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AN EVALUATION OF RECENT INNOVATIONS IN FOOD SAFETY TESTING AND ENFORCEMENT: DRUG RESIDUES IN CALVES

By

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ABSTRACT

AN EVALUATION OF RECENT INNOVATIONS
IN FOOD SAFETY TESTING AND ENFORCEMENT:
DRUG RESIDUES IN CALVES

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Approximately 1.4 million newborn dairy calves were purchased by slaughterers for immediate kill in 1984, representing an estimated $82 million to dairy farmers. Incentives exist for dairy farmers to utilize drugs rather than alternative, labor-intensive methods to manage unhealthy surplus calves. The required withdrawal periods for most antibiotic or sulfonamide drugs legally available for treating common calfhood diseases exceed the life of slaughter calves. Residues of these drugs pose known and potential risks to human health.

This research examines changes in expected costs and expected benefits of marketing violative calves following implementation of both an innovative testing procedure and a certification process within calf markets by the U.S. Department of Agriculture's Food Safety and Inspection Service. Results indicate that this regulatory approach was ineffective in reducing residues. Identification information was not utilized to penalize individual violators causing positive net benefits to exist for falsely certifying violative calves.

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LIST OF ABBREVIATIONS USED

CAST	Calf Antibiotic and Sulfa Test
FDA	Food and Drug Administration
FSIS	Food Safety and Inspection Service of USDA (formerly FSQS)
FSQS	Food Safety and Quality Service
REPD	Residue Evaluation and Planning Division of FSIS, United States Department of Agriculture
STOP	Swab Test on Premises
SPSS	Statistical Package for the Social Sciences
SST	Sulfa STOP Test
USDA	United States Department of Agriculture

CHAPTER ONE

INTRODUCTION

THE RESIDUE PROBLEM

One of the major tasks of food safety regulatory agencies is to protect consumers from risks associated with excessive drug use in raising livestock. Antibiotics and sulfa drugs are used in livestock production for treating illness, preventing disease, or stimulating growth. Residues of these drugs pose both known and potential risks to human health. Three risks include: allergic reactions in sensitive humans, a potential carcinogenic response, and development of resistance to antibacterials now used in human medical therapy.

In the U.S., withdrawal periods are required for drugs authorized for use in food producing animals. Tolerances have been established on allowable levels of drug residues in meat by the Food and Drug Administration (FDA). Procedures for random monthly assays of animal tissues to determine the extent of non-compliance with established tolerances are in place in all slaughterplants which butcher for commercial sale.

Results of a national monitoring program conducted by

the Food Safety and Inspection Service of the U.S. Department of Agriculture show that between 1978 and 1982, the incidence of residues in major meat animal species was reduced from 4.7% to 1.0% for antibiotics and from 9.0% to 3.0% for sulfa.[1] Figures from the national testing program also show that of the antibiotic residues found in 1982, seventy-eight percent were detected in calves. Between 1978 and 1982, the national average rate of detection of antibiotic residues in calves was 5.3%. According to FSIS, antibiotic residues found in these animals during this period "were well above levels that cause allergic reaction in sensitive humans."[2]

Newborn calves were determined by FSIS to be the source of the residue problem because the average drug withdrawal period exceeds the life of the animal. The newborn calves include "bob" or "drop" calves which are mainly surplus dairy calves slaughtered before two weeks of age. Those surplus calves which are born unhealthy or become ill before being marketed, are treated with drugs, and then purchased by a slaughterer for immediate kill, will contain residues.

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[1]As cited in "Antibiotics, Sulfonamides, and Public Health," CRC Handbook Series In Zoonoses, edited by James H. Steele and George W. Beran. These statistics were confirmed by the Residue Planning and Evaluation Division, Food Safety and Inspection Service, U.S. Department of Agriculture, Washington, D.C.

[2]Unpublished report titled "Meeting of Wisconsin Veal Industry Representatives With Food Safety and Inspection Service Officials," May 4, 1984, Washington, D.C. Made available to the author by the Residue Evaluation and Planning Division, FSIS, USDA.

In 1982, FSIS inspectors found many instances of partially dissolved sulfa boluses in post-mortem inspections of bob calves. This provided the evidence that the calf residue problem was focused in the bob calf sector of the calf market.

A NEW ENFORCEMENT APPROACH

Beginning in 1984, FSIS responded to high levels of antibiotic and sulfanomide residues in calves using a new approach. The FSIS program had two main features: 1) increased sampling of calves at slaughter using an innovative, in-plant residue testing procedure called the Calf Antibiotic and Sulfa Test (CAST) and, 2) a process of voluntary certification which allows a formal transfer of drug use information concerning individual calves to take place between buyers and sellers. The latter feature is what distinguishes this program from previous enforcement efforts.

To provide an effective incentive for utilization of the voluntary process, FSIS required uncertified calves to be tested for drug residues at slaughter at a significantly higher rate than certified calves. This sampling plan was intended to impact slaughterplant demand for certified animals and therefore market supply. The certification process is simple: every time a calf changes ownership, a short statement which indicates that the animal was not

recently treated with any type of drug which could leave illegal residues must be signed by the previous owner. This statement is usually stamped on the receipt for the animal which the seller signs.

There are two reasons why this voluntary certification process is important. First, certification represents the first animal identification program introduced within a livestock sector by a regulatory agency. Shriver (1984) and Kramer (1982) concluded that due to the lack of identification in livestock markets in general, government institutions exercise inadequate control over chemical residues in retail meat products. According to Shriver, consumers pay twice for protection against potential health risks associated with consumption of meat with residues: once in the form of taxes to fund government agencies associated with setting and enforcing tolerance levels, and a second time in the form of higher retail meat prices. Increased prices are the result of slaughterers passing along the cost of the risk they assume in purchasing animals which may ultimately be condemned. In that violative levels of residues persist in the retail meat supply despite regulation and enforcement efforts, consumers pay a third time in the form of actual health risks.

Shriver maintained that these excessive consumer costs are due in part to the inability of governmental agencies to bring producers under the control of the consequences of the their decision to violate regulations

concerning legal residue tolerance levels. Producers who violate existing regulations do so because the risk associated with drug use is often less than the benefits from improved weight gain, feed efficiency, etc. Although regulatory institutions cite producer lack of information as the main reason for residues, Shriver asserted that an equally important reason is that the direct costs of unauthorized residues in meat animals are not assessed to responsible producers. She prescribed governmental initiatives which impose direct costs on violating producers as being necessary for improved enforcement of federal standards for chemicals in meat. The result of such efforts would be the shifting of costs from all producers, slaughterers, and non-violators to actual violating producers.

A similar conclusion was forwarded in the 1985 evaluation of the scientific basis of the current system for inspecting meat and poultry conducted by the National Research Council. One of the central aspects of the system considered in this evaluation was public risks from chemical agents. The recommendation they made for preventing consumer exposure to potential hazards caused by chemical agents was the introduction of a system to identify and trace back animals to their farms.

The second reason for the importance of the certification program is that it reflects an innovative regulatory approach. FSIS cannot easily penalize violators of residue regulations detected though its residue testing programs.

Certification represents an attempt to get around this restriction by creating costs within the market which are intended to reach individual violators.

The certification process allows sellers to choose whether to state in writing that calves have been treated in compliance with FDA drug withdrawal restrictions. As a result of this process, both slaughterhouses and regulatory agencies have documented ownership information on all certified animals. This instituted system allows for penalties to be assessed for individual violation(s) of drug withdrawal regulations. The liability for product quality (absence or presence of residues) is shifted from the buyer to the seller through the documentation of the drug-free status of the calf at the time of sale. In effect, buyers of certified calves receive a guarantee of product quality with their purchase. FSIS was able to impose this system by creating a new testing program which sampled uncertified calves at a significantly higher rate than certified calves. This innovative approach needs to be carefully evaluated to improve future enforcement efforts.

THE RESEARCH QUESTION AND APPROACH

The problem focus of this thesis is on determining the response of market participants to the certification process: Is this mechanism used honestly by market participants as a method for signalling product quality? How are

penalties for marketing violative animals altered by the certification process? What is the producer response to these penalties? In answering these questions, it will be possible to assess the effectiveness of the FSIS regulatory program in reducing chronic rates of residue violations within calf markets, and make recommendations for program improvements.

General Approach: Assessing Changes in the Structure and Performance of Calf Markets

To evaluate the certification program, a likely first step would be to determine whether residue violations had decreased following program implementation. However, this type of information alone is insufficient because changes in aggregate violation rates in calves following program implementation can reflect a diversity of factors such as adverse weather conditions and changes in market prices.

A more valid approach would be to establish causal links between elements of the certification regulatory program and performance outcomes and rule out other potential factors such as price and weather. Direct relationships between the certification program and behavioral responses of market participants concerning drug use can be determined by assessing incentives for drug use before and after program implementation. The main focus of this research is on comparing the expected benefits of drug use and the expected costs of selling violative calves before and after certification implementation. Program effective-

ness can be evaluated by determining the net change in expected costs and expected benefits of drug use.

What is needed to complement this approach is the development of a theory of the underlying causes of market participant behavior concerning drug use. The theory then provides information on the interaction of the regulated environment, as a system, with the implemented program. As a method for evaluating governmental actions, this allows for retrospective identification of all discernable outcomes, both intended and unintended. Both types could have a bearing on the effectiveness of certification in reducing residues in calves.

Evaluating Signalling Performance

There is an additional approach for determining changes in incentives concerning drug use which can be used to reaffirm the outcome of the general comparison of expected costs and expected benefits described above. Before certification, producers of low quality calves (those with residues) were able to pass off their animals as high quality calves (those without residues) with a very low probability of being detected or penalized. If these same conditions existed following regulatory changes, the percentage of residue violations which were from certified and uncertified calves would be the same. A lack of penalty for violation would indicate a lack of any meaningful distinction between certified and uncertified animals. The

effectiveness of the certification program in improving compliance with withdrawal regulations can therefore be determined by the performance of the signalling system as a reliable indicator of the drug history of an animal.

The factors which cause market participants to use the signalling system honestly would concurrently affect compliance decisions. These include charges by slaughterplants for calves condemned for residues, increased testing of individual producers by FSIS following detection of residues in previous shipments of calves, or prosecution by FDA for repeat offenses. Any one of these penalties would alter the expected costs associated with drug use. An assessment of whether the certification status reliably signals quality differences among seemingly homogeneous products provides evidence of an effective penalty for marketing violative calves.

ORGANIZATION OF THE THESIS

The certification program was designed to influence market participant behavior through alteration of the institutional incentive structure. In the next chapter, the conditions necessary for certification to be effective in changing market participant behavior is discussed.

The second section of the next chapter considers the impact of asymmetric information on seller decision making concerning product quality. A model of calf markets

is developed to illustrate a hypothesized outcome of informational asymmetry: sequential market deterioration. Several of the assumptions of the model are unrealistic in comparison to actual calf market conditions. However, this does not detract from the purpose of the model which is to identify the conditions necessary within an asymmetric market for a signalling system such as certification to be sucessful. By determining the main factors influencing the reliability of the certification status of a calf as an indicator of drug history, the description of calf market conditions before and after certification can be better focused.

The purpose of chapters four and five is to assess market and regulatory changes in incentives for drug use in calves before and after implementation of certification. In chapter four, the general management needs of calves and the organization of the market for surplus dairy calves prior to certification are described. This description facilitates an analysis of the incentives of market participants for using drugs within their calf management practices and, of particular importance, the possible causes for participants not to observe federal drug withdrawal regulations prior to the new regulatory initiatives.

FSIS perceptions of the origin and magnitude of the residue problem in calves had an important bearing on policy design and therefore program effectiveness. The purpose of

chapter five is to review FSIS assessments of the source and extent of residue violations in dairy calves prior to formulation of the certification approach.

The approach in both chapters four and five is to determine relevent market and regulatory factors which influence market structure. The impact of the certification program can then be assessed as a flow of consequences with direct implications for the performance outcome of the calf market system. This flow of consequences is discussed further in the final chapter.

The purpose of chapter three is to describe how data was collected and assessed to test the hypotheses developed in the theory chapter. Two different data sets were obtained (in addition to regional price data for newborn calves and FSIS violation rates for calves).

First, the results of the approximately 60,000 CAST tests conducted during the first nine months of the certification program were obtained with the following information:

Slaughterplant (by region)			
Total Negative Tests		Total Positive Tests	
Certified Calves	Uncertified Calves	Certified Calves	Uncertified Calves

The main question to be determined from this data is whether the proportion of violations differs significantly between certified and uncertified calves. This provides an

indication of the extent to which market participants used the certification system honestly.

The second data set was obtained by surveying slaughterplants which purchase newborn calves for immediate kill. Survey questions were designed to determine whether certification facilitated the identification of animal owners and whether this information was used to recover losses from condemnations due to residues. The questionnaire was also designed to find out the standard operating procedures of slaughterplants concerning the purchase of certified and/or uncertified animals and the reasons why these developed.

SUMMARY

The approach taken for the evaluation of the effectiveness of certification in reducing residues is to first theoretically assess the probable outcome of the regulatory program design which can be predicted by economic theory, describe the observed market structure and behavior of participants before and after program implementation, test the hypothesized outcomes concerning changes in incentives for drug use in calves, and compare predicted and observed performance outcomes. In effect, the calf certification program provides an opportunity to empirically test and measure the performance of a food safety program designed to influence market participant behavior through alteration of the instititutional incentive structure.

CHAPTER TWO

THEORY

INTRODUCTION

The purpose of this chapter is to identify the conditions necessary for the certification program to be successful in reducing residue violation rates. Identification of these conditions shows us what information we need to collect in order to assess the effectiveness of this regulatory approach.

The first section examines why the problem of violations occurred in calf markets by examining decision-making concerning drug use. The second section examines how a signalling system could change drug management practices. The final section lays out the research questions which follow from the theoretical framework.

A THEORY OF DRUG USE

Calves are a joint-product of all dairy operations. Both beef and dairy calves are characterized by high death and illness rates in comparison to other livestock sectors. Drug use can be viewed as one of many approaches for treating calves. For now, we assume each alternative

approach produces the same amount of damage control, i.e., the benefit of each method is similar (in chapter four we will examine this assumption).

Calf producers are rational maximizers who choose actions by evaluating the expected costs and benefits of alternative actions. Inputs are chosen on the basis of which combination will minimize the cost of producing a given level of output or, in this case, disease (damage) control.

The relevant cost of most inputs is price. However, drug use has an additional cost because it is regulated. Thus, the cost of drug use becomes a function not only of its price, but also the expected cost imposed by regulation.

According to Becker's (1968) model of crime and punishment, the supply of offenses of regulatory standards is a function of the probability of being tested, the fine associated with detection, and a "portmanteau variable," which represents the sum of all other influences.

To impact producer decision making concerning alternative input combinations, regulators must create conditions whereby the relative cost of using drugs is greater than that of alternative calf health management practices. Since the benefits of using drugs without considering mandatory withdrawal periods outweighed the costs for a given proportion of market participants prior to the implementation of certification in June of 1984, we will want to show that the relative cost of using drugs was less than the cost of other methods. That is, the price of drugs

plus the components in Becker's cost function, the probability of testing times the penalty for violation, is less than the cost of other methods of treating calves. Following this, we will examine whether the certification program changed the relative cost of drug use.

It is important to note, however, that the certification program did not simply change the probability of testing or cause the penalty for violating residue regulations to increase the cost of drugs as an input for treating sick calves. Rather, it did something much more subtle; it tried to set up a product quality signalling system in calf markets. We examine this signalling approach next.

THE ROLE OF SIGNALLING IN CALF MARKETS

The institution of a signalling system reflects FSIS' maneuvering around its limited legal mandate for dealing with individual owners of animals condemned for residue detection. FSIS is legally restricted from imposing monetary penalties on individuals who market violative animals.

The signalling system was devised as a way to indirectly increase the cost of violation to producers. FSIS imposed costs on slaughterers with the intention that these costs would be handed down to sellers of violative calves in the form of individual penalties. Increased testing causes costs to increase due to slower kill lines, higher condem-

nation rates, and increased carcass holding facilities. Based on these costs, FSIS expected slaughterplants to purchase only certified calves.

FSIS expected sellers to use the certification system honestly because buyers of certified animals had complete ownership information and could penalize in cases of violation. However, this expectation is incongruous with the sampling plan associated with CAST which was implemented at the same time as certification. The main cause of the incongruity is that the FSIS sampling plan required uncertified calves to be tested more heavily than certified calves. This creates a benefit for certifying calves. Lower testing of certified calves means less condemnations and because slaughterers penalize only when losses due to residues occur, incentives may also exist to certify violative calves. If identification information was not utilized to penalize violators, both violators and non-violators would be expected to certify calves to take advantage of the lower rate of testing and therefore lower probability of detection. The result would be a signalling system which was an unreliable indicator of the residue status of a particular animal.

The outcome of the signalling system imposed in calf markets through the certification process indicates the extent to which incentives to not use drugs were passed from FSIS to slaughterers to violators. Honest use of the

signalling system would indicate that there was a penalty for selling violative calves, otherwise the certification status would be used by both violators and non-violators. If the latter were the case we would not expect violation rates to decline.

A successful signalling system would need to overcome the impacts of asymmetric information, where one side of the market knows something the other doesn't. The market effects of asymmetric information and the conditions necessary for effective (i.e., honest) signalling to occur are discussed in the following sections.

Excessive Information Costs

The prohibitive cost to buyers for information concerning the quality (referring only to the absence or presence of residues) of individual calves causes a problem of information impactedness in the market for surplus calves. Beginning at the retail level, any evidence of residues derived from calf management practices is not detectable by consumers. Also, there is a general lack of consumer awareness of both the known and possible health risks associated with residues in meat. In that residues are not detectable and the benefits of safe, wholesome meats are not perceived by consumers, a premium is not offered for these qualities.

Because information concerning quality is costly, prices in intermediary livestock markets do not signal a

consumer preference concerning food safety. Despite federal regulations requiring minimal residue levels, the market lacks a price incentive to supply residue-free calves.

In asymmetric markets where one side knows something the other doesn't, there can be unrealized gains from trade. It pays producers who use drugs in managing surplus calves to pass off their low quality goods (calves with residues) as high quality goods (calves without residues). The aggregate result can be higher average levels of residues for all buyers because it profits lower quality sellers to produce this seemingly undifferentiated product.

Market Effects of Asymmetric Information

Akerlof (1970) contends that an effect of asymmetric information is sequential deterioration of a market. Buyers know the average quality within the market but not the quality of specific purchases. Due to this, prices must reflect the average quality. Sellers of higher quality products may withdraw from the market due to decreased returns, leaving only low quality sellers. When this occurs, buyers will notice a decline in average quality, causing demand to decrease. The result is an unravelling of the market: the bad drives out the not-so-good which drives out the medium, etc. Inefficiency results from the consequence of a collapsed market though effective demand may exist for both the higher and average quality goods.

Akerlof assumes the size of the market shrinks in relation to quality deterioration. The extreme case of market collapse which he models for the used car market can be assumed to occur when, on average, the expected costs from buying a second-hand car exceeds the expected benefits. If the quality of used cars is low enough to overwhelm any benefit from buying within this market, the price range available to buyers would diminish in size, the overall market for cars in general would be smaller, and fewer people would have an opportunity to own cars.

Akerlof's used car model is difficult to apply to the asymmetric situation of calf markets because buyers don't always know the residue status (true quality) after purchasing a calf unless it is tested by FSIS. However, this distinction does not necessarily prevent comparison. For example, Darby and Karni (1973) distinguish between three types of qualities associated with specific purchases: search quality, experience quality, and credence quality. The first can be known before a final transaction takes place and the second is known only after ownership rights have been transferred. This knowledge has an associated cost. The third type of quality respresents a combination of the other two: credence quality can be known only after a purchase and at a cost.

According to this typology, the quality information lacking in Akerloff's model is experience quality. Awareness of the deficiencies of a used car come after ownership

takes place and with an associated cost. In calf markets, awareness of credence quality is stochastic in that it is dependent on FSIS testing. The cost of this knowledge to slaughterers is equal to the losses incurred from condemnations (if any) due to residues.1

The availability of only credence quality information can be assumed to cause market deterioration to proceed at a slower rate in calf markets than in the used car market. The joint-product aspect and biologically determined proportion of healthy calves prevents complete market deterioration. Only a percentage of total newborn calves will be born ill or become sick while still on the farm.

Another important discrepency between Akerlof's model and the actual calf market is that calf markets are regulated in regard to quality. For the purposes of this research, the value of Akerlof's model lies in the alternatives he forwards for offsetting market deterioration (see discussion below). Analysis of a virtually unregulated market may weaken conclusions concerning calf markets but facilitates comparison with Akerlof's model. The difference between the assumptions for his used car market and the actual features of the market for surplus calves does not affect the applicability of his recommendations for dealing effectively with asymmetric information.

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[1]Whether a condemnation occurs following a positive residue test outcome depends on a number of factors which are explained in later chapters.

Conditions Necessary For Effective Signalling

Akerlof assumes that buyers respond to a market statistic in making purchasing decisions because of quality uncertainty. The institutions which he names as being possible mechanisms for offsetting sequential deterioration in asymmetric markets include guarantees, brand names (including chain stores), and licensing. These are actually signalling devices which sellers invest in to differentiate their product, i.e., they are devices designed to dominate the market statistics available to buyers for a given product.

To Spence (1973), signalling devices are actually observable, imperfect proxies which can relate information about unobservable quality characteristics to potential buyers. For these proxies or signals to be effective, two criteria must be met: 1) the cost of signalling quality must be inversely related to the quality of the product and, 2) the cost of the proxy to the seller must not exceed the benefits.

The critical focus of Spences' analysis is on the alterability of a proxy. Sellers of higher quality products capture benefits from investing in the proxy by differentiating themselves in a market of seemingly homogeneous products. When there is a negative correlation between the unobservable attribute which the buyer values and the cost of (upgrading) the signal, investment in the signal is

profitable up to the point where benefits equal the cost of the device.

In Akerlof's market for cars as well as calf markets, neither of Spences' requirements for effective signalling are evident. The problem in these markets is that there is nothing that the higher quality seller can buy at a reasonable price which correlates with the quality of the product that lower quality sellers cannot duplicate at the same cost. What were the features of the certification program which would cause the inverse relationship necessary for effective signalling?

Guarantees

A possible signalling system Akerlof suggests as a means for overcoming market deterioration is product guarantees. The signalling effect of a guarantee on potential buyers is the impact it may have on assessments of a probability of breakdown. As the level of coverage increases, the utility of owning the good increases. Guarantees can be an effective signal of product reliability because consumers can rationally assume that: 1) the quality of the good is controlled by the seller and, 2) the cost of the quarantee varies directly with the reliability of the product. Buyers can infer the quality of the product by assessing the probability of a breakdown and the guarantee costs to the seller. A good with a guarantee is therefore different from seemingly homogeneous goods because

the payoffs in durability have been altered. The guarantee serves to signal the range of this payoff.

In calf markets, the certification mechanism represents a type of instituted guarantee system. Sellers who choose to certify their animals are guaranteeing that the buyer will not lose his/her investment due to condemnation from residue detection. If condemnation does occur for this reason, the buyer has a written statement which can be used to identify the seller and collect the loss.

The effectiveness of this signalling process depends upon whether sellers of guaranteed calves are required to compensate buyers or face regulatory costs when the terms of trade are determined not to have been upheld following FSIS testing. The important factor here is FSIS condemnations of calves. When calves are condemned, there is a loss to buyers of surplus calves which they may choose to offset by charging original sellers. FSIS testing must result in condemnations in order for the guarantee mechanism to be valuable to a slaughterer.

If, in fact, the owners of certified calves which are condemned for residues are penalized for their actions through the guarantee mechanism, violators and non-violators face unequal expected costs for certifying their animals. The signalling system would provide a reliable statistic, thus eliminating the condition of asymmetric information. A question to be answered in assessing the certification program was whether the guarantee was utilized by buyers

and/or regulatory agencies to assess a penalty. A penalty for marketing a violative, certified calf would directly impact incentives for drug use as well as incentives to falsely certify calves.

MODELLING AN ASYMMETRIC MARKET

The problem of distinquishing quality within an asymmetric market such as the market for calves can be modelled to assess the magnitude of the penalty which is necessary for honest use of the certification method of signalling product quality.

To begin with, the following assumptions are made in Akerlof's model: a market exists with at least two grades of the product, private information concerning quality is not shared, the cost of information to buyers concerning these grades is prohibitive, buyers use some market statistic when choosing among products, a large number of buyers and sellers exist in the market, and any one individual appears only infrequently in the market. The last two assumptions prevent any benefits from accruing to sellers who choose to invest privately in signalling devices. In the model to be developed, it is additionally assumed that sellers have control over the quality of their goods which, in this example, are calves.

Again, it is acknowledged that the assumptions are unrealistic in depicting calf markets. The main differences are as follows: 1) minimum quality standards and therefore

government regulation do exist in calf markets and, 2) complete market deterioration is not possible given general production incentives and biological probabilities for healthy calves. These differences from Akerlof's model weaken results for this market but they can still be instructive.

Within the market it is assumed that there are two types of buyers (i=1,2) and two types of calves (j=1,2). The two types of buyers are identical except that they value the two types of calves differently:

$$V_{ij} = \text{value to buyer } i \text{ of calf } j$$

Given a preference, all buyers desire Type 1 calves (they are all residue-free). However, there exists a price lower than the price for Type 1 calves at which Type 2 buyers prefer Type 2 calves (those with residues) though Type 1 buyers do not. Type 1 buyers value residue-free calves up to the point where the cost of the quality difference equals the benefits:

$$V_{11} > V_{12} \quad \text{given} \quad V_{11} - V_{12} > b \quad \text{and}$$
$$V_{22} > V_{21} \quad \text{given} \quad V_{21} - V_{22} < b$$

The b variable reflects the assumption that the cost of producing a Type 1 calf is greater than a Type 2 calf:

$$C1 = b + C2$$

In this model, b is assumed to be equal to the extra labor involved in raising animals without the use of drug therapy techniques (i.e., all other material costs are equivalent between the two alternatives). It is assumed that the opportunity cost to labor for raising calves without using antibiotic or sulfa drugs is higher than raising calves with drugs. This assumption, as well as the conclusion that surplus calves are more likely to become ill than replacement calves, is described in detail in chapter four. C1 is the total cost of producing animals without drugs and C2 is the cost of producing with drugs.

Based on the assumption of perfect competition, marginal cost would be driven down to where:

$$P = C2$$

The assumption of asymmetric information prevents buyers from detecting quality differences so that it no longer pays producers to invest b, the difference between drug use and non-use in raising calves. According to Akerlof's prediction, the market would diminish in relation to quality deterioration.

To retain Type 1 calves and Type 1 sellers in the market, there must be an established method for differen-

tiating between the two types of calves and an associated penalty for selling a Type 2 calf as a Type 1 calf. For the penalty to be effective in achieving honest use of the certification mechanism, the expected cost of misrepresenting the quality of the animals must exceed the expected gain (i.e., price difference between high and low quality animals) in transactions with buyers:

$$(p)\ f > b$$

Alternatively stated, the difference in opportunity cost to labor between Type 1 and Type 2 calves (b) must be less than the cost of the penalty (p) for violating residue standards and falsely certifying an animal, times the probability of being detected (f).

SUMMARY

It was theorized in this chapter that compliance with regulations concerning quality can be predicted by focusing on the incentives and disincentives of drug use. Incentives for drug use are a function of the expected costs and expected benefits associated with drug use. The benefit of drug use in calves is the increased quantity of marketable calves caused by decreased death and illness rates attributed to chemical inputs. As determined by Becker, the cost function facing potential violators of drug residue restric-

tions consists of two main components: the probability of detection and the size of the penalty for violating.

Noticeably absent from Becker's cost function for the supply of offenses in a regulated market is the psychic cost economic actors may feel they incur in breaking the law or causing unaccounted hazards for others in the market. Not expressing this cost may imply that farmers do not consider either of these outcomes of their actions.

This topic is discussed more fully in the final chapter of this thesis. At this stage, it is important make a point concerning this possible, implicit judgement concerning the moral disposition of dairy producers. Dairy producers may not attribute a cost to these particular aspects of the decision to use drugs because of information and beliefs specific to residues in animals. Producers may view residue violations as analogous to littering or speeding regulations where it is tacitly understood that violation is not an "immoral act" though it does involve breaking the law. Due to this, it may be inappropriate to include this consideration as a type of cost and/or to draw generalizations or inferences concerning attitudes toward social responsibility.

In this chapter, it was pointed out that FSIS lacks the legal ability to directly impose fines or penalties on violators. To overcome this limitation, FSIS instituted a signalling system which created a mechanism for documenting the terms of trade concerning the drug history of a particu-

lar animal and for identifying previous owners of a calf. FSIS then imposed costs on buyers of calves which made it more expensive to buy uncertified calves.

For FSIS' cost to slaughterplants to have been translated to sellers of violative calves, two conditions must exist within calf markets following certification implementation: 1) the quality of the product is inversely related to the cost of signalling and, 2) the costs of signalling are less than the benefits.

Because the physical act of certifying is not costly to a seller, how can the signalling cost be made to be inversely related to quality? First, the expected costs for cheating on the signal by certifying a violative calf must be higher than for certifying a non-violative animal. Individuals must be penalized for cheating on the system. The certification statement provides buyers with a guarantee of product quality; lack of compliance with these terms of trade must result in a cost to sellers. Either the buyer must be compensated for losses (i.e., the seller charged for losses through the guarantee offered through the certification mechanism) and/or a regulatory cost must be invoked. It was established that the magnitude of the penalty must be equal to or greater than the difference in opportunity costs between treating and not treating calves with drugs.

If this condition is met, the rate of residue detections can be expected to decrease. Analysis of whether the

certification regulatory approach for calf markets required answering such questions as what were the expected costs and expected benefits of drug use before and after certification? Was there a change which would have caused management practices concerning drug use to be altered? Secondly, was the cost of certification inversely related to the quality of calves in regard to residues and was there a benefit to certifying? A description of calf markets before and after the implementation of certification is included in chapters four and five which are oriented toward addressing these questions.

CHAPTER THREE

METHODS

INTRODUCTION

The purpose of this chapter is to describe the methods used to estimate the expected costs and expected benefits associated with drug use before and after certification. Expected costs are a function of the probability of testing and the size of the penalty. Data used to estimate probabilities is presented first. Then the data used to estimate penalties is discussed.

Expected benefits of drug use are a function of the death losses avoided (damage control) by drugs and the cost of use relative to other management techniques. Data used to estimate expected benefits is discussed next.

The methods used in obtaining information to describe calf market structures before and after certification follows next. Residue violation data is discussed last.

Prior to descriptions of the mechanics of calculating expected costs and benefits, it is necessary to establish the relevent time frame used to make comparisons of estimates before and after certification.

TIME FRAME CONSIDERATIONS

It will become evident in the following discussion that data for bob calves is limited. To obtain estimates of expected costs and benefits, a considerable amount of extrapolation was necessary.

In making comparisons, all estimates of expected costs and benefits both before and after certification are calculated for the twelve months of 1984. The main reason for this approach is that the certification program was instituted mid-year in 1984 (beginning in June, 1984) and the relevent figures that are available, particularly for calves sold as veal or slaughtered, reflect calandar year totals. To facilitate comparison of expected costs and expected benefits before and after certification, monthly averages are calculated and then multiplied by twelve to project calandar year totals. In effect, the pre-certification figures reflect market outcomes for 1984 assuming no certification that year; the post-certification figures assume certification was in place during all of 1984.

This approach necessitates the assumption that all FSIS testing is undertaken at a constant rate across months and that the amount of calves marketed is evenly distributed throughout the year. This is true of conditions in calf markets both before and after certifiction. Prior to certification, levels of random sampling to be conducted for an entire year are planned ahead for each plant based on

past volumes and these tests are usually taken at even intervals. Following certification, the established sampling rate for CAST has never been altered. Any fluctuation in testing would reflect changes in supply or changes in individual inspector practices. In regard to calf marketing, dairy calving is distributed evenly across months to maintain constant levels of milk output. Suplus calves are taken to market at a constant rate throughout the year.

ESTIMATING EXPECTED COSTS

Probability of Detection

The likelihood that a calf is chosen by FSIS for residue testing is calculated by dividing the total number of bob veal tested by the total number of bob veal slaughtered.

1) Before Certification. Calves were tested prior to certification under two different programs, one which was based on random selection (monitoring) and one which was inspector-generated (surveillance). Calves chosen under surveillance must exhibit suspicious characteristics to be selected by an inspector for testing and therefore have a probability of one of being selected when those conditions exist (these are discussed later). Unlike monitoring tests, surveillance residue testing is not probabilistic for each bob calf and surveillance totals are therefore not included in the total of tests conducted for 1984. FSIS projections of total of calves to be randomly sampled under the monitor-

ing program in 1984 was listed in "The National Residue Program Annual Plan."

FSIS slaughterplant records concerning total calf slaughter in a given year do not differentiate between types of calves which makes it difficult to estimate the number of bob veal slaughtered prior to certification. In response to the high rates of residues detected in calves, a survey was undertaken by FSIS in early 1984 to discern the approximate population of bob veal. FSIS plant inspectors were surveyed as to the percentage of each of five types of calves slaughtered at their plant:

1. Bob : calves less than two weeks old
2. Veal: calves less than two weeks, up to 300 lbs.
3. Fancy: milk-fed calves weighing 200 to 400 lbs.
4. Large: calves between 301 to 600 lbs.
5. Extra Large: calves over 601 lbs.

The survey results were entered into the FSIS computer system but were never requested for use by personnel within FSIS prior to this research project.[1] Analysis of the data shows that during 1984, forty percent of calves slaughtered nationally were bob calves. This percentage is used to estimate the number of bob veal tested in conjunction with figures for calves included in an extrapolation of existing dairy and beef operation data (Ferris, 1984; see Appendix B)

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[1]Data and explanation of the survey was obtained from Dr. William Burke, Branch Chief, Quality Control Branch, Mathematics and Statistics Division, Science Program, FSIS, U.S. Department of Agriculture, March 20, 26-28, June 17-19, 1985.

oriented toward projecting total animals to be marketed. Results of Ferris' derivation indicate that approximately sixty percent of newborn dairy calves totalling 5.6 million animals were marketed in 1984 and approximately three and a half million dairy calves were sold annually for veal. This latter figure was multiplied by the forty percent figure obtained from the FSIS inspector survey to estimate the number of bob veal slaughtered.

2) After certification. To estimate the probability of detection following certification, figures are needed for both certified and uncertified bob calves tested and slaughtered. The method for determining the proportion of calves purchased certified or uncertified by slaughterers is explained below in a discussion of a survey of slaughterers undertaken to determine procedures for recovering losses due to condemnations from residues. Slaughterers were also asked what proportion of calves was purchased with a certified or uncertified status. The reported proportions were applied to the total of bob calves slaughtered in 1984 (calculated previously for determining the total calves tested prior to certification) to determine certified and uncertified bob calves slaughtered in 1984.

The number of calves tested following certification was obtained by physically counting the total CAST test outcomes. Over 60,000 CAST tests were conducted by plant inspectors during the first nine months following certification. The information needed concerning these tests was the

total number of positives (residue detected) and negatives and the corresponding number of certified and uncertified calves within these two catagories.

To facilitate counting, one-hundred percent of the test outcomes were counted in regard to the following variables: slaughterplant, region, month, test outcome, and certification status. The reason that random sampling techniques were not utilized was the numerous problems associated with FSIS documentation of test results. Internal FSIS record-keeping concerning CAST is not computerized except for positive tests. This computerized data set, however, does not contain information concerning the certification status of tested calves.

Documentation of CAST tests at the slaughterplant level mainly involves inspector completion of a worksheet designed specifically for CAST testing. Three different sources contributed to the problems concerning the accuracy of data from these worksheets: inspectors, administrators, and data entry. First, CAST tests are conducted at seventy-seven separate slaughterplants (though only approximately forty plants kill over two thousand head per year). Inspectors were required to record all CAST tests on the worksheet. There is a noticable but not complete decline in the number of incomplete worksheets, lost worksheets, and erroneous information after the first few months of the certification program, probably due to personnel from the federal level

being dispatched to clarify the documentation process in the worst cases.

Tissues from animals with a postive test outome were to be forwarded to a central FSIS laboratory with an additional and separate form and each test was documented into the FSIS computer system when it arrived at a lab. FSIS did not require that one-hundred percent of violative cases be confirmed by laboratory testing though samples from all positive cases were required to be forwarded to a lab. A major type of error in CAST documentation occured when lab reports were completed by the inspector but the test was not recorded on the worksheet, or vice versa. Nearly eight-hundred cases were found where positive tests included on worksheets were not included on laboratory computer listings. It was discovered that this was due to either laboratory data entry problems or oversight on the part of inspectors.2

Secondly, aggregate figures concerning CAST are calculated by both the Microbiology and the Residue Evaluation and Planning Divisions (REPD) of FSIS. Microbiology calculates monthly totals from carbon copies of inspector worksheets which arrive in Washington, D.C. within three months of the month of testing. REPD continually updates monthly totals. Worksheets are forwarded at extremely varied intervals by slaughterplants so that totals calcu-

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[2] The tests which were included on the worksheet but not on the computer list of positive tests created by laboratories were included in the final data set.

lated by the two divisions are not comparable. In addition, neither records the certification status. Due to this latter ommission, all worksheet entries had to be recounted in regard to the appropriate certification status.

The counting process took place in two stages.[3] First, each positive test outcome listed on the computer report from FSIS laboratories was matched to the original worksheet entries to obtain the certification status. Second, total numbers of tests, both positive and negative outcomes, were recorded from the worksheets in the REPD for the first nine months of certification. Using SPSS, each of the two data files was aggregated to give monthly totals for each plant. The two files were then merged and the number of positive test outcomes was subtracted from the number of total tests for each plant in each month to determine the number of negative tests. The final data file provides the number of certified and uncertified calves associated with all positive tests and the same for all negative tests.

To test whether there was a relationship between certification status and test outcome, a contingency table was created from this data and Cramer's V, a measure of association, was estimated to measure the strength of the relationship between test outcome and certification

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[3]At the time counting took place, complete data for CAST was available from June of 1984 to February of 1985, though fifteen worksheets from assorted months were missing due to administrative error. Each worksheet contains eleven test records.

status.[4] This data is considered inadequate, however, for estimating population parameters concerning the certification status of calves marketed. Though five percent of bob calves were tested under CAST during the first nine months, the sampling rate was biased heavily toward uncertified animals and the lack of documentation as to the size of lots that calves were chosen from creates problems in attempting to assume any representativeness of tested calves. This is discussed further in chapter five. Information concerning the proportion of calves sold certified or uncertified was acquired through a slaughterer survey discussed later.

A monthly average of tests conducted for certified and uncertified calves during this nine month period was calculated and multiplied by twelve to obtain the approximate number of tests conducted in 1984, assuming certification been established by FSIS in calf markets in January of 1984.

It was noted previously in the description of the calculation of the number of tests conducted prior to certification that only random tests conducted under the monitoring program were included. Monitoring tests are included in the post-certification total of tests conducted

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[4]The calculated value varies between zero and positive one with a large value signifying a high degree of association. The Cramer's V was chosen because it adjusts for unequal number of rows and columns. The contingency table had two rows (negative and positive tests) and three columns (certified, uncertified, and unknown status).

along with CAST tests. Surveillance testing should be excluded because it is not random. However, calves chosen for testing by inspectors because of suspicious conditions were conducted by using CAST following certification and it is impossible to differentiate these tests from those conducted in accordance with sampling requirements specifically designed for bob veal (this sampling program unique to bob veal and is described in chapter five). The fact that surveillance tests are included in the total for calves tested following certification but not prior to program implementation is a known limitation of the data. Results are assumed to be relatively unaffected because the number of surveillance tests (approximately 1,500 in 1984) is relatively small compared to the 63,663 total CAST tests.

Size of the Penalty

A cost for marketing violative calves can be imposed by FSIS through follow-up investigations or by slaughterplants when a condemnation occurs.

1) Before Certification. Animals tested under the monitoring program are chosen on a random basis and because there is no reason to suspect that the chosen calf has residues, it is not detained while test results are completed. There is no loss to slaughterers for violations detected through the monitoring program. However, FSIS can impose costs on violators by requiring follow-up

surveillance testing. This process is described in detail in chapter four (including the ways to avoid follow-up surveillance testing). The process generally involves an identified violator having five calves of his/her choice tested by FSIS for residues before marketing another lot of calves. It is important to note that under this system, the magnitude of the penalty for violators is independent of the number of calves which are found violative.

The cost of follow-up surveillance testing to a violator is assumed to be equal to one and a half hours of labor time required to assemble five undrugged calves and make a special marketing trip for the testing to be conducted. This is assumed because FSIS does not charge violators for follow-up testing costs. The cost of labor is based on the USDA wage rates for hired, hourly wage farm workers in 1984. It is important to note that under this system, the penalty to violators is independent of the number of calves in a shipment which are found violative.

2) After certification. Following certification, calves found violative with CAST were condemned by FSIS and slaughterers therefore lost investments on those animals. The amount of the penalty for violators would be the sum of the expected cost of FSIS follow-up testing and slaughterer charges for losses from condemnations due to residues.

The calculation of the expected cost of a slaughter-plant penalty for marketing an identifiable, violative calf

includes the probability of testing for certified and uncertified calves and the average price difference between certified and uncertified calves. The market price of calves is assumed to represent the cost of a slaughterplant charge-back to a seller. Information concerning prices as well as insights as to the proportion of slaughterers who do charge for losses due to condemnations was obtained from results of a national slaughterplant survey which I conducted in August of 1985, fifteen months following the implementation of the certification program.

The population targeted was U.S. slaughterplants which kill bob calves. A 1983 (fiscal year) FSIS listing of slaughterhouses ordered in terms of annual volume of calves killed (over 2,00) was used as the sampling frame. This listing was used in conjunction with the 1984 FSIS survey described earlier which estimates the types of calves killed in specific plants: bob, veal, fancy, large, or extra large calves.

To determine whether slaughterers penalize individual sellers of bob calves, a comparative sampling approach was undertaken by stratifying the sample of bob calf slaughterers in terms of annual plant volume. The ten smallest and ten largest slaughterplants identified as a slaughterer of bob veal were chosen as sampling units. Based on this method, fifty percent of plants were questioned. The comparison between the largest and smallest plants facilitates validity by ensuring the inclusion of the full range

of the population: the smallest plant kills an annual average of 1 calf per hour while the largest plant kills an average of 2.5 calf per minute (of those plants which kill over 2,000 per head per year).

The main question of the survey concerned charge-backs for losses due to residues and procedures for charging sellers of calves condemned due to residues. The Student's t-test was used to determine whether there was a significant difference between the actual and expected mean of slaughterplant responses to the survey question concerning charge-back practices. A yes response was given a value of one and a no response a value of zero. If effective signalling did exist, the expected mean would have been close to one.

Additional questions were concerned with establishing whether the certification program caused changes in a number of different areas: the speed of kill lines, slaughterers ability to trace back calves to original sellers, and the percentage of bob veal slaughtered. To understand buying procedures following certification, slaughterers were asked whether they observed price differences between certified and uncertified bob calves in stockyards where surplus calves are purchased.

Also, a question was included as to what percentage of calves purchased are certified and why. The results of this question provides insight into slaughterplant incentives as well as market demand for certified bob calves.

The research objective of obtaining national results overshadowed the limitations of having to enumerate over the phone due to the time and resource constraints associated with personal visits. A rapid appraisal was first undertaken by contacting a plant (not included in the selected sample) for gaining feedback on potential survey questions. Valuable information was gained concerning the most appropriate person within slaugherplants to ask for, additional legal constraints perceived by packers who want to charge producers for condemnations, and industry jargon.

The national survey was conducted over the course of several mornings and afternoons to accomodate different time zones. Nine short-answer questions which focused on four main topics took an average of ten minutes for respondents to answer. Though all questions were completely precoded with relevent ranges, the majority of respondents provided specific percentages or figures which proved useful in developing more exact descriptive statistics (a copy of the survey questions is in Appendix A).

From this collected information, calculating expected costs of slaughterplant charge-backs requires multiplying the probability of detection by the average price received for a certified or uncertified animal. The price used in the calculation was obtained from the USDA Agricultural Marketing Service, Livestock, Grains, Seed and Poultry Division. Prices for bob veal (those calves weighing between 75 and 115 pounds) were recorded weekly in sixteen

New York stockyards for 1984. This was averaged to obtain an annual average price. This average is assumed to be representative of national prices and is used as a proxy for national price throughout this research. Prices of surplus dairy calves is not a widely registered type of data.

To determine the average price difference between a certified and uncertified calf, the price per pound difference (live-weight) reported by slaughterers was averaged and multiplied by one-hundred pounds, an estimated average weight for dairy calves.

The expected cost of a slaughterplant charge-back is assumed to be applicable to those sellers of violative calves who can be identified and who sell at a plant which conducts charge-backs. These percentages were obtained from the slaughterplant survey. They are not included in the calculation of expected cost for two reasons. First, transportation limitations and calf health considerations prevent sellers from marketing at any plant in the U.S. Sellers do not, therefore, have an equally likely chance of selling at a plant which does conduct charge-backs. Second, there are a number of actions which sellers can take to reduce the likelihood of being identified. Sellers who ensure that they will not be identified face a zero expected cost of violation. Because the receipt of a charge-back is something which producers can control by influencing the possibility of identified to a violative animal, this factor cannot be included as a probability in the calcula-

tion of the expected cost of charge-backs. The actions which sellers can undertake to reduce or eliminate their chances of being identified are discussed in later chapters.

The cost of follow-up surveillance testing following certification must also be calculated for both certified and uncertified calves. As in the estimate prior to certification, the cost of follow-up surveillance testing equals the probability of testing multiplied by the cost of having five samples tested prior to marketing another lot of calves. The probability of testing was already calculated for certified and uncertified animals and the cost of testing was also previously established (see above).

ESTIMATING EXPECTED BENEFITS

Drugs are used mainly in calves to minimize deaths due to illness. As an agricultural input, drugs increase the quantity of marketable calves by reducing losses due to calves which are born with poor health or become ill before leaving a farm.

1) Before Certification. The expected benefit of drug use can be calculated by comparing the difference in costs between drug use and alternative calf management approaches which do not use drugs for gaining the same amount of damage control (increased output). The two relevant costs to estimate are the input costs and the labor

cost in treating an individual, sick calf to a comparable degree of health.

In chapter four, two separate empirical tests of approaches to calf health management, one which used drugs and one which did not, are compared. A comparison of results show that both drug therapy and alternative management techniques which do not include drugs of any kind can be effective in reducing death losses. In effect, damage control can be assumed to be the same for the two approaches. As a result, the relevant comparison for estimating the benefit of drug use then becomes the cost difference between the two approaches.

The difference in cost between the two methods, drug use and non-use of drugs, can be measured by the degree of difference in the opportunity cost to labor and materials cost. The empirical tests concerning health management practices for calves described above did not estimate labor costs.

To calculate these costs, a list of calf management practices which can substitute for drug use was provided in a University of Wisconsin Extension Service booklet concerning calf management (Piwoni and Kliebenstein, 1981). A major mid-Western supplier of veterinary drugs was contacted (Lakeland-Vet, Inc., Eden Prarie, Minnesota). Estimated costs of materials cost and labor input needed to effectively use these inputs was determined based on this information.

2) After certification. Regulatory action can increase the cost of the use of a regulated input such as drugs by increasing the rate of detection or the size of the penalty. The benefit of drug use is the increased output created by minimized death rates in calves. Regulatory action cannot increase the output gained by drug use, the benefit of drug use, but could increase the value of the increased output by causing a premium to be offered for calves. The signalling process was intended to result in premiums for sellers of certified calves. If violative sellers were able to continue drug use and also obtain the premium (certify honestly without being caught), this regulatory approach would have created a benefit for drug use. However, it is shown in the last chapter that the price differential which developed is only reflective of a benefit of certifying and not of drug use. The price differential was obtained by averaging the price differences between certified and uncertified calves cited by slaughterers in the national survey which was previously described.

OBTAINING INFORMATION ON THE STRUCTURE OF CALF MARKETS

The majority of the information concerning calf markets was obtained from personal interviews or from FSIS documents. The most valuable documents were unpublished minutes from the Veal Calf Task Force Meetings.[5] Personal inter-

[5]This was a business-government coalition formed in 1982 to serve as an advisory committee to FSIS in developing regulatory policy for eliminating the residue problem in bob

views with government officials are listed at the end of the thesis. In addition, several slaughterers contacted while conducting my national survey provided excellent insights into their perspective of the residue problem in veal. A trip to the 1984 National Vealers Convention in Columbus, Ohio was important in understanding calves and calf management. Veterinary, dairy industry, and extension literature was also utilized.

RESIDUE VIOLATION RATES

FSIS Residue Evaluation and Planning Division provided a list of monthly residue rates for each of the five FSIS-designated regions from January of 1983 through March of 1985. This data shows residue rates for antibiotics and sulfonamides separately. For each of the two types of drugs, monthly national totals were calculated so that overall trends before and after certification could be observed. The graph of the two rates of residue detection, sulfonamides and antibiotics, is included in the last chapter which discusses the likely outcome of residue rates given results of the comparison of expected costs and expected benefits before and after certification.

The Student's t test was calculated to determine whether there was a significant difference between violation rates before and after the implementation of certification.

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calves.

Residue rates for the twelve months prior to June, 1984, the starting date of certification, were compared to residue rates from the first ten months following certification implementation. The comparison of rates for the same months accounts for any seasonal factors, though data limitations resulted in two extra months being included in the residue rates prior to certification which were not available for the same months following certification. This is a known limitation of the data. Results of the t test are included in the final conclusions chapter along with the graphs of the violation rates.

The FSIS monitoring data is far from adequate in terms of revealing rates of residue detection in bob calves and for identifying any fluctuations in violation rates following regulatory intervention in this market. The main problem is that the different types of calves (e.g., fancy, bob, feeder) are not differentiated in monitoring records or in any FSIS documentation of slaughter data except CAST which is specifically designed for bobs.

Bob calves are estimated to represent forty percent of total calves slaughtered. The rate shown by national monitoring data can be assumed to underestimate the true residue figure in bob calves, based on evidence that the residue problem was focused in bob calves. Any assumptions concerning the impact of the certification program on violation rates must be qualified by pointing out these limitations of the monitoring data.

CHAPTER FOUR

THE STRUCTURE AND PERFORMANCE OF CALF MARKETS PRIOR TO CERTIFICATION

INTRODUCTION

This chapter focuses on the structural conditions of calf markets prior to certification. The purpose of this focus is to determine the expected costs of marketing a violative calf and the expected benefits associated with drug use in calves prior to certification.

The first section of the chapter describes the general market for calves. Of particular importance is a description of the production and marketing processes associated with different types of calves slaughtered in the U.S. This facilitates an understanding of the general incentives and disincentives for treating calves with drugs. The second section of this chapter describes the proportions of calves sold in each of the available market outlets for surplus dairy calves. The third and fourth sections focus on the benefits of drug use and the expected costs associated with marketing violative calves.

The calculated expected costs and benefits are used to explain the five percent rate of residue violation in the calf market detected by FSIS before certification. Accord-

ing to Akerlof, this rate reflects quality deterioration due to asymmetric information.

DISTINCTIONS BETWEEN TYPES OF VEAL CALVES

Most veal produced in this country originates from surplus dairy calves which are a joint-product of all dairy operations. Calves are a result of the biological requirement that cows be impregnated or "freshened" on an annual basis in order to maintain high levels of milk production. Livestock replacement needs within the dairy industry are low in comparison to the total number of calves born each year, due particularly to innovations in artificial insemination.

The use of drugs is legal in all types of calves, including newborn calves. It is established in the following discussion concerning calf marketing processes that time constraints can prevent withdrawal regulations from being observed in newborn calves sold to slaughterplants for immediate kill. Newborn calves purchased for slaughter reach slaughterplants in an average of seven to ten days. The average drug withdrawal period is fourteen days for antibiotics and three to four weeks for sulfa drugs.

Calf Production Processes

Veal is meat from calves. There are two main types of calves: dairy and beef calves. Dairy calving is evenly

distributed throughout the year while calf births on beef operations occurs mainly in spring (approximately thirty percent occurs in March and fifty percent in April). Most veal in the U.S. is from dairy calves as it is usually more profitable for cattle growers to feed out animals to adult size before selling to a slaughterer.

There are differences in types of veal which reflect differences in age, weight, etc. among calf carcasses. Generally, three types can be distinguished: bob veal, feeder calf veal (cow-calf, grass fed, or grain fed), and formula-fed fancy veal.

The term "bob" or "slaughter" calf refers to newborn calves of less than three weeks of age which are purchased by slaughterhouses for immediate kill. Bob veal ranges in weight from 80 pounds to 110 pounds. The meat from these animals is the light pink color expected in veal and is less dense in texture than other types of calf meat. Because the animal is small, sizable cuts of meat cannot be obtained from the carcass. For this reason, most bob veal is ground for veal patties or for processed foods containing meat.

Feeder calves, a product of the cow-calf herds on pasture, are usually 3 to 5 months of age at the time of slaughter and range from 350 to 500 pounds in weight depending on environmental conditions. The meat from these calves, sometimes referred to as "light veal" is coarse and grainy. These calves generally receive milk from their repective dams until they are weaned. Drug use varies.

Once they are on the range, however, very few drugs are administered due to the difficulty and time required in detecting distressed animals.

Nearly 100% of fancy veal calves, the third type of veal produced, are raised in confined, environmentally controlled buildings. They are fed milk-replacer twice daily so that their ruminent system never develops. At the end of 14 to 16 weeks, "finished" calves will weigh 330 to 350 pounds. The meat will usually be of light pink color, firm and very tender. Fancy veal calves, at purchase, are generally of better quality than the bob calves that are slaughtered at this age.[1] Subtheraputic doses of antibiotics in the all-milk diets of these calves can have a (highly desirable) growth stimulating effect.

Marketing Constraints for Observing Withdrawal Periods

The speed in which calves move through the market system to the slaughterplant is the most significant factor for recognizing the potential residue problem in the bob calf sector of calf markets. As shown in the following table, the maximum time it takes a bob veal calf to move through the market is ten days.

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[1]Interview with Jim Anderson, Agricultural Marketing Service; Livestock, Poultry, Grain & Seed Division, U.S. Department of Agriculture, March 28, and April 5, 1985.

Table 1: Marketing System for Surplus Dairy Calves and Time Spent at Each Location2

PRODUCER

(0-7 days)

TRUCKER **DEALER** **DIRECT**

(12-36 hours)

AUCTION FIRMS

(2-6 hours)

SLAUGHTER PLANTS	**FANCY VEAL**	**GROW-OUT OPERATIONS**
(6-24 hours)	(1-16 weeks) (poor growers go back to auction within one week)	(1 week to six months on most west coast operations; 12-16 months on other feedlots)

According to USDA estimates, nearly ninety percent of surplus dairy calves are sold through stockyards (auction firms). There are three general stockyard classifications for calves from dairy operations. The top grade calves which bring the highest price are chosen for health and weight considerations to be raised on fancy veal operations. Bull calves are usually selected by veal growers because they grow larger than female calves. The lightest

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[2]Obtained from internal FSIS correspondence to R.E. Engel, Deputy Director for Science from J.E. Spaulding, Director, Residue Evaluation and Planning Division, June 22, 1983.

calves receive the lowest prices and are purchased mainly by slaughterers. Borderline calves are bid for by both types of buyers. Prices depend mainly on the supply of calves and other market conditions such as dairy replacement needs and beef calf prices.[3]

Producers of newborn calves usually have no control over the market outcome of individual calves sold to stockyards though as described above the health and weight status of a particular calf may provide a general indication.

The major implication of this marketing process is that newborn calves treated with drugs at the farm level (or during the transportation process) will contain violative levels of residues if they are purchased for immediate kill by a slaughterer.

There are two additional implications. First, due to the short period of time between the administration of a drug in a newborn calf and the time it is slaughtered, the level of the drug residue in the carcass will be very high. This poses an immediate danger to consumers who are allergic to sulfa drugs or antibiotics. Second, the high level of residue means that nearly one-hundred percent of the bob calves which are tested by FSIS and found to have residues will exceed the legal tolerance level for residues.

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[3]Anderson, ibid.

DETERMINING THE TOTAL NUMBER OF BOB VEAL

The approximate number of newborn calves purchased by slaughterplants provides a general indication of the proportion of surplus calves in which a withdrawal period cannot be observed. However, the national percentage of surplus dairy calves sold within each of the market channels described above is not contained within registered data collected by the USDA. Consequently, we have to use an estimate.

According to a study conducted by the University of Wisconsin Extension Service, of the 800,000 bull calves (from the 1.8 million dairy cows) that were marketed in Wisconsin in 1982, fifty percent were purchased for fancy veal, twenty percent were purchased for feedlot or herd replacements, and only thirty percent were bought for immediate slaughter. Analysis of FSIS survey data shows that during 1984, forty percent of calves slaughtered nationally were bob calves. The survey showed that the percentage of bob calves killed in Wisconsin was consistent with the Extension Service estimate of thirty percent. The FSIS survey estimate is also consistent with the one found in my own slaughterplant survey. The estimate of the percentage of calves killed provided by slaughterers was higher than the FSIS survey estimate for half of the respondents and lower for the other ten slaughterers contacted. The average difference between the FSIS inspector and the slaughterplant representative response was

fourteen percent for those with a lower estimate and fifteen percent for those with a higher estimate.

According to Ferris' estimate (discussed in chapter three), 3.5 million dairy calves were sold for veal in 1984. Based on the finding that forty percent are purchased by slaughterers, total bob calf slaughter in 1984 is estimated at 1.4 million, representing almost $82 million to U.S. dairy farmers.

THE EXPECTED BENEFIT OF DRUG USE

The following section describes the benefit of using drugs in treating common calfhood disease. The main reason for choosing drug therapy over other types of management techniques is shown to be the lower opportunity cost to labor associated with drugs.

Calf Health Requirements

Newborn calves are recognized by extension agents, veterinarians, and producers themselves as having special management needs. Calves demand individual attention at the time of birth. Receipt of appropriate levels of colostrum, the first lacteal secretions of a cow after the birth of a calf, is critical from between the time of birth and the first six hours of life. Colostrum is necessary for proper

development of bacterial resistance and for meeting nutritional needs.4

The Cornell Cooperative Extension Service stresses to producers that a feeding of four to six pounds of colostrum within one to two hours after birth is essential to a calf's chances of survival. According to USDA extension veterinarian Dr. Basil Eastwood, twenty-five percent of dairy calves do not get colostrum.5

Poor management at the pre-natal stage can result in severe calf health problems with a common condition being selenium deficiency. At the time of birth, cold, damp, or unsuitable birthing conditions can result in a number of common calfhood diseases such as "scours" (diarrhea), pneumonia, and respiratory infections. A study conducted at Pennsylvania State University estimates that twenty-five percent of all calves will suffer from scours.

Ninety percent of dairy calf death losses occur during the first two weeks of life. In 1981, forty-four percent of the 31,217 calves condemned during ante-mortem inspection

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[4]"Colostrum contains antibodies against all the diseases the mother has been exposed to or has been vaccinated for. The calf absorbs these protective agents into its blood system for only the first twenty-four hours after birth. The antibody content of colostrum is highest immediately after calving and declines so that the colostrum twenty-four hours after calving has only about five to ten percent of the antibody content as that immediately after calving." Richard C. Searl, D.V.M., "Colostrum," The Vealer. Volume 5, No. 12, 1983. Page 25, 46.

[5]) Unpublished minutes of a Veal Task Force Meeting, June 11, 1982 made available to the author by the Division of Residue Planning and Evaluation, FSIS, USDA.

were labelled "deads."[6] In comparison, only eight percent of ante-mortem condemned cattle were taken out of the human food supply for this reason. In effect, nearly half of the ante-mortem inspection condemnations of calves were due to the fact that the animal died during (or just after) being transported to a slaughterhouse. The second most common cause of ante-mortem condemnations of calves, accounting for thirteen percent of the total pre-slaughter condemnations, was pneumonia.

According to the USDA, the calf survival rate in 1983 was 91.8%.[7] Based on this, the general death rate in calves of approximately ten percent is assumed to be applicable to the bob calf sector of the calf market in 1984.

Empirical Findings Concerning Calf Management Techniques

In treating the viruses and bacteria which cause illness, drug therapy has been shown to be effective in minimizing death losses in calves. A study in 1982 by Dr. D. Van Damme served to confirm both the effectiveness of sulfa (sulfachlorpyridazine) in treating scours and also the importance of colostrum. Seventy-five calves with scours were given sulfa boluses for five to seven days. Sixty-five

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[6]"Statistical Summary: Federal Meat and Poultry Inspection," U.S. Department of Agriculture, 1981 as cited by Tanya Roberts in "Benefit Analysis of Selected Slaughter-house Meat Inspection Practices." Working Paper No. 71, North Central Project 117: Studies of the Organization and Control of the Food System, 1981.

[7]Agricultural Statistics 1984, U.S. Department of Agriculture, Washington, D.C.

survived with the majority recovering within the first four days of treatment. Of the ten calves which died, five had inadequate colostral antibodies.8

Alernatively, an extension veterinarian in New York, Dr. Mike Brunner, found in a study of calves that good management practices rather than medication are most important in keeping calves alive.9 This study documented weight gain, disease, and differences in returns at sale for forty calves of which half had been given antibiotics and half had been given any other treatment except drugs. The results showed that antibiotics did not reduce mortality rates significantly better than other types of management practices.

Brunner's study appears to contrast with Van Damme's conclusions concerning the effectiveness of sulfa in treating sick calves. Actually, the results of both experiments affirm the importance of colostrum in raising healthy calves and point out the viability of both alternatives, using drugs and not using drugs, for treating common calfhood illnesses. Though Brunner's study followed calves through the marketing stage to document sale prices at auction, he did not account for the costs of managing calves

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[8]D. Van Damme, "Sulfachlorpyridazine in the Treatment of Colibacillosis in Neonatal Calves," Bovine Practice 3(2): 26, pp. 28-30, 1982.

[9]Unpublished minutes of a Veal Calf Task Force Meeting, May 3-4, 1983, made available to the author by the Residue Evaluation and Planning Division, FSIS, U.S. Department of Agriculture.

without drugs, particularly in regard to the difference in the opportunity cost of labor.

When comparing the two alternative approaches to calf management, use or non-use of drugs, the opportunity cost of labor for using drugs is less than alternative approaches for an individual calf. This is a critical point of comparing expected costs and expected benefits of drug use. It is shown below that materials costs and damage control are roughly equivalent for drug use and alternative management techniques used in treating sickly newborn calves. The relevent factor for a comparison of costs between the two approaches is therefore labor costs.

According to Piwoni and Kliebenstien (1981) at the University of Wisconsin, recommended management techniques for treating sick calves other than drug therapy include force-feeding, monitoring for colostrum intake, and drying and massaging newborn calves.[10] Also, rehydration is necessary for calves suffering from scours. The administration of fluids which contain electrolytes is required in these cases.

The legal administration of an injection or bolus into a calf costs approximately $1.50. Assuming the average length of stay on a dairy farm before being marketed is five

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[10]These represent only a few of the calf management techniques recommended by the University of Wisconsin Extension Service. Further practices are described in "Marketing Strategies for Calves," by Richard Piwoni and Jim Kliebenstein, publication for Wisconsin Residue Avoidance Project, Cooperative Extension Service, University of Wisconsin, 1984.

days, approximately three drug applications at an approximate cost of $4.50 would be required. These take only a few minutes to administer. The alternative management techniques mentioned above require esophagal feeders, towels, and monitoring charts. Assuming the same five day length of stay on-farm, the materials cost can be assumed to be roughly equivalent to that of drug management practices.

However, drug use is obviously less time consuming than these alternative practices. The lower opportunity cost of labor represents a benefit for using drugs in the proportion of surplus calves which are born unhealthy or become ill while still on a dairy farm. The main constraint to estimating the value of this benefit is that the average time it takes to treat a calf without drugs is unknown. It is assumed for the purposes of calculating the benefit of drug use that alternative management approaches would entail a minimum of an extra half an hour of labor per day during the days which surplus calves remain on-farm prior to being sold. The hourly, hired farm wage in 1984 was $4.09 per hour. The $10.23 total represents the net benefit of using drugs in treating calves, excluding regulatory costs, assuming that each alternative is equally effective.

An option not considered in this comparison of expected costs is that of using drugs but withholding calves which may be purchased for immediate slaughter until the withdrawal period has been properly observed. This management approach is prohibitively costly to any dairy operation

that has more than a few cows. The cost of monitoring, segregating, and feeding and housing these calves would make this approach more expensive than management techniques which do not include drugs but market surplus calves within a very short period of time. In addition, a fifteen to twenty-five day old calf is a different commodity than a newborn calf, making cost comparisons difficult.

EXPECTED COST OF A RESIDUE VIOLATION

It was established in chapter two that the main components of the expected cost of violating residue standards were the probability of detection and size of penalty. This section focuses on the factors which influence this cost facing market participants who sell violative calves before certification. The first three sections describe the regulatory mechanisms designed to enforce residue tolerance standards in calves. In the final two sections, the expected cost to a seller of marketing a violative calf is calculated.

Regulatory Agencies

The institutional design to deal with drug use in livestock basically involves two regulatory agencies though additional agencies are active at both the state and federal levels. The Food and Drug Administration (FDA) sets tolerance levels for every drug which it approves for

commercial sale. The United States Department of Agriculture (USDA), Food Safety and Inspection Service (FSIS) inspects meat at the slaughtering stage of meat production for drug residues.

An important distinction between the jurisdiction of FSIS and FDA is that FSIS has control over producers only from the time that the animal arrives at a slaughterhouse. In contrast, the FDA has the authority to send inspectors to a farm to conduct a search or impose an injunction. In addition, only the FDA can bring legal proceedings against a producer. The basic role of FSIS is to condemn violative animals and keep the FDA informed of violation levels through residue monitoring and surveillance programs. As a result, FSIS has extremely limited enforcement powers.

To prosecute a livestock producer for violating residue regulations, the FDA must established that the act was intentional rather than accidental. According to the FDA, this is difficult because it requires having an FDA representative witness an informed producer administer drugs in a manner which intentionally violates existing regulations on dosage, type, or withdrawal requirements. It is also difficult when FSIS testing does not require holding the animal until the test results are obtained. When residues are found, the carcass has been processed and only the test samples are left as evidence (the evidence has already entered the human food supply).

The following is Shriver's account of the range of FDA responses to cases of violations identified in all phases of FSIS testing:11

> "If the producer can be traced, FDA officials may visit the farm to investigate in person, or conduct an inquiry by letter. If the source of the residue can be identified, FDA may either let the producer off with a warning to discontinue the practice, ... or seek a consent order from the courts to stop her from doing so. If the producer then violates the consent decree, FDA may bring suit in the courts for violation of the decree. This is not an option which FDA has yet chosen to exercise in a residue case."12

Due to the limited FDA enforcement activities described above, it is assumed that there is a zero penalty associated with FDA follow-up procedures. Thus, the relevant penalties are those imposed by FSIS. These can take one of two forms: condemnations of violative animals and follow-up investigations of subsequent marketings of a violative producer. As we shall see, condemnations are unlikely. As a result, the only penalties are from follow-up investigations of violations conducted by FSIS. The penalty from follow-up investigations is assessed later in this chapter.

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11) Ann Shriver, Enforcement of Federal Standards for Chemical Residues in Meat: An Evaluation. Master's Thesis, Department of Agricultural Economics, Michigan State University, 1984.

12) The FDA did not bring a suit against a producer between the date of the interview between the FDA Compliance Officer and Shriver and the beginning of the certification program in June of 1984.

Residue Testing Procedures

The expected cost of violation is a function of the probability of detection as well as the penalty. The probability of detection depends on FSIS's testing procedures for calves.

Prior to certification, a calf was tested for chemical residues under the following circumstances:13

1. Monitoring (Objective Phase Testing)

Calves which appear healthy are chosen for residue testing on a statistically random basis so that each individual animal entering a slaughterhouse has an equally likely chance of being tested. This method of testing provides a national rate of residue frequency and levels of incidence in calves and is designed to give a 95% confidence level of detecting a 1% violation rate.

2. Surveillance (Selective Phase Testing)

Calves are chosen in a biased manner. Inspectors select calves for testing through both ante-mortem and post-mortem inspections when there are indications that residues may be present, i.e., a calf has a suspicious injection site, displays friskiness despite a poor physical appearance, etc. In addition, testing can occur as a follow-up enforcement measure when the producer is known to have had violative calves in her/his last shipment.

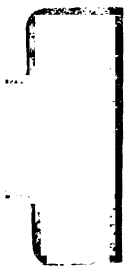
3. Exploratory testing

This phase can be of three types:
a. To determine residue occurances for drugs which have yet to be given an established FDA tolerance level.
b. To provide information for the RAP program.
c. Other specific information-seeking purposes.

13"National Residue Program Annual Plan," January, 1984, FSIS, U.S. Department of Agriculture.

Under the monitoring program, calves are randomly chosen for testing. The animals are tested to determine the national incidence of residues and because there is no reason to assume that residues exist, the carcasses chosen for monitoring testing are not held until test results are completed. There is no condmenation regardless of the test outcome. In contrast, carcasses are detained when an animal is tested under surveillance program when the inspector initiates a test for residues because of suspicious conditions of a specific calf. Calves tested under the surveillance program are condemned if test results show a violation of tolerance levels.

These distinctions are important in the following sections where the probability of testing and expected costs of violation are estimated. It is important to note that in these calculations, there is no cost of condemnation. We are concerned only with calves tested under the monitoring program. Carcasses from monitoring testing would be rendered and out of the slaughterplant before test results are completed. Surveillance testing is not random; the probability of testing is equal to one for calves which display certain attributes linked to drug use and is therefore not included in the calculation of the probability of testing (this is dicussed in more detail below).



Probability of Residue Detection at Slaughter

The probability of an individual calf being tested by FSIS can be determined by assessing the estimated number of calves marketed and the number of calves tested by FSIS. The probability reflects the liklihood of a calf being chosen for testing under the random sampling conducted through the National Monitoring Program in 1984. The probability is calculated based on the assumption that neither CAST nor certification were implemented that year. This allows for a comparison with the probability of testing after certification which is calculated in the next chapter.

According to the National Residue Program Annual Plan (FSIS) for 1984, the number of calves to be randomly sampled for monitoring purposes that year was 5,676. This total was higher than for any other of the seventeen types of animal species designated for FSIS monitoring including hogs and cattle. Sampling of calves represented almost a quarter of all FSIS monitoring phase testing.

Total calf slaughter in 1984 is estimated to have been 3,016,934. The estimated probability of an individual calf being selected for testing prior to the certification program in 1984 was therefore just under .2% or two in every thousand calves slaughtered. This same probability can be assumed to apply to the bob calf market.

Seller Control Over the Probability of Identification

An important factor which influences expected costs associated with the detection rate established above is the ability of slaughterplants, stockyards, and FSIS to identify the original owner of a violative calf.

According to the slaughterplant survey conducted for this research, eighty-eight percent of calves could be traced back to previous owners prior to certification by slaughterers (and it will be shown the FSIS estimated only a fifty-five percent rate of identification). This level of slaughterer identification was made possible by animal tagging systems which were instituted mainly for facilitating payments between market participants. Market systems of ear tags or back tags are usually reliable but cannot be used in a court as evidence because the numbering system is prone to human error and tags often fall off or are missing by the time an animal reaches a slaughterplant. FSIS must depend on the cooperation of both slaughterplants and stockyards for identification information. Between 1981 and 1983, the FSIS rate of producer identification in the northeast region was estimated to be only fifty-five percent. The expected cost of violation for the forty-five percent of producers which FSIS cannot identify and the twelve percent which cannot be identified by slaughterplants is zero.

From FSIS' perspective, identification is

probabilistic. However, from a sellers' viewpoint, there are a number of methods by which the chance of identification can be controlled. Surveillance testing or identification can be influenced by several types of actions undertaken by sellers:

1. Use boluses that do not contain coloring material or injectable antibiotics to decrease the probability of detection.
2. Sell under assumed names to thwart identification processes.
3. Use different markets at uneven intervals.
4. Blame another market participant if tested by FSIS and identified.

The limited number of stockyards might decrease the possibility of marketing at different places or using fake names. In general, however, these production and marketing alternatives provide decreased expected costs associated with drug use by reducing the probability of successfully tracing the original calf owner(s). As a consequence, the expected cost calculations estimated below should be viewed as the maximum penalty producers could expect. Actions which succeed in making ownership identification impossible result in a zero cost of violation.

The Penalty: FSIS Follow-Up Surveillance Testing

Since monitored calves are not held until test results are available, the only penalty FSIS can impose is to change how a producer's subsequent livestock sales will be handled. FSIS follow-up investigations are costly when

violators are identified by the monitoring program, informed of the illegality of their actions, and notified that they are subject to "follow-up" surveillance. Surveillance testing in this case means that five animals from the violators' next lot of marketed calves must be tested for residues.

Two alternatives to follow-up surveillance can be taken by producers: 1) Market the next lot and have five animals randomly selected by the inspector for testing while the rest are detained within the slaughterplant until results are available or, 2) Send five animals ahead of the entire shipment for testing. The latter alternative eliminates the necessity of having the entire lot detained at the slaughterplant and, according to FSIS, is the usual method chosen by producers. The $53.88 laboratory cost of each follow-up test is paid by FSIS.[14]

These two alternatives create conditions for seller evasion of a further penalty. For example, it is the responsibility of the producer to notify the inspector that either a shipment of animals or a preselected group (five animals) is being presented for surveillance testing. To

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[14]See Table 8 for a description of actual FSIS costs for follow-up surveillance. One hour of FSIS laboratory labor time in 1984 costs $35.92. A sulfa test requires one hour and an antibiotic test requires a half an hour of laboratory time according to Neal J. Whitney, Director, Field Service Laboratories Division, FSIS, USDA. The cost of lab tests is only paid by a violator when he/she needs the results in a hurry. In these cases, the samples are sent to proprietary laboratories and the producer is charged.

avoid a second detection of residues the producer only needs to make sure that the animals chosen for either the lot or sample are residue-free. In addition, follow-up surveillance testing can be postponed or evaded altogether by selling to a different slaughterer or auction market. This may be easier for some producers than others. Higher transportation costs would limit the benefits from continuously selling at more distant markets.

The following calculation of the expected cost of FSIS surveillance testing for marketing an identifiable, violative calf reflects the maximum expected penalty. The decisive factor concerning the actual cost is whether a producer can be identified as the owner of a violative, condemned calf. Forty-five percent of market participants cannot be identified by FSIS. The expected cost of FSIS surveillance testing is zero for these sellers.

Producers can estimate their individual probability of being identified by either FSIS or slaughterers by evaluating the marketing approach they use, previous experiences with residue detection, and knowledge of other violators and their experience with detection. It is recognized that not all producers who have a zero chance of being traced are aware of it. However, the following estimate of the expected cost of follow-up testing for identifiable calves assumes that violators are aware of the ways to avoid a second detection in follow-up surveillance testing, i.e., they ensure that calves are residue-free when they take them

to a slaughterplant for follow-up testing for a previous violation.

In addition, it is assumed that the opportunity cost to labor for complying with the follow-up surveillance testing requirements can be represented by the cost of an hour and a half of hired labor time it is estimated to take to bring five non-violative calves through the market system and have them brought to the attention of an FSIS inspector for testing. The opportunity cost to labor will vary depending on the seasons and alternative demands for management time in other production areas.

Table 2: Expected Cost of FSIS Follow-up Testing for Marketing an Identifiable, Violative Calf
(Assuming No Certification - 1984)

(1) Probability of testing	.002
(2) Size of penalty: Opportunity cost of labor used to arrange and conduct a special trip for testing [1.5 hours at $4.09 on-farm hired hourly labor rate for 1984]	$6.14
(3) Expected Cost of FSIS penalty [(1) x (2)]	$.01

Slaughterplant Charge-backs

A slaughterplant penalty would take the form of a "charge-back" whereby the seller is notified of the condemnation of a calf and is charged by the slaughterplant for

the original price paid. Charge-backs would only apply to violative calves detected through the surveillance testing program because, unlike violative calves tested under the monitoring program, carcasses from these tested animals are held for possible condemnation until the test outcome is available. Surveillance testing is not random and the expected probability of testing is near one for calves which display symptoms of drug use. These tests are not included in the estimate of the probability of detection which makes a slaughterplant charge-back irrelevent to this calculation.

However, slaughterplant penalties would be relevent in cases where violations are detected in follow-up surveillance testing. As previously described, the probability of this occuring is very low because violators choose the animals to be tested. Condemnations can be assumed to be zero in follow-up testing.

SUMMARY

Dairy farmers have a great deal of flexibility in determining how calves are raised. There are several reasons for less time intensive management techniques to be used on surplus calves in comparison to potential dairy herd replacements. Competing labor demands and low returns associated with surplus calves would be the main justifications for differences in treatment among calves. Calves

require time, space, and labor intensive management practices. Incentives exist at the farm level for calves designated for immediate marketing to receive "second-class" treatment due to the necessity of prioritizing scarce labor resources. As a result, surplus calves can be assumed to be more prone to disease than replacement calves.

In addition, timing is clearly an important consideration for dairy producers concerning the marketing of calves. It is generally acknowledged that farmers desire surplus calves to be placed in the marketing chain as soon as possible to minimize costs associated with facilities and labor need in handling calves.

Compliance and Non-compliance

An estimated forty-percent of surplus dairy calves are annually sold to slaughterplants. For newborn calves which have been treated with drugs, there is not enough time between the application of the drug and the time of slaughter for the average withdrawal period to be observed. Chemical residues which greatly exceed established tolerance levels can cause extreme reactions in individuals who are allergic to sulfa drugs or antibiotics and consume bob veal.

Drug therapy using sulfa and antibiotics can minimize death losses in calves. The legal administration of an injection or bolus into a calf can be substituted with

alternative management techniques which do not require drugs but which require more labor time.

To assess whether non-compliance with drug residue restrictions is generally cheaper for dairy farmers than compliance, the expected cost of violation was calculated. This expected cost can be compared to the difference in the cost of labor associated with alternative calf management methods which do not use drugs to establish the least-cost method for managing surplus dairy calves. The outcome of this comparison reflects the incentives within calf markets for using drugs prior to certification and can be compared to the same calculation following certification to determine whether changes occured in incentives. Conclusions concerning behavioral reactions to certification can be determined from the latter comparison.

To make a comparison between the cost of compliance and non-compliance to withdrawal regulations in bob veal, three assumptions are made. First, it is assumed that each of the approaches to calf management, drug use and non-drug use, result in equivalent reductions in calf deaths. This was established in the third section of this chapter. Second, the opportunity cost of labor is considered to be zero in treating calves with drugs because the administration of an injection or bolus takes only minutes. Third, the materials cost is considered to be equal between the two approaches: the application of three boluses or injections over a five day period costs approximately $4.50 and alternative,

recommended management techniques require towels, charts, and bottles or other liquid applicators which would cost approximately the same over the course of the five days that the surplus calf was assumed to remain on the dairy farm.

The application of a drug takes only minutes, however, the average amount of time for effectively treating calves without drugs is unknown. The assumption was made that a minimum would be a total of a half an hour per calf per day over the course of five days. Multiplying this amount of labor time by the $4.09 cost of hired, on-farm labor in 1984 results in a net benefit of $10.23 per calf for using drugs, excluding regulatory cost. This benefit obviously exceeds the $.01 expected cost of violation calculated for producers who sell calves which can be identified by FSIS and slaughterplants, the zero cost for the fifty-five percent of sellers who can't be identified by FSIS, and the twelve percent who can't be identified by slaughterplants (these last two groups are not likely to be mutually exclusive given that FSIS must depend on slaughterplants and stockyards for producer identification information).

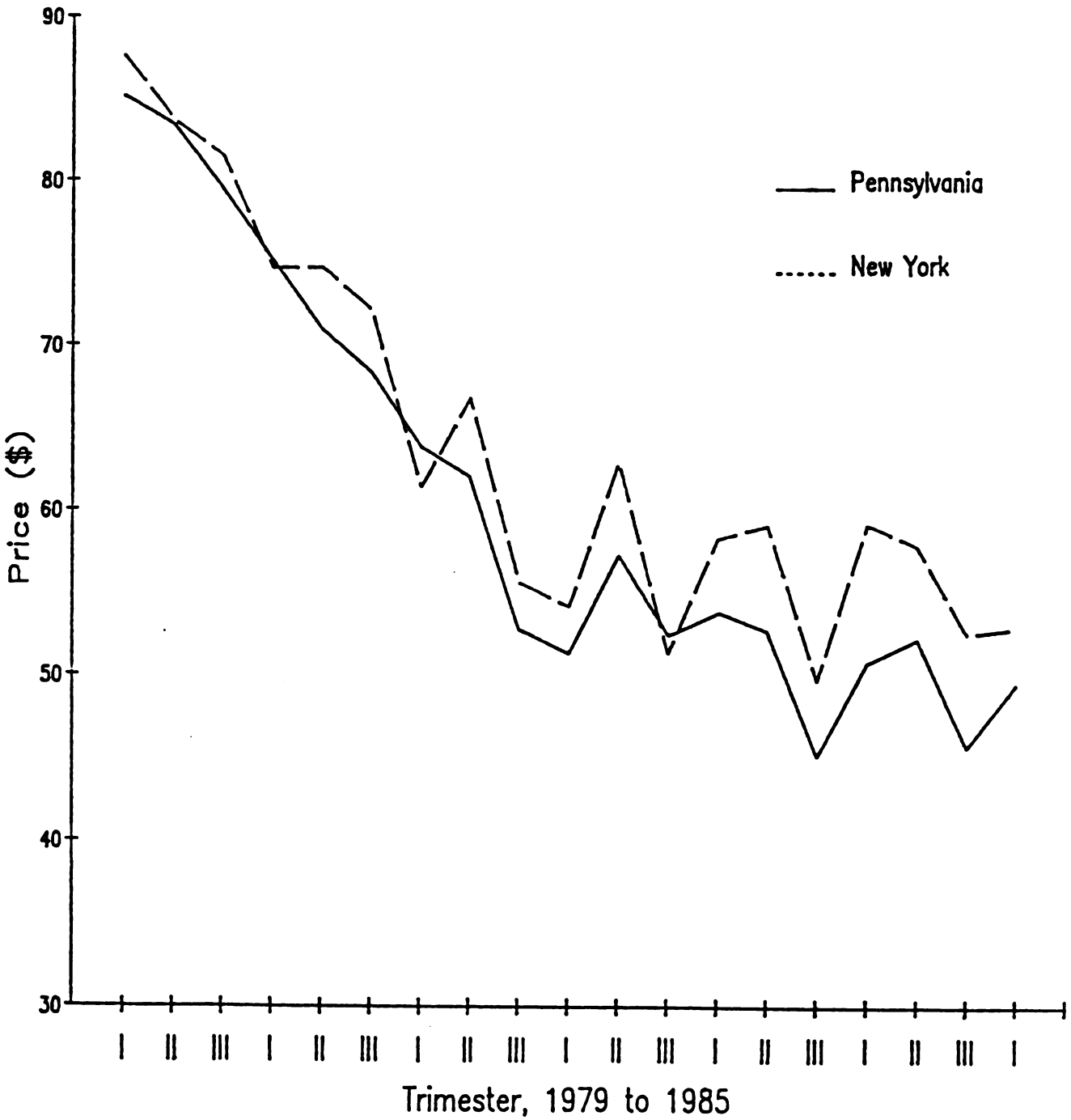
In effect, drug use is cheaper than alternative techniques of treating calves. The difference is much greater when demands for labor increase due to alternative priorities on a dairy operation such as harvesting forage or other seasonal tasks. A seasonal trend in drug use would be expected.

Estimating the Amount of Drug Use in Bob Calves

Estimating the underlying rate of death and illness in newborn calves would seem to be an effective way to determine the extent of drug use in the bob calf sector of calf markets prior to certification. However, even if the average proportion of calves born unhealthy and the average rate of illness were known for bob calves, other market factors would influence the proportion of drug use.

A major influencing factor would be market prices. A decrease in drug use or any type of treatment would be an expected response to decreases in price as the marginal returns for use would be diminishing as the return for animals was reduced. A trend of decreasing prices is apparent in the intermediary markets for calves during the late 1970's and early 1980's:

Figure 1
Bob Calf Prices
1979 to 1985
(Trimester)



Source: USDA Agricultural Marketing Service

Total number of cows changed very little during this period.[15] For the ten year period between 1974 and 1984, this total ranged from 10.8 million to 11.3 million. The estimated variance of the annual percentage change in the number of dairy cows and heifers to calf during this period was only thirteen percent. In effect, dairy producers were experiencing lower returns for the same number of surplus calves marketed. Causes of this decrease in price are unclear. Possible factors could be changes in demand for bob veal as an input in processed foods or changes in demand for beef or fancy veal calves. Decreasing prices result in a lower marginal product of drug use or any treatment. This in turn results in a decrease in the incentives to use drugs or any other treatment.

According to Akerlof's model discussed in the second chapter, the amount of drug use would reflect the amount of market deterioration due to asymmetric information. The residue rate for all types of calves prior to certification was estimated by FSIS as five percent. Does the description of bob calf markets provided within this chapter give evidence that this rate of violation could have been contained completely within the bob calf sector of calf markets? Could the averaging effect of the general rate of violation for calves be disguising a much higher rate in bob calf markets?

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[15] Agricultural Statistics, U.S. Department of Agriculture, 1974-1984.

It was stated earlier that according to the USDA, the death loss rate among calves was close to ten percent in 1983. Assuming that the death and sickness rate of newborn calves on-farm (losses to producers) was ten percent of total bob veal, this would represent five percent of total calves marketed. Given the lack of data, this is the only estimate for answering these questions. The information contained in this chapter is valuable for establishing the advantage of drug use in surplus calves born unhealthy or which become sick before they are marketed and the incentive for using drugs and immediately marketing these animals. From this, the three and a half percent rate of antibiotic residues and two percent rate of sulfonamide residues detected in all calves prior to certification can be reasonably attributed to the bob calf sector of the general market.

CHAPTER FIVE

THE STRUCTURE AND PERFORMANCE OF CALF MARKETS FOLLOWING THE CERTIFICATION PROGRAM

INTRODUCTION

The purpose of this chapter is to describe the changes in the structure of calf markets following certification and to assess how these changes impacted existing costs associated with drug use in bob calves.

The first two sections provide a historical perspective of the design and intended effects of the certification program. The limited enforcement tools available to FSIS in dealing with violators of drug residue regulations is central to this discussion of policymakers intentions. FSIS does not have the legal mandate to penalize violators directly; the certification program therefore represents a way to change seller incentives concerning withdrawal periods without having explicit regulatory power. A description of the main features of the program show that the intended effect of certification is to publicize the problem of residues in bob calves and to improve the ability of other economic actors in the system to assess penalties for violations.

In the first section is an overview of the certification program, including FSIS' explanation of why this particular regulatory approach was chosen. FSIS attributed high rates of residues in calf markets to a lack of information among market participants and a lack of motivation on the part of a small minority of producers. There is evidence, however, which contradicts the FSIS conclusion that producers violate because they are unaware of residue regulations. Despite the fact that this contradictory information was available to FSIS, the conclusion that dairy farmers were unaware of the problem led FSIS to allocate expenditures on educational programs oriented toward dairy farmers. To increase awareness, it was necessary to increase publicity.

In 1982, a business-government coalition was formed to serve as an advisory committee to FSIS in developing regulatory policy for eliminating the residue problem in bob calves. The Veal Calf Task Force decided by majority vote to implement the certification program as recommended by FSIS in January of 1984. The features of the certification program, implemented in June of 1984, are discussed in the second section.

The remainder of the chapter is divided according to slaughterplant and then producer perspectives of the changes caused by certification. Slaughterhouse incentives to purchase mainly certified animals were influenced by the potential cost which CAST imposed on operating systems and

the value of the identification information which certification offered. The section on slaughterplant perspectives also focuses on the factors which influenced buying practices and incentives to price certified calves higher than non-certified calves.

In the last three sections, estimates are made of the new probability of detection facing producers selling violative calves and also the revised expected costs associated with detection following certification. In the final section, these estimates are compared to the pre-certification figures calculated in the last chapter.

FSIS PERCEPTIONS OF THE RESIDUE PROBLEM

This section describes the FSIS approach to residues in calves. Of central importance is a description of FSIS stated perceptions concerning the cause of residues within bob calf markets.

FSIS attributed the majority of residues in bob calves to those dairy producers who were unaware of the possiblity that their surplus animals could be slaughtered within days after leaving their farm.[1] In addition, a small number of repeat offenders who had been identified and informed by FDA of the illegality of their actions yet continued to

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[1]Interview with John E. Spaulding, Director, Residue Planning and Evaluation Division, FSIS and Harold W. Davis, Packers and Stockyard Administration, March 28, 1985.

market violative animals were considered to be another source of the problem.

Based on these perceptions, residues in dairy calves were viewed as being inevitable without educational efforts targeted toward uninformed dairy farmers. Producer education became a main priority and the regulatory approach chosen by FSIS and affirmed by the Veal Calf Task Force reflected this priority. FSIS planned the following stages of action:

1) Develop an information and education program.
2) Dispense information to dairy producer cooperatives through the USDA Extension Service.
3) Implement certification process for continuous identification and market confirmation of non-treated calves.
4) Increase sampling and testing to determine impacts of education and certification.

According to this plan, certification and testing were to serve as follow-up mechanisms to the producer awareness programs. The residue problem was approached on the basis that if producers were better informed, the problem would diminish.

There is evidence that residues in bob calves were less of a result of ill-informed producers and more of a problem of calculated neglect of known regulations. First, according to a study of producers in Minnesota, lack of knowledge as to the existence and importance of drug withdrawal regulations was not a problem among dairy

producers prior to certification (Farrar, 1983). A survey of 2200 Minnesota livestock producers was conducted to determine the extent of producer awareness of residue problems associated with drug use. Analysis of the survey showed that dairy producers were more informed of proper withdrawal times for animal drugs than either beef or swine producers. The author ventured that a possible explanation for the significantly different amount of awareness in this livestock sector was the previous experience most dairy producers have had with residues in bulk milk tanks.

In addition, of the 449 responses (twenty percent return rate), significant results were obtained concerning whether producers felt they had enough information to prevent residues. Of the ninety-eight percent who answered the question concerning the adequacy of the information they had for preventing residues from occuring in their livestock, ninety-two percent felt that they did, in fact, have sufficient information.

The second source of evidence that producers were not as ill-informed as FSIS claimed were inspector reports of changes in the types of drugs used in newborn calves. FSIS records indicate that following inspector findings of undissolved boluses within gastrointestinal tracts of bob calves in 1982, there was an obvious switch to other types

of treatments including colorless boluses and antibiotics administered through injection.[2]

The implication of this apparent misperception of the cause of the residue problem is that it allowed FSIS to expand its limited enforcement leverage. To facilitate reactions of other economic actors such as the FDA and slaughterplants in the market for calves to the residue problem, widespread acceptance that a problem did exist was necessary. An educational campaign oriented towards this end was FSIS' first step in dealing with residues in calves.

Publicity concerning the residue problem is also a way to foster peer pressure among sellers in the market. This effect is viewed by FSIS as an added component of the cost function facing producers in their compliance decision.[3] Peer pressure would be a part of the "portmanteau" variable which Becker includes in his supply of offenses function. This variable represents all influencing factors other than the probability of detection and size of penalty.

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[2]Unpublished minutes of a Cooperative Planning Session of the Veal Calf Task Force Meeting, April 9, 1982, pg. 3, made available to the author by the Residue Planning and Evaluation Division, FSIS, USDA.

[3]Shriver, pg. 166.

THE POTENTIAL ROLE OF TRUCKERS IN THE RESIDUE PROBLEM IN CALVES

The regulatory policy focus of changing producer marketing and management practices possibly overlooked the important role that truckers (acting as buying agents) may have played in causing residue problems in calf markets. The incentive for these market participants to use drugs would exist when truckers take on the role of dealer. In these cases, the amount they receive for shipping and handling is directly related to the market value received for each shipment. Drugs may be used to ensure that deaths during this stage of the marketing process are minimized.

There are two other factors which are important in substantiating the possible role of truckers in causing the residue problem: 1) the fact that a sulfa bolus metabolizes within twelve to twenty-four hours requires partially dissolved pills discovered during post-mortem inspection to be administered almost immediately before slaughter and, 2) on-site investigations of slaughterplants made by FSIS administrators (discussed in Veal Calf Task Force meetings) revealed that healthy calves were being treated as well as sickly calves and that violations were being detected mainly in "clusters."

In effect, drugs were being used regardless of the health condition of specific animals.[4] The lack of

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[4]Unpublished Minutes of a Veal Calf Task Force Meeting, January 26-27, 1984, provided to the author by the Residue Planning and Evaluation Division, FSIS, U.S. Department of Agriculture.

sorting or differentiating calves prior to the application of drugs indicates either an unfamiliarity with the health background of the animals or a management practice of indiscriminately administering drugs to all calves. An implication of the latter cause is that the potential benefit of drug use in calves is considered high enough for some producers and truckers that they apply drugs without first screening for distressed animals.

Further inquiry is needed to determine the extent to which transporters depend on drug therapy for damage control. The obvious implication of a finding that a significant amount of drug use takes place during the transportation process is that FSIS' producer education program was irrelevent to the solution of this part of the residue problem.

PROGRAM DESIGN FOR DECREASING RESIDUES IN BOB CALVES

This section provides a description of the main features of the certification program implemented by FSIS in June of 1984. This description is necessary for understanding the specific impacts of the regulatory program on the market conditions described in the previous chapter.

Residue Aviodance Program (RAP)

Implementation of the certification program was preceded by the development of a USDA Extension program

oriented toward informing producers of residue problems and ways to prevent residues from occuring. In 1982, nearly one million dollars in "pass-through" funds were appropriated for the Extension Service of the USDA to develop the national Residue Avoidance Program (RAP). The Extension Service funds specialists at land grant universities to develop projects oriented toward educating livestock producers concerning residues.

Approximately one-third of the 1982 RAP budget allocation was used for projects which taught dairy producers the importance and mechanics of implementing residue avoidance measures within their management practices.[5] These projects reflected a variety of approaches: newsletters to veterinarians and county extension agents, informational exchanges at educational meetings, and the design and distribution of inserts to go with checks from stockyards to dairy producers.

The Certification Process

The certification program was viewed as a means to limit the FDA's need for two consecutive violations in order to determine producer prior knowledge of residue regulations. A signed statement attesting to compliance was considered adequate documentation as to prior knowledge of the legal requirements associated with chemical use in

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[5]The RAP program was continued in subsequent years though less funding was allocated.

calves. In addition, the certification statement was considered by FSIS to be an "implied guarantee" and was expected to increase incentives of buyers to hold sellers responsible for condemnations due to residues.

The certification process was also chosen for its usefulness in assuring that all traders in the calf market were aware of the potential residue problem in calves chosen for immediate slaughter. Each time that a calf was sold, the producer or other seller was required to choose whether to certify or not. Through this, FSIS ensured that all sellers were continuously reminded of the residue problem in the dairy calf market.

Calf Antibiotic and Sulfa Test (CAST)

The newly devised CAST test was installed in slaughter plants at the same time that certification was being introduced in calf markets. The test was designated for in-plant testing of bob calves. The sampling rate was unlike that of surveillance or monitoring testing (the established criteria is discussed in the next section). Testing of all types of calves other than bob was conducted in accordance with testing procedures which existed prior to certification as described in the last chapter.

To conduct a CAST test, two small swabs are soaked in fluids from the kidney at the time of slaughter and are placed in a solution of spores which encourage bacterial growth. After the established incubation period, a clear

"zone" appearing around the swabs indicates the presence of an inhibitory substance. The lack of a clear zone means that a detectable inhibitory substance was absent from the tissue. The size of the zone is indicative of the concentration of the residue in the tissue. The test costs approximately $.80 per animal for materials and takes about 10 to 15 minutes to conduct. Results are available in 18 hours. If the test shows evidence of residues, the bob calf carcass is condemned. Otherwise, it proceeds through the slaughtering system. This means that tested animals were held at slaughter until test results were in. This is a different procedure than was used in monitoring phase testing.

CAST is a combination of two screening procedures, the Sulfa Swab Test (SST) which is used in a lab to detect sulfa and the Swab Test on Premise (STOP) which is conducted within a slaughterplant to test for antibiotics. CAST combines the in-plant capability to detect sulfa with the laboratory capability to test for antibiotics. CAST also screens for chloramphenicol, a type of antibiotic banned for use in any animal which is to be marketed for human consumption.

The condemnation procedures asociated with CAST represent a significant departure from standard condemnation procedures. A positive CAST outcome results in a carcass being condemned for residues. All other inspector-conducted tests must be confirmed in a regional FSIS laboratory before

a final condemnation can be issued. This procedure was adopted by FSIS because the small size of the calf carcasses causes spoilage when it is stored for an extended period of time, including the time necessary to obtain lab confirmation following a CAST positive result.

A New Residue Sampling Plan

The special sampling plan associated with CAST was intended to reward slaughterhouses for purchasing certified animals by testing these calves less intensively than uncertified calves.[6] A total of 63,663 CAST tests were conducted within the first nine months of the program. Of these, 3,215 were positive, resulting in a five percent rate of condemnation among tested calves.

The sampling rate for bob calves is very different from other FSIS sampling procedures. Bob calves are chosen according to a schedule so that it is unlike surveillance testing in that inspectors test in cases other than those where suspicious conditions exist. However, those bob calves which inspectors choose for surveillance testing because of suspicious features are tested with CAST rather than a laboratory test following certification. These tests cannot be separated from totals of CAST tests taken in accordance with the established sampling procedures. In

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[6]Increased testing within a slaughterplant may cause production lines to slow, requires increased cooler space for holding detained carcasses, and may increased losses if greater numbers of condemnations are made.

1983, surveillance testing totalled approximately 1,500 calves and follow-up surveillance testing is included in this total. Assuming this rate is constant across years, the inclusion of this relatively small number of tests in the data concerning CAST sampling would not have a discernable effect on results.

The monitoring program is not affected by CAST testing. Though calves tested under the monitoring program are not held and therefore not condemned (slaughterers do not lose carcasses due to positive test results), this figure is added to the CAST total to derive the new probability of detection following certification. Inclusion of these tests biases results for the slaughterplant penalty upwards because the lack of condemnation means there is no charge-back for calves found violative through monitoring phase testing. However, FSIS follow-up surveillance testing can result from monitoring program testing making these tests relevant to the calculation of the expected cost of FSIS follow-up testing. Approximately 5,000 monitoring tests were conducted in 1984 while an estimated 84,000 CAST tests would have been conducted, assuming certification was in place the entire calandar year. The monitoring tests were included in the estimation of the probability of detection following certification due to the fact that the impact on slaughterplant penalty results will be minimal.

Under certification, the plant inspector assigns

all calves to "lots."[7] Inspectors choose the number of calves in each lot. Incoming calves are usually grouped in accordance with the original owner or market origin.

The sampling rate for an individual lot of calves depends on the certification status.

All certified lots have three animals tested. None of the other animals in the lot are detained but if residues are found in any of the three tested calves, the entire lot is tested in accordance with the rate established for uncertified lots, if the animals are still on the premises.

Uncertified lots are tested according to the specific rate of sampling shown below. Calf carcasses from an uncertified lot which have not been chosen for testing are held until CAST results are available.

Number of Healthy Calves	Number of Carcasses Sampled
1 - 11	All
12 - 16	12
17 - 40	15
41 - 250	25
more than 250	30

The lot system prevents population parameters from being estimated from test data because of the unrepresenta-

[7]"A lot is a group of calves delivered to an establishment from a single source at one time. The inspector-in-charge may arbitrarily assign calves to lots when the establishment fails to provide adequate information concerning the source." FSIS Notice in Federal Register, 9 CFR, Parts 309, 310, and 318. Vol. 49, No. 111 (June 7, 1984): 23602-23606.

tive manner in which calves are selected. The following section describes the slaughterplant survey results concerning buying procedures of certified and uncertified calves. The certification status of total bob calves slaughtered following certification can be estimated based on this information.

SLAUGHTERPLANT INCENTIVES FOLLOWING CERTIFICATION

The purpose of this section is to identify the impact of the certification process on existing standard operating procedures of slaughterplants. The incentives and disincentives created by certification for slaughterplant purchasing of either certified or uncertified animals has important implications for the incentives of sellers concerning drug use in bob calf markets.

Conclusions concerning how slaughterplants reacted to new incentives created by certification are drawn from results of the slaughterplant survey described previously in the third chapter. The identification information provided through the certification process was anticipated by FSIS to be utilized by slaughterplants as well as the FDA. FSIS also intended that the high rate of testing for uncertified animals would cause slaughterplants to purchase only certified animals, thus creating a demand for certified calves.

The first part of this section addresses the slaughterplant survey outcomes concerning buying procedures, identification, and charge-backs. Observed outcomes concerning prices are discussed in the last section. The implications of the average price difference between certified and uncertified calves reported to exist in the markets frequented by the slaughterplants contacted in the survey are discussed in the summary section of this chapter.

Charge-backs

According to the national survey of slaughterplants conducted for this research, thirty-five percent of slaughterplants sometimes assess a charge to producers for the cost of a calf condemned for residues. Of the sixty-five percent who do not charge producers for losses, the distribution of reasons why charges are not made is as follows:

1) Impossible to accurately identify drug user...35%
2) The amount of the loss didn't warrent the administrative expense.....35%
3) Legally impossible to charge seller.....10%
4) Didn't know.....10%

A description of the type of charge-back mechanisms used was requested of those slaughterplants which indicated that they do charge producers for losses. Of the remaining thirty percent who sometimes charge producers for losses, thirty percent bill directly, twenty percent deduct the

purchase price from subsequent calf payments, and fifty percent buy on a conditional basis.

Conditional Purchasing

The survey showed that conditional purchasing was used as a way to offset the added costs of testing associated with purchasing uncertified calves. According to Packers and Stockyards Administration regulations, payment to a seller must take place within twenty-four hours of a sale. This regulation can inhibit the development of contingent types of purchase agreements. Transactions based on the stipulation that payment will take place only if the animal passes inspection are viable in calf markets when the buyer knows the test results can be obtained before twenty-four hours following purchase, less any delivery time in making the payment. For bob calves, this requires that the calf be transported, slaughtered, and tested within a minimum of six hours after purchase given the eighteen hours required for CAST results.

Buying Practices

The value of the identification information made available by certification influences buyer decisions of whether to purchase certified or uncertified animals. The difference in testing rates between certified and uncertified calves would also influence purchasing decisions. Slaughterhouses were provided with an incentive

to purchase mainly certified calves due to the potential costs associated with CAST sampling of uncertified calves. The difference in the rate of testing between certified and uncertified calves can be significant, depending on lot sizes.[8]

Seventy-percent of slaughterplants responded in the survey that the CAST test slowed their line down. However, one-hundred percent of the respondents indicated that the total amount of bob veal purchased in their plant did not change following certification.

In regard to specific buying practices, slaughterplants reported that an average of ninety-six percent of bob calves purchased are certified. Responses as to why certified calves were purchased were distributed as follows:

1) Testing rate is lower.....40%
2) Residue rate is lower.....25%
3) Only kind (calf) available.....15%
4) Use identification info.....10%
5) Government regulations require it.....10%

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[8]The size of a lot of calves is important in the probability of testing as well as slaughterplant incentives for handling particular lots in a hurry. In certifed lots, only three animnals are chosen for testing and all others continue through the system. If the test results are positive, the other animals in the lot must be tested in accordance with the rate for uncertified lots. This occurs only if the original lot the violative calf came from is still on the premises. This creates an incentive for slaughterplants to move lots of animals out of their establishment before the results of the eighteen hour CAST tests are known.

There were no plants which indicated that they purchased one-hundred percent uncertified calves. The following reasons were given for the question concerning why some uncertified calves are purchased:

1) To meet purchasing needs.....40%
2) Lower prices.....35%
3) Calf appeared OK, seemed a profitable risk.....25%

Market Prices Observed by Slaughterplants

To determine if a price differential exists between certified and uncertified calves, slaughterplants were asked whether they observed a difference in the stockyards they frequent. Sixty-five percent reported an observed difference. The reported difference averaged approximately seventeen dollars per calf, or approximately thirty percent less for uncertified calves. In addition, fifteen percent of respondents reported that uncertified calves usually sold for only $1 or $2 dollars rather than providing an average difference per pound. The calves which sold for $1 bring approximately a penny per pound. This was not included in the averaging of price per pound differences reported by slaughterers.[9]

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[9]After completion of this analysis, it became apparent that a $1 price for uncertified animals was inconsistent with findings concerning violator incentives. Because it is costless for a producer to certify calves, all uncertified animals can be assumed to have been given drugs. The average cost of a bolus is $1.50 per application. A calf retained on farm for five days would be assumed to receive at least three drug applications if this approach to calf

In comparison, twenty-five percent of respondents reported that there was no price difference. This observation was affirmed by a USDA Livestock Marketing reporter in Pennsylvania who explained that a price difference in the two major calf markets he monitors existed for only the first four to six weeks of the certification program. Following that, certified and uncertified calves were sold for the same price. It is important to note that slaughterers as well as the market reporter were contacted approximately one year after program implementation.

The implications of these outcomes concerning price are important in evaluating incentives to producers for choosing whether to certify their calves. It is apparent that differences in price for certified and uncertified calves varies greatly among markets. For the purpose of making estimates of the expected cost of violation, the magnitude of a price differential is needed. The survey of slaughterplants revealed that a slight majority of slaughterers observe price differences and this averages about $17 per calf. This difference is assumed to represent the general case in calf markets following certification though only a

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management were chosen. Why would nearly $5 be spent on drugs if the animal will sell for only $1? The slaughterers who indicated that they observe $1 prices on uncertified calves were called back to determine the reason for this apparent inconsistency. According to one of the respondents, the nominal price she was referring to is observed on one day-old calves who are extremely weak appearing. The certification status is irrelevent for these animals as it is well understood by market participants that the animal will not last more than a few more hours. The second respondent could not be reached at the time.

slight majority of slaughterers cited an observed difference in the markets they frequent for purchasing slaughter calves.

EXPECTED COST OF A RESIDUE VIOLATION

The purpose of this section is to revise the expected costs of violation for bob calves estimated in the last chapter to reflect changes caused by certification.

The probability of detection is described in the first part of this section. Detection probabilities differ between certified and uncertified calves due to the different testing rates. Separate estimates for certified and uncertified calves are also made for calculations of the size of penalty which, following certification, may include both a slaughterer charge-back and FSIS surveillance testing.

Probability of Detection

The probability of detection in bob calves depends on the probability of testing. The purpose of the following is to determine the 1984 probability of testing, assuming certification was in place in calf markets all year.

The rate of CAST testing in certified and uncertified calves can be estimated by assuming that the proportions of certified and uncertified animals purchased by slaughter-

plants as indicated in the survey is representative of the true population proportions. Complete counts of CAST testing outcomes were available only for the first nine months of the certification program. The estimate below utilizes the monthly average of CAST tests during that period and extrapolates for calandar year 1984, based on the assumption that certification was in place all year.

Table 3: Probability of Residue Detection Following Certification
(1984 - Assuming Certification All Year)

Certified Calves

1)	Slaughterplant buying practices: percent of bob veal purchased which is certified	.96
2)	Estimated total bob calves slaughtered	1,400,000
3)	Total certified bob calves slaughtered [(1) x (2)]	1,344,000
4)	Total certified calves tested	44,498
5)	Probability of detection in certified calves [(4) ÷ (3)]	.03

Uncertified Calves

1)	Slaughterplant buying practices: percent of bob veal purchased which is uncertified	.04
2)	Estimated total bob calves slaughtered	1,400,000
3)	Total uncertified bob calves slaughtered [(1) x (2)]	56,000
4)	Total uncertified calves tested	42,855
5)	Probability of detection in uncertified calves [(4) ÷ (3)]	.77

Because inspectors use their discretion in determining lot sizes, producers could only expect with certainty that the probability of a certified calf being tested is less than that of an uncertified calf. This reduces risks to sellers of certified calves and makes certification more beneficial.

The calculation for uncertified, violative bob calves indicates that lot sizes were generally small. In consideration of the established sampling rate for uncertified animals, the average lot size must have been twelve to sixteen uncertified bob calves per uncertified lot. For lots of this size, twelve calves are tested. This average size would have resulted in an average testing rate of seventy-seven percent of each lot for uncertified animals.

Lot sizes were not recorded by inspectors in documentation of CAST tests. This deduction of the approximate size of uncertified lots shows that approximately 42,685 calves were sold uncertified during the first nine months of the program(numbers in Table 3 reflect a twelve month estimate). This information can be used to verify similar information gained from slaughterers. According to slaughterers, three percent of calves were sold uncertified. In regard to the 1984 bob calf estimate, this represents 42,000 calves. (The additional calves sold uncertified during the remaining three months of 1984 can be partly attributed to the four percent of calves CAST tested for which the certification status could not be established). In effect,

the slaughterplant and CAST test estimates of total uncertified calves are roughly equivalent. This affirms the contention that only a small minority of calves were marketed uncertified.

At this point, it seems much more advantageous for sellers to certify calves regardless of the residue status. However, sellers face an important trade-off in certifying calves in regard to increased probabilities of identification associated with the certification process. This trade-off, as well as consideration of price differences, is important in producer assessments of whether to certify calves and is discussed in the following sections concerning expected costs.

FDA Follow-up Procedures

Despite the new leverage that certification offered the FDA in regard to its ability to identify violators and verify knowledge of the legal aspects of drug use, the standard procedure in pursuing the 3,215 violations detected during the first nine months of the certification program did not involve prosecution.

Though FDA did not initiate any litigation against a producer or other market participants following certification, on-farm visits of violators were "stepped up" during the initial stages of implementation. These were not, however, sustained for long. Injunctions and seizures following farm visits continued to be rare. In effect, the

expected size of an FDA penalty remained unchanged following certification.

Probability of Identification: Seller Alternatives

It was established in chapter four that prior to certification, the average rate of identification was fifty-five percent. As a result, for nearly half of bob calf sellers, the expected cost of FSIS follow-up surveillance was zero.

The identification information which must be supplied for certified calves requires that an individual seller has a one-hundred percent chance of being identified. The trade-off between a lower rate of testing and a higher probability of identification is the main factor in producer decision making concerning whether to certify calves. Price differences between uncertified and certified calves in area markets would also need to be considered to estimate the least cost method of marketing newborn calves.

For example, if a seller is using colored sulfa boluses in newborn calves, the probability of surveillance testing and therefore detection is one. The lower rate of identification associated with uncertified calves would make this the least cost alternative in regard to the expected cost of FSIS follow-up surveillance testing. However, if there is a large difference in price between certified and uncertified calves, this choice would only be beneficial if

the price difference was less than the expected cost of FSIS follow-up testing.

Due to these factors, the low rate of detection and higher average price associated with certified calves causes the expected net benefits of certifying violative calves to be greater than the expected net benefits of not certifying. This is true even when uncertified calves cannot be identified and therefore face a zero penalty. It will be shown that the price difference between a certified and uncertifed calf is greater than the estimated expected benefit of drug use, resulting in a positive benefit of drug use only when a calf is sold certified (this is described in the following sections which include calculations of expected costs).

The expected cost of a slaughterplant charge-back is an additional influencing factor for animals condemned due to residues and is estimated in the next section concerning the expected cost of surveillance testing.

FSIS Follow-up Surveillance Testing

The changes to be considered in calculating the expected cost following certification must reflect the different probabilities for certified and uncertified bob calves:

Table 4: Expected Cost of FSIS Follow-up Surveillance Testing for Marketing an Identifiable, Violative Bob Calf
(1984 - Assuming Certification All Year)

	Certified	Uncertified
1) Probability of testing	.03	.77
2) Cost of testing: [Opportunity cost to labor to arrange and conduct a special trip for testing [1.5 hours x $4.09 on-farm hired hourly labor wage rate for 1984]	$6.14	$6.14
3) Expected cost of FSIS follow-up surveillance testing [(1) x (2)]	$.18	$4.75

Slaughterplant Charge-backs

According to the slaughterplant survey conducted for this research, thirty-five percent of slaughterplants sometimes charge producers for losses from condemnations due to residues. There are a number of incentives and dis-incentives for slaughterplants to consider in making their decision to charge producers for condmenations due to residues.

First, the potential for error within the identification system prohibits charges to be assessed for all violative calves. Second, the relatively low value of calves in comparison to other types of calves or animals may cause the administrative cost to exceed the amount paid for the calf. Payment of a charge-back may require taking a producer to small claims court. Third, skins from condemned

calves are marketable. A bob calf slaughterer does not realize a one-hundred percent loss on claves condemned by FSIS for violation of chemical residue standards. Fourth, there are mixed views as to whether slaughterplants were able to conduct charge-backs prior to certification. Producer identification was not formally documented. Also, the residue status of a calf was not normally made a part of the terms of sale.

Table 5: Expected Cost of a Slaughterplant Charge-back for Marketing An Identifiable, Violative Bob Calf At a Plant Which Charges For Losses Due to Residues
(1984 - Assuming Certification all Year)

	Certified	Uncertified
(1) Probability of residue testing	.03	.77
(2) Average bob calf price [represents cost of slaughterplant charge-back]	$56.59	$39.61
(3) Expected cost of selling a violative calf at a slaughter-plant which charges for losses [(1) x (2)]	$1.70	$30.50

SUMMARY

The probability associated with testing and the size of penalties were calculated to provide estimates of the change in expected costs of marketing violative animals. A comparison of these calculations is complicated somewhat

by the fact that producers can control whether or not they are identified as the original owner of a calf which is found violative in FSIS testing programs. The maximum expected costs of marketing identifiable, violative calves before and after certification were calculated. The expected cost of violation would be zero for those sellers who cannot be identified.

Results show that the expected cost of marketing a violative calf before certification is a penny, or zero percent of the price of the calf. Following certification, the expected cost increased to three percent of the price of calves which are certified and almost eighty percent of the value of uncertified calves.

The benefit of drug use was established to be equal to the opportunity cost of treating calves with management techniques that did not include drug therapy. Prior to certification, the net benefit of drug use was $10.22, including the expected regulatory cost. Because the expected cost of violation was so little ($.01), the net benefit was essentially the same for those producers which could be identified and those which could not be identified to a violative calf.

In comparison, following certification the net benefit of drug use was determined to be $8.35 for producers who certified their calves and -$41.98 for those that did not (a summary table of these estimates is included in the next

chapter). The benefit of using drugs exceeded the cost both before and after certification.

THE OUTCOME OF THE SIGNALLING SYSTEM

Results of the CAST test for the first nine months of the certification program were used in the following contingency table to determine the strength of the relationship between certification status and test outcome:

Table 6: CAST Test Results
June 1984 to February 1985
(Figures Represent Percentages)

	Positive	Negative
Certified	39	46
Uncertified	46	51
Unknown	15	3

A Cramer's V statistic was estimated to measure the strength of the relationship between the test outcome of a calf and the certification status. The resulting value was .13 which reflects a lack of a statistically significant relationship (the scale for this test is zero to positive one with higher numbers indicating a high degree of association). This result is expected given the fact that

violative calves which were tested were sold both certified and uncertified (forty-six percent certified vs. thirty-nine percent uncertified). If an inverse relationship between quality and cost of signalling had existed following certification, there would be a statistically significant difference between the number of violative calves tested which were certified and uncertified.

This outcome is affirmed by results of the slaughter-plant survey. If a penalty existed in bob calf markets following certification for marketing a condemned calf, the survey responses would have indicated that slaughterers did, in fact, charge producers for losses due to condemnations for residues. The actual mean response differed from the expected response at a ninety-nine percent significant level.

CHAPTER SIX

CONCLUSIONS

INTRODUCTION

The purpose of this chapter is to draw conclusions from the results of the last two chapters concerning estimated expected costs and expected benefits of drug use before and after certification to evaluate the effectiveness of certification in reducing residue levels in calves. The first section of this chapter compares the net benefit of drug use before and after certification and assesses the general implications of this comparison. The second section re-examines the conditions necessary for a signalling system to overcome the market constraint of asymmetric information and assesses results concerning bob calf markets obtained in chapters four and five in regard to these conditions.

The third section describes expected changes in violations in calves based on the outcome of the comparison of expected costs and expected benefits. This is followed by a discussion of the optimal conditions for ensuring a successful certification program. Certification offers lessons for other livestock markets concerning the issue of producer identification and these are described in the fifth section. Last are suggestions for improving FSIS documenta-

tion of regulatory programs, particularly testing programs which concern calves, and topics for future research.

SUMMARY OF THE RESULTS OF CALCULATED EXPECTED NET BENEFITS OF DRUG USE BEFORE AND AFTER CERTIFICATION

The results within the last two chapters indicate that there was a positive net benefit for drug use both before and after certification. The following table summarizes the approach used to estimate expected costs and expected benefits and then provides a comparison of the results of calculated net benefits for drug use before and after certification.

Table 7: A Comparison of Expected Net Benefits For Marketing an Identifiable, Violative Calf Before and After Certification Implementation

1. $E(C) = [T\ (P + S)] + R$
2. $E(B) = D$

where:
- $E(C)$ = Expected Cost of violation
  - T = Probability of being tested by FSIS
  - P = Average size of FSIS penalty
  - S = Average size of slaughterplant penalty
  - R = Cost of not certifying (i.e., lower return of uncertified)
- $E(B)$ = Expected benefit of marketing a violative calf
  - D = Cost of not using drugs in calf management techniques

VARIABLE	BEFORE CERTIFICATION	AFTER CERTIFICATION Certified	AFTER CERTIFICATION Uncertified
T	.002	.03	.77
P	$6.14	$6.14	$6.14
S	0	$56.59	$30.61
R	0	0	$16.98
E(C)	$.01	$1.88	$52.21
E(B) = D	$10.23	$10.23	$10.23
Net Benefit [E(B) - E(C)]	$10.22	$8.35	-$41.98

General Implications

It is important to note that the expected cost and benefits in Table 7 apply only to those sellers who can be identified by both slaughterers and FSIS. Those sellers who take actions to eliminate the possibility of identification cannot be penalized and face a zero expected cost of drug use. Consequently, the expected benefits of violating are greater for unidentifiable sellers.

There are four important points to be made concerning Table 7. First, the comparison of net benefits shows that although the incentive to use drugs decreased following certification, a positive return could be expected for using drugs for treating sick calves if they were certified. Thus, the program did not produce significant disincentives for drug use.

Second, it is clear that following certification incentives existed for producers to certify violative calves, regardless of the identifiability of the seller. Specifically, the net benefit of certifying violative calves and facing expected regulatory and slaughterplant penalties is larger than the net benefit of selling an unidentifiable, uncertified calf. The average price difference between certified and uncertified calves was $16.98 which is greater than the $10.23 benefit of drug use. This causes the net benefit of marketing an identifiable, violative, and uncertified calf to be -$41.98. Even if the animal were unidentifiable, the net benefit would still be negative

(i.e., -$6.75). As a result, the lower rate of testing associated with certified calves and the lower price received for uncertified calves causes it to be more advantageous for violators to certify rather than to sell uncertified and take precautions against being identified. The expected costs exceeded the expected benefits of selling uncertified, violative calves regardless of the identifiability of the seller.

The third important feature of the table is that it can be used to calculate the testing rate necessary for causing the expected benefit of certifying violative calves to be equal to the expected cost of violation (for sellers who can be identified by FSIS and slaughterers). Dividing the expected benefit by the total penalty ($10.23/$6.14 + $56.59) shows that a .16 testing rate is needed to cause the expected benefits of drug use to exceed the costs of marketing certified, violative calves following certification if penalties are unchanged. In effect, sixteen in every hundred certified calves rather than three in every hundred certified calves should be tested to eliminate the incentive for violation of drug withdrawal regulations. However, if this testing rate were used, price differences between certified and uncertified would surely decrease.

However, there is an alternative method for increasing the expected cost to producers for certifying violative calves which is within FSIS' legal jurisdiction: the cost of follow-up surveillance testing can be charged to produ-

cers found with violative calves in either monitoring or CAST testing programs. This would serve to increase the size of the penalty for FSIS surveillance testing (the "P" variable in the table). Dividing the expected benefit of drug use by the probability of testing ($10.23/.03) shows that the size of the total penalty would have to be equal to $341 for expected costs to equal expected benefits of certifying a violative calf. The expected cost of FSIS surveillance testing (because FSIS cannot control slaughterer chargebacks) must increase to $334.86 (or $341 minus the existing FSIS expected cost of $6.14). The following table shows that this amount can be assessed by requiring violators detected through CAST or monitoring to not only present animals for special testing before marketing another lot but to also pay the laboratory cost for these tests:

Table 8: 1984 Cost of FSIS Follow-up Surveillance Testing1

(1)	1984 labor cost of one hour of FSIS laboratory time	$35.92
(2)	Time required to conduct a sulfonomide and antibiotic test on calf tissues (in hours)	1.5
(3)	Cost of FSIS follow-up surveillance testing for the five required calves [5 calves x (1) x (2)]	$269.40

[1]All figures were obtained from Neal J. Whitney, Director, Field Service Laboratories Division, Science Program, FSIS, U.S. Department of Agriculture, March 19, 1985.

FSIS could create negative net benefits for sellers to market violative, certified calves by increasing the number of calves required for follow-up surveillance testing to six and charging producers for the cost. Alternatively, the required number of calves tested could be kept at five and violators could also be charged for material and shipping cost as well as laboratory labor costs. The outcome of either approaches would be negative net benefits for certifying violative calves.

A fourth point to be made from Table 7 which compares net benefits of drug use before and after certification is that calves must be condemned in residue testing programs to create an incentive for slaughterers to penalize violators of residue regulations. The reason the size of the expected penalty is small prior to certification is because animals tested in the national monitoring program are not required to be retained until tests are completed (violative carcasses have therefore reached the human food supply by the time FSIS residue test results are obtained).

The required retention of all animals tested is recommended to increase condemnations and therefore increase the cost of residues to slaughterers. In that FSIS' main residue testing program does not condemn violative animals and also that skins and other parts of calf carcasses are salvagable when condemnations due to residues occurs, slaughterplant incentives for conducting charge-backs are

reduced.[2] Requiring that all tested calves are held until tests are completed is consistent with FSIS' approach of encouraging slaughterers to pass along the costs of violations to individual violators.

Behavioral Assumptions of the Evaluative Approach

This evaluation of expected costs and expected benefits was based on the assumption that drug use would occur if the expected benefits exceeded the expected costs. Becker's tenet that the supply of regulatory offenses in a market is a function of the size of the penalty and probability of detection was used as the basis for calculating expected costs. Becker's cost function implicitly assumes that sellers do not associate a cost with the act of violating federal regulations or possibly imposing health risks on others (unless this is included in the "portmanteau" variable which he mentions as the sum of all other effects).

Should concern for the public health risks associated with chemicals in meat be included as a variable producers consider when choosing methods for treating sick, surplus calves? Do producers attribute a cost to the personal act of violating the law (federal residue regulations) and should this be included in expected cost calculations?

There are five main factors which may cause producers

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[2]The USDA does not record or publish figures on calf hide prices.

to discount any costs they associate with actions which result in breaking the law or possibly harming others. First, they may not personally agree with the idea that drug residues are dangerous to human health. Second, the probabilistic market outcome of surplus calves may be considered an important factor. Dairy producers may conclude that the chance of their calves being purchased by a slaughterer is very small and that their use of drugs will likely not result in residues in veal sold to the public.

Another possibility is that only part of the risk of residues in calves is known to producers. The main concern of FSIS, that residue levels in carcasses of newborn calves can sometimes be high enough to kill a consumer who is allergic to either antibiotics or sulfonamides, may not be known by producers. Producers may only be aware (and not fully convinced) of possible, long run effects of residues in meat: potential carcinogenic risks and the possibility of the development of resistance to anti-bacterials now used in human medical therapy.

Fourth, in the case of dairy producers, the cost to society in regard to real or potential health risks may or may not be accounted for, depending on individual circumstances and information. In this analysis, the certification process is explored based on the assumption that participants in the market for surplus calves act as rational maximizers. Decision making is based on comparing expected returns and expected costs with alternative uses of

the same resources. The key to this assumption is that each dairy producer (as an economic agent) assesses cost and benefits of using an input on the basis of his/her individual circumstances.

Finally, there is the "free-rider" problem in calf markets concerning drug use. Free-riders are those who receive benefits without having to pay for them. This is perhaps the critical aspect of the question of whether producers assess a cost for disobeying government regulations or contributing to a possible public health hazard.

In this case, free-riders are those market participants who receive the benefit of higher average prices that a low rate of residues (in comparison to a high average rate of residues or quality) would cause but act to reduce their own marginal cost of production by using drugs. In effect, the positive market effect of other participants placing a cost on the societal implications or action of disregarding the law is captured without having to personally absorb the cost of forgoing the use of drugs.

Producers can be expected to curb their own use of drugs on the basis of the societal health consequences or because of a lack of willingness to disobey federal laws only when their individual calculations of expected cost and expected benefits warrant this action. Due to information constraints in determining the quality of meat in regard to residues, producers who include costs for disobeying the law or contributing to a public health problem which are greater

than the benefits of drug use, will face higher marginal costs of managing surplus calves. It can be assumed that the residue violation detections found by FSIS were created by "free-riders," those individuals who do not associate a cost with the act of breaking the law or contributing to potential health risks due to illegal levels of residues which exceeds the benefits of drug use. For these individuals, the certain, short run financial cost of using alternative management techniques outweighs any costs they associate with possible, long run health consequences caused by residues and the illegality of marketing violative calves.

Limitations of the Data

The shortcomings of the data used to calculate expected costs and expected benefits have been mentioned throughout the text. This section summarizes the critical data problems associated with this evaluation of the certification program and provides recommendations to FSIS on program data collection.

First, the most questionable proxy figure used in calculating expected costs and expected benefits was the difference in prices between certified and uncertified calves. This proxy was obtained by sampling slaughterers who purchase newborn calves for immediate kill. Due to the fact that the USDA did not record differences in certified

and uncertified in those few markets in which bob calf prices are recorded, there is not an alternative source with which to validate this finding. Because the price incentive was an important component of FSIS' program, it would have been wise to have contacted the Agricultural Marketing Service prior to program implementation to ensure that necessary data was available for evaluating program effectiveness.

Second, data on the proportion of certified and uncertified animals marketed following program implementation did not exist. It could have if inspectors had been requested to include lot sizes associated with tested animals. Because lot data was not documented for tested calves, it was only possible to make a deduction of the proportion of uncertified calves using the test results and the FSIS sampling requirements and comparing this to the figures obtained from the survey of slaughterplants. The inclusion of lot sizes on inspector worksheets for CAST would allow for more reliable statistics to be calculated concerning the certification status of calves.

Third, there is a lack of conclusive research concerning the difference in labor costs between drug use and other, alternative methods for dealing with sickly surplus calves.

The fourth major data problem was the determination of the proportion of calves for which special management techniques are necessary. This information was important

for estimating the approximate extent of the residue problem within newborn calves. FSIS residue data was insufficient for making this determination (the shortcomings of FSIS national residue monitoring statistics for calves is discussed in detail later in this chapter).

Last, the many problems associated with tabulating the national CAST test results in regard to test outcome and certification status are described in detail in chapter three. The main problems were the number of incomplete and missing inspector worksheets. Suggestions for improvements in FSIS data managment of CAST tests are included in a later section of this chapter.

ASSESSMENT OF THE SIGNALLING SYSTEM OUTCOME IN CALF MARKETS FOLLOWING CERTIFICATION

Was Spence's criteria for effective signalling met in calf markets following certification? As stated in chapter two, his criteria requires that: 1) the cost of the proxy is inversely related to the quality of the good and, 2) the cost of signalling does not exceed the benefits to sellers.

In chapter five, the certification status was shown to be an unreliable signal of product quality because there is not an inverse relationship between quality and the cost of signalling. In other words, it is less costly to produce and certify a calf treated with drugs than to produce and certify a calf treated with non-drug alternatives. The

expected cost of being detected as a violator does not make the use of drugs more costly than the use of non-drug alternatives.

The second condition forwarded by Spence is interesting to consider in regard to the price differential observed in some calf markets following certification. This condition requires there to be a benefit to sellers for signalling that equals or exceeds the cost of the proxy. However, slaughterers cannot be expected to offer a premium that they cannot pass along to their buyers. It would be difficult for slaughterers to charge consumers for a "residue-free" product. Most buyers of bob veal are processors and are unlikely to pay a premium which would also be difficult for them to pass along to buyers.

The price differential observed by a majority of slaughterplants in stockyards for bob veal is a reflection of lower prices being offered for uncertified calves due to increased costs (due to increased testing associated with uncertified lots of calves rather than a higher price being offered for certified bob calves). The incentive for sellers to certify calves was in the form of lower prices for uncertified rather than increased prices to certify. This price differential was instituted by buyers to deter producers from selling uncertified calves, not from selling violative (i.e., lower quality) calves. In effect, the price differential reflects a positive benefit for signalling despite the expected cost of $1.88 (as shown in

Table 7) for being identified. As a result, Spences' second condition for effective signalling was met in calf markets.

Actually, one wonders why there were any uncertified calves remaining in the market given that the expected net benefit was negative (i.e., -$41.98). In fact, only a small percentage were uncertified and survey evidence suggests some of these were simply unhealthy calves for which the certification status was irrelevent.

EXPECTED OUTCOMES CONCERNING RESIDUE LEVELS IN CALVES

This analysis revealed that prior to certification, the net benefit of using drugs in treating surplus calves was $10.22, including the expected cost of regulatory action. For calves which were born ill or became sick before marketing, incentives existed to use drugs because alternative management options were more labor-intensive and expected costs for non-compliance with residue withdrawal requirements were low. The results also show that the net benefit of drug use after certification was $8.35 per calf, for calves which were certified.

In effect, there was a net benefit for using drugs both before and after certification. Based on this, violation rates would be expected to stay the same. However, a lull in drug use could be expected just before and after program implementation as producers who were uncertain of the new costs associated with regulatory action adjusted their

management practices. These two expectations, based on the results of the comparison of expected costs and expected benefits, are clearly depicted in the following graphs of National Residue Monitoring Program data:

Figure 2
Antibiotic Residues In Calves
FSIS National Residue Monitoring Program
January 1983 to March 1985

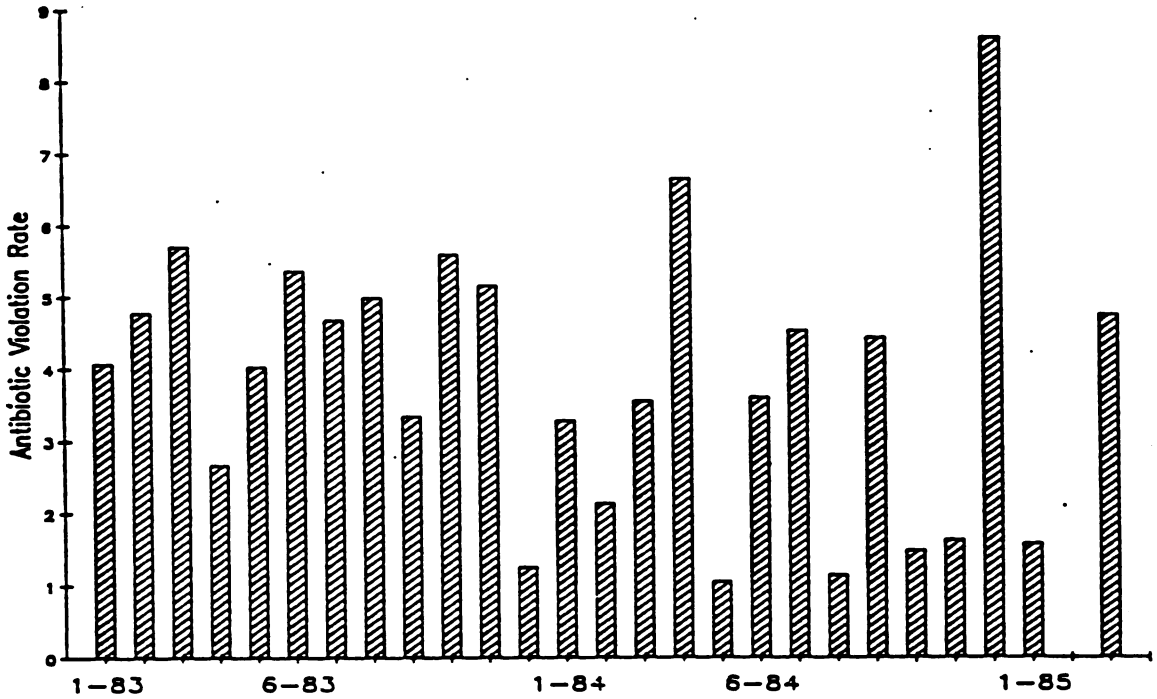
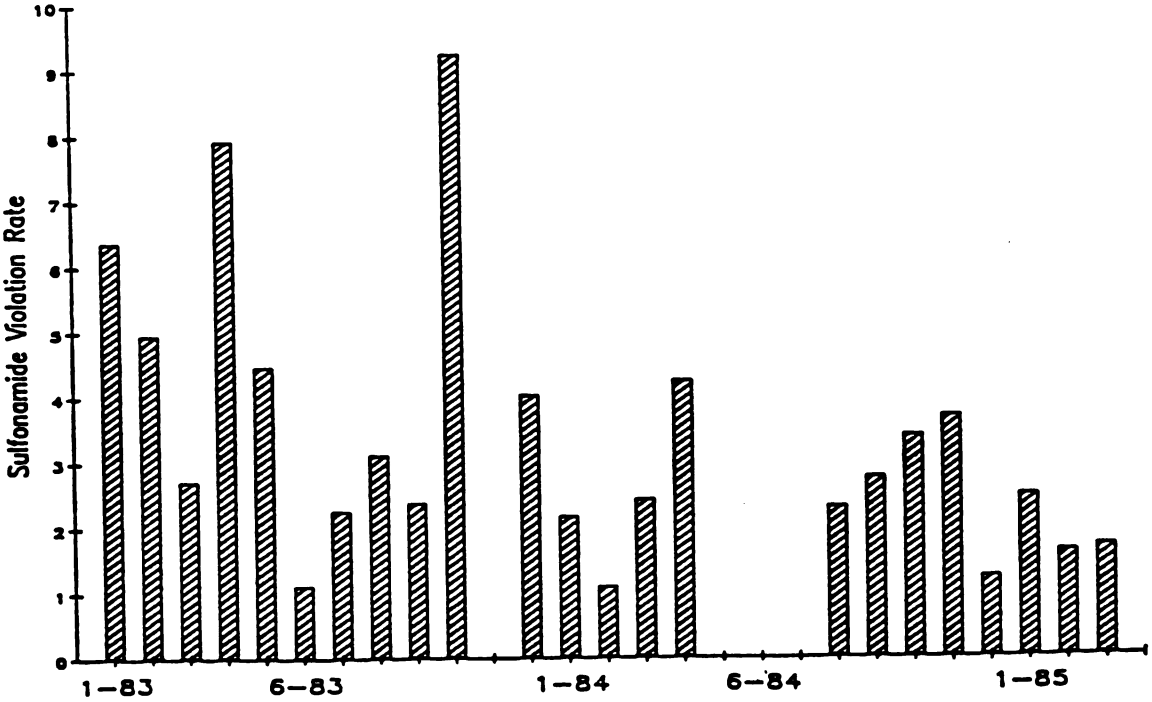


Figure 3
Sulfonamide Residues In Calves
FSIS National Residue Monitoring Program
January 1983 to March 1985



It is interesting to note the complete absence of sulfa detection during June of 1984 when certification was implemented. This observation adds evidence to the contention that contrary to FSIS perceptions, producers are not unaware of withdrawal regulations. Sulfa boluses are more easily detected at slaughter than antibiotics which is one reason for the decrease in sulfa and increase in antibiotic use following certification.

The seasonality associated with drug use is also depicted in these graphs. Sulfa use was high in the winter months of 1983/84, dropped off in the summer of 1984, and antibiotics reached the highest level of residue detection in the winter of 1984/85. Overall, these graphs show that the effect of certification is as expected: little reduction in the overall use of drugs but a short period when the new expected cost of regulatory action was unknown and producers acted to minimize risks.

The results of a statistical test of significance show that there was not a significant difference between rates in calves twelve months prior to certification and ten months after (the latter data was all that was available at the time data was collected). For antibiotics, the hypothesis that there is no significant difference between the groups of residue violation rates could be rejected at only the forty-three percent level of significance and at the forty percent level for sulfonamides. The mean and standard deviation of the residue violation rates are as follows:

Table 9: Mean and Standard Deviation of Rates of Residue Detection Before and After Certification FSIS National Residue Monitoring Program

	Mean	Standard Deviation	t Value (20 degrees of freedom)
Antibiotic Residues			
6/83 to 5/84	3.9343	1.784	
6/84 to 3/85	3.1858	2.533	.81
Sulfonamide Residues			
6/83 to 5/84	2.6825	2.480	
6/84 to 3/85	1.9330	1.272	.86

Table 9 shows an interesting reversal in the standard deviations in the two types of drugs before and after certification. The use of anibiotics became more variable following certification whereas the standard deviation decreased in sulfonamides following certification. This is consistent with the observation from the previous graph (Figures 2 and 3) which showed changes in the types of drugs administered. The hypothesized reason for this occurance is that sulfonamides are more easily detectable in post-mortem inspections and that producers began using less detectable types of drugs as a result of improvements in FSIS testing capabilities. Increasing the amount of data would be useful in affirming this contention.

As stated in the methods chapter, there are three main limitations associated with this data. First, the national monitoring program violation rates reflect residues detected in all calves, not just bob veal. Any drug use trends

This limits the validity of the findings based on these figures.

Second, FSIS monitoring data represents an average of six regional average rates of detection. Each FSIS-designated region is given equal weight in regard to the national average. Regions with very low calf kill volumes have much lower rates of violation than large volume regions. This biases overall averages downward.

Third, it was established earlier that the majority of residue violations in calves could reasonably be attributed to the bob calf sector. If ten percent of bob calves slaughtered in 1984 had required and were given drug treatment (the average death rate in calves is almost ten percent according to the USDA), the residue monitoring program should reflect a five percent rate of residue detection in calves (assuming zero residues in other sectors). The actual, average rates shown above are consistent with this approximation. In effect, bob calves are the likely source of the majority of detections found in the monitoring program. However, if bobs were tested separately, the rate is likely to be higher than depicted here.

All of these factors must be noted when judging the outcome of the residue violation data available for determining if the rate of detection in calves declined following certification. Further suggestions for improving FSIS testing programs and documentation of residue data within

the calf livestock sector is included later in this chapter.

THE OPTIMAL CONDITIONS FOR CERTIFICATION EFFECTIVENESS

The certification program for calves, including dramatically increased testing, represents the full range of enforcement powers available to FSIS. In this perspective, certification represents an imaginative approach toward influencing producer behavior when jurisdictional boundaries are constrained by the existing legal powers.

Under what circumstances would expansion of these limited enforcement tools be warranted? Food safety concerns associated with meat products have changed with the advent of chemical inputs: in the early part of this century, the main concerns were sanitary conditions, proper refrigeration, and animal health. Problems of injection sites, masked disease, and undissolved boluses associated with chemical residues pose new dangers to consumers and may require new enforcement jurisdictions for regulatory agencies.

Producers, however, have an incentive to prevent debate from occuring within the national legislature concerning new enforcement powers. In addition, FSIS has an incentive to prevent residues in any one livestock sector from reaching a level which causes the entire federal approach to residue control from coming under public scrutiny.

For a certification program to be effective in a livestock market, the previous analysis has shown that violators of residue standards must face individual costs for their actions. FSIS needs the power to impose a penalty such as a direct fine (perhaps as a percentage of profits) or the cost of testing, storage, or quarrantine when violative animals are found. At present, the range of enforcement options is extremely limited.

IMPLICATIONS FOR IDENTIFICATION IN OTHER LIVESTOCK MARKETS

Livestock identification is currently a popular topic in the realm of food safety. Technological advances in electronic and tagging devices have created incentives for regulatory agencies to begin evaluating the feasibility of mandating identification. Producer groups are considering whether they should advocate and operationalize industry investment in expensive electronic systems which can also be used with feed efficiency monitors and animal health monitors which may, in the long run, be more beneficial to invest in if a whole industry undertakes implementation of a universally compatible system.

The certification program for bob calves provides important lessons concerning the usefulness of identification devices. Though there is greater room for error and dishonest use associated with this system in comparison to more sophisticated technologies becoming available, the

certification process was considered adequate for providing evidence of previous ownership and prior knowledge of residue illegality.

The identification information generated by the certification process was, however, virtually unused in calf markets. The main reason, according to the survey of slaughterers, was that the administrative hassle with utilizing the information was not worth the losses due to condemnation. This may not be true in higher valued animals such as beef or swine.

However, the information was also not utilized by FDA. Before implementing expensive information systems, the actual uses of the information by all relevent actors within the market system must be assessed, particularly in light of the effectiveness of identification as a way to reduce residue violations.

THE OPTIMAL CONDITIONS FOR IDENTIFYING SOURCES OF RESIDUES IN CALF MARKETS

This section summarizes the suggested changes associated with future monitoring and evaluation of the certification program in calves.

The discussion of the calf market structure indicates that the bob veal sector is likely to have been the focus of the residue problem in calves. However, there seems to be little reason for the FSIS testing process not to differentiate between types of calves tested and slaughtered in

U.S. slaughterplants. More specific information would have improved regulatory planning, implementation, and effectiveness. Production constraints associated with kill lines for calves allow only one size of calf to proceed at a time, allowing for easy and virtually costless documentation of the different types of calves being slaughtered or tested. It is suggested that all future documentation of calf testing require information concerning the type of calf tested.

In addition, the documentation of bob calves for CAST testing needs to be revised to include the lot sizes and the certification status to facilitate on-going evaluation of the certification program. More importantly, however, the cost associated with two separate divisions within FSIS (two individuals) manually counting and compiling national statistics for CAST can be drastically reduced by transferring the data to a computerized process.

The weakness of an evaluation which is based on data gathered after public policy has been implemented is that the optimal type of data is not usually that which is available (or possible to obtain). This makes unambiguous interpretation of the effect of regulatory action difficult. This lesson can be generally applied to future programs implemented by FSIS.

A possible way to overcome this problem is to ensure that efforts are made to coordinate with data collection agencies within USDA to establish FSIS' needs before a

program is implemented. In regard to certification, the Agricultural Marketing Service could have been consulted as to the importance of price information concerning certified and uncertified calves and perhaps sampling of markets to determine the distribution of animals being sold certified and uncertified.

Also, coordination with FDA as to the requirement that all boluses legally available for use in calves must contain a dye would facilitate FSIS inspector detections of drug residues. According to the FDA, only a small percentage of boluses approved by their agency now contain dyes.

TOPICS FOR FUTURE RESEARCH

It became apparent through this analysis that futher information is needed in the following areas:

1) Non-regulatory alternatives to reducing residues. The objective of this research was to determine the effectiveness of the certification program in reducing residue levels in calf markets. A relevant question to consider (though it is outside of the scope of this research) in relation to this new and innovative regulatory program is whether there are alternative means by which the same results could have obtained. Specifically, what are the conditions necessary for legal actions to be undertaken by consumers who have been physically harmed by residues in calves? Would a class-action suit by a group of consumers

who are allergic to residues against FSIS succeed in reducing residues? If an individual became ill or died from residues and identified the source to a bob veal product, who could be sued? Is this an effective approach for sending a message through the market system for producers to alter their drug management practices? Is it a practical solution?

2) The difference in costs associated with drug use and other, alternative calf management techniques. The exact difference in the labor and materials costs for using drugs and not using drugs would be useful information for FSIS to have for all types of livestock sectors. This would improve FSIS understanding of the specific incentives to use drugs which exists in the different livestock markets it monitors.

3. The role of truckers in the residue problem in calves. It was established in this analysis that there is strong evidence that dairy producers were not the only economic actors in the market for surplus calves to use drugs (see the third section of chapter five). This possibility has important implications as to whether FSIS misspecified the source of the residue problem in calves. The USDA Extension Service would seem a likely source of information concerning this possibility. Coordination with this agency for determining the extent of the trucker role in drug use in calves is suggested.

4. Animal identification systems. There is presently considerable emphasis in livestock markets as to the possible benefits of implementing universally compatible electronic identification systems which (may) also monitor the feed efficiency and/or health status and background of an individual animal. Further investigation needs to be undertaken as to the reasons why certification identification information was not used by either slaughterers or the FDA. This could result in important information concerning the value of identification information to enforcement results. In this analysis, it was shown that identification without sanction does little to change incentive contingencies concerning drug use. The assessment of penalties is needed if incentives are to be altered in accordance with regulatory goals.

APPENDICES

APPENDIX A

Questionnaire For Surveying Slaughterplants Which Kill Bob Veal August, 1985

Plant _____ **Total calf kill** survey_____
FSIS _____
difference_____

State _____ **% bob killed** survey _____
FSIS _____
difference_____

Region _____ **% of national total** _____

SURVEY QUESTIONS

1. What was your approximate total calf kill in 1984?

1	_____	less than 2,0000
2	_____	2,001 to 10,000
3	_____	10,001 to 50,000
4	_____	50,001 to 75,000
5	_____	75,001 to 100,000
6	_____	100.001 to 125,000
7	_____	125,001 to 150,000
8	_____	150.001 to 175,000
9	_____	175,001 to 200,000
10	_____	200,000 to 400,000
11	_____	over 400,000
12	_____	Refused to comment
13	_____	Don't know

2. Prior to the certification program beginning in June, 1984, on average, what percentage of total calf kill in your plant was bob veal?

1	____	None	(0%)
2	____	Small amount	(1% to 20%)
3	____	Less than half	(21% to 40%)
4	____	Half	(41% to 60%)
5	____	Most	(61% to 80%)
6	____	All	(81% to 100%)
7	____	Don't know	
8	____	Refused to comment	
9	____	Exact percentage given	

3. Following the certification program until March of this year, what percentage of total kill was bob veal?

1	____	None	(0%)
2	____	Small amount	(1% to 20%)
3	____	Less than half	(21% to 40%)
4	____	Half	(41% to 60%)
5	____	Most	(61% to 80%)
6	____	All	(81% to 100%)
7	____	Don't know	
8	____	Refused to comment	
9	____	Exact percentage given	

3a. (if different) Why is this different?

1	____	Increased testing caused increased condemnations
2	____	Increased testing caused decreased line speeds
3	____	Don't know
4	____	Refused to comment
5	____	Other

4. Generally, is there a difference in price between certified and uncertified bob veal?

1 _____ Yes, by _____ higher/lower on average
2 _____ Yes, difference not given
3 _____ No
4 _____ Don't know
5 _____ Refused to answer

5. Immediately following certification, what percentage of bob veal slaughtered is certified?

1	____	None	(0%)
2	____	Small amount	(1% to 20%)
3	____	Less than half	(21% to 40%)
4	____	Half	(41% to 60%)
5	____	Most	(61% to 80%)
6	____	All	(81% to 100%)
7	____	Don't know	
8	____	Refused to comment	
9	____	Exact percentage given	

5a. (if none) Why don't you buy certified calves?

1 ____ Price difference, uncertified much cheaper
2 ____ No difference in residue condemnations
3 ____ Don't believe in government intervention
4 ____ Most calves are not certified
5 ____ Don't know
6 ____ Refused to comment
7 ____ Other

5b. (if some/all) Why do you buy certified calves?

1 ____ No price difference between two types
2 ____ Testing rate is lower for this type
3 ____ Residue rate is lower for this type
4 ____ Use the identification information to recover losses due to condemnations
5 ____ Most calves are certified
6 ____ Don't know
7 ____ Refused to comment
8 ____ Other

5c. (if some) Of the percentage of calves which are not certified, why are these purchased?

1 ____ Price difference, uncertified much cheaper
2 ____ No difference in residue condemnations
3 ____ Don't believe in government intervention
4 ____ To meet our quota for calves
5 ____ Don't know
6 ____ Refused to comment
7 ____ Other

6. Prior to certification in June, 1984, when animals were condemned due to residues or any other reason, did you charge the producer or other seller for the loss?

1 ____ Yes
2 ____ No
3 ____ Sometimes
4 ____ Refused to comment
5 ____ Don't know

6a. Did this change following certification?

1 ____ Yes
2 ____ No

COMMENTS:

6b. (if no charge-backs) Why are producers not charged for losses from condemnations due to residues?

1 ____ Impossible to trace producer
2 ____ Too expensive to trace, amount of loss
3 ____ Didn't warrent administrative expense
4 ____ Too many condemnations
5 ____ Hardly any condemnations
6 ____ Don't know
7 ____ Refused to comment
8 ____ Other

6c. (if yes/sometimes) How are charges made to individual sellers?

1 ____ On subsequent sales, costs for previous condemnations are deducted from total
2 ____ Stockyards are charged
3 ____ A bill is forwarded directly to the seller
4 ____ Don't know
5 ____ Refused to comment
6 ____ Other

7. Prior to certification, what percentage of bob calves could be identified to individual sellers?

1 ____ None (0%)
2 ____ Small amount (1% to 20%)
3 ____ Less than half (21% to 40%)
4 ____ Half (41% to 60%)
5 ____ Most (61% to 80%)
6 ____ All (81% to 100%)
7 ____ Don't know
8 ____ Refused to comment
9 ____ Exact percentage given

8. After the implementation of certification, did this percentage change?

1 ____ Yes, increase
2 ____ Yes, decrease
3 ____ No change
4 ____ Refused to comment
5 ____ Don't know

9. Has the CAST test caused your line to decrease in speed?

1 ______Yes
2 ______No
3 ______Sometimes
4 ______Don't know
5 ______Refused to comment

extra questions:

10. What is the salvage value of condemned bob veal carcasses?

11. What percentage of the value of a bob calf is from meat?

12. Who are your main types of buyers of bob calf products?

13. Do they in any way influence your choice of purchasing certified or uncertified animals?

APPENDIX B

Availability of Steers and Heifers for Slaughter

Line	Item	Years 1976	1977	1978	1979	1980	1981	1982	1983	1984
		Million Head								
(1)	Beef calf crop	37.4	36.3	34.1	32.8	35.3	34.8	34.6	34.0	33.4
(2)	50% x survival rate on calves, t	46.4%	45.7%	45.7%	45.7%	46.0%	46.4%	45.9%	45.9%	45.9%*
(3)	Beef heifer calves [(1)x(2)]	17.4	16.6	15.6	15.0	16.2	16.2	15.9	15.6	15.3
(4)	Beef heifers for replacement in t+2	5.9	5.5	5.9	6.1	6.6	6.3	6.2	5.9*	5.8*
(5)	Beef heifers for finishing [(3)-(4)]	11.5	11.0	9.6	8.8	9.6	9.8	9.7	9.7	9.5
(6)	Total calf crop	47.4	46.0	43.8	42.6	45.0	44.8	44.4	44.1	43.4
(7)	Dairy calf crop [(6)-(1)]	10.0	9.8	9.8	9.8	9.7	10.0	9.8	10.1	10.0
(8)	Dairy heifers for replacement in t+2	3.9	3.9	4.2	4.3	4.5	4.5	4.5	4.6*	4.5*
(9)	Dairy heifers for veal [(7)-(2)-(8)]	.7	.6	.3	.2	0.0	.1	0.0	0.0	.1
(10)	Total calf slaughter	5.5	5.7	4.3	2.9	2.7	2.9	3.1	3.2	3.5*
(11)	Dairy steers for veal [(10)-(9)]	4.8	5.0	4.0	2.8	2.7	2.8	3.1	3.1	3.4
(12)	Dairy steers for finishing [(7)-(2)-(11)]	0.0	0.0	.5	1.7	1.8	1.8	1.4	1.5	1.2
(13)	Beef steers for finishing (3)	17.4	16.6	15.6	15.0	16.2	16.2	15.9	15.6	15.3
(14)	Steer calves available, domestic [(12)+(13)]	17.4	16.6	16.0	16.7	18.0	18.0	17.3	17.1	16.5
(15)	Live net imports of steers, t+1	.7	.8	.4	.4	.4	.6	.6	1.2*	1.2*
(16)	Total steers available, t+2 [(14)+(15)]	18.1	17.4	16.5	17.1	18.4	18.6	17.9	18.3	17.7
(17)	Survival rate on cattle, t+1	98.4%	98.4%	98.4%	98.4%	98.6%	98.4%	98.4%	98.4%	98.4%*
(18)	Live steers available, t+2 [(16)-(17)]	17.8	17.1	16.2	16.8	18.1	18.3	17.6	18.0	17.4
(19)	Beef heifer calves available, domestic (5)	11.5	11.0	9.6	8.8	9.6	9.8	9.7	9.7	9.5
(20)	Live net imports of heifers, t+1	.4	.4	.2	.2	.2	.3	.3	.6*	.6*
(21)	Total heifers available, t+2 [(19)+(20)]	11.9	11.4	9.9	9.0	9.8	10.1	10.0	10.3	10.1
(22)	Live heifers available, t+2 [(17)-(21)]	11.7	11.3	9.7	8.9	9.7	10.0	9.8	10.1	10.0

*Predicted.

SOURCE: Jake Ferris, "Cattle Outlook, 1984-1986." Paper prepared for the Midwest Agricultural Outlook Conference, Manhattan, Kansas, August 15-17, 1985. Agricultural Economics Staff Paper #84-44, Michigan State University, August,1984.

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LIST OF GOVERNMENT OFFICIALS INTERVIEWED

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Bhargava, Brij. Staff Officer, Planning Branch, Residue Evaluation and Planning Division, Science Program. March 19-29, 1985.

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Whitney, Neal J. Director, Field Service Laboratories Division, Science Program. March 19, 1985.

Agricultural Marketing Service, U.S. Department of Agriculture

Anderson, James. Officer in Charge, Livestock and Grain Market News Office, Lancaster, Pennsylvania; Livestock, Poultry, Grain and Seed Division, March 28 and April 5, 1985.

Bevan, Donald E. Central Area Supervisor, Livestock and Grain Market News Branch; Livestock, Poultry, Grain and Seed Division, March 28, 1985.

Ray, James. Chief, Livestock and Grain Market News Branch; Livestock, Poultry, Grain and Seed Division, March 28, 1985.

Extension Service, Office of the Administrator, U.S. Department of Agriculture

Eastwood, Basil R. Program Leader, Dairy Production Chairman, Residue Avoidance Program Steering Committee, March 28, 1985.