United States is a major difference between the costs to American producers and their Danish counterparts.

The different characteristics of the vertical integration in the two countries are another major factor that would cause a difference in the cost to the industry from the ban, or the ability to stay in business. In the US system there is an imbalance of power between the slaughterhouses and the producers, causing the farmer to be less willing to place a long-term investment in improving or making their management system capable of implementing a subtherapeutic antibiotic free environment. This could be due to farmers being uncertain about their future and thus unwilling to take the risk with not knowing if they will be able to pay off the loan or gain the benefits over time to pay for it. However, in the Danish system, the industry associations control the slaughter. Since the producers are controllers of the associations, they basically control the slaughter, which leaves less uncertainty in the future (Smith, 2003). In turn, the producer is more willing to taking risks in making long-term investments.

One of the more substantial differences between the U.S. producer and their European counterpart are the animal husbandry practices. Things like strict adherence to the all-in-all-out system, increasing the days to weaning, and lowering the stress levels that the animals experience promote higher herd health. In the U.S., adherence to the all-in-all-out is not always followed. Sometimes, slower growing pigs are moved in with younger pigs to conserve room and open pens for new groups. This exposes the younger pigs to different diseases and cross contamination. In the current system, pigs in the United States are weaned one to two weeks before pigs in Denmark. A lesson that is evident when comparing the Denmark ban to the Swedish ban on subtherapeutic antibiotics is changing animal husbandry practices and farm management to benefit the growth will facilitate in the transition (Barlam et al., 2001). Much of the current research looks at the impact of a ban on United States producers, treating the US hog industry as a single entity (Hayes, 2001, Hayes, 2003, and Waddell, 2003), when in reality the ban would affect different levels of producers in different ways. One of the contributing factors is the style of production system that they use. Some producers are more dependent on antibiotics than others, causing a difference in the effect of the ban.

CHAPTER THREE

PORK PRODUCTION IN THE UNITED STATES

3.1 Characteristics of the US Swine Industry

The United States Swine industry has changed dramatically in terms of technology, horizontal structure, and vertical structure over the past couple of decades—faster than in any previous period of time. There are many factors influencing the rate of change and the structure that has emerged. Because the consumer influences many aspects of the industry, consumer preferences are the driving factor for changes. Technology changes and new information can be attributed to trying efficiently to produce what the consumer wants. However, producers sometimes have a hard time adapting to the change. There are many reasons for this: for example, resistance to change could cause a producer not to accept these new technologies, while the cost associated with implementing the technologies or changes could be another impediment to adoption. The following sections provide an overview of some of the more dramatic changes in the U.S. Swine Industry during the recent years.

3.1.1 An Overview of Swine Production

The swine industry, like most agricultural industries, constantly tries to adapt to changing consumer preferences. There are other factors that also affect behavior of swine producers, such as packer preferences, changes in rural development, and governmental regulations. For instance, packers have changed the producer's management style by slowly increasing the market weight they are willing to accept from 230 pounds in the late 1980's to the current size of near 270 pounds. This has forced the producer to spend more money and keep the animals longer in order to reach their ideal market weight. Another change that has taken place is the ever-increasing rural migration (Meredith, 2003). According to the US Census data, more and more people are moving out of the city to live in the country[1]. This has caused tension between the new population of rural people and farmers. Lawsuits have been on the rise as farmers are getting sued for infringing on the ability of these people to live comfortably. This has led to government regulations and laws to protect the farmer from "nuisance" lawsuits and provide guidelines to follow; examples being the Right to Farm Act, GAMMP's, and CAFO standards (Michigan Department of Agriculture, 2005; Michigan Department of Environmental Quality, 2005). However, even with these outside influences, a producer's management style and the overall market structure are still driven by one main force: the consumers' preferences.

Consumers have great influence over the price of market hogs, management styles, and the market structure. For example, in the middle of the 20th century, an ideal market pig would be short and have over 3 inches of conditioning on the carcass for added marbling and by-products (i.e. lard and soap). This changed toward the end of the twentieth century as consumers became more conscious about their health and wanted a leaner product. That leads to the current animal, which has under an inch of subcutaneous fat. Producers accomplished this by feeding the pigs higher protein diets with less use of fats as an energy source. Consumers also want to pay the least amount possible, which has lead to great consolidation within the swine industry, along with growth in the vertical integration and coordination to keep costs down. Producers' desire

[1] In 1950, 23.3% of Americans lived in the suburbs. In 1990 this number had grown to 46.1% according to the US Census Bureau

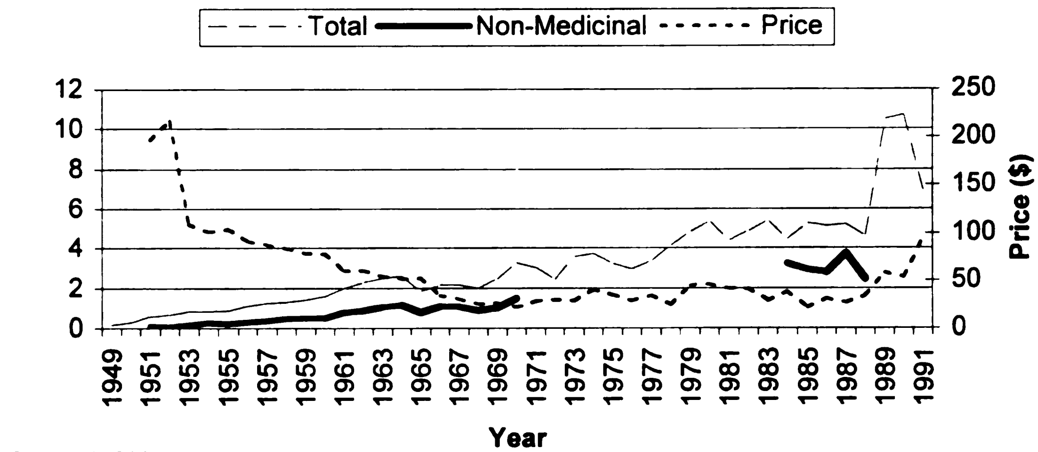
to minimize costs and maximize their profits has also contributed to the consolidation within the swine industry. These two factors are the main components behind changes in the swine industry.

3.1.2. Use of Antibiotics in American Swine Production

Following the release of the Swann Committee report in 1969, the FDA tried to join the rest of the world and ban Penicillin and Tetracycline use as a subtherapeutic antibiotic in animal production. Congress had other plans though and threatened to cut the FDA funding if they went through with the ban. Antibiotic use continues to grow today in the United States.

In 1963, U.S. swine producers were using approximately one million kg of antibiotics in animal feeds per year. By 1980, this number increased to over 3 million kg, and reached 8 million kg by 1990 (Cromwell, 2002). One of the major contributors to the increase in antibiotic use was the 1,000 percent decrease in the price of antibiotics over the 30-year span (Cromwell, 2002). Figure 3.1 shows the cost for antibiotics compared to the sales of medicinal and non-medicinal antibiotics over a 42 year period. Sales of non-medicinal antibiotics are the amount of antibiotics bought mainly for growth promotion reasons. The cost of tetracycline decreased the least with an average cost of approximately 35 to 40 dollars per kg, where most antibiotics are between 20 and 30 dollars per kg (Cromwell, 2002). The decrease in the cost of antibiotics, along with the growing knowledge of their impact on growth and ultimately profitability, promoted the increasing use by farmers.

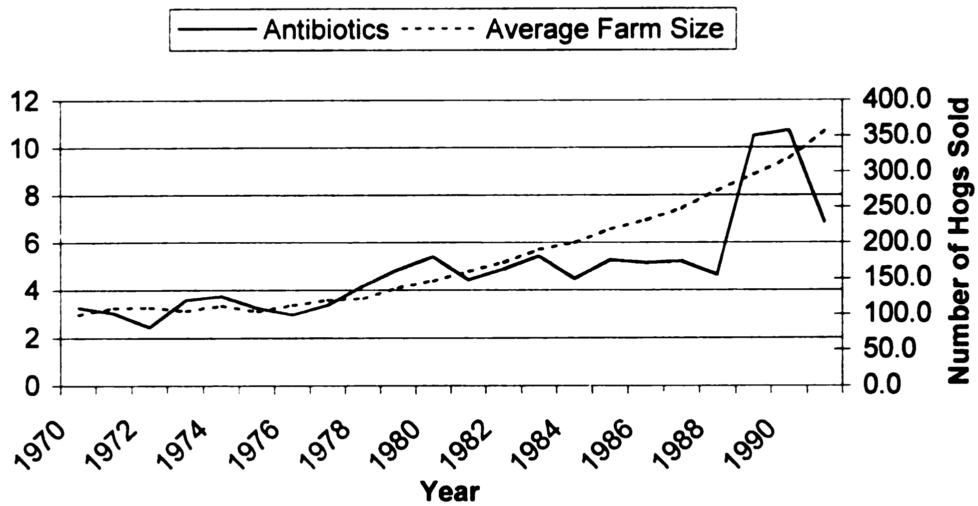
Figure 3.1 Sales of Non-medicinal Antibiotics versus the Price of Antibiotics per Ton



Cromwell, 2005

As producers used more antibiotics in their feed, they discovered that the pigs could be kept in closer contact without getting sick. This caused farm sizes to grow in numbers marketed and an increase in the consolidation and vertical integration of the swine market shown in Figure 3.2. With the increase in consolidation and vertical integration, subtherapeutic antibiotic use was on the rise to maintain growth rates and decrease morbidity. With the growing number of pigs in each room and the rooms being bigger, producers would add antibiotics to prevent major outbreaks of disease and to gain a more uniform growth performance with the animals (Brorsen et al., 2001). According to figure 3.2, as farms grew in size, the use of antibiotics increased. The reason for this is hypothesized that the antibiotics allowed the employees to spend less time managing the health of the herd, which decreased the cost for the producers as it was not necessary to hire labor with high skill levels or train as extensively the entry level workers. Workers did not need to spend as much time looking for the onset of disease and were allowed to focus their time elsewhere. The original use of antibiotics led to changes in management practices that created a further dependence on AGP.

Figure 3.2 Graph of Average Farm Size over Time and the Use of Antibiotics as Growth Promotants.



Source: Cromwell, 2005 and USDA Red Meat Yearbook, 2005

Cromwell (1991) states that the greatest effect of antibiotics on growth rate and feed efficiency is on the younger pigs, and that effect declines as pigs get older. According to the NAHMS report released in 2000, producers used 19% more growth promotants antibiotics in the nursery than in the grower-finishing phase (82.7% of nursery pigs fed antibiotics compared to 63.7% of Grower Finisher). This makes it evident that producers feel that there is more advantage to add growth antibiotics in the nursery diets than in growing and finishing diets. Research supports the farmer's behavior due to nursery pigs being more susceptible to disease from a weaker immune system (USDA, 2002 and Miller et al., 2003).

Because the FDA has not banned the use of tetracycline, it is among the most frequently used antibiotics in United States swine feeds. In nursery diets, it is the most often used growth promotant, in contrast to grower-finisher diets, where it is most often used in disease prevention and treatment. The continued use of tetracycline leads to a greater chance of antibiotic resistant bacteria, which will make the antibiotic less effective in both livestock and human treatments. Table 3.1 shows a list of the antibiotics and chemotherapeutics that the Food and Drug Administration allows to be mixed in swine feeds. Of these antibiotics and chemicals, Tetracycline and penicillin are most used in treating human cases of diseases and were cited by the Swann Committee report as the biggest loss if bacteria become resistant. However, prohibiting the use of tetracycline would cause producers to have to use another antibiotic or change their management style.

Table 3.1 All Families of Antibiotics that can be used in Animal Production in the United States

Antibiotics	Chemotherapeutics
Apramycin	Arsanilic Acid
Bacitracin methylene disalicylate	Carbadox
Bacitracin zinc	Roxarsone
Banbermycins	Sulfamethazine
Chlortetracycline	Sulfathiazole
Lincomycin	
Neomycin	
Oxytetracycline	
Penicillin	
Tiamulin	
Tylosin	
Virginiamycin	

Source: Cromwell, 2002

3.1.2.1 The Changing Market Structure and Conduct

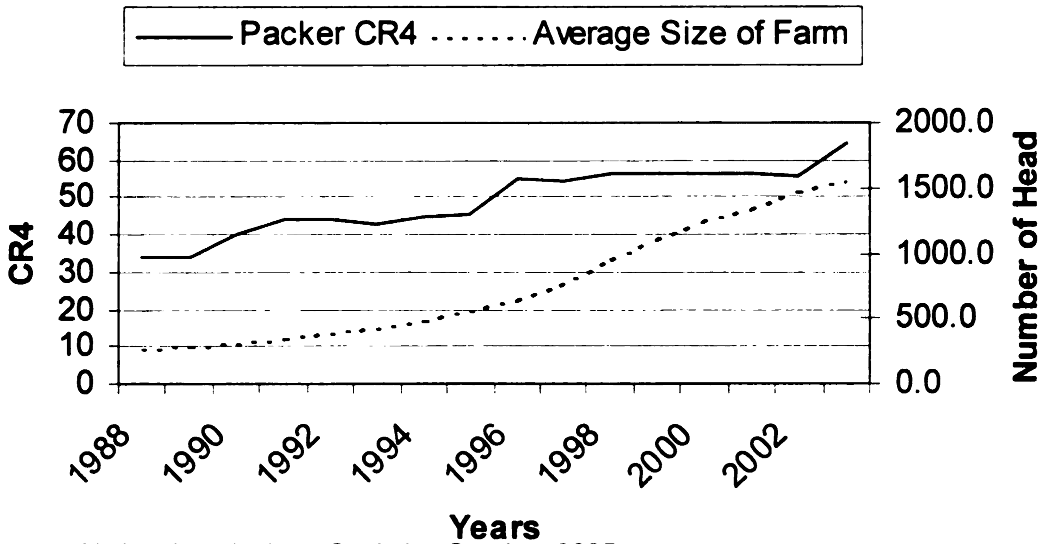
At the onset of antibiotic use in the 1950's there was not much structural change taking place. Most production happened on small independent farms that were often diversified in their production. The number of farms has been dwindling and production has become more specialized (Huffman and Evanson, 1993). Over time the amount of diversification on the farm has decreased and specialized farms emerged. In livestock, this became more apparent with the growth in the use of antibiotics. Producers were able to reach greater efficiency using antibiotics because animals grew faster and growth efficiency was not lost to disease. With the ability to grow more animals per year, producers were moving toward confinement farms and greater vertical coordination. From the 1980's to today, there has been ever changing market structure and conduct.

3.1.2.2 Market Structure Changes

The market structure is defined as those features that are economically significant to the behavior of firms in the industry (Caves, 1992). From the increasing concentration of firms to the end product to the international competition for products, the United States market structure has gone through a massive change.

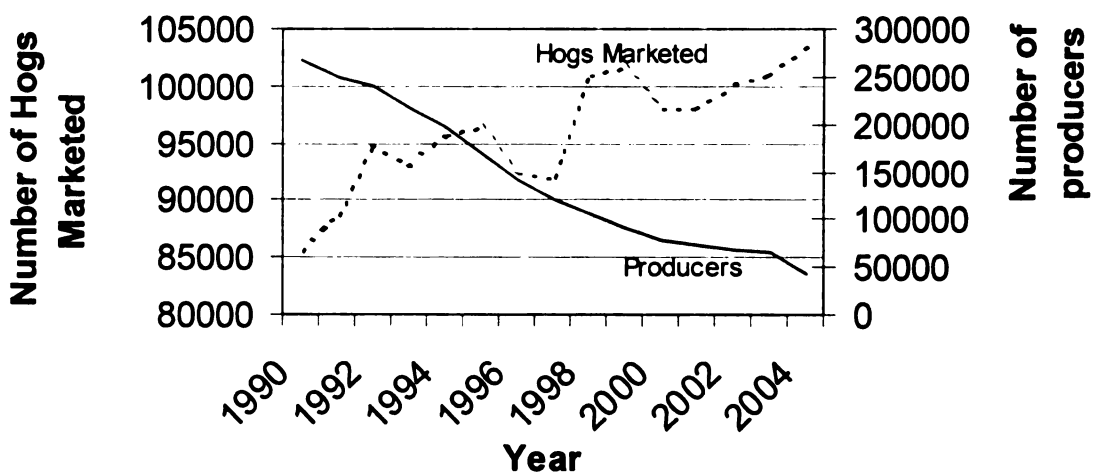
Buyer and seller concentration has increased greatly since the 1980's. Figure 3.5 shows the concentration ratio of the packers versus the average size of farms in the United States. There are a smaller number of farmers selling to fewer packers. Farms are becoming large confinement operations, which are able to produce market pigs at a larger scale of operation. This is evident in figure 3.4, which shows that although the number of farms has been decreasing steadily over the years, the amount of pork being produced has increased. This means that producers are increasing the number of head they market. While quantity supplied has increased over the years, the number of sales outlets for these farms has actually decreased. Many of the smaller packers are getting bought out by the larger companies or have to close for not being able to gain the economies of scale their larger competitors reach (Morrison Paul, 2000), which is causing an increase in the concentration of the market as shown in figure 3.3. Even the large packers are acquiring other large packers. This was evident when Tyson bought IBP Incorporated (CNN Money, 2000). Although Tyson was not in the pork packing market before the acquisition, by the time that the purchase was completed, Tyson was at the top of beef packing, second in hogs, and first in broiler slaughter. Their status in pork and beef packing was purely the result of the purchase (CNN Money, 2000). The packing industry is further consolidating because of a tremendous advantage in using economies of scale while maintaining harvest capacity similar to production capacity (MacDonald, 2000). Due to their increased unit price of slaughter, the smaller packers are thus at a disadvantage to the large packing groups.

Figure 3.3 Concentration Ratio of Packers in the Swine Industry and Number of Head Marketed per Farm on Average.



Source: National Agriculture Statistics Service, 2005

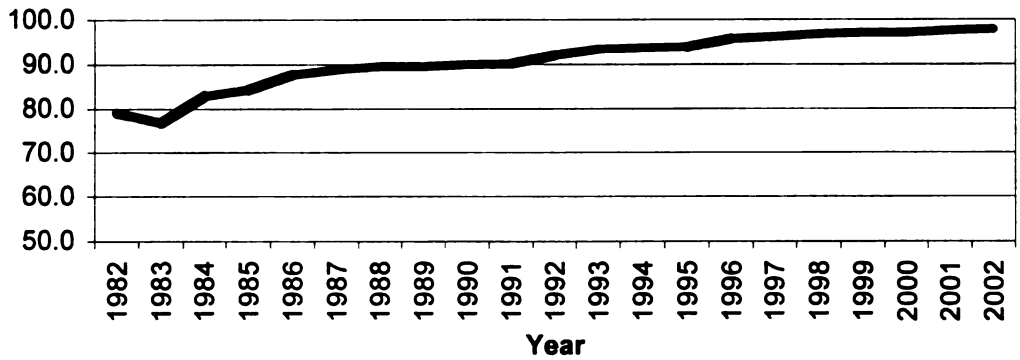
Figure 3.4 Number of Hogs Marketed per Year in Comparison to the Number of Producers



Source: National Agriculture Statistics Service, 2005

An increase in the concentration of an industry typically brings barriers to entry for any firm wishing to enter into the market. This applies to firms wishing to enter the swine industry. There are many things that have contributed to this decrease in accessibility into the market. For one example, there has been an increase in the reliance of contracts for sales instead of using spot markets (McBride and Key, 2003). Figure 3.5 illustrates the increasing use of contracts and other non-public forms of marketing between producers and packers. These can either be forward contracts, direct sale to packers, or other types of direct marketing (Sexton and Lavoie, 2001). Non-public markets are used by producers and packers wanting to decrease their risk, and contracts are able to decrease this risk by ensuring supply for packers as well as providing a known price and market date for producers (Poray, et al., 2003). Because of these contracts and producers' ability to fill the needs of the packers, the larger slaughter operations have been moving away from using stockyards and other forms of spot markets for supply needs and increasing the use of contracts. In addition to shrinking marketing options, interested entrants in the market face a high start-up cost. Any prospective producer that wants to contract has to market enough pigs to meet the contracting company's specifications (Poray et al., 2003). As the number of inputs needed to satisfy these marketing agreements increase, the investment needed has increased. However, there is one entry barrier that has decreased in the past few decades. Due to increased vertical coordination, entrants now do not necessarily have to purchase the livestock or feed (McBride and Key, 2003). They can become contract feeders. A larger company provides the animals and feed, and then pays the producer for the management of the animals, normally on a per head basis with production incentives. This presents the producer with an option that requires less initial capital, but raises the question of whether the farmer is now an owner or an employee.

Figure 3.5 Percentage of Hogs Sold to Packers using Non-public Sales



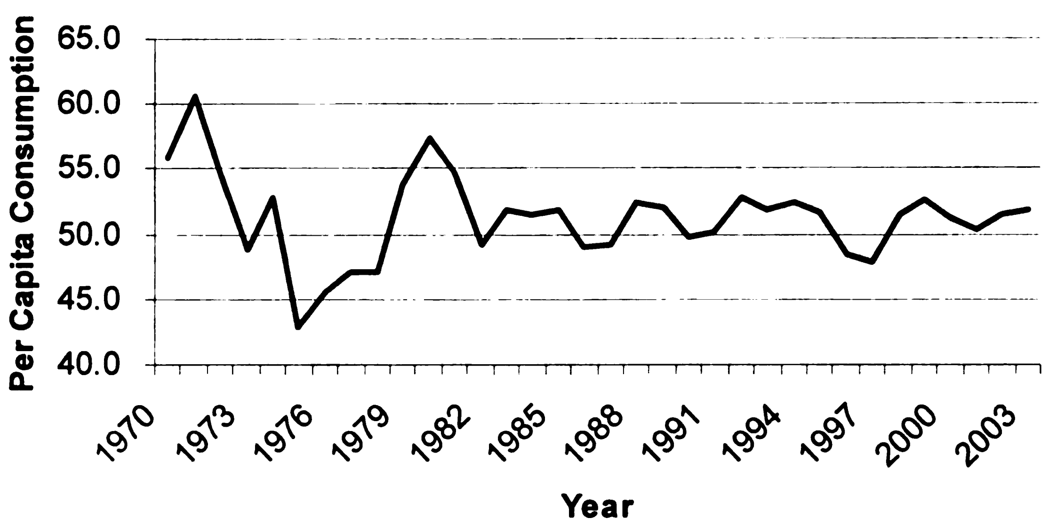
Source: GIPSA. Packers and Stockyards, 2002

Sunk costs are another characteristic that has changed over the past decades. Previously, producers could use low-investment-cost housing that could be used for other purposes. This has changed over the past decades, with modern operations requiring investment in confinement buildings, which do not have another use other than storage or a swine production building swine housing, resulting in higher sunk costs for the producer. This asset fixity keeps producers in the business longer than would otherwise be economically feasible (Johnson, 1972).

The amount of product differentiation is another defining characteristic of the market structure of the pork industry. As with almost all agricultural products, diversification in the swine products has been occurring at a rapid pace (Martinez, 2000). Instead of one homogeneous product that has gone through production to the consumer, the consumer is now getting a greater choice within their pork products. Whereas a couple of decades ago, consumers only had the choice of what cut they wanted, they now have the choice of value added products (i.e. microwave meals, Ready-to-Eat products, and marinated tenderloins) and there has even been brand labeling like that in the beef industry. This allows the consumer to have a broader choice and added convenience while allowing the industry to gain a greater share of the consumer's food budget. Producers are also using verified and branded products such as Berkshire Gold®, antibiotic free pork, and other programs to add value to the finished product and increase profit margins. Berkshire Gold® is a branded breed program to give consumers a more consistent, tender product. This program was set up by the American Berkshire Association to utilize the benefits that the Berkshire breed has with consumers taste preferences. There are two different programs, one for animals that are purebred and others that are at least 50% Berkshire. This is to distinguish the products on the international market as Japan only allows purebred Berkshire meat to be labeled as premium. Antibiotic free pork is currently a niche market where producers are able to provide consumers that are willing to pay more money to know that the producer did not use antibiotics in the production. Margins increase due to the fact that packers are more willing to pay for these higher quality products because their market value is higher to consumers. When the producer offers a different product to the consumer, he or she is also able to gain a greater share of the market value.

Another aspect of the market structure is the ever changing market demand. In agricultural products markets, demand is fairly stable in nature as can be seen in figure 3.6. One of the major drivers of demand for agriculture products is the health information that has been disseminated to the public. If the public is provided with information that a certain food is unhealthy, they are able easily to replace it with a substitute. Many close substitutes are another reason for the fluctuating market demand in agriculture products. For example, swine demand has increased lately due to the BSE scare in beef, which hit the United States and Canada in 2001 (USDA, 2004).

Figure 3.6 Market Demand for Pork Products Based on Average Annual Consumption per Capita.



Source: USDA, ERS, Red Meat Yearbook, 2004

Import competition is the final aspect of changing market structure that has been identified. The United States producers are feeling pressure from other parts of the world as the market grows. Some of the greatest international competition is from the United States' neighboring countries. Canada is starting to produce greater numbers of hogs. Canada is shipping their hogs to the United States slaughter facilities to gain a higher price (7.4 million head in 2003; an increase of 30 percent from 2002) (USDA-FAS, 2004). This has pushed the United States producers to sell their hogs at a lower price. In

2004, the United States pork producers filed a grievance with the United States International Trade Commission that Canadian Pork Producers were dumping their product in America (International Trade Administration, 2005). Dumping occurs when another governing body sells a product to a country for less then the market price in the exporting country (World Trade Organization, 2006). The United States International Trade Commission came to the conclusion that producers were not yet at a disadvantage with Canadian hogs being "dumped" in the United States industry (International Trade Administration, 2005). The commission did state, however, that there was dumping happening, but there was not enough evidence to accuse Canada's dumping of affecting the prices received by American Producers (International Trade Administration, 2005). This shows that there is a growing concern for producers regarding the influx of foreign commodities on the United States packing industry.

Over the past decades, the United States pork producers have experienced dramatic changes in the market structure. Swine production has become highly technologically dependent to reach its current efficiency. With the potential removal of subtherapeutic antibiotics in the system, this has the potential to change the current market structure, but the extent of these effects is yet to be determined. Through the examples above, the market changes that have occurred in the past 20 years could have a profound impact on the ease of transition for producers to terminate the use of subtherapeutic antibiotics.

3.1.2.3 Market Conduct Changes

Market conduct is another important market property to look at when determining how an industry will react to a given change. Looking at how companies use policies to aid their product in the market and responses by industry rivals helps to analyze how companies would respond to outside impacts. Market conduct is made up of three key points in business policy: setting prices, setting product quality and other non-price policies, and seeking strategic advantage and deterring entry.

The first strategy of business policy is the setting of prices. Farmers of the past never had the chance to set their prices. The most influence farmers had in the past was determining when they took the animals to market, and so could gamble that the price would increase if they delayed. The market was competitive and producers sold at spot markets, thus the price they received was dependant on the supply of hogs that day and the demand from packers. Producers had little control over the price that they received at the market. Then, as farms became bigger, producers started finding ways to set the price in order to diversify some of their risk. Contracts with packers started to become a more popular way of marketing in addition to providing a higher proportion of the consumer's dollar to the farmer. Each farmer that uses a contract based marketing system is diversifying more of his risk than his predecessors. Producers now are closer to being able to set their own prices and diversify risk as they can negotiate future prices with the packers. In the late 1990's a problem arose because they could not observe what other producers are receiving from packers. This problem of poor information was somewhat alleviated by the passing of the mandatory price reporting act in 1999. This act stated that all base prices had to be reported to the USDA so that producers can find the prices other producers received for their animals. Producers are gaining more and more control over the price setting for live market hogs, and are gaining more information about their competitors.

Another aspect of business policy that goes into market conduct is control over quality and other non-price related policies. The main driver of quality, like in most agriculture products, is the consumer. Hog producers have improved product safety by establishing guidelines that all producers can follow to ensure proper quality and to keep flaws in the meat to a minimum. Pork Quality Assurance (PQA) helps to teach the producer about withdrawal times, proper injection sites, and proper handling. This is to reduce bruising of the carcass and decrease the antibiotic residue in the final product. It also decreases trim loss at the packing plant by keeping the injection sites away from the more expensive cuts of meat. There has also been an increase in the number of operations that are owned by or market with packers and created a brand name product to sell to consumers. These brands stand out from the normal commodity pork and allow the consumer to have more choice in the brands that they are choosing from. There may not be a significant difference between brands, but the number of brand choices is increasing.

The final business policy area to look at is using strategic advantage and deterring entry into the industry. Producers have typically produced a commodity product, which neither uses a strategic advantage nor deters entry. Beef producers have adapted to different conditions and given themselves a strategic advantage by creating diversification within the industry. They have created branded beef products, which target different niche markets and allow the producers to gain more profits. Pork producers have not created branded products to the extent of beef producers. Yet, there are a few exceptions: and one is Berkshire Gold®. The biggest way that producers have been able to deter entry into the industry, as discussed in section 3.1.2.2, is the use of contracts. Substantial capital investments and a shrinking free market to sell to are deterrence's for new producers (McBride and Key, 2003). Producers use strategic alliances more than creating niche markets to gain a strategic advantage over other producers.

3.2 Antibiotics Role in Production and the Current Market Structure and Conduct

AGP have different advantages at each stage of production. These advantages allow producers to intensify their production in many ways. The use of subtherapeutic antibiotics as growth promotants has given producers an increase of about three dollars per head (Cromwell, 2002) for use in starter and grow-finisher diets; this includes subtracting the cost of the antibiotics. This figure only counts the savings from the growth of the pig, not the extra income the producer would receive using a value based system where uniformity, muscle quality, and age of animal would gain more money, and does not include the effects of widespread AGP use on prices received by producers. With this extra capital, the producer can re-invest more capital into the farm business, which could lead to more intense production. Subtherapeutic antibiotics in production affect the industries' market structures and conduct through growth promotion, disease control, and providing higher production numbers.

The use of antibiotics in gestating and lactating sow feeds has the smallest impact relative to other production stages. Table 3.2 shows that using antibiotics in gestating and lactating sows has little effect on litter production numbers. It also shows that there is a great benefit when antibiotics are used and management is held constant at average levels. In some cases, adoption of proper management techniques generates larger gains than antibiotics use at this stage of production. In a study done in 1964 by Mayrose et al., the farrowing rate decreased through the use of antibiotics. Although this may be due to poorer management practices in the control group, it shows that knowledge may be more important than use of antibiotics.

Table 3.2 The Effect that Subtherapeutic Antibiotics have on Production Factors in Gestating and Lactating Sows.

Production Measure	Antibiotics (1963-1972)	No Antibiotics (1972-1985)
Number of Litters	398	688
Conception Rate (%)	91.4	82.6
Number of Pigs Born per Litter	10.8	10.2
Live Pigs per Litter	9.8	9.3
Average Birth Weight (kg)	1.29	1.38
Number weaned (21d)	8.8	7.5
Average Weaning Weight (kg)	5.67	5.37
Survival of Live Born (%)	89.7	80.9
Incidence of Mastitis, metris, and agalactia	<10	66 (for 1972-75 only)

Source: Cromwell, 2002

Antibiotics show their greatest effect in decreasing production costs and increasing gain when fed in starter diets as is evident from the Danish Ban example (Hayes, 2003). This is because the younger pigs have a higher susceptibility to disease. Newly weaned pigs have a higher susceptibility to disease than any other pigs because they are under great stress after weaning and have an underdeveloped immune system, causing a decrease in the ability of the immune system to fight off diseases (Ensminger, 1991). The stress of weaning, changing dietary forms, and changes in the environment increases the chances illness among newly weaned pigs. Antibiotics help prevent bacteria from infecting the newly weaned pigs. This leads to a lower mortality rate and a higher rate of gain for young pigs. Table 3.3 shows the advantages of using antibiotics in starter diets. Starter pigs in this table are categorized as 6 to 20 kg (14 to 44 lbs). The mortality rate is cut in half, from 4.0% in the control group to 2.0% in the AGP group. The number of days the pigs are fed falls from 35.9 to 30.8, a reduction of 5.1 days. It would be more difficult to duplicate these gains with a change in management styles due to the nature of the starter pig's susceptibility to diseases.

Table 3.3 Comparison of Fed Antibiotics Versus Not Fed Antibiotics (control) in Starter Pig Diets.

Production Measure	Control	Antibiotics in Diet
Daily Gain (kg)	0.39	0.45
Feed/pound gain	2.28	2.13
Mortality (%)	4.0	2.0
Number of Days	35.9	30.8
Feed (kg)	31.9	29.7

Source: Cromwell, 2002

The final stage of production where antibiotics are used is in the growing and finishing diets. These pigs normally weigh between 20 and 115 kg (44 to 253 lbs). This stage has a lower risk of disease because the pigs have had a chance to gain immunity to the diseases present in the herd. Antibiotics at this stage are mainly used for growth promotion and improving feed efficiency (NAHMS, 2000), as is evident from Table 3.4. AGP caused reduction in pounds of feed used per pound weight gain and number of days on feed indicate a greater efficiency in the diets with antibiotics.

Table 3.4 Comparison of Fed Antibiotics Versus Not Fed Antibiotics (control) in Grower-Finisher Diets.

Production Measure	Control	Antibiotics in Diet
Daily Gain (kg)	0.75	0.78
Feed/pound gain	3.30	3.23
Number of Days	126.7	121.5
Feed (kg)	314	306

Source: Cromwell, 2002

As evidenced in earlier discussions, AGP allows producers to increase productivity and efficiency while decreasing production costs. It also leads to more uniform growth, and less managerial time looking for and treating sick animals. Before the heavy use of subtherapeutic antibiotics, producers had to worry about the spread of disease, causing the need for a low number of animals per room and outdoor housing. This changed with the growing use of antibiotics as buildings were constructed to house more animals in bigger rooms. Confinement operations were gaining popularity as the method for growing and finishing hogs to take to packers. This was due to the fact that more animals could be raised within a smaller land base, and fewer personnel were needed to watch over them. Antibiotics provided some of the means necessary to reduce the risk associated with disease and an intense farming operation.

CHAPTER FOUR

CHANGES TO THE COST AND MARKET STRUCTURE

4.1 Changes in the Cost Structure

Removal of AGP from the pork industry will likely have a greater impact on the cost structure of producers than the revenue. With the expected increase in mortality rates, sort loss, and feed costs per gain; producers could face a challenge in maintaining low production costs. Changes in costs along with size constraints for production facilities may cause producers to have to either adopt new technologies or move to less spatially efficient production systems (more square foot per head). However, the total impact also depends on the producer's size, production system, management skills, and whether there will be a full or partial ban. A partial ban would directly affect the grower/ finisher feed additives and the producers involved with this stage of production (Farrow to Finish and Wean to Finish), while a full ban would affect all stages of production.

The overall change in the feed cost per pound gain will depend on two factors: 1) the change in average daily gain (ADG) and 2) the change in feed efficiency. According to accounting, the cost of using antibiotics in feed is considered a veterinary expense. However, ADG and feed efficiency will change feed costs per pound gain dramatically. Not only do pigs receiving subtherapeutic antibiotics grow about 10 percent faster, but also they are about five percent more efficient in converting feed to body weight (Mathews, 2001). This lowered efficiency will have a greater affect on total cost for lower cost producers, but marginally, could cost the higher cost producers more. Lower cost producers may be benefiting from economies of scale and the ability to buy feed in bulk.

In terms of non-feed costs, there are many factors that change with respect to the size and style of the operation. Of the $43.65 million spent on veterinary expenses in the swine industry, $21.4 million of it is on antimicrobial feed additives (USDA, 2001). This means that the veterinary expense should decrease by 49%. However, there will be a cost incurred by the producer to treat animals that do get sick. This increase of sick pigs will then slow growth and likely raise the labor cost as workers would have to spend more time treating sick animals and identifying problems. Costs for therapeutic antibiotics are greater than the cost of subtherapeutic antibiotics, thus possibly off-setting the reduction of AGP cost and may cause minimal change in veterinary expenses.

Mortality on a farm can have a significant impact on its profit. Death loss will increase as a result of a ban, as is evident in studies conducted where subtherapeutic antibiotics were taken out of the feed and compared to groups with varying levels of antibiotics in the feed (Cromwell, 2002; Hayes, et al., 2001; Mathews, 2001). The average mortality difference, as reported by Cromwell (2001), was an increase of 2% in deaths. This translates into an increase in cost of $0.46 per head from mortality if AGP are to be taken from the system (Miller et al., 2003). The majority of the cost from death would be in the nursery and farrowing stages as indicated in chapter three.

Sort loss can have its affect on the producers bottom line as well. Pigs under or over a certain weight will receive a discount by the packer. Antibiotics have been shown to help reduce market weight variability (Tillman, 1996), which leads to higher profits for producers. It was found that there would be an overall sort loss of $1.39 per pig. However, due to the increased days on feed for the group, allowing for slower growing animals to reach the target range, would cause the cost to be one third as much, or $0.49 per pig, on average (Liu et al., 2003).

Wages that are paid to the employees may also be affected by a ban on antibiotics. Employees will have to increase the time spent observing and treating animals. In addition, employee's average wages may increase because education (training) levels would increase due to the demand for employees that were able to correctly identify diseases and proper treatment. A study done by Wade and Barkley (1992) determined that the change to the human capital would be 5.236 percent with the removal of antibiotics. Data from a survey done by the National Hog Farmer (2005) was then used to help adjust this change to a more modern number. This was done by multiplying the percentage change (5.236%) by the change in education (training) levels of employees since 1992 (4.8892%). Because there has been an increase in education over the past decade of the average swine employee, the percentage change was then dropped down to a 4.98 percent change in labor costs due to a ban on AGP. Ideally labor would be more descriptive for various management styles and their characteristics, but due to insufficient data, this could not be conducted.

If an AGP ban implies fewer animals marketed per farm, then per animal fixed costs for production would increase. Due to mortality rates, lower numbers weaned, and less litters per sow cause fewer animals sold per year in which to spread the fixed costs over.

Currently, antibiotic use allows producers to reach a greater efficiency through lower cost of production. In order to estimate the changes to the swine industry after a ban on AGP, different management styles need to be observed. For this study, cost structure will be used as a determinant of management and how antibiotics affect the different cost structures is a method of determining how the different management styles will react to the change. Management skill is often hard to quantify for individual producers; their reaction to the ban may be unknown. However, using cost structures for groups of producers at different efficiencies can provide insight into how different management styles could dampen or magnify the total affect on producers from banning AGP.

Changes in production values were determined by taking data from a study done at the University of Kentucky. The farm used antibiotics, and then switched to an antibiotic free herd for the reason of research safety. Production data was kept on the farm for the nine years preceding the change and for the following 13 predeceasing years (Cromwell, 2002). The categories for this production data are given in table 4.1. Percentage change was calculated using the University of Kentucky Data for subtherapeutic antibiotic free and AGP herds through the following equation:

$$\% \text{ change} = (\text{antibiotic free-antibiotic})/\text{antibiotic} \qquad (1)$$

This formula allows the production data to be changed according to the same magnitude found in the University of Kentucky (UK) study. These numbers were considered the average affect a ban on AGP would have on production and costs. In order to get a range of impacts a higher impact and lower impact was found by adding or subtracting 10 percent from the average calculated effect. This was done by using the formula established here:

$$((\text{Antibiotic free-Antibiotic}) \pm (|\text{Antibiotic Free-Antibiotic}| *.10))/\text{Antibiotic} \qquad (2)$$

This allowed for a range of approximately 10 percent for errors and variations of effects and physiological differences. The results from formulas one and two are represented in table 4.1.

After these changes in the production characteristics were calculated, the next step was applying these changes to the production data from United Feeds. First, the middle third of producers had to be calculated. This was done by using the following equation:

$$\text{Middle third values} = ((AF^* \#)-(TF\ {}^*\#/3)-(BF^*\#/3))/(\#/3) \qquad (3)$$

AF - All Farms
- Number of Farms
TF - Top Third of Producers
BF – Bottom Third of Producers

Once the values for the middle third of producers were calculated, equations could then be assigned to the production values. The production figures were placed into an equation to distinguish how that factor affects the total cost of production, matched up in table 4.1. This was done using the following equation:

$$\text{New Production Value} = \text{Original Value} + (\text{Original Value}^* \ \%\ \text{change}) \qquad (4)$$

Changes were all matched up with the production factors and changed for all variables that were identified in table 4.1. The new numbers provided a change in the cost structure for differing levels of the management skill and how each level would be affected from the change. A sensitivity analysis was then conducted to determine how the results fluctuated by using the high and the low changes for each of the variables. For certain production characteristics that had more than one change from the UK study, the changes were calculated as a combination proportional to the amount of change that was taking place. For example, in the United Feeds Data, there was only one value for the amount of feed in wean to finish production. However, the UK study showed different changes for the newly weaned pigs and the finishing pigs. In order to account for this change, the total feed intake was taken on a percentage of the weights in the stages. For instance, the pig is in the starter phase for 12.8% of the total growth weight. So the final feed intake was multiplied by 12.8% to account for the time spent in the nursery. The same was then done for the finishing phase and then the results were added together. Once it was discovered how the production characteristics affected the costs, the production figures were matched up with their corresponding changes from the University of Kentucky study. The changes were applied by multiplying the percentage change to the production figures to gain a probable performance from the ban on AGP. Equations were then identified using accounting methods that linked different production aspects so changing one variable would affect another, which in turn would affect the costs that the producer endured.

Table 4.1 Percentage and Nominal Change to the production performance from using AGP to AGP free.

United Feeds Production Measure	Production Measure	Average % Change from U of K Study	Avg. United Feeds before Change	Avg. United Feeds after Change
Litters/Sow/Year (B to W)	Litters/sow/year	-0.09628	2.22	2.01
Pigs sold/sow/year (F to F)	Litters/sow/year	-0.09628	16.52	14.08
Number of Hogs Sold (F to F)	Number weaned	-0.14773	8156	6198
Weaned Pigs Sold/Year (B to W)	Number weaned	-0.14773	16092	12508
Pigs/sow/Year (B to W)	Survival of Live Born	-0.08800	19.95	17.00
All Hogs Sold (F to F)	Survival of Live Born	-0.08800	8156	6198
Total Feed/CWT of Pork (F to F)	Daily Gain (starter)	-0.13333	331.30	347.92
Average Daily Gain (W to F)	Daily Gain (starter)	-0.13333	1.43	1.36
Lbs of feed/hog/day (F to F)	Feed/gain (starter)	0.07042	4.21	4.27
Lbs of feed/head/day (W to F)	Feed/gain (starter)	0.07042	4.04	3.95
Total Feed/CWT of Pork (F to F)	Feed (starter)	0.07407	331.30	347.92
Total Feed/CWT Pork (W to F)	Feed (starter)	0.07407	282.59	291.69
All Hogs Sold (F to F)	Mortality (%)	0.02000	8156	6198
Mortality Rate (W to F)	Mortality (%)	0.02000	3.82	5.83
Total Feed/CWT of Pork (F to F)	Daily Gain (finisher)	-0.03846	331.30	347.92
Average Daily Gain (W to F)	Daily Gain (finisher)	0.02167	1.43	1.36
Lbs of feed/hog/day (F to F)	Feed/gain (finisher)	0.02167	4.21	4.27
Lbs of feed/head/day (W to F)	Feed/gain (finisher)	0.02167	4.04	3.95
Total Feed/CWT Pork (F to F)	Feed (finisher)	0.02614	331.30	347.92
Total Feed/CWT Pork (W to F)	Feed (finisher)	0.02614	282.59	291.69
Labor (F to F)	Labor	0.0498	5.82	6.71
Labor (B to W)	Labor	0.0498	7.62	9.32
Labor (W to F)	Labor	0.0498	3.43	4.52

4.1.1 Changes in the Cost Structure for a Partial Ban

A partial ban includes only AGP fed during the growing and finishing phase of production. Antibiotics are mainly fed at this stage for growth promotion and not to control the onset of disease. This means that these producers on average should have the easiest time adjusting to the ban. A partial ban would also allow the industry to respond with a minimal effect since they are not disease reducing.

Table 4.2 shows the changes in cost for the three different types of management dependent on their previous cost level. The breed to wean producers would not notice a difference as a partial ban would not affect them.

Table 4.2 Pre and Post Ban Production Costs for All Production after a Partial Ban on Antibiotic Use in Swine

	Farrow-Finish[1]		Breed-Wean[2]		Wean-Finish[1]	
	Pre	Post	Pre	Post	Pre	Post
High Management	\$38.92	\$39.52	\$24.91	\$24.91	\$40.93	\$41.78
Medium Management	\$40.89	\$42.06	\$28.48	\$28.48	\$41.46	\$41.73
Low Management	\$45.09	\$48.12	\$32.37	\$32.37	\$45.87	\$47.69

[1]Reported as cost per hundred weight
[2]Reported as cost per head

According to these changes, the cost minimizing firms for the Wean to Finish operations would change from the top third to the middle third. This means that there could be a diseconomy of scale with the removal of antibiotics in the grower/finisher diets. In the data, the top third of producers also happens to be the larger firms and the bottom third of producers on average are the smaller producers. Assuming that the firms are cost minimizing firms and are representative of their size, this means that there might be a shift in the market structure of the industry to smaller, more cost efficient facilities. Some of these firms may be taking part in captive supplies by the packing industry and have requirements to maintain large farms. Although these firms are not profit maximizing or cost minimizing, they still are making a profit, as indicated in table 4.3, with their new costs as presented in table 4.2.

Table 4.3 Profits for All Production after a Partial Ban on Subtherapeutic Antibiotic Use in the Swine Industry.

	Farrow-Finish[1]	Breed-Wean[2]	Wean-Finish[1]
High Management	$12.19	$8.07	$10.17
Medium Management	$9.15	$5.93	$11.44
Low Management	$3.87	$6.81	$4.51

[1]Reported as profit per hundred weight
[2]Reported as profit per head

4.2 Changes in the Cost Structure for a Complete Ban

Changes to the cost structure for a complete ban of AGP are greater than that of a partial ban, and affect more producers in the industry. Weaning pigs have the hardest time adapting to the change physiologically, thus causing the bottom line of these producers the most (Hayes, 2001). This is due to the decrease in the total number of pigs produced (income) and also causing the fixed costs per pig or hundred weight to increase. A full ban on AGP will produce similar results as a partial ban for wean to finish producers, but breed to wean and the farrow to finish producers costs should change more dramatically then the partial ban.

Table 4.4, shows the average cost before and after the ban. Like the partial ban, the low cost producer for wean to finish producers changes to the middle producer. This is discussed later in section 4.2.3. All other producer's average costs remain in the same rank. Another interesting result from the ban is that the costs other than feed are most significantly affected by a ban on antibiotics for all production groups with the exception of wean to finish producers. The changes in above feed cost to feed cost ratios are provided in table 4.5 for each of the different producers. Using the above feed costs and dividing them into the feed costs calculated the ratios in table 4.5. This shows that production phases with higher ratios should be affected greater by the ban, giving evidence that the benefits of feeding antibiotics are better for the phases that are not as feed intensive. Evaluations of the results of the full ban, separated by production style, are discussed in the following sections.

Table 4.4 Pre and Post Ban Production Costs Compared for All Production for a Full Ban on Subtherapeutic Antibiotic use in the Swine Industry

	Farrow-Finish[1]		Breed-Wean[2]		Wean-Finish[1]	
	Pre	Post	Pre	Post	Pre	Post
High Management	\$38.92	\$45.65	\$24.91	\$34.64	\$40.93	\$42.42
Medium Management	\$40.89	\$46.56	\$28.48	\$36.12	\$41.46	\$42.37
Low Management	\$45.09	\$53.65	\$32.37	\$39.33	\$45.87	\$48.46

[1]Reported as cost per hundred weight
[2]Reported as cost per head

Table 4.5 Difference in Above Feed Cost to Feed Cost Ratio for All Production in Swine Industry

	Farrow-Finish	Breed-Wean	Wean-Finish
Above Feed Cost: Feed Cost	4.373	5675	1.342

Table 4.6 shows the total profit levels of farms with the varying cost structures before and after the ban takes place. While both middle and low management firms are able to decrease the distance between them and the top firms, neither is able to catch the large firms in terms of total profit level. Previously profit maximizing firms appear to

remain as the profit maximizing firms after a ban on antibiotics. This means that high profit firms are not going to shift out of their current market size; however, they will loose some efficiency. It is interesting to note that even though the producers may have switched their profits on a marginal basis, there was no change in total profit for the various production styles with the exception of the breed to wean producers. For breed to wean producers the middle cost producers move ahead of the low cost. Even though the low performance producers for the breed to wean are the largest, it doesn't aid them after the ban like the rest of the producers.

Table 4.6 Total Profit Levels per Farm Pre and Post Ban for All Styles of Production

		Farrow to Finish	Breed to Wean	Wean to Finish
High Management	Pre	$389,679.59	$95,425.56	$245,149.62
	Post	$142,414.98	-$29,856.40	$208,067.98
Medium Management	Pre	$233,152.33	$94,023.57	$192,289.08
	Post	$81,692.84	-$25,907.70	$173,900.58
Low Management	Pre	$84,253.60	$67,538.16	$102,525.30
	Post	-$13,271.50	-$52,512.20	$60,500.62

4.2.1 A Complete Ban of AGP on Farrow to Finish Producers

The cost changes in table 4.7 displaying the difference in the traits that were developed using the formulas one through four. This table shows that there is an advantage to the middle third of producers; however, the top third of producers still have the lowest cost level. The bottom third of producer's costs level increases enough to drop profit below zero, so therefore should exit the industry or change their technology to capture more economies of scale that the higher management firms have already captured.

The effects of the ban could potentially increase costs to a range of $45.31 to $53.80 per hundred weight depending on the previous profit category. The number weaned, survival of the live born, and labor are the most sensitive factors to the changes from antibiotics. Producers that are considered as medium management are affected the least by the antibiotics. This could be due to lower fixed costs than the other management styles as well as having better production ability. By spreading their lower fixed costs over the inventory, the change in total costs is less than the top producers. The low management producers appear to remain the lowest because their production costs are the highest before the ban, and therefore the change in total costs is going to remain the highest, and in this case exceed the input. The low management producers appear to experience a negative profit, likely forcing them to exit the industry.

Table 4.7 Changes in Costs per Hundred Weight for Farrow to Finish Producers and the Sensitivity Analysis

			Base Estimation			Larger Impact		Smaller Impact	
		Management	Initial Cost Level	Cost Change	Post Ban Cost Level	Cost Change	Post Ban Cost Level	Cost Change	Post Ban Cost Level
Sows	Litters Per Sow	High	$38.92	$6.76	$45.68	$6.77	$45.69	$6.75	$45.67
		Medium	$40.89	$5.66	$46.55	$5.68	$46.57	$5.65	$46.54
		Low	$45.09	$8.54	$53.63	$8.56	$53.65	$8.52	$53.61
	Number Weaned	High	$38.92	$6.76	$45.68	$7.14	$46.06	$6.39	$45.31
		Medium	$40.89	$5.66	$46.55	$5.91	$46.80	$5.42	$46.31
		Low	$45.09	$8.54	$53.63	$8.85	$53.94	$8.24	$53.33
	Survival of Live Born	High	$38.92	$6.76	$45.68	$6.97	$45.89	$6.55	$45.47
		Medium	$40.89	$5.66	$46.55	$5.81	$46.70	$5.53	$46.42
		Low	$45.09	$8.54	$53.63	$8.71	$53.80	$8.36	$53.45
Starter/ Nursery Pigs	Daily Gain	High	$38.92	$6.76	$45.68	$6.77	$45.69	$6.74	$45.66
		Medium	$40.89	$5.66	$46.55	$5.68	$46.57	$5.65	$46.54
		Low	$45.09	$8.54	$53.63	$8.55	$53.64	$8.53	$53.62
	Feed Efficiency	High	$38.92	$6.76	$45.68	$6.77	$45.69	$6.74	$45.66
		Medium	$40.89	$5.66	$46.55	$5.68	$46.57	$5.65	$46.54
		Low	$45.09	$8.54	$53.63	$8.56	$53.65	$8.51	$53.60

Table 4.7 Changes in Costs per Hundred Weight for Farrow to Finish Producers and the Sensitivity Analysis Continued

			Base Estimation			Larger Impact		Smaller Impact	
		Management	Initial Cost Level	Cost Change	Post Ban Cost Level	Cost Change	Post Ban Cost Level	Cost Change	Post Ban Cost Level
Starter/ Nursery Pigs	Mortality	High	$38.92	$6.76	$45.68	$6.80	$45.72	$6.71	$45.63
		Medium	$40.89	$5.66	$46.55	$5.70	$46.59	$5.63	$46.52
		Low	$45.09	$8.54	$53.63	$8.58	$53.67	$8.50	$53.59
	Feed	High	$38.92	$6.76	$45.68	$6.84	$45.76	$6.67	$45.59
		Medium	$40.89	$5.66	$46.55	$5.76	$46.65	$5.57	$46.46
		Low	$45.09	$8.54	$53.63	$8.64	$53.73	$8.43	$53.52
Grower/ Finisher Pigs	Daily Gain	High	$38.92	$6.76	$45.68	$6.78	$45.70	$6.73	$45.65
		Medium	$40.89	$5.66	$46.55	$5.69	$46.58	$5.64	$46.53
		Low	$45.09	$8.54	$53.63	$8.56	$53.65	$8.51	$53.60
	Feed Efficiency	High	$38.92	$6.76	$45.68	$6.79	$45.71	$6.72	$45.64
		Medium	$40.89	$5.66	$46.55	$5.70	$46.59	$5.62	$46.51
		Low	$45.09	$8.54	$53.63	$8.59	$53.68	$8.49	$53.58
	Feed	High	$38.92	$6.76	$45.68	$6.79	$45.71	$6.73	$45.65
		Medium	$40.89	$5.66	$46.55	$5.70	$46.59	$5.63	$46.52
		Low	$45.09	$8.54	$53.63	$8.57	$53.66	$8.50	$53.59
	Labor	High	$38.92	$6.76	$45.68	$7.11	$46.03	$6.62	$45.54
		Medium	$40.89	$5.66	$46.55	$5.94	$46.83	$5.56	$46.45
		Low	$45.09	$8.54	$53.63	$8.87	$53.96	$8.41	$53.50

4.2.2 A Complete Ban of AGP on Breed to Wean Producers

When the scenario for the complete ban of AGP was simulated for the breed to wean producers, the change in costs resulted in negative profits for every group. This may indicate that the breed to wean industry is competitive or vertically coordinated enough that savings were passed on to the wean to finish production facilities through lower prices. The potential new level in costs are in a range from a high of $39.86 to a low of $34.07 per head sold depending on the previous profit level. Cost structure of the producers will apparently remain the same after a ban is enacted. With the relatively dramatic change in costs, many of the producers fall to a negative marginal profit. This means that unless there is a change in feeder pig prices, no breed to wean producer would be able to make a profit. Even if feeder prices increase, producers all three groups may decide that raising feeder pigs is not profitable enough anymore and change to a farrow to finish operation where they could collect gains or opt to leave the industry.

The breed to wean producers exhibit the highest above feed cost to feed cost ratio, shown in table 4.5. Because antibiotics affect the physiological production of the sows, not the feed efficiency or feed intake per head, it is no surprise that these producers could potentially take the biggest hit from a ban on AGP. Most of the benefits associated with the use of antibiotics for this stage are with hogs produced and the amount of weaned pigs sold. It has been found however, that producers could therefore, with proper management, offset the significant effects of the change in use of antibiotics.

Table 4.8 Changes in Costs per Pig for Breed to Wean Producers and the Sensitivity Analysis

			Base Estimation		Larger Impact		Smaller Impact	
	Management	Initial Cost Level	Cost Change	Post Ban Cost Level	Cost Change	Post Ban Cost Level	Cost Change	Post Ban Cost Level
Sows: Daily Gain	High	$24.91	$9.70	$34.61	$9.72	$34.63	$9.68	$34.59
	Medium	$28.48	$7.64	$36.12	$7.66	$36.14	$7.61	$36.09
	Low	$32.37	$6.99	$39.36	$7.02	$39.39	$6.96	$39.33
Sows: Feed Efficiency	High	$24.91	$9.70	$34.61	$10.15	$35.06	$9.26	$34.17
	Medium	$28.48	$7.64	$36.12	$8.10	$36.58	$7.19	$35.67
	Low	$32.37	$6.99	$39.36	$7.49	$39.86	$6.50	$38.87
Sows: Feed	High	$24.91	$9.70	$34.61	$9.95	$34.86	$9.46	$34.37
	Medium	$28.48	$7.64	$36.12	$7.89	$36.37	$7.39	$35.87
	Low	$32.37	$6.99	$39.36	$7.27	$39.64	$6.72	$39.09
Labor	High	$24.91	$9.70	$34.61	$9.91	$34.82	$9.16	$34.07
	Medium	$28.48	$7.64	$36.12	$7.82	$36.30	$7.14	$35.62
	Low	$32.37	$6.99	$39.36	$7.18	$39.55	$6.48	$38.85

The sensitivity analysis shows the same as the farrow to finish producers; the labor and number weaned variable can be most sensitive to changes followed by survival of live born. This is due to the fact that labor and number of animals weaned make up so much of the above feed costs.

4.2.3 A Complete Ban of AGP on Wean to Finish Producers

Wean to finish producers are affected the least by a ban on AGP in terms of changes in costs. With the costs potentially ranging from $42.39 and the $48.79, wean to finish producers will have an easier time adjusting to the ban than other producers. This is due to the nature of the operations. Most of the operations are all-in-all-out and keep the animals in groups. This helps to decrease and control diseases within the herd.

In wean to finish production, like farrow to finish production, we see a change in the economies of scale. The medium management producers have the lowest cost because of a shift of cost minimizing size due to the ban on AGP. This indicates that the previously medium cost producers are reaching greater economies of scale, and the high management producers have passed them and are potentially large enough to reach diseconomies of scale. Table 4.9 shows the differences in costs before a ban and after a ban and the sensitivity of individual characteristics.

Table 4.9 shows a non-proportional growth in costs where the middle producers actually become the low cost producers. This would cause a shift for producers that are cost minimizing to replicate the medium management production style. Profit maximizing producers will already be in the middle pre-ban, because the middle third of producers were already had the highest profit levels.

The change in above feed cost to feed cost ratio, displayed in table 4.5, is the lowest of all the other production categories. This is the result of the antibiotics mainly providing benefit to the growth and feed efficiency. This means that if AGP stopped being fed to the grower and finisher pigs, they would require more feed to reach the same market weight. There is little difference in the mortality rate of the animals after the weaning stage, so antibiotics do not have a significant effect on the total number sold.

Table 4.9 Changes in Costs per Hundred Weight for Wean to Finish Producers and the Sensitivity Analysis

		Management	Base Estimation			Larger Impact		Smaller Impact	
			Initial Cost Level	Cost Change	Post Ban Cost Level	Cost Change	Post Ban Cost Level	Cost Change	Post Ban Cost Level
Starter/ Nursery Pigs	Daily Gain	High	$40.93	$1.50	$42.43	$1.52	$42.45	$1.49	$42.42
		Medium	$41.46	$0.91	$42.37	$0.92	$42.38	$0.90	$42.36
		Low	$45.87	$2.57	$48.44	$2.59	$48.46	$2.56	$48.43
	Feed Efficiency	High	$40.93	$1.50	$42.43	$1.52	$42.45	$1.49	$42.42
		Medium	$41.46	$0.91	$42.37	$0.92	$42.38	$0.90	$42.36
		Low	$45.87	$2.57	$48.44	$2.59	$48.46	$2.56	$48.43
	Mortality	High	$40.93	$1.50	$42.43	$1.55	$42.48	$1.46	$42.39
		Medium	$41.46	$0.91	$42.37	$0.95	$42.41	$0.86	$42.32
		Low	$45.87	$2.57	$48.44	$2.63	$48.50	$2.52	$48.39
	Feed	High	$40.93	$1.50	$42.43	$1.52	$42.45	$1.49	$42.42
		Medium	$41.46	$0.91	$42.37	$0.93	$42.39	$0.89	$42.35
		Low	$45.87	$2.57	$48.44	$2.59	$48.46	$2.55	$48.42

Table 4.10 Changes in Costs per Hundred Weight for Wean to Finish Producers and the Sensitivity Analysis Continued

			Base Estimation			Larger Impact		Smaller Impact	
		Management	Initial Cost Level	Cost Change	Post Ban Cost Level	Cost Change	Post Ban Cost Level	Cost Change	Post Ban Cost Level
Grower/ Finisher Pigs	Daily Gain	High	$40.93	$1.50	$42.43	$1.53	$42.46	$1.48	$42.41
		Medium	$41.46	$0.91	$42.37	$0.93	$42.39	$0.88	$42.34
		Low	$45.87	$2.57	$48.44	$2.60	$48.47	$2.55	$48.42
	Feed Efficiency	High	$40.93	$1.50	$42.43	$1.53	$42.46	$1.48	$42.41
		Medium	$41.46	$0.91	$42.37	$0.94	$42.40	$0.88	$42.34
		Low	$45.87	$2.57	$48.44	$2.61	$48.48	$2.54	$48.41
	Feed	High	$40.93	$1.50	$42.43	$1.55	$42.48	$1.46	$42.39
		Medium	$41.46	$0.91	$42.37	$0.95	$42.41	$0.86	$42.32
		Low	$45.87	$2.57	$48.44	$2.92	$48.79	$2.52	$48.39
	Labor	High	$40.93	$1.50	$42.43	$1.72	$42.65	$1.42	$42.35
		Medium	$41.46	$0.91	$42.37	$1.09	$42.55	$0.84	$42.30
		Low	$45.87	$2.57	$48.44	$2.82	$48.69	$2.48	$48.35

CHAPTER FIVE

SUMMARY AND CONCLUSIONS

5.1 Summary

The impact of a ban on Antibiotic Growth Promotants (AGP) depends on the structure of the swine industry and on the nature of the ban. Many studies have examined the effects of a ban on consumers and producers, but these studies have considered swine production and producers to be homogeneous. However, producers manage various types of operations, and even within an operational type, have different cost structures. These differences mean that the effect of removing AGP from production will affect each producer differently. Viewing the swine producer as heterogeneous leads to interesting conclusions about how an AGP ban would impact the various cost structures.

The question posed at the onset was whether an AGP ban would impact various cost structures differently; in particular whether a ban would have a relatively larger effect on low-cost producers. Low-cost producers typically operate larger farms that generate economies of scale by spreading their labor and fixed costs over a greater number of animals. It was hypothesized that a ban would reduce these economies of scale by increasing the optimal amount of labor per animal.

One of the assumptions that were made in this project is that the companies that have high management (low cost) firms were also on average on the larger firms. This assumption was consistent for the Farrow to Finish and Wean to Finish producers. This was reverse for the Breed to Wean firm though. The connection between cost and size for the producers was taken from the average size of the producers in those categories. Conclusions of economies of scale were made from these assumptions.

The findings first and foremost show that a full ban on AGP would increase productions costs for all producers (Table 5.1). To a degree, there are differences among the cost increases faced by different producers that corroborate the hypothesis. For example, a full ban would increase the labor costs by $2.04 per cwt for the low-cost producers, but increase the medium-cost firms' labor costs only by $0.27 per cwt. In one case, breed to wean producers, the medium-cost producers without the ban become the low-cost producers in the presence of a full ban. However, according to the results, the effects do not increase the relative profitability of the high-cost producers sufficiently to compete with the low-cost producers. Nonetheless, the results are sufficient to show that a full AGP ban would affect the producers differently, particularly the medium-cost producers v. the high-cost producers.

Table 5.1 Pre and Post Ban Production Costs Compared for All Production for a Full Ban on Subtherapeutic Antibiotic in the Swine Industry

	Farrow-Finish[1]		Breed-Wean[2]		Wean-Finish[1]	
	Pre	Post	Pre	Post	Pre	Post
High Management	$38.92	$45.65	$24.91	$34.64	$40.93	$42.42
Medium Management	$40.89	$46.56	$28.48	$36.12	$41.46	$42.37
Low Management	$45.09	$53.65	$32.37	$39.33	$45.87	$48.46

[1]Reported as cost per hundred weight
[2]Reported as cost per head

The most important factors affecting profits is labor costs. With antibiotics, employees did not have to spend time observing and treating pigs for illness. Without antibiotics, not only does the time with the animals increase, but employees would require a higher education to observe different symptoms and to be able to diagnose and treat them correctly, thus increasing both hours and hourly wages. Because labor costs are a large part of the above-feed costs, total costs are volatile with respect to relatively small changes in labor use and costs.. Thus, the effect of an AGP ban is sensitive to changes in labor costs across farm types, and to the impact of the ban on labor use and costs. This was evident in the sensitivity analysis presented in chapter 4.

The complete findings for a full ban on antibiotics are as follows:

- The ban would increase production costs for all types of producers and swine operations.
- The ban would limit or reduce economies of scale in the swine industry.
- This change in the economies of scale are sufficient to change cost minimizing (productivity maximizing) from the large to medium for wean to finish producers.
- The change in profit from labor costs does not seem to increase enough to help the smallest farms, but this is could change with sufficient data.
- The effects of an AGP ban are strongly influenced by labor costs.
- Changes in labor costs have differential effects on profit for different farm sizes/efficiencies by an AGP ban.
- Holding prices constant, a ban on AGP would make many producers unprofitable, most likely leading to an exit from the industry and/or an increase in prices. Small producers, while closing the profit gap, are still the most likely to exit the industry.

This paper also examined the impacts of a partial AGP ban on the different types of swine operations and cost structures. A partial ban is a ban enacted for only the AGP in grower/finisher feeds. This means that in the starter pigs, where the antibiotics are most effective physiologically, AGP would still be used. This is because young pigs have weaker immune systems, and antibiotics allow them to stay healthy and grow faster. A partial ban would help reduce the amount of bacteria that develop resistance to antibiotics, yet not affect the production phases where the antibiotics are most needed for the welfare of the animal.

The effects on costs of a partial ban are listed in table 5.2 for the various operations and cost structures. Because the partial ban does not affect use of AGP in the breed to wean operation, there is no effect on costs. For farrow to finish operations, costs increase for all producers, and increase the most for high-cost producers. For wean to finish, costs increase for all producers, but increase by $0.85 per cwt for low cost producers and only $0.27 per cwt for medium producers. This would be sufficient to make the current medium-cost producers into the low-cost producer with the partial ban.

Table 5.2 Pre and Post Ban Production Costs for All Production after a Partial Ban on Antibiotic Use in Swine

	Farrow-Finish[1]		Breed-Wean[2]		Wean-Finish[1]	
	Pre	Post	Pre	Post	Pre	Post
High Management	$38.92	$39.52	$24.91	$24.91	$40.93	$41.78
Medium Management	$40.89	$42.06	$28.48	$28.48	$41.46	$41.73
Low Management	$45.09	$48.12	$32.37	$32.37	$45.87	$47.69

[1]Reported as cost per hundred weight
[2]Reported as cost per head

Given that prices producers received stayed relatively constant following a ban, many producers would end up with a negative income level.[2] This would almost inevitably lead to an exit in from the industry. Many of these producers are in the breed to wean stage of production. These producers would then either have to switch to a farrow to finish operation or exit the industry. Small producers in the farrow to finish operations would also run into the same predicament and decisions that the producers in the breed to wean operations would have. Small producers in every segment are more likely to exit following a ban than large or medium producers as their profits are the lowest (Table 5.5).

One of the characteristics associated with the cost structures is farm size. Although they are not a one-to-one correspondence, high-cost producers tend to be smaller and low-cost producers tend to be larger. For example, average farrow to finish farm size is 11,336 head sold per year for the low-cost producers, 8,490 head sold per year for the medium-cost producers, and 4,634 head sold per year for the high-cost producers.

One of the major observations from this study is that for the large farrow to finish and wean to finish producers the ban has an important effect that reduces existing economies of scales. Whether this reduction is large enough to affect farm sizes is unclear at this point, since the farm size decision is affected by many factors other than productive efficiency. This means that the cost minimizing firms, that aren't constrained by a contract, asset fixity, or other constraints or costs will scale back their production and fall into the middle or medium size. Depending on where their utility lies, some

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[2] Passing cost increases on to consumers would decrease the quantity of pork consumed, again leading to exit from the industry.

large producers would still be able to remain large because they are still making a profit. However, these producers (on a per head basis) are not going to be considered a cost minimizing or profit maximizing firm. On a total ban issue, there is no evidence that shows that profit maximizing firms will change size as is evident in table 5.5, with the exception of the Breed to Wean producers.

Table 5.3 Total Profits for Top, Middle, and Low Production Producers Pre and Post a Complete Ban on AGP

		Farrow to Finish	Breed to Wean	Wean to Finish
Top Production	Pre	$389,679.59	$95,425.56	$245,149.62
	Post	$142,414.98	-$29,856.40	$208,067.98
Middle Production	Pre	$233,152.33	$94,023.57	$192,289.08
	Post	$81,692.84	-$25,907.70	$173,900.58
Low Production	Pre	$84,253.60	$67,538.16	$102,525.30
	Post	-$13,271.50	-$52,512.20	$60,500.62

The results show that in the farrow to finish and wean to finish operations the ban introduces diseconomies of scale for the large low-cost producers as the effect on their costs are going to be higher than the middle third of producers. Although this study didn't measure economies of scale directly, the high cost structure for previously low-cost producers indicate the presents of diseconomies of scale. In the case of wean to finish producers; this could lead cost minimizing producers to decrease in size. However, in the breed to wean group, there would actually be a greater economy of scale and production would go toward the larger farms.

5.2 Policy Recommendations

From the conclusions discussed, the following policy recommendations are to aid the producers into a smooth transition and decrease the impacts of a ban on antibiotics, but are not essential to a successful ban.

5.2.1 Policy Learned from Europe

Denmark and Sweden's experiences with banning AGP provide insight on methods and lessons to decrease the impact that a ban would have on producers. Observing their steps and reactions and what worked and what didn't will help better to prepare the United States swine producer. The following two recommendations will help the producer and the government cope with the impact of an AGP ban in the swine industry.

First, the government should mandate a change in management practices before an AGP ban. This will ease the transition and spread the costs over a larger timeframe. In Europe, many of the management practices that aided producers were put into place before their ban. Management practices such as creating more space per animal and increasing the age at which an animal can be weaned are examples of management practices that some countries in Europe enacted. While at the time this legislation may not have been intended for this consequence, it did affect the impact that the producer noticed during the ban. These practices allow for the animals to gain a stronger immune system and cause less stress on the animals, which help to control the incidence and spread of disease on the farm.

The second problem that the United States government could encounter is that currently, there is no governing body that oversees the use of antibiotics. The Food and Drug Administration (FDA) controls which antibiotics can and cannot be used and how they should be used, but cannot monitor in practice how the drugs are used. At the current time, there is no agency that records or monitors antibiotic production or use in the United States livestock industry. Denmark and Sweden both have the ability to monitor individual veterinarians and how they use the drugs. The government would need to monitor drug use on farms more closely in order to keep reluctant producers from using AGP.

5.2.2 Policy Recommendations from this Study

One of the first observations of this study is that the impacts of a partial ban on AGP should allow the producers to remain profitable, causing minimal effects on production costs and industry structure in relation to the full ban. While there may be a change in cost-minimizing producers to the previously medium-cost firms in the wean to finish phase, overall the change in cost structures is minimal compared to the impact that a full ban would create. A partial ban on the use of AGP would be more cost efficient than the full ban in terms of getting the most benefits for the least amount of costs. Denmark used a partial ban to start the full ban, thus spreading out the costs and allowing farmers to ease into a full ban. According to Hayes et al., in 2003, Denmark using a partial ban received 80 percent of the benefits of not using antibiotics for about 20 percent of the cost of the full ban. However, if removal of AGP from the complete system is the final goal, then using a partial ban as a starting block would be extremely helpful to producers by spreading changeover costs over a longer timeline.

When enacting a full ban, producers will witness many changes to their cost structure. Something that would be helpful, especially to the breed to wean firms, would be a subsidy that declines over time. This could be done with the use of a price floor for feeder pigs that would be enough to help offset the increase in costs. The subsidy would then phase out over time by getting smaller and smaller so that those producers that would exit the industry could do so at a slower pace and decrease the shock that the market would experience. Lowering the price floor gradually over time would allow the market price to gradually meet with market demand. Once the price floor has been lowered to the original market price, it can be eliminated. This would help maintain a steady supply of pork and weaken the shock to the market. A declining subsidy would allow the market slowly to make the adjustments needed to the new market conditions and allow producers to change their marketing strategies and decrease the impact that producers of various sizes feel.

If the United States government passes a law banning the use of AGP in swine, there would be more of a positive view on United States Pork, which could lead to more exports. It could provide the United States pork producer with the opportunity to access niche markets the world over in addition to their current domestic and international markets.

5.3 Limitations of the Study and Future Research

Current limitations prevented me from fully exploring the initial hypothesis that the high-cost producers would be affected less by the ban to a level where they could compete equally with the current low-cost producers. Not enough labor data and a lack of measuring management capacity could have altered the results of the hypothesis.

Ideally, a poll of producers across America would allow individual results to be observed. This would allow discovery on how individual regions of hog production would be affected as well as fill in holes and not have the assumptions present in this paper. A national survey would also help develop a better picture of how management styles and labor costs vary across the United States. One of the problems of using the United Feeds data set is that only the averages are reported. It is often hard to determine how the producer calculated their numbers and if they have the same calculations that the company/researcher is using.

Finally, there is no current way to quantify various management styles and how they deal with change. The only way to measure this is to use an indicator, such as education, experience, or costs. This method, however, does not capture the ability of the producer to respond to situations. As stated previously, having good management can often offset, or exceed, the effects of a ban on AGP, especially in the breeding and finishing stages. Thus, being able to measure management would allow the researcher to develop models to determine the impact that a ban on antibiotics would have on various producers and determine how much of the changes in cost are attributed to management and how much are attributed to AGP.

The following are some relevant needs that should be addressed in future research:

- Develop methods and measures in order to quantify management capacity and how shocks to the system will affect these managers.
- Determine how the heterogeneity of the producer's management capacity contributes to firms' decisions. For instance, how would the management capacity affect how a firm would deal with the ban on antibiotics?
- Obtain more information on the cost differences across different operation characteristics.
- Measure how the effects of the change in market structure go through the market channel and consumers willingness to pay for the change?

APPENDICES

Appendix A The Original United Feeds Data Set for Farrow to Finish Producers.

	All Farms	Top 1/3	Middle 1/3	Low 1/3
All Hogs Sold: Avg. Number	8156	11336	8490	4634
Calculated Pigs Sold/Sow/Year	16.52	18.42	16.54	14.60
Lbs. Pork Product/Sow/Year	4287.00	4893.00	4336.87	3630.00
All Hogs Sold: Avg. Weight	256.63	258.43	258.75	252.66
Market Hogs Sold: Avg. Weight	260.96	264.99	261.36	256.52
All Hogs Sold: Avg Net Price	51.82	51.89	51.40	52.18
Market Hogs Sold: Avg Net Price	52.22	52.07	51.93	52.67
Total Feed/CWT Pork	331.30	298.51	328.79	366.66
Lbs. Feed/Hog/Day	4.21	4.10	4.31	4.22
Lbs. Corn/CWT Pork	246.89	218.84	243.44	278.47
Cost/Bushel Corn	2.44	2.45	2.47	2.40
Lbs. Soybean Meal/CWT Pork	64.52	61.17	64.68	67.71
Cost/Ton Soybean Meal	239.19	229.97	246.67	240.76
Lbs. Premix/Cwt Pork	5.48	4.61	5.56	6.27
Feed Costs Other than Corn and SBM	6.64	6.23	6.51	7.18
Feed Costs/Ton Feed	151.70	152.94	153.32	148.80
Supplies and Miscellaneous	0.36	0.41	0.29	0.38
Veterinarian and Medicine	1.05	1.15	1.01	0.99
LP Gas and Electricity	1.39	1.26	1.22	1.69
Insurance and Taxes	0.68	0.69	0.66	0.69
Repairs or Maintenance	1.14	1.04	1.17	1.21
Tractor and Truck	0.61	0.57	0.53	0.73
Interest on Average Inventory	1.45	1.31	1.44	1.60
Building and Equipment Depreciation	2.55	2.38	2.64	2.63
Building and Equipment Charge	3.30	3.23	3.08	3.60
Building and Equipment Rent	2.21	3.17	1.88	1.59
Boar and Semen Cost	0.69	0.76	0.71	0.60
Gilt Premium	0.74	0.70	0.70	0.82
Labor	5.82	5.43	5.45	6.59
Costs above Feed/Cwt Pork	16.52	16.09	15.69	17.81
Feed Cost/CWT Pork	25.13	22.83	25.21	27.28
Total Cost/CWT Pork	41.65	38.92	40.89	45.09
Profit/CWT Pork	10.17	12.97	10.51	7.09

Appendix B The Original United Feeds Data Set for Wean to Finish Producers.

	All Farms	Top 1/3	Middle 1/3	Low 1/3
Market Hogs Sold: Avg. Number	6709	8153	6095	5930
Market Hogs: Average Weight	266.46	268.47	265.42	265.58
Market Hogs: Average Price/CWT	52.64	52.13	53.35	52.38
Pigs Purchased: Avg Weight	12.20	12.16	12.13	12.32
Pigs Purchased: Avg Price/Head	33.25	32.10	33.16	34.50
Total Feed/CWT Pork	282.59	256.00	284.27	307.36
Lbs. Feed/Head/Day	4.04	3.68	4.22	4.20
Avg. Daily Gain	1.43	1.44	1.48	1.37
Death Loss (%)	3.82	3.55	3.53	4.40
Lbs. Corn/CWT Pork	207.62	184.57	204.49	234.06
Cost/Bushel Corn	2.41	2.38	2.39	2.46
Lbs. Soybean Meal/CWT Pork	57.94	55.08	57.71	61.05
Cost/Ton Soybean Meal	229.16	222.13	228.99	236.37
Lbs. Premix/Cwt Pork	5.48	4.61	5.55	6.27
Feed Costs Other than Corn and SBM	5.31	5.75	5.04	5.16
Feed Costs/Ton Feed	148.18	154.08	143.44	147.42
Supplies and Miscellaneous	0.28	0.23	0.35	0.25
Veterinarian and Medicine	0.60	0.66	0.54	0.61
LP Gas and Electricity	0.78	0.68	0.90	0.75
Insurance and Taxes	0.46	0.49	0.43	0.46
Repairs or Maintenance	0.79	0.50	0.42	1.48
Tractor and Truck	0.74	0.79	0.76	0.67
Interest on Average Inventory	1.30	1.16	1.07	1.69
Building and Equipment Depreciation	2.19	2.25	2.22	2.10
Building and Equipment Charge	2.31	2.43	1.88	2.66
Building and Equipment Rent	2.41	2.95	2.11	2.20
Labor	3.43	4.15	2.68	3.52
Calculated Weaned Pig Cost/CWT	11.14	10.63	11.26	11.52
Costs above Feed/Cwt Pork	21.80	21.78	20.53	23.19
Feed Cost/CWT Pork	20.91	19.72	20.39	22.66
Total Cost/CWT Pork	42.72	40.93	41.46	45.87
Profit/CWT Pork	9.92	11.20	11.89	6.51

Appendix C The Original United Feeds Data Set for Breed to Wean Producers.

	All Farms	Top 1/2	Low 1/2
Weaned Pigs Sold: Avg. Number	16092	11651	19748
Calculated Pigs Sold/Sow/Year	19.95	20.61	18.84
Litters/Sow/Year	2.22	2.29	2.10
Pigs/Crate/Year	165.87	210.34	120.09
Breeding Herd Replacement Rate (%)	52	50	55
Weaned Pigs Sold: Avg Price/Pig	33.73	31.78	35.91
Weaned Pigs Sold: Avg Weight	12.43	12.16	12.63
Breeding Stock Sold: Avg Price CWT	41.22	42.22	40.11
Breeding Stock Sold: Avg Weight	475.04	484.21	461.89
Total Feed/Pig	127.28	115.69	142.00
Feed Cost/Pig	9.77	9.02	10.88
Lbs. Sow Feed/Sow/Year	2422.00	2275.00	2507.00
Avg Feed Cost/Sow/Year	189.62	181.34	200.88
Average Corn Price/Bushel	2.42	2.40	2.46
Average Soybean Meal Price/Ton	233.34	241.45	230.49
Feed Cost Other Than Corn and SBM/Pig	3.06	2.84	3.36
Feed Costs/Ton Feed	153.53	156.12	153.21
Supplies and Miscellaneous	0.59	0.55	0.63
Veterinarian and Medicine	1.56	1.40	1.78
LP Gas and Electricity	1.20	0.94	1.58
Insurance and Taxes	0.66	0.43	0.91
Repairs or Maintenance	0.63	0.51	0.74
Tractor and Truck	0.48	0.39	0.60
Interest on Average Inventory	1.57	0.85	1.98
Building and Equipment Depreciation	2.39	1.84	2.95
Building and Equipment Charge	2.91	2.25	3.65
Building and Equipment Rent	3.57	4.75	0.64
Boar and Semen Cost	1.94	1.80	2.18
Premium for Gilts Purchased	1.59	1.50	1.95
Labor	7.62	6.10	9.72
Costs above Feed/Pig	20.67	17.23	24.48
Feed Cost/Pig	9.77	9.02	10.88
Total Cost/Pig	28.48	24.91	32.37
Profit/Pig	5.93	8.07	3.42
Profit/Sow	118.30	166.32	64.43

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