PESTICIDES AND POLICY: RISK-BENEFIT ANALYSIS AT THE ENVIRONMENTAL PROTECTION AGENCY

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ABSTRACT

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There has been much criticism of the U.S. Environmental Protection Agency's regulation of pesticides, but very little empirical work to describe that process. In this research, the quality of EPA's information on risks and benefits of pesticide use is quantified for eight case-study pesticides, using EPA documents. Goodman and Kruskal's coefficient of ordinal association measures correlations between those data and five explanatory variables depicting interest group incentives to influence the regulatory process. The five explanatory variables are: value of pesticide use to manufacturers, percent of crop treated, per acre user losses, total user losses, and risk of the pesticide. These variables are also quantified from EPA documents. In general, risk information was poorer than benefits information, interest groups do not influence risk information, manufacturers and users influence benefits information, the pesticide's relative risk does not influence benefit information, and pesticide manufacturers and users impact EPA decisions.

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CHAPTER 1

INTRODUCTION

OVERVIEW

A variety of chemicals are used in the U.S. food system to obtain a variety of economic benefits. Pesticides are used to improve crop quality and yields. Pharmaceuticals are used to improve the health of livestock. Preservatives are used to reduce food spoilage and food poisoning risks.

While chemical technologies provide benefits, they also pose risks to human health and the environment. Governments have responded to this situation by enacting regulatory statutes which set general policy on the use of these technologies. The responsibility for carrying out these laws has been assigned to regulatory agencies. The manner in which the laws have been carried out by the agencies has created a great deal of controversy.

One of the major points of criticism has focused on the way information about the benefits and risks of chemicals has been collected, analyzed, and used for choice-making within regulatory agencies. Agencies have been accused of being less than thorough in collecting data, arbitrary in their analysis of data, and vague about how they use information to weigh benefits and risks. A variety of reforms, such as cost-benefit analysis, have been proposed as

potential remedies for the perceived problems. And the proposed reforms have themselves become the targets of criticism. For the most part, however, criticisms and proposed reforms have not been based on systematic, empirical information about regulatory decision processes.

The objective of this research is to provide systematic, empirical information about the regulatory process of collecting and analyzing data on the consequences of chemical technologies. Theories of regulatory decision-making are used to explain the types and quality of information observed in case studies of actual regulatory decisions. The research focuses on pesticide regulation. Concentration on one regulatory area rather than on several allows us to study the use of risk-benefit analysis between cases within a regulatory program without having to study decision making under two or more different legislative mandates and/or within two or more different agencies. Therefore, the complexities of inter-agency and inter-program behavior are avoided.

The remainder of this chapter is organized under three subheadings. Under the first, the broad topic of pesticide regulation is narrowed down into a statement of the research problem and several research questions, thus answering the question of what it is about pesticide regulation that is to be investigated. The second section of this chapter describes the research setting by providing an overview of the

Environmental Protection Agency's (EPA) regulation of pesticides that are suspected of posing a risk to humans or other organisms in the ecosystem. The final section is a brief description of the organization of the body of the thesis.

THE RESEARCH PROBLEM

Research on regulation by economists tends to take one of two directions: analysis of the impacts of regulation on different groups in the economic system and analysis of the process of regulatory decision making. Although the vast majority of work by economists is of the former variety, this research is concerned with the process of regulatory decision making on pesticides. This process is essentially one of conflict-resolution.

Why be concerned with such a complex process? Many people see no point in examining the process if the outcome of the process is known. However, there are at least six compelling reasons for having a knowledge of the process. First, in order to justify the resources devoted to public policy analysis, it is necessary to understand the utility of such analysis in the conflict-resolution process. Second, knowledge of the process highlights points of uncertainty in the regulatory problem, which may help to focus on relevant issues and prioritize the use of limited policy analysis resources.[1] Third, desired changes in regulatory

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[1] Steven Maynard-Moody and Charles C. McClintock, "Square Pegs in Round Holes: Program Evaluation and Organizational Uncertainty." Policy Studies Journal 9, no. 5 (Spring 1981): 644-666.

performance can be identified (assumedly through the political process), but these changes cannot be implemented unless the variables affecting the agency decision-making process are known. As George Stigler puts it, "Until the basic logic of political life is developed, reformers will be ill-equipped to use the state for their reforms ..."[2] Fourth, a great deal of the controversy over regulation focuses on the process rather than the outcome per se. For example, regarding risk-related regulation such as pesticide regulation, there is much disagreement in the scientific community over how to determine risk, how to extrapolate risk findings in other organisms to humans, how to translate risk into numbers of deaths or injuries, how to weigh risk factors in decision making, and other questions of process. For all types of regulation, one often hears the argument that bureaucratic processes are inherently inefficient and counterproductive. In order to answer these charges, policy analysts need to know how decisions are being made in the face of uncertainty and limited resources. A fifth reason for investigating the process of pesticide regulation is that knowledge of the regulatory process allows us to predict, as well as explain, agency decisions. Predicting decisions allows more accurate analysis of

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[2]George Stigler, "The Theory of Economic Regulation." <u>Bell Journal of Economics and Management Science</u> 2, no. 1 (Spring 1971): 18.

program impacts, leading to more precise policy design. Finally, knowledge of the process enables individuals or groups affected by the regulation to have a greater impact on the decision-making process (i.e., to articulate their preferences or ideas on regulatory reform).

Gaining insights about regulatory decision making is extremely complex due to the intricacies of human psychology and sociology. Things are not always what they appear to be: Majone warns us that "[R]egulators have sought legitimacy for their decisions by wrapping them in a cloak of scientific respectability."[3] Samuels and Shaffer (1982) tell us that policymakers and interested parties often invoke symbols, myths and ideology to convince others of their views. Similarly, Edelman (1977) describes how "political language" in bureaucracy is used to justify decisions to the various conflicting groups that can impact the agency. Language is used to shape behavior within an agency and to evoke favorable perceptions of agency performance outside of the agency: "It is not facts that are crucial, but language forms and socially cued perceptions."[4] Regulatory decisions are not cut-and-dried choices

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[3]Giandomenico Majone, "Process and Outcome in Regulatory Decision-Making." American Behavioral Scientist 22, no. 5 (May/June 1979), p. 561.

[4]Murray Edelman, Political Language: Words that Succeed and Policies that Fail (New York: Academic Press, 1977), p. 85.

based on objective calculations of net social benefits. Ultimately, they are political choices between conflicting interests. In addition, various subprocesses of risk-related decision making are characterized by what van Ravenswaay (1983) calls a "science-policy interface." That is, there are points in decision making and its subprocesses where choices are based on policy considerations rather than science. Choices can be politicized due to the nature of the choice (e.g., choices made by weighing benefits and costs, or choices made under uncertainty and risk) or due to an inability or unwillingness to expend the funds necessary to make completely informed decisions. Whatever the reason, there is discretion in regulatory agency decision making which cannot be explained by scientific knowledge or legislative mandates.

Adding to the complexity of the decision-making process is the fact that a number of different subprocesses combine to form the entire decision-making process. These subprocesses or stages include problem detection, identification of alternative solutions to the problem, identification of consequences associated with alternatives and choice between alternatives. These stages of decision-making do not necessarily occur in the order presented, and the extent to which each occurs varies. All four of these stages and their substages contain policy (as well as science) aspects.

It is the policy aspects of the third stage, the identification of consequences, that this research investigates. There is an attempt to answer the following questions:

1. Which consequences of pesticide use and regulation are identified? Somehow, decisions are made to evaluate some impacts and not others in EPA's RPAR risk-benefit analyses.[5] One of the objectives of this research is to determine which impacts are evaluated and to suggest reasons for the choice of impacts.

2. To what extent are the consequences evaluated? This is the heart of the empirical work contained in this thesis. The question can be worded in another way: How good is the information on consequences? The question is answered by a careful examination of EPA's "position documents" which constitute one of the outputs of the pesticide regulatory process.

3. Why are consequences evaluated to that extent? There is also an attempt to explain variations in the quality and amount of information obtained for a particular consequence (mostly variations between uses of a pesticide). There is a complex array of factors that could cause this variation, but the focus here is on the influence of external interest groups on EPA's information-gathering behavior. Chapter 2 reviews the literature on factors affecting the regulatory decision-making process.

4. Which consequences are ignored? EPA does not consider some of the impacts of pesticide use and regulation

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[5] See Chapter 3 for a discussion of the value judgments involved in conceptualizing and choosing impacts for analysis.

for budgetary and other reasons. In order to determine which impacts are excluded, the risks and benefits of pesticide use and/or regulation must be conceptualized. This taxonomy of risks and benefits is found in Chapter 3.

There are several reasons for investigating this particular stage of decision making. The most obvious is the need to narrow the scope of the research in some manner in order to make it more manageable. Examining one subprocess or stage of regulatory decision making allows a reduction in scope without resulting in a superficial investigation of the entire process. Second, and perhaps most important, most of the criticisms and attempts at reform of pesticide regulation have focused on the identification of consequences. In fact, there have already been two major studies of pesticide regulation since the regulatory reforms of 1972.[6] In both studies a policy aspect of regulatory decision making on pesticides is acknowledged, but the emphasis in both is on obtaining additional and better information on the consequences of regulatory alternatives rather than on understanding how such policy choices are made or how more information affects decisions that are essentially policy choices. Many of the reforms of the pesticide regulatory process are attempts to "objectively" reconcile the

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[6]Environmental Studies Board Committee on Prototype Explicit Analyses for Pesticides, Regulating Pesticides (Washington, DC: National Research Council, 1980).

National Research Council, Pesticide Decision-Making (Washington, DC: National Academy of Sciences, 1977).

uncertainty inherent in risk-benefit analysis; examples include a Scientific Advisory Panel (SAP) established to review assessments of the risks of pesticide use, the creation of a role for the United States Department of Agriculture (USDA) and state experts in the benefits analysis, and the opportunity for members of the general public to comment on EPA actions at various points in the regulatory process. In addition, a number of proposed reforms relate to the identification of the consequences in pesticide regulation. In order to evaluate the validity of criticisms and the effectiveness of reforms it is essential to understand the constraints on regulatory decision making[7] which limit the extent of consequence identification, even in the absence of uncertainty. A final reason for studying this stage of decision making is that knowledge about one stage of decision making is useful in understanding the other stages of decision making since they are interdependent. In the case of consequence identification, some theories of decision making state that decisions are (or should be) made on the basis of information on the consequences of alternative courses of action. If this describes actual decision making, then the identification of consequences is crucial to the choice between alternative policies. Although this is probably an overstatement of the

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[7]See Chapter 2 for a theoretical discussion of these constraints.

role of information in regulatory decision making and an understatement of the influence of other factors, there is undoubtedly a relationship between the two stages, as well as between the identification of consequences and the other two stages of regulatory decision making.

Thus, this research attempts to answer two general questions -- how extensively are consequences identified for each alternative, and why? The research consists of both descriptive and explanatory work on one stage of regulatory decision making.

THE RESEARCH SETTING: EPA REGULATION OF PESTICIDES

The above research questions are examined in the context of the process developed by Congress and the Environmental Protection Agency (EPA) to determine how pesticides that pose a risk to human health and the environment should be used. The Rebuttable Presumption Against Registration (RPAR) process was developed by the EPA in response to the Federal Environmental Pesticide Control Act (FEPCA), which was a 1972 amendment to the 1947 Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). The RPAR process is the major mechanism with which EPA makes regulatory decisions on pesticides which are suspected of causing harm to humans or other non-target organisms.

The following is a brief overview of the RPAR process. Although the focus of the research is on the identification of consequences of alternative regulatory actions, a general description of the entire process is appropriate in order to provide a setting for the research, given the interdependence of the four stages of regulatory decision making.

Before 1970, while USDA still administered FIFRA, the focus of the Act was on the registration and accurate labeling of efficacious (as opposed to safe) chemicals. In response to increasing knowledge and concern about the safety of pesticides, the Act was amended in 1964 to include chemicals which injure man, other vertebrates and other organisms valuable to man in the definition of a "misbranded" chemical. The 1964 amendments also ended "protest registration," a practice which allowed the registration of a suspected misbranded chemical and placed the burden of proving that a chemical was misbranded on the USDA. Instead, the registrants now had to prove that their chemicals were safe, efficacious and/or properly branded in order to obtain registration.

In 1970, the administration of FIFRA was transferred from USDA to EPA. Two years later, major changes were made in FIFRA when FEPCA was adopted. The most widely-quoted phrase in the new FIFRA summarizes the major change in philosophy contained in this amendment: EPA can register or reregister only those pesticides which "... when used in accordance with widespread and commonly recognized practice ... will not generally cause unreasonable adverse effects on the environment ..."[8] where unreasonable adverse effects on

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[8] Federal Insecticide, Fungicide and Rodenticide Act, 7 US Code Annotated, Sec. 136(a)(5)(D).

the environment are "[a]ny unreasonable risk to man or the environment, taking into account the economic, social and environmental costs and benefits of the use of any pesticide ... "[9] These phrases signified a breaking of ties between FIFRA and the interests of farmers. No longer was the Act to solve conflicts between farmers and pesticide producers -- the arena for conflict now contained pesticide producers and farmers on the one hand versus those exposed involuntarily to the health risks of pesticides on the other.

Additional amendments to FIFRA in 1975 seemed intended to promote accurate and balanced consideration of the benefits and risks of pesticide use in EPA decisions on pesticide registration. First, the amendments provided a role for the USDA in the benefits analysis. Also, the 1975 amendments authorized the creation of a Scientific Advisory Panel (SAP) to review the risk analysis for each pesticide.

The RPAR process itself was created by EPA regulation in 1975. Initially, the process was meant to be a mechanism for finding problem pesticides, with administrative hearings used to make regulatory decisions on the problem chemicals. However, it soon became evident that EPA would like to replace lengthy hearings with the RPAR process, which was an informal and non-adversarial regulatory mechanism when compared with the administrative hearings.

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[9] Federal Insecticide, Fungicide and Rodenticide Act, 7 US Code Annotated, Sec. 136(bb).

Figure 1.1 summarizes the steps in the RPAR process in the form of an idealized timetable. This timetable has never been followed for any chemical so far in FEPCA's brief history, but it does provide a general chronology of the process.

First, there is the pre-RPAR review, during which the EPA decides whether or not to begin the RPAR process for the particular pesticide in question. The decision is supposedly based entirely on risk. In order to make this decision, EPA obtains data from registrants and from the open literature, and can also require additional information (e.g., tests on toxicity of the chemical) from registrants. From this information, EPA determines whether or not one or more specific "triggers" for various health and environmental risks are met or exceeded.[10] Supposedly, EPA considers exposure levels and margins-of-safety in addition to information on the toxicity of the chemical in making the preliminary risk assessment. It is generally EPA procedure not to share much information with registrants during this phase of the process.

Next, if EPA feels that a risk trigger has been met (as it almost always does once pre-RPAR review has begun), a Notice of Rebuttable Presumption Against Registration is published in the Federal Register, often with the supporting

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[10] U.S. Environmental Protection Agency, "Regulations for the Enforcement of the Federal Insecticide, Fungicide and Rodenticide Act," 40 Code of Federal Regulations, part 162.11 (July, 1983).

Day	Activity
-90	Pre-RPAR Review. EPA lets USDA and registrants know of its intentions. USDA may begin work on joint EPA/USDA/States Benefits analysis if it feels that the EPA's Notice of Presumption Against Registration will not be rebutted.
0	Position Document 1 (Preliminary risk assessment) and Notice of Presumption Against Registration published in Federal Register.
by +105	Development of rebuttals to PDI and Notice of Presumption Against Registration by pesticide registrants and perhaps USDA. If rebuttals are successful, then EPA publishes Position Document 2 (which terminates the RPAR process) in the Federal Register.
by +180	Benefits Analysis by USDA/EPA/States. This report is used in EPA's risk-benefit analysis.
by +210	EPA completes risk-benefit analysis.
by +240	Position Document 2/3 becomes available (discusses risks, rebuttals, benefits, regulatory alternatives and recommended alternative). Call for public comment. Availability of PD 2/3 and Preliminary Notice of Determination published in Federal Register.
by +270	Comments due from public and from the Scientific Advisory Panel (SAP evaluates the risk analysis only). Comments also due from the Secretary of Agriculture on impacts on the agricultural economy.
by +300	Position Document 4 (analysis of comments and final Agency decision) published in Federal Register with Notice of Intent to Cancel.

Sources:

1. Meeting with Dr. Fred Tschirley on April 15, 1981.

2. Environmental Studies Board Committee on Prototype Explicit Analyses for Pesticides, Regulating Pesticides. (Washington, DC: National Research Council, 1980).

3. U.S. Environmental Protection Agency Office of Pesticide Programs, "Status Report on Rebuttable Presumption Against Registration (RPAR) or Special Review Chemicals, Registration Standards Program, and Data Call-In Program" (Washington, D.C.: U.S. Environmental Protection Agency, March 1984).

Figure 1.1 - Idealized Timetable for the RPAR Process

document, Position Document One, which is a preliminary risk assessment of the pesticide. This Notice of RPAR and Position Document One are subject to rebuttal attempts by registrants and other interested parties. The official time period allowed for rebuttal responses is 45 days from publication of the Notice of RPAR, but EPA generally grants 60-day extensions. Rebuttal can be accomplished by proving that the pesticide doesn't meet the trigger(s) or by showing that exposure is low enough so that risk is not great. In addition, EPA also seems to consider rebuttal comments that show that the benefits of pesticide use are so great that the risk is worth it. Rebuttals are rarely successful.

The next step, if the notice of RPAR is successfully rebutted, is the issuance of a Position Document 2 explaining why PD1 was rebutted and the return of the pesticide in question to the registration process. If the rebuttal attempts are unsuccessful, then a risk-benefit analysis of

the status-quo use of the pesticide is developed, alternative solutions to risk reduction are generated, the risk-benefit analysis is extrapolated and embellished upon for each alternative solution, and a preliminary decision is made between the alternative solutions (generally for each use of the pesticide). All of this, as well as the chemical background and regulatory history of the pesticide, and an analysis of the rebuttal comments, is contained in Position Document 2/3, which supports the Preliminary Notice of Determination published in the Federal Register.

There is opportunity for external review of and comment on the Position Document 2/3 and the proposed regulatory action. Interested parties have 30 days to submit comments, but sometimes extensions are granted by EPA. In addition, the risk-benefit analysis and proposed regulatory decision are reviewed by the Secretary of Agriculture and the Scientific Advisory Panel (SAP). These two parties have 60 days from the publication of the Preliminary Notice of Determination in the Federal Register to respond. If their comments are received by EPA within 30 days, they must be published in the Federal Register with EPA's reply and the Final Notice of Determination.

The Final Notice of Determination is published in the Federal Register, often with its supporting Position Document 4. Position Document 4 replies to comments from the Secretary of Agriculture, the SAP and others, and explains the rationale for the final Agency decision. Once this document is published, cancellation activities can begin.[11] After this step, the RPAR process is complete and the only recourse for interested parties is administrative hearings.

The details of the process are still very much in a developmental stage, as can be evidenced by reforms proposed by EPA in the August 7, 1980, Federal Register and more recent proposals to attempt to negotiate solutions to risk problems with pesticide manufacturers instead of undertaking the benefits analysis.

Figure 2 shows how the steps of the RPAR process correspond with the four stages of decision making. There are some additional aspects of the identification of consequences stage which should be noted since that stage is the focus of the research. The EPA obtains much of its information from parties outside of the agency, such as the USDA, state experts and the registrants. Many of these external parties have a vested interest in the outcome of the regulatory process, and they may have an influence on the process due to their control over information. Two different divisions of the EPA's Office of Pesticide Programs collect and analyze data for the risk and benefit assessments. The risk analysis is performed by the Hazard Evaluation Division and the benefits analysis is performed by the Benefits and Field

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[11]"Conditional Cancellation" means that a particular use of the chemical will be banned if changes in labeling and/or use practices are not made. "Unconditional Cancellation" means that the chemical is banned.

Steps in the RPAR Process	Stages of Decision Making
Pre-RPAR Review	Problem Detection; Identification of Consequences
Notice of Presumption Against Registration and Position Document 1	Problem Detection; Identification of Consequences
Rebuttal attempts and public comments	Problem Detection; Identification of Consequences
If successful rebuttal, Position Document 2 and return to registration	Choice Between Alternatives (alternatives = return to registration and initiate RPAR Process)
USDA/EPA/States Benefits Analysis and EPA risk-benefit analysis	Identification of Consequences
Position Document 2/3 and Preliminary Notice of Determination	Generation of Alternative Solutions; Identification of Consequences; Choice Between Alternatives
Public Comments	Identification of Consequences; perhaps Problem Detection and Generation of Alternative Solutions
Position Document 4	Choice Between Alternatives

Source: Compiled by the author.

Figure 1.2 - Steps in the RPAR process and van Ravenswaay's four stages of regulatory decision making.

Studies Division (in conjunction with USDA and State experts). A third division, the Special Pesticide Review Division (SPRD), has overall responsibility for coordinating implementation of the RPAR process and also supervises the weighing of risks and benefits and recommends a regulatory option to the Deputy Assistant Administrator for Pesticide Programs (who ultimately answers to the Administrator of the EPA). The common thread throughout the risk-benefit analysis for a particular pesticide is the project manager, who is from the SPRD. However, the final decision is technically the responsibility of the Administrator; thus, the situation is one in which information on the consequences of alternative regulatory options is not generated by the final decision maker.

One of the outputs of the RPAR process, aside from the regulatory decision, is the set of position documents for each pesticide which goes through the process. These documents provide information supporting various actions taken by the Agency, from the initial rebuttable presumption through the final decision. These position documents contain information on the consequences of full use of a pesticide and of alternative regulatory actions. Thus, the position documents for the eight pesticides for which the RPAR process had been completed at the commencement of the empirical work serve as the data base for the work on consequence identification. One limitation of the use of the position documents as the data base is that all consequences which are considered may not be in the position documents. However, it is still of value (as discussed in the previous subsection) to know which consequences are identified, why, and whether or not the consequences identified appear to have any bearing on the choice between regulatory alternatives.

ORGANIZATION OF THE THESIS

The remainder of this thesis is organized as follows:

Chapter 2 consists of a review of the theoretical literature on regulatory decision-making processes. Some of the works examined in this chapter serve as the basis for the explanatory variables conceptualized and operationalized to explain EPA's identification of consequences in pesticide decision making.

Chapter 3 is a conceptualization of the risks and benefits of pesticide use. The intent of this chapter is to provide a comprehensive taxonomy of risks and benefits to serve as a basis of comparison with EPA's taxonomy of risks and benefits.

Chapter 4 describes the methodology used in coding data and testing relationships about EPA identification of consequences in the RPAR process. The data set consists of the position documents for eight pesticides for which RPARs have been completed.

Chapter 5 is the first empirical chapter, consisting of an analysis of the descriptive statistics and explanatory work on the risks of pesticide use.

Chapter 6 presents the results of empirical work on the benefits of pesticide use.

Chapter 7 contains results, conclusions and directions for future research.

CHAPTER 2

THEORIES OF THE REGULATORY PROCESS: A REVIEW OF THE LITERATURE

INTRODUCTION

There is an immense body of literature from many different disciplines on various aspects of regulatory agency decision making. The objective of this chapter is to organize and summarize some of this diverse literature to help in describing, explaining and predicting the EPA's behavior with regard to pesticide regulation. The literature review is organized under four subheadings: the nature of regulation, theories of regulatory decision making, the role of information in decision making, and the usefulness of the theories in explaining the quality of information obtained by EPA to evaluate consequences of pesticide use or regulation.[12]

THE NATURE OF REGULATION

Several authors have explored the nature of regulation in general, as mandated and implemented, rather than details

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[12]Other reviews of the literature on regulation are contained in Noll (1976), Posner (1974), McCraw (1975), Fiorino and Metlay (1977), Owen and Braeutigam (1978), Mueller (1979) and Mitnick (1980).

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of regulatory decision making. The readings discussed below do not constitute a random sample of this literature -- three of the four works are written by institutional economists. However, the articles suffice in presenting a picture of regulation which is not commonly considered in the literature of neoclassical welfare economics. Regulation is seen as the outcome of a power struggle for rights between competing interests, the product of the value system of some dominant class, or a response to an inappropriate balance between equity and efficiency, rather than as a mechanism for achieving greater economic efficiency within the status quo system of rights. This literature provides a view of regulation which supports the work of many of the theorists in the next section, who concern themselves more with the political realities of regulatory decision making and its attendant impacts than with unconstrained decision making with the goal of economic efficiency.

Paul Weaver (1978), a non-institutionalist (and also a non-economist), feels that the nature of regulation has changed over time, but that it is and always has been the manifestation of the values of a particular dominant class. The "old" decision making (e.g., airlines, public utilities), characterized by the "iron triangle" -- a coalition of the regulated industry, the regulatory agency or commission, and the Congressional subcommittees responsible for legislative hearings and oversight -- was a reflection of the values of the liberal democratic class which dominated

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national thought at the time of the enactment of the enabling legislation. The "new" decision making, which is not explained by the capture theories of regulation or by most empirical work, is a result of the humanistic values characteristic of a new dominant class. This regulation includes much of the health and safety and income maintenance regulation, and Weaver claims that the new iron triangle is comprised of the press, public interest groups and the Federal government.

Weaver sees regulation as social policy rather than economic policy. Indeed,

> That is why all economists, whatever their political views, end up being so critical of government regulation, at least as it works out in practice. They think regulatory policy should make sense economically -- which, of course, it never quite does.[13]

Weaver is wrong. Although many economists see the purpose of regulation as correcting "market imperfections" in an economically efficient manner, and judge regulation accordingly, not all do. Among those who do not are the following institutional economists, who attempt to describe the regulatory process in a positive manner in terms of the relationship between institutions (common and statutory law, regulation, customs, morals, et cetera) and economics.

Reynolds (1981) criticizes some of his fellow economists for judging regulations which are a response to efficiency

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[13]Paul Weaver, "Regulation, Social Policy, and Class Conflict." The Public Interest 50 (Winter 1978): 56.

and/or equity problems in terms of efficiency alone. Like Weaver, he notices variations in regulation depending on the time of the enactment of the enabling legislation. The old regulation (basically pre-1970) is industry-specific and attempts to achieve the desired allocational or distributional goals by augmenting revenues of the regulated group. Such regulation is typically demanded (and captured) by firms, industry groups or trade associations. Function-specific regulation (post-1969) is seen by Reynolds as often being a response to the industry-specific regulation's impacts on equity and/or efficiency. However, this type of regulation affects costs rather than revenues of the firms or other regulated groups.

When describing the industry-specific and function-specific regulation, Reynolds is describing two types of explicit regulation. Explicit regulation consists of the implementation and enforcement of statutory and common law chosen in the political process, whereas implicit regulation refers to informal "laws" such as habits, norms, ethics and values.

The entire system of regulation in Reynolds' world is affected by and affects technology. The system needs to be a combination of implicit and explicit regulation which exhibits some degree of companionship with the technological and physical world. If this compatibility does not exist, then the regulatory system will change. Compatibility is essentially an appropriate (socially acceptable) balance

between equity and efficiency and an adequate level of flexibility. It is a function of the legislation, supporting institutions, and "escapements" in the regulation (mechanisms which result in distorted perceptions of the relationship between compliance with and impacts or costs of the regulation). Sudden perceptions of market failure are really responses to social and ethical changes, and/or the loss of escapements for existing regulation.

Changes in the regulatory system comprise a life cycle. In general, Reynolds sees implicit regulation evolving over the long run. If the implicit regulation fails to produce socially acceptable allocative and distributive impacts, then revenue-augmenting (industry-specific) regulation is established.[14] In response to new allocations an distributions, other groups may attempt to obtain their own revenue-augmenting regulation to offset costs of the revenue-augmenting regulation of others. Function-specific regulation is often a response to perceived inadequacies of industry-specific regulations. Finally, the current popular support for "deregulation" is a response to changes which have made the function-specific regulation unacceptable. Reynolds' regulatory system is dynamic and it determines and is determined by technological progress.

Samuels, Schmid, and Shaffer (1981) also see the regulatory system as dynamic and as a dependent and explanatory

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[14]Explicit regulation usually overrules implicit regulation.

variable in larger systems. To these economists, the central issue in regulatory decision making is not which form of regulation is "best" or the efficiency of regulation, but rather "whose interests are to be promoted by regulation and how...,"[15] for regulation restricts the opportunity set of some individuals while expanding or improving opportunities for others. As implemented, regulation (and changes in regulation) are rights in that both regulations and rights distribute costs, benefits and risk among interdependent parties.

In a broader context, regulation both exists in and determines a power structure. It is only one of many forms of social control which are intended to achieve a balance between freedom and control, hierarchy and equality, and continuity and change. Various groups within a power structure try to use government to achieve regulation in their favor. Both "public" and "private" regulations free some individuals at the expense of others (albeit different individuals); they are merely alternative ways of achieving social control. According to the authors, "Arguments over regulation concern the pattern of freedom versus exposure to

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[15]Warren J. Samuels, A. Allan Schmid and James D. Shaffer, "Regulation and Regulatory Reform: Some Fundamental Conceptions" in Law and Economics: An Institutional Perspective, eds. Warren J. Samuels and A. Allan Schmid (Boston: Martinus Nijhoff Publishing, 1981), p. 248.

the freedoms of others ..., made by power-playing actors participating in the drama of working out social control."[16]

Samuels and Shaffer (1982) continue this theme in their paper on deregulation. In this paper, they attempt to show that eight arguments commonly put forth in favor of deregulation are normative arguments and are inconclusive. Some of the major points in the paper are that deregulation and regulation are funtionally the same in that both protect rights (different people's rights), deregulation represents a restructuring of rights, only selective perception makes deregulation distinct from rights, to say that regulation and/or deregulation are good or bad requires normative judgments, both regulation and deregulation require coercion of those whose opportunity sets are restricted, and definitions of output (which are determined by regulation and deregulation) determine whether or not deregulation promotes productivity and efficiency along with the set of rights used to determine the efficient or Pareto-optimal allocation of resources (which is also determined by regulation and deregulation).

All of these writings on the nature of regulation are based on the general theme that regulatory decisions are political as well as scientific. Decisions do not simply fall out of the analysis of benefit and cost information, nor does the regulatory process revolve around the gathering

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[16]Ibid., p. 255.

of objective information. This has strong implications for decision making in general and for the identification of consequences of regulatory decisions in particular. The next section of this chapter is an attempt to move from the general to the specific by summarizing different theories on the factors which influence the regulatory process and its output.

THEORIES OF REGULATORY DECISION MAKING

Regulation theorists need to address two major questions if they are to provide information on the regulatory decision-making process: what are the goals (objective functions) of regulators, and what factors constrain the achievement of those goals? The theorists answer these questions in different ways. In order to facilitate the discussion of this diverse group of theories, the works are organized according to the hypothesized objective functions of the regulators. The theories can be classified under the subheadings of theories with agency-wide objective functions, theories with different objective functions for various coalitions within an agency and theories with different objective functions for individual regulators in the agency.

Theories With Agency-Wide Objective Functions. Some theorists assume that agency goals dominate the behavior of individual regulators within the agency. This behavioral assumption has some validity, and perhaps good explanatory power since agency leaders (as well as managers in the private sector) have mechanisms to encourage individuals to adopt agency goals. Also, such assumptions simplify the study of agency decision making by ignoring individual aberrations from agency goals.

Agency survival. Several theorists assert that there is a link between voter behavior and agency behavior. That link is the elected politician whose fate is determined by the voter and who, in turn, determines the fate of the agency. Legislators and other elected officials have power over agency officials via appropriations, program authorization, appointments and legislative oversight (see Thurber (1976)).[17] Thus, the agency officials try to make decisions which improve the number of votes, size of the campaign chest, and perhaps personal wealth of the politician.

One of the more interesting theories of this type was formulated by one University of Chicago professor and extended and formalized by another. Nobel prize-winner George Stigler (1971) is really explaining legislative creation in his work on economic regulation, but Sam Peltzman extends Stigler's work to agency decision making by assuming that voters will express dissatisfaction with agency decisions by voting against the elected politicians who appointed the agency officials. Voters and regulatory agencies are linked

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[17]Thurber also hypothesizes that the agency-elected official relationship may be one of cooperation rather than confrontation.

because agency officials require elected politicians' support in order to perpetuate their activities. It is conceivable that this hypothesis applies to the EPA since the environmental lobby influences a large number of voters and is politically sophisticated, the environmental groups are often opposed by industry groups that are also well organized and powerful, and legislators are often rather clearly for or against government programs for environmental protection.

Stigler suggests that regulation is often obtained by (and for) industry due to the nature of the "market" for regulation. The regulatory market is different from the economic market in that the output must be adhered to (in principle, anyway) by everyone. If all regulatory decisions were made democratically (i.e., by voting), then policies which resulted in more gainers than losers would be adopted, assuming perfectly informed and rational voting.

Why, then, do regulations often seem to benefit fewer people than they hurt? The answer has to do with the nature of the market for regulation. People do not vote on all issues; instead they elect representatives to vote on issues. These representatives and their political parties (and, if extended one step further, the agencies) are the suppliers of regulation. Regulation is demanded by industry and other groups in Stigler's model because it results in the redistribution of wealth and income, and it is paid for with votes and dollars for the politician. Thus, in order to pay for regulation with the required number of votes and/or dollars, voters must incur the costs of informing themselves on an issue, organizing to articulate their preferences and persuading others to support (or not oppose) the politician supplying the regulation.[18] They will only incur these costs if the benefits from obtaining the favorable regulation exceed the costs. As the size of the group demanding regulation increases, the per capita benefits decrease and the costs of organization and persuading other voters increase. The free-rider problem also increases with size -- firms may expect other firms within the industry to pay for beneficial regulation from which no already-existing firm can be excluded. Since costs increase and benefits decrease with size, smaller groups with an economic incentive to precisely articulate their demand (such as industry groups) may be the only demanders of regulation according to Stigler.

Peltzman (1972) formalizes and generalizes Stigler's theory. He explicitly establishes the voter-agency link by making note of the power of the President and Congress to appoint agency officials and the resulting potential for these elected officials to be held accountable for agency performance. The goal of regulators is to maximize votes and/or resources for elected representatives in order to

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[18]Bartlett (1973) develops a framework which shows how groups may subsidize information on the outcomes of policy to other groups in order to influence perceptions of the policy.

assure agency survival. Resources are assumed by Peltzman to be used by politicians to diffuse opposition to regulation.

Peltzman's mathematical model solves for the vote-maximizing sizes of the groups to be benefited and taxed as well as the vote-maximizing distribution of benefits and costs among groups. The variables which explain the regulators' decisions on distribution of benefits and costs include the wealth of the winning and losing groups, the groups' responses (in terms of votes and resources) to taxation or benefits, and the sizes of the winning and losing groups. Thus, in order to maximize votes for the politician, the agency decision must reflect each group's relative power to affect the politician and, ultimately, the agency. If there is no opposition to a policy and if all beneficiaries will vote for the politician, then size becomes the dominant factor. However, if there is opposition and if votes are difficult to deliver, beneficiaries must expend resources to obtain votes (i.e., organize and articulate preferences) and mitigate opposition, so wealth of the groups becomes important.

The explanatory variables in the decision on the sizes of benefiting and losing groups include the amount of support for the regulation, the amount of opposition, and the costs of organization facing the different groups.

Several general conclusions can be drawn from Peltzman's model. First, even if one group obtains all of the benefits of the regulation, the groups would have obtained more benefits if a cartel had been formed without help from the government. The reason for this phenomenon in Peltzman's model is that regulators must account for the political power of opposing groups in order to maximize votes; the vote maximizing distribution of benefits and costs of regulation is determined by equating marginal political costs (to the regulator) and marginal political benefits. Second, Peltzman concludes from his model that there may be more than one group of beneficiaries if regulators can supply different levels of benefits to individual voters according to their sensitivity to benefits or taxes. In fact, tax-sensitive members of the losing group may actually benefit from the regulation while insensitive members of the winning group may be taxed. Stigler's theory, which proposes that the regulated industry is the only winning group, is a special case of Peltzman's general theory.

Other theories hypothesizing agency-wide goals of vote-maximization are very similar to the Peltzman-Stigler theories, although not as precisely stated.

Owen and Braeutigam also assume crucial links between voters, Congress and regulatory agencies. According to this theory, voters wish to obtain regulation to protect their wealth in the face of technological and economic change (Stigler and Peltzman, in focusing on economic regulation, see regulation as a means of increasing wealth). In other words, voters wish to take some of the risk out of the marketplace. This desire is communicated to the agencies by Congress and voters via administrative law, which slows change, allows all interested parties to voice their concerns, and protects the status quo.[19]

Therefore, if regulatory agencies want Congressional support, they must protect voters from sudden changes in income or wealth. Administrative law helps to ensure this protection. This result is essentially equivalent to Peltzman's result that the winners in the regulatory process cannot receive all potential gains due to the necessity for regulators to account for conflicting interests. Owen and Braeutigam weaken the link between the agency and the voter by suggesting that other theories of regulation may be usefully interjected into their framework to explain discretionary agency behavior.

John Baldwin's (1975) theory likewise makes a connection between the agency, elected officials and voters. Bureaucrats are assumed to be self-interested with a dominant goal of agency perpetuation, which is accomplished by helping to ensure the re-election of the incumbent government. Since regulation imposes costs on some groups, the agency's role is to establish an agreement between conflicting interests. Regulators thus attempt to choose the regulatory alternative with costs that can be disguised from the losers (resulting

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[19] This is an example of "voice" as described in Hirschman (1970).

in fewer lost votes to the incumbent government). This conclusion is consistent with the Peltzman and Stigler models, which predict decisions resulting in diffuse costs and concentrated benefits. Baldwin acknowledges the existence of agency behavior independent of the incumbent government when he suggests that some agency support may come from outside of the government.

A goal which is related to vote-maximization is that of conflict-minimization. The conflict-minimization theorists take a somewhat broader view of external pressures on agencies than do the vote-maximization theorists, and conflict minimization may imply efforts to avoid opposition rather than to seek support. In fact, efforts to disguise costs as suggested by Baldwin may actually point more toward conflict minimization than vote maximization. However, the general idea is still the same. The agency is seen as being subject to pressures from the courts, the media, other agencies and interest groups, as well as from elected officials. In order to maintain the agency, regulators attempt to minimize conflict from these sources.

Paul Joskow (1974) points out that agencies are generally given a good deal of flexibility in decision making with regard to the intent of a mandate, the method of achieving the intent and procedures for implementing the method. Constraints of due process from the courts and the legislature limit this discretion somewhat. Regulatory behavior is also constrained by the agency environment, which consists of interactions between the agency and groups affected by regulatory decisions. Regulators experience pressures from other participants in the regulatory process -- consumer groups may act as "intervenors" during the regulatory process or exert pressure on the agency outside of the formal process, and regulated firms are also in contact with the agency during the formal process as well as on an informal basis.

According to Joskow, an agency can be in equilibrium with its environment if procedures and regulatory instruments have been developed to balance the conflicting interests, or the agency can be in the "innovation mode," during which a search for procedures and instruments to restore equilibrium occurs. Factors which create an impetus for change in the regulatory process include economic factors (e.g., industry changes, inflation) and political factors (e.g., the environmental movement, civil rights movement). These changes modify the relative power and the nature of the various interests in the regulatory process. Thus, the theory is similar to Peltzman's in terms of explanatory variables.

Richard Posner (1971) implicitly assumes some sort of conflict-minimization or vote-maximization goal for agencies when he describes the rationale for the cross-subsidization form of regulation. Internal- or cross-subsidization is regulation which results in the production of goods or services at lower prices or in larger amounts than what would have been produced in the absence of regulation. The result is that some people pay (are taxed) so that others can obtain goods at subsidized prices.

Posner hypothesizes that cross-subsidization is popular with regulators as an instrument for redistributive policy due to its low visibility relative to direct taxes (again, the Stigler-Peltzman theme of dispersed costs), the difficulty of judicial review, relatively low administrative costs and implementation without need for Congressional approval. This type of regulation scores high marks with regulated firms because it often results in entry control, and comprehensive enforcement of prices and quantities of goods is difficult. In Posner's theory, regulators appear to make regulatory decisions which balance conflicting interests in response to environmental pressures.

All of the preceding theories contain some common elements. All, of course, retain the agency goal of survival via vote-maximization or conflict-minimization. In addition, they all suggest that constraints on goal attainment include pressures in the agency's external environment -- namely, pressures from conflicting interests, courts, legislators and/or the executive branch. Thus, if these theories represent a realistic abstraction of regulatory agency behavior, relevant explanatory variables of regulatory decision making would include the power of groups in the regulatory process to impact the agency.

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Budget-maximizing or size-maximizing agencies. Another important set of theories with agency-wide goals is based on the assumption that regulators want to maximize agency size, budget or influence. There are two rationales for assuming this goal: some theorists feel that agency survival is assured not by maximizing votes for legislators or balancing conflicting interests, but rather by more actively trying to increase agency size over time; and other theorists believe that agency size and/or scope is tied to goals of individual regulators, such as salary, prestige, power or job security. These theories do not necessarily invalidate the theories described in the previous section; instead, they may better explain regulatory decision making at certain points in an agency's history. For example, it may be that the EPA was a "growth" agency during much of the 1970s when there was a great demand for environmental protection, but that it is currently a "conflict-minimization" or "survival" agency in the face of recession.

Warren Samuels (1973) believes that regulators seek to increase agency authority or power as a means of achieving their own individual goals, such as maximization of income, status or power. The main constraint in his model is the power of others to affect regulators' decisions. However, the power structure not only determines decisions but is also determined by previous decisions.

Thus, the system of regulatory decision making is a struggle between interested parties to obtain favorable legislation or regulation. A group's strategy is often to attempt to make its particular goals the goals of the agency:

> Rational decision-making would seem to require well-defined, precise, agreed-upon objectives and goals of regulation, and the absence of same in regulation has been widely lamented. But a heterogeneous institution leads to ambiguous statements of purpose and goals because of the continuing jockeying for position as parties-in-interest compete to have their particular goals become the goals of the institution and to revise the statutory goals, the intermediate ends and the working rules in their interests. With multiple, competing goals and criteria advanced by competing parties-in-interest, clear and consistent goals or solutions are not permanently possible, as all are subject to continual revision in one corner or another of the institution.[20]

In furthering its own goals, then, the agency must be responsive to the power and goals of conflicting interests.

Other variables in Samuels' general equilibrium system which affect and are affected by decision making include working rules (institutions which control the distribution and use of power), the system of values (regulatory impacts may be capitalized into asset values while those values are used in making decisions), the structure of opportunity sets of various interested groups, ideology, preferences, individual choice, resource allocation and distribution of

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[20] Warren J. Samuels, "Public Utilities and the Theory of Power" in Perspectives in Public Regulation: Essays on Political Economy, ed. Milton Russell (Carbondale, Ill: Southern Illinois University Press, 1973), p. 10.

income and wealth. These variables, in defining the power structure, help to explain regulatory decisions.

There are similarities between Samuels' approach and that of Peltzman. Both theorists stress the importance of economic and political power and the ability of groups to organize, given the structure of benefits and costs of action. Both recognize the advantage of regulated industries in the power struggle. But Samuels' theory is a much more comprehensive conceptualization of regulatory decision making. Peltzman, by his own admission, does not attempt to describe the determinants of the power which he suggests explains regulatory decision making. Samuels, on the other hand, provides a general equilibrium model of the determinants of power as well as its impacts on regulatory decision making.

William Niskanen (1975) develops a theory of the supply of government output based on two major assumptions: agencies strive to maximize their budgets, and both suppliers (agencies) and demanders (government review groups) of regulation are monopolistic. The latter assumption provides a bilateral monopoly situation in the market for regulation and establishes the agency-elected official link favored by so many other theorists. However, Niskanen does not feel that the link is so complete that the goals of the elected officials are directly transferred to the agency. Instead, the power of elected officials serves as a constraint on agency attainment of the budget-maximization goal, along with other factors which determine the reward structures of bureaucrats. Niskanen's major conclusion is that monopolistic agencies overproduce and overspend relative to the demand for the good or service produced by regulation when the agency goal is budget maximization and when a monopolistic review committee is the demander of regulation.

Shapiro and Shelton (1977) suggest that agency size is related to personal goals of regulators, particularly salary, so they assume that the agency-wide goal is to increase agency size. Agency discretion in the attainment of this goal is constrained by relationships with other groups in the regulatory process, such as legislators, taxpayers, the executive branch and beneficiaries of regulation. According to this theory, agency officials attempt to make decisions which garner support from beneficiaries of the decision, facilitate re-election of elected officials and disperse costs of the regulation so that taxpayers perceive the costs as being lower than the costs of opposing the regulatory decision. These are the same factors that are emphasized in the theories of Stigler and Peltzman.

Downing and Brady (1979) also assume that bureaucrats are interested in increasing agency responsibility in order to increase their own income and power and to further specific agency goals. They suggest that politicians have goals of re-election, upward mobility and the furthering of some concept of the public interest; firm managers try to increase their own real incomes by increasing firm profits and stock values; and consumer group leaders desire changes in property rights which reflect their ideas of equity.

Choices by these groups are constrained by income and by the costs of action. Rational behavior involves bargaining with other groups for votes, contributions and/or resource transfers. Trades affecting the benefits and costs of policy decisions are made between groups in order to mutually improve their situations. There also may be attempts to change the costs of action faced by groups favoring or opposing policies which affect a particular group's welfare.

McKenzie and Macaulay (1980) assume a primary agency goal of increasing size and domain. Regulators attain this goal by making decisions which decrease efficiency in the private sector in order to make the public sector look relatively efficient. For example, monopolization of the private sector raises the price of privately-produced goods relative to public sector substitutes. Constraints on this type of behavior by the agency are not discussed in the article. The implication is that costs of action to one group are related to the power of other groups in the regulatory process.

Summary -- theories with agency-wide objective functions. The major contribution of the preceding theories to this research is to develop the concept of interest group power as an explanatory variable for regulatory decision making. The Peltzman model is particularly precise in its description of how various characteristics of groups in the regulatory process affect the nature of the regulatory process, and thus proves very useful in hypothesizing relationships between explanatory and dependent variables.

Theories Assuming Different Goals Within an Agency. Another group of theorists hypothesizes that individual regulators or coalitions of regulators have unique, multiple-argument objective functions. These theorists believe that attempts to aggregate individual behavior on the basis of some dominant goal do not result in accurate explanations of decision making. However, this argument is not adopted in this research. Individual or coalition goals which vary from an agency-wide goal may account for unexplained variations between observed agency behavior and behavior predicted by one of the theories in the previous section, but it is assumed here that good explanatory power is obtained from models with agency-wide goals (especially when considering the relative simplicity of these models), for many of the same reasons that firm-wide objective functions have proven useful in the theory of the firm. Furthermore, there is no reason why individual goals couldn't be incorporated into one of the theories with agency-wide goals to improve its explanatory power in future research -- the two views are not necessarily mutually exclusive. Since the choice in this research is to place more emphasis on agency-wide objective functions, the following theories will be described with more brevity than the preceding theories.

Coalitions of regulators. Wilson and Downs are the major proponents of a group of theories in which individual regulators are assumed to have objective functions which are similar enough for the regulators to be categorized into discrete groups of individuals with common goals.

In James Q. Wilson's theory (1980), there are three types of bureaucrats. Careerists look to agency success for their own personal success. Their primary goal is to maintain the agency, which is accomplished by cultivating political support and avoiding scandals.[21] An example of the latter strategy appears in Wilson's book: "In regulating pesticides, EPA is keenly aware that if a product it has registered is later shown to produce cancer on a large scale, the agency will be crucified and the careers of all concerned blighted, if not destroyed."[22] Careerists in agencies learn through reinforcement to accommodate people who will use errors against them.

Politicians in an agency have long-term goals of upward mobility outside of the agency which will result in financial rewards and desirable career patterns. Therefore, they want to be as visible as possible to potential future employers.

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[21] Careerists appear to be the pure form of bureaucrats described in the theories with agency-wide objective functions.

[22] James Q. Wilson, The Politics of Regulation (New York: Basic Books, Inc., 1980), p. 375.

Finally, there are professionals in Wilson's typical agency, who obtain utility from others in the same profession. Individuals in the same professions have similar ways of looking at the world, so they are likely to form coalitions within an agency. When there are individuals from several different professions in an agency, such as in the EPA, decision making may be greatly influenced by the profession which dominates.

The behavior of the three types of regulators is influenced by certain key characteristics of the environment within which regulatory decisions are made. Wilson believes that technological and economic change, institutions, and politics and ideas (e.g., access to the political system, the media and friendly legislators) are three important characteristics of the regulatory environment.

Anthony Downs (1965) also delineates several different groups of regulators according to their goals. Climbers and Conservers behave only according to personal goals. Climbers attempt to maximize their own power, income and prestige by obtaining promotions, moving to better jobs outside of the agency or increasing the prestige and power of their current positions. Conservers, on the other hand, maximize security and convenience, and thus are very much interested in protecting the status quo. Other regulators pursue both personal and collective goals; mixed-motive officials include zealots, advocates and statesmen. Zealots devote their collective energies to narrow issues, whereas advocates fight for particular organizations or policy areas. Statesmen support the broadest collective group -- they maintain goals relevant to society as a whole in their objective functions.

In considering variables affecting agency decision making, Downs feels that the internal structural variables of an organization cannot be considered separately from variables describing the external environment within which an agency operates. Some of the internal and external variables contained in his hypotheses on agency behavior include information costs, capability of decision makers, degree of uncertainty, degree of information distortion and conformity of lower-level bureaucracy to agency goals (both affected by the degree of hierarchy in the agency), time constraints, bias of decision makers, degree of coordination between agencies with overlapping duties, degree of goal homogeneity between individual regulators, the age of the agency and the agency's rate of growth. Thus, decision making is influenced by the internal structure of the agency, which determines and is determined by the agency's external environment.

Unique objective functions for individual regulators. The models which hypothesize unique objective functions for individual regulators are more complex and less definitive than those which assume an agency-wide objective function. However, they may result in greater explanatory power. The following is a brief summary of some of these theories. The theories are not necessarily in conflict with the Stigler-Peltzman and other theories; instead, they may explain some of the deviation of actual decision making from decision making predicted by theories with agency-wide objective functions.

Roger Noll (1971a) assumes that individual regulators maximize unique objective functions which may contain the regulator's welfare, agency maintenance and/or growth,[23] and the welfare of groups and individuals impacted by the regulators' decisions. Noll downplays somewhat the Congress-agency link. Although he feels that Congress is able to influence decision making, he also believes that the budget of a single agency is such a small portion of the total, complex federal budget that Congress is not particularly informed or concerned about individual decisions in an agency when making budget decisions.

Like Stigler and Peltzman and many others, Noll sees the power of interest groups, dependent on benefits and costs of group activity, as affecting decisions. The tendency to overcompromise so that all interested parties "gain" something (as in Peltzman's theory) results in a sacrifice of the "social optimum" in Noll's mind. The degree of controversy is hypothesized to be directly related to the

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[23]It is conceivable that an agency could be growing during one time period (e.g., EPA in early 1970s) and struggle for maintenance during another time period (EPA now?).

length of time it takes an agency to reach a decision, the amount of information search, the shifting of responsibility for the decision and the costs of access to the agency by interested parties. The latter strategy for diffusing controversy may backfire if interest groups bypass the agency and go directly to Congress, thus increasing Congressional pressure on the agency. Many of these ideas are reiterated in Noll (1971b).

Marc Roberts (1975) has formulated a framework of the variables which explain the decision outcomes of private and public organizations. In an effort to explain how individual decisions are translated into an organization's decisions, Roberts classifies explanatory variables into four groups: variables describing the agency's external environment, the internal structure of the organization, the set of rewards and punishments which control an individual's behavior within the organization and individual beliefs and goals.

Roberts feels that the "external variables" are less important than "internal variables" in explaining organizational decision making, which is counter to most of the other theories examined thus far. However, this hypothesis may be less true for government agencies requiring legislative and taxpayer support than for organizations which do not have to account to external constituencies.

Shaffer (1979) identifies several groups as participants in the regulatory process: government (including the legislature and the bureaucracy), consumers, the media and producers of non-regulation goods. The individuals in these groups have their own sets of goals and operate in an environment constrained by the institutional structure, ideology, physical constraints and uncertainty. These constraints on decision making both determine behavior and are determined by prior behavior in the political-economic system.

Government suppliers of regulation have different goals and face unique environments, and may not be held responsible for decisions since much government output is unmeasurable. Regulators seek information on the preferences of those groups which demand regulation. As Stigler, Peltzman and others recognize, it may be costly for some individuals or groups to make their preferences known to regulators, but Shaffer extends this concept by suggesting that there is a market for information on preferences. Thus, the suppliers of this information are able to influence the regulatory process.

Ross Eckert (1973) attempts to explain decision making with alternative internal structures of regulatory bodies (an agency structure and a commission structure) in an empirical study of taxicab regulation. He specifically examines how different incentive structures facing commissioners and agency officials result in different choices.

Eckert assumes that regulators rationally maximize utility, with utility a function of multiple variables such as wealth, prestige and convenience. Commissioners usually have a legislatively-determined income independent of hours worked or difficulty of duties, whereas agency officials may obtain salary increases as the scope and complexity of their tasks increase. Therefore, commissioners may generate more utility by simplifying tasks while agency officials may maximize utility by increasing the agency budget or the number of firms regulated. Eckert presents data on commission and agency regulation of taxicabs which tentatively support his ideas.

Kohlmeier (1973) sheds some light on the informal regulatory process -- specifically, with regard to private meetings between regulators and the regulated. If the regulators' objective functions include future employment within the regulated industry or avoidance of adverse industry-wide publicity against the agency, then private meetings may impact regulatory decisions.

Theories assuming unique individual objective functions usually result in fewer definitive conclusions than the theories assuming individual conformity to agency-wide goals. Although the former group of theories may have greater explanatory power, their use in applied research may be difficult due to problems in measuring the variables, determining individuals' objective functions, and aggregating individual behavior to make a statement about agency behavior.

THE USE OF INFORMATION IN REGULATORY DECISION MAKING

If it is acknowledged that regulators operate in a political setting and have goals other than maximizing net benefits to society, then it becomes necessary to examine the role of policy analysis and its resultant benefit-cost information in regulatory decision making in order to understand why the information is of a particular quality. This section of the chapter examines the issues of whether more information leads to better decisions, the characteristics of regulators' information searches and the various hypothesized roles of information in regulatory decision making.

Is More Information Better? Many economists believe that with enough information, a decision will "fall out" of an economic analysis,[24] but this viewpoint is not shared by all. Still, many people do believe that more information enhances decision making, even if it doesn't explicitly point to decisions.

Schmid (1978) points out that no matter how good the information is on costs and benefits, there is still no objective decision rule for choosing winners and losers in regulatory decisions. The concept of potential Pareto-optimality in neoclassical welfare economics is based on an assumption that winners reimburse losers; however, this does not occur in the real world. Schmid feels that a careful

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[24]This conclusion is reached after adopting the normative premises that utility can be summed across individuals and that objective values can be obtained for benefits and costs.

taxonomy and analysis of impacts can lead to better-informed decisions, and therefore is very useful, but such information does not tell regulators what to decide.

Lowrance (1976) specifically addresses risk analysis, such as the type used in pesticide regulation. He distinguishes between two subprocesses in regulatory risk analyses: the determination of risk, which has the potential of being a scientific process, and the judgment of the acceptability of that risk, which is a value judgment. Like Schmid, he feels that information can provide the regulator with a determination of policy impacts, but it does not provide an answer as to the acceptability of those impacts.

Majone (1979) also feels that risk evaluation is not scientific or factual due to uncertainty and the necessity of value judgments in regulatory decisions. He believes that changes in the decision process may result in the channeling of disagreement and conflict into better information and better decisions.

Characteristics of Information Search. Several authors stress the need for regulators to make uncertainty and information overload more manageable in decision making. All of these authors suggest that decision makers develop standard operating procedures to achieve this manageability.

van Ravenswaay and Hull (1981) look at the information requirements of food safety regulation which would result if the goal of a regulator was maximization of net social benefits. They imply that there is a market for information, with supply determined by costs of the information and demand determined in part by the agency's information budget. Both information costs and the information budget are affected by the regulatory context (including methods for calculating the maximum amount of a contaminant to allow in food, legal and technical constraints on information production, and the total budget and other tasks facing the agency) and by characteristics of the regulatory problem (including complexity, familiarity and urgency).[25] Since the agency is unable to "buy" perfect knowledge, strategies are developed to deal with uncertainty and conflict. Strategies for obtaining information on risks from food contaminants include using high-dosage animal tests to determine toxicity, extrapolating results from animals to humans and from high-dose to low-dose, and making assumptions about human exposure. Strategies for dealing with benefits include assuming full compliance and ignoring changes in the price of food (and of other inputs in the production of food) due to impacts of the proposed regulation. Thus, regulators simplify their information search in order to make it more manageable.

Fiorino and Metlay (1977) also hypothesize that agency strategies for coping with uncertainty are a crucial aspect of decision making. When uncertainty is present in a problem, standard operating procedures for dividing issues into

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[25]Many of these variables are controlled by interested parties, including the regulated firms and Congress.

sets of simpler problems are developed. These strategies tend to be cybernetic, with previous outcomes partially determining current strategies. Sometimes these strategies fail to ensure rational decision making under uncertainty: major issues may not be noticed, the decision process may not be sensitized to signs of failure, subjective judgments may have unintended outcomes, there may be imprecision in implementing desired solutions and standard operating procedures may not be useful when a case-by-case approach is needed.

Edmunds (1980) also stresses the need for agencies to simplify problems to make them more manageable. He specifically addresses the complexity and information overload which accompany environmental policy decisions. One way in which information is reduced to manageable levels is by excluding consideration of some of the impacts of environmental activity, or by "bounding the problem rationally." Thus, complex interrelationships are reduced to simpler concepts which are comprehensible to humans. Furthermore, regulatory agencies and decision making processes are actually structured to deal with issues within the bounded area of a problem, and to ignore issues outside of that domain. Information search goes no further than the organization's boundaries. In the case of toxic substances, where uncertainty is present in both problem definition and solution, EPA definitely must limit the amount of information obtained on interactions between chemicals and the ecological and economic systems. Congress has helped the agency to some extent in this bounding process.

Sabatier (1978) provides a framework to conceptualize the acquisition and provision of technical information in regulatory decision making. He is essentially describing an information market. Provision of information depends on resources, characteristics of the problem, the legal and political setting, and the expected reaction of decision makers to the information. Acquisition of information varies between agencies, within an agency, and between branches of government. Between branches of government, acquisition is affected by agency resources relative to other branches, sources of legitimization of decisions, agency mandates and court review of agency decisions. Differences in acquisition of information within an agency can be explained by the degree of risk from decision impacts, the social class of affected groups, the degree of conflict and the potential influence of the information on decisions. Variance between agencies depends on personnel, the degree of risk from decision impacts, the capacity and willingness of agencies to deal with technical issues and the amount of conflict in the political environment.[26] Sabatier shows that information search can be limited by many factors other than the complexity of the problem.

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[26]In the presence of conflict, agencies may seek information on political preferences rather than technical information.

In summary, the authors in this section suggest that information acquisition is not simply a matter of determining what data are needed and then obtaining them. Information costs, complexity of the problem, and political, legal, budgetary, technical and time constraints are just a few of the factors which determine the search for and acquisition of information.

The Use of Information. After information is acquired, how do agencies use it in the decision making process? The literature addressing this question is categorized according to the way it answers the question.

Information leads to rational decisions. Neoclassical welfare economics deserves mention under this category. It is widely believed among economists that policy analysis involves obtaining information on net benefits of alternative policies, and that once enough information is acquired the only remaining task is to determine which policy alternative maximizes net social benefits.[27] This view assumes that the goal of regulator is (or ought to be) to maximize net social benefits, an assumption which has been discredited by the theories of regulatory decision making presented earlier in this chapter.

Information is used by conflicting interests to influence decision makers. Several authors believe that

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[27] Accordingly, much criticism from these economists centers on the failure of regulators to obtain the "correct" information and choose the most efficient solution.

analysis is used by interested parties to influence decision making. Johnson (1973) feels that information contained in economic analysis is not used as much as information from interested parties in making decisions. According to Johnson, the Federal Communications Commission (and assumedly, other regulatory bodies) sees itself as a quasi-judicial body which gathers information from interested parties and then makes decisions based on that information rather than on formal economic analysis.

Randall Bartlett (1973) proposes that uncertainty in decision making results in information subsidies to agencies from interest groups and individuals who control access to information. Shaffer (1979) also feels that parties who control information are able to influence regulatory decision making, since they provide information on preferences of various groups. Stigler and Peltzman both acknowledge the potential use of information to influence decision making by including lobbying and the mitigation of opposition to a policy as variables in their theories.

Information legitimizes decisions. The idea that information serves to legitimize previously-made agency decisions is accepted by several theorists.

Majone (1979), in trying to persuade analysts to examine the process by which decisions are made rather than the outcomes, sees analysis as a legitimization of decisions:

"Regulators have sought legitimacy for their decisions by wrapping them in a cloak of scientific respectability."[28]

Kelman (1974) also thinks that information justifies, rather than aids, decision making when he studies the risk-based regulatory process of the Consumer Safety Product Commission (CSPC). Regulators must make a value judgment regarding safety (see Lowrance (1976)). One of the apparent biases in CSPC is to at least partially decrease risk when a product is investigated.

In order to cope with uncertainty, the CPSC has developed an information system to obtain data on injuries from products and accompanying decision rules to determine which products to regulate. Kelman suggests that the CPSC puts energy and resources into the justification of product investigation, the determination of the expected success of the chosen policy (as opposed to all alternative policies) and estimates of the worth of averted risks and the costs associated with the chosen policy.

Finally, Andrews (1980) suggests that information is obtained and documented in order to satisfy superiors within an agency (or external reviewers, such as the Congress) and to support previously-made decisions. Complex regulatory decisions are too value-laden to be solved by information alone. Andrews takes this idea a step further by hypothesizing that information may actually result in worse

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[28]Majone, p. 561.

decisions by confusing affected parties and diverting attention from crucial issues.

Information clarifies issues and potential solutions. Another widely-held impression is that information aids the decision maker in determining what the issues in a regulatory problem are, and what the potential solutions to the problem are.

Schwerin and Coyer (1979), like many other theorists, recognize that regulatory decisions must be political choices, but they attempt to show that the state of knowledge and/or the amount of information in a particular policy area affects the amounts of uncertainty and disagreement in decision making, which in turn determine the outcomes of decision rules based on voting, bargaining or hierarchy.

Knowledge is "paradigmatic" when there is a generally accepted way of analyzing the problem and "preparadigmatic" when there is no clear theoretical basis for analyzing the problem. Schwerin and Coyer hypothesize that, given the amount of information, paradigmatic knowledge narrows the range of alternative solutions available to decision makers since there is less uncertainty as to what the issues are and how they can be solved. Decision outcomes are also predicted based on the state of the knowledge, decision-making rules and the power structure involved.

Maynard-Moody and McClintock (1981) feel that applied policy research plays a large role in helping decision makers grasp issues and limit possible solutions. Policy analysis provides general background information for problems rather than specific answers.

Multiple uses of information. Many authors acknowledge various uses of policy research without placing special emphasis on any particular use. They generally agree with the preceding authors on the nature of the uses of information.

Paul Sabatier (1978) provides a framework for information use along with the previously described framework on information acquisition and provision. In this framework, information is used to influence decision makers; to conform with mandates, case law, ethics, standard operating procedures and court review (i.e., to justify decisions); and to facilitate long-term changes in agency perspective. There are many determinants of how information is used in Sabatier's framework -- some include the resources of the information source (credibility, communication skills, power), the content of the information message, the political context and the resources and perspective of decision makers. An implication is that the greater the degree of conflict in a regulatory issue the more information is obtained (all other variables equal), but the less influence it has on decision making.

A work similar in scope to Sabatier's is the article by Peter H. Schuck (1979). Schuck outlines five general groups of factors which may affect the implementation of a regulatory program. Information is only one of the five groups, implying that many other factors may determine decisions. Those other factors include the structure of the regulated parties, the nature of the regulatory objective, the enforceability of the regulation and the political support for the regulation. Although Schuck does not specifically predict the impact on regulation of the fifth group of factors, supply of and demand for information, the implication is that information use in regulatory decision making depends on the other groups of factors as well as on the sources and availability of information, the quality of information, the quantity of information and other determinants of information supply and demand.

Finally, Park (1973) suggests several alternative uses of information when he concludes that policy analysis does not point to a clear decision. Information may be used by conflicting interests to support their viewpoints, it may be used by the agency and its supporters to justify previously-made decisions, or it may provide regulators with a common framework for discussing the policy issues of specific problems.

Summary: The Nature and Use of Information in Regulatory Decision Making. The above theorists all agree that there is much more to regulatory decision making than obtaining objective information to make economically efficient decisions. Regulators have discretion in decision making; thus, decision making is influenced by factors such as the goals of the agency and the power of other groups to influence the agency. Information may be used to justify decisions, influence decision makers or clarify issues and potential solutions, and this use is also affected by a variety of variables. Which variables affect information acquisition and use depends on the regulatory situation, so it is necessary to attempt to describe which aspects of the above theories apply to EPA in its regulation of pesticides.

EPA'S REGULATION OF PESTICIDES: DETERMINANTS OF DECISION MAKING AND USES OF INFORMATION

The many uses of information in the regulatory process were outlined in the last section. Information may be used to identify the consequences of regulatory alternatives for different groups. It may be used to clarify issues, preferences and solutions. It may be used to justify regulatory choices or to influence decision makers. But regardless of how information is used, it can generally be said that information is considered important in decision-making and that information is often costly. These two characteristics of information make it important and interesting to examine the types and quality of information that EPA and other participants get into the RPAR process.

The empirical work presented in Chapters 5 and 6 will show the types and quality of information on the consequences of pesticide use found in eight RPAR cases. The data on quality of information, obtained from formal EPA position documents, reflect how the RPAR participants in each of the eight cases allocated their limited resources in order to get information into EPA's decision process. The position documents also contain measures of explanatory variables -- that is, variables suggested in theories of regulatory decision making to explain the quality of EPA's information.

Thus, the empirical findings will be examined to see how well the theories of regulation explain the quality of information in the RPAR cases. Virtually all of the theories reviewed in this chapter lead to the prediction that the pattern of information will be related to the preferences and power of groups affected by the EPA's decisions. But the two major theories -- vote-maximization and budget-maximization -- yield somewhat different predictions about the relative influence of interest groups in the regulatory process.

Theories which assume that EPA's goal is to maximize votes or political support (or minimize conflict) suggest that interest group power is strictly a function of size, wealth and organization costs. As a result, costly information which supports a group's position should be found only if the group is large, wealthy and well-organized. When information is too costly to obtain, EPA should make assumptions which favor the most powerful groups. But Peltzman points out that vote-maximizing agencies make some concessions to groups that oppose powerful interests, so there should be some information reflecting the opposition.

However, the opposing information would not be expected to appear if it was costly to provide. EPA would not go out of its way to perform exposure studies or make assumptions favoring the opposition.

What should be expected if EPA is a budget-maximizing agency? Interest group power would be related to the degree to which a group furthers EPA's budget-maximization goal, as well as the group's size, wealth and organization costs. Accordingly, less powerful groups could become more powerful if they were EPA allies, and stronger groups could be weakened if they did not help to expand EPA's regulatory authority. The latter groups could expect challenges to their information from EPA. Agency assumptions should favor agency growth, even if the assumptions were challenged by powerful (but anti-EPA) groups. In addition, EPA could be expected to expend resources on information increasing its authority, and it could force powerful groups to obtain pro-EPA information (or make it more costly for them to provide anti-EPA information).

The ability of the vote-maximizing and budget-maximizing theories to explain the empirical results will be analyzed in Chapter 7.

CHAPTER 3

CONCEPTUALIZING THE IMPACTS OF PESTICIDE USE

INTRODUCTION

The objective of this chapter is to conceptualize the risks and benefits of pesticide use, and to point out the difficulties and value judgments inherent in conceptualizing these impacts. Such a conceptualization provides a baseline with which to compare EPA's assessment of impacts for various uses of different pesticides, in terms of both excluded impacts and the quality of information obtained for included impacts.

OVERVIEW OF EPA'S ANALYSIS OF PESTICIDES

EPA, in analyzing the impacts of pesticide use, adopts a risk-benefit framework based on modern toxicological principles and neo-classical welfare economics. EPA focuses on the risks and benefits of pesticide use rather than pesticide regulation or pesticide manufacture and use. It is difficult to determine all of the impacts of pesticide use, but the choice of a framework provides some direction with regard to the identification of impacts. The decision to focus on pesticide use narrows the scope of EPA's analysis, but it also reduces the emphasis on the impacts associated with various regulatory alternatives. In pesticide regulation, EPA does consider the impacts of alternative regulatory options, but in an incremental manner that is very much dependent on the analysis of pesticide use impacts. Finally, the emphasis on use enables (even assures) EPA to ignore the regulatory impacts on manufacturers, formulators, and marketers of pesticide chemicals; the effects of compliance costs and non-compliance with regulatory decisions on regulatory outcomes; and the effects of other costs of regulation on society.

The outcome of these problem-reducing techniques is that some impacts of pesticide use and regulation are not considered, so the interests of some affected parties are not considered in the regulatory process. This is not completely true of manufacturers, although the impacts on pesticide producers are not explicitly considered in EPA's risk-benefit analysis, because manufacturers are able to make themselves heard in the rebuttal phase and at other points in the RPAR process (including the assessment of benefits). Although the process is supposedly open to all interested parties, other groups with a stake in the outcome often do not participate, perhaps due to high transactions costs or low per capita benefits. Such groups may include formulators of the pesticide, marketers of both the pesticide and the goods for which the pesticide is an input, some users of the pesticide and certain risk-bearers (although the EPA and the Environmental Defense Fund play the role of political entrepreneur in some cases).

PROBLEMS IN CONCEPTUALIZING RISKS AND BENEFITS

The difficulties in conceptualizing the impacts of an action fall into two general categories -- information overload and the need for value judgments. Information overload refers to the overwhelming number and complexity of interrelationships in the system under analysis, and the need for value judgments results from the aggregation of welfare measures across individuals in policy analysis techniques.

The Amount of Information and Difficulties in Tracing Impacts. Many policy analysis textbooks tend to overshadow problems in conceptualizing impacts while focusing on measurement problems. The implication is that quantitative description of impacts is an objective process totally dependent for its accuracy on the resources and skills of the analyst (see, for example, Anderson and Settle (1979)).

However, given the complexity of social, economic and ecological systems, there is a problem of information overload in attempting to determine the impacts of an action (Edmunds, 1982), much less the direction of the impacts. For that reason, a benefit-cost or risk-benefit analysis must be limited in scope. The impression from reading the public documents from the EPA's regulatory actions on pesticides is that an incremental approach is adopted: current risk-benefit analyses tend to be similar in structure and scope (i.e., impacts examined) to past analyses. Thus, one criterion for limiting the impacts identified in an analysis (aside from limits already imposed by the choice of a framework of analysis and the focus on pesticide use) may be whether or not the impacts have been studied in past analyses. Other criteria may include choosing the most important impacts for study in terms of dollars of benefits or lives at risk, choosing the most obvious impacts for study, or choosing those impacts which are the focus of the most public input or controversy.

Value Judgments in Risk-Benefit Analysis. Some skeptics of policy analysis seem to feel that there is a way to make risk-benefit or cost-benefit analysis objective, but that we lack the technology, resources or expertise to accomplish this objectivity (Hapgood (1979), Anderson and Settle (1978)). However, others see policy analysis as being comprised of value-laden elements which can never be avoided and which are best dealt with in the open.

Scientists have noticed the value judgments inherent in risk-benefit analysis, probably because they are often requested to determine the acceptability of the risk of certain actions. Lowrance (1980) points out that there are two components of a risk analysis: measuring risk (which can theoretically be done in an objective manner) and judging the acceptability of risk (which is always a value judgment). Wessel (1980) also describes value judgments in risk-benefit analysis -- he notes that although science itself is valueless, the use of science involves values.

Other scientists continuing this theme include Gusman (1980) and Sieck (1980).

Economists have also noted the value judgments in policy analysis, especially in trying to aggregate individual welfare into societal welfare. Assumptions must be made regarding the marginal utility of a unit of income or wealth to individuals at different points in the societal income distribution, and about the ability to develop a single social welfare function. Most economists feel that these problems can either be solved or are not serious enough to hinder the practice of policy analysis. The usual method of aggregating individual welfare is to adopt the Hicks-Kaldor criterion of potential Pareto-optimality. This criterion assumes that the marginal utility of money or wealth is equal for all individuals regardless of income, and that costs and benefits can be summed across individuals to obtain a net benefit calculation for society. The value-laden rationale for this economic efficiency calculation of social welfare is that an action is good for society if those who benefit from the action would be able to compensate the losers and still have some benefits left over. Thus, it assumes that efficiency is the primary goal of public policy.

In literature which is mostly theoretical, economists have suggested ways of designing a social welfare function incorporating more than economic efficiency. Haveman and Weisbrod (1977) suggest attaching weights to different benefits and costs to incorporate equity in calculations of net benefits. Many others, including Steiner (1977) and Freeman (1977), suggest the possibility of obtaining societal welfare functions.

Others reject the view of a social welfare function. Schmid (1979) believes that a social welfare function can never be objectively determined, and it is not the analyst's place to make the necessary value judgments in an attempt to do so. Such value judgments are questions of public choice, and as such belong in the political process rather than buried in a benefit-cost analysis.[29]

Schmid also points out some of the more subtle value judgments involved in policy analysis. The choice of impacts to be examined in an analysis involves decisions on which are to be included and how they are to be categorized. These choices affect the issues addressed, measurements of costs and benefits, and solutions to the problems. Schmid also articulates a point that is rarely noticed by policy analysts and welfare economists -- in order to calculate costs and benefits, one must assume a particular distribution of property rights. In order for a policy to result in the accrual of benefits to certain individuals, those individuals must be endowed with an initial set of rights and the rights to possess the benefits. Likewise, a cost to an individual is a cost only if the rights of others allow them

[29]For a similar viewpoint, see Hanke and Walkey (1977).

to impose costs on that individual. In other words, benefits and costs are defined by a system of rights. Analysts generally assume the status quo distribution of rights in assessing the impacts of a policy, but this is a value judgment which implies that the current set of rights is the best set of rights. If the desire of policymakers is to change the system of rights, then analyzing the economic efficiency of a policy is not terribly relevant, especially given that the new set of rights will probably result in a different efficient solution than the current set of rights (which is used in the analysis).[30]

CONCEPTUALIZING THE IMPACTS OF PESTICIDE USE

In the last section, the choices involved in conceptualizing the impacts of an action were outlined. In this section, those choices must be made in order to conceptualize the benefits and risks of pesticide use. The choices made will be the same choices that EPA makes, for the objective is to measure the quality of EPA's information against some standard; it is the standard that is to be developed here.

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[30] A widely quoted "axiom" of the new welfare economics, known as the Coase Rule, postulates that ownership of resources (as determined by property rights) has no effect on resource allocation, given no transactions costs in operating in the market. However, Schmid (1978) points out that the Coase Rule only holds true if the change in rights does not affect real income of the rights-holders, transactions costs are zero, resources are perfectly mobile and the rights of other parties are not affected by the exchange between two parties. The result is that the Coase Rule is <u>not</u> widely applicable.

One choice has already been made -- to consider impacts from the viewpoint of pesticide use (versus pesticide regulation, pesticide manufacture, etc.). Some of the reasons for EPA's choice of this viewpoint were previously discussed. The result of the decision is that some impacts are excluded from consideration.

Another decision is made regarding the analytical method, with contingent value judgments, to be used. The EPA has chosen risk-benefit analysis as its method for assessing impacts. There is an implicit assumption of a set of property rights to be used as a basis for determining costs and benefits; specifically, the status quo distribution of rights. EPA is also assuming that benefits and risks can be aggregated across individuals. Finally, the choice of risk-benefit analysis as a methodology for determining impacts means that health risks are compared to benefits net of all other costs, rather than total benefits compared to total costs.

After choosing the method of analysis, EPA must classify risks and benefits into operational categories, decide how extensively to measure impacts, and choose methods of measurement. All of these decisions require value judgments, as does the final regulatory decision.

Since the empirical work in this research is intended to describe and explain the quality of information obtained for various impacts of pesticide use, some of EPA's value judgments will be adopted in the following specification of impacts in order to facilitate comparison and develop dependent variables.

Risk Measurement. Lowrance (1980) divides risk analysis into two separate subprocesses -- the measurement of risk (which can be objective) and an evaluation of the safety of the risk (which is subjective). For the purposes of this research, greater emphasis is placed on EPA's measurement of risk than on the judgment of the acceptability of that risk.

Toxicity. Toxicity of a pesticide to human or nonhuman organisms refers to the disease- or injury-causing capability of the pesticide. Ideally, scientists would like to establish a dose-response curve for each affected organism which would describe the correlation between different levels of exposure to a chemical and the incidence of disease. However, due to limited resources and technological constraints, scientists must make do with group dose-response data from nonhuman organisms which are often based on high-dosage experiments. Therefore, estimates for humans usually are extrapolated from rodents or other test animals to humans and from high doses to lower doses. On the rare occasions when human exposure data is available (e.g., as a result of known accidental exposure), there is generally only one dosage level which is sometimes unknown. In such instances, the most that scientists can objectively discern is that exposure to a particular compound is or is not associated with an increased occurrence of disease. Sometimes data are not even available for test animals; in these cases, EPA must rely on more economical cellular tests, data for compounds with similar chemical structures and other less desirable methods of estimated toxicity.

Environmental Fate. A very complex aspect of pesticide risk is the environmental fate of a pesticide. Environmental fate generally refers to where and how long a pesticide persists in an environment. This depends on a myriad of chemical and physical processes that a pesticide is exposed to after it is introduced into the environment. Ideally, EPA would have a reliable model to determine environmental fate for all of the possible use conditions of a pesticide. Obviously, if a pesticide dissipates or degrades rapidly, exposure will be lessened and so will risk.

EPA's difficulties in measuring environmental fate arise from the difficulties in conceptualizing and measuring the many possible mechanisms for pesticide degradation. These mechanisms include: photolysis, hydrolysis, oxidation, drift, and runoff. The degree to which any of these or other processes occur depends on field conditions, climate, application methods, pesticide characteristics, and other criteria. Data for all of these criteria are difficult, if not impossible, to obtain. Just conceptualizing the physical and chemical processes to which a pesticide will be exposed is a major challenge.

Exposure. A third major component of risk measurement is the determination of levels of exposure of individuals coming into contact with a pesticide. First, the various groups exposed to the pesticide must be identified. Then, the exposure of the individuals in these groups to the pesticide via various routes (ingestion, inhalation, dermal absorption) must somehow be estimated. Figure 3.1 lists some of the groups that may be exposed to a given pesticide and the potential routes of exposure.

Group	Potential Route of Exposure
Mixers and Loaders and Aerial Ground Crews	Dermal Absorption Inhalation of Spray Ingestion of Food Residues
Aerial and Ground Applicators	Dermal Absorption Inhalation of Spray Ingestion of Food Residues
Persons Exposed to Spray Drift	Dermal Absorption Inhalation of Spray Ingestion of Food Residues
Farmworkers	Dermal Absorption Inhalation of Spray Ingestion of Food Residues
Consumers of Contaminated Food	Ingestion of Food Residues
Persons Exposed Via Accidents	Dermal Absoption Inhalation of Spray Ingestion of Food Residues

Figure 3.1 - Groups and Routes of Pesticide Exposure

Exposure would ideally be measured for each individual under various conditions, but this is beyond EPA's means. In descending order of accuracy, other methods of estimating exposure would include estimating average exposure for subgroups within a larger group (e.g., female applicators, infant consumers), estimating average exposure under "normal" conditions for a random sample of individuals in a group, estimating average exposure for a non-random sample under experimentally-imposed conditions, using exposure data from similar pesticides, and guessing or assuming levels of exposure. All of these methods have been used by EPA in pesticide risk analyses.

For exposure to be meaningful across groups, it must be put into common units of measurement. For example, the average U.S. consumer may ingest 50 milligrams of endrin per year throughout his or her lifespan while the average applicator is dermally exposed to 500 milligrams per year for forty years, ten percent of which is absorbed through the skin. In order to compare the two types of exposure, the estimates are recalculated in terms of average body weight and a particular period of time. Therefore, the final estimate would be expressed as milligrams of pesticide per kilogram of body weight per year.

The risk analysis. In order to estimate the probability of disease, or risk, the EPA needs to bring the estimates of toxicity together with the estimates of environmental fate and exposure. When animal data are used instead of human data for estimating human exposure, the data must be extrapolated. Often, EPA assumes that the same relationships between dose and response hold for humans as for the test animals. In addition, extrapolation from high dose to low dose must be accomplished if the test animals were exposed to higher dosages than humans. There are a number of mathematical models for accomplishing this; EPA generally chooses the linear or one-hit model, which is based on the assumption that the smallest doses of a chemical result in some increased probability of disease. Other models, such as probit and logit models, predict less risk at lower levels of exposure. (See Figure 3.2 for a comparison of the models.)

EPA always multiplies the exposure estimates by a "margin of safety," allegedly to insure that potential errors in extrapolation leading to low risk estimates are corrected for and to provide for sensitive members of a population. The effect of a margin of safety is to overstate the risk estimate relative to a risk estimate calculated without the margin of safety. There is no generally-accepted margin of safety. EPA used a margin of safety of 100 for seven of the eight pesticides studied in this research, and used a margin of safety of 500 for the remaining pesticide, Endrin. In the case of Endrin, the margin of safety of 500 allowed a definitive finding of human risk based on animal test results. However, EPA was able to provide sketchy evidence suggesting that humans are more sensitive to Endrin than

Model	Relationship of Dose to Risk	Relative Prediction of Risk At Low Levels of Exposure
Probit[1]	Normal	Low Risk
Logit[2]	Logarithmic	Medium Risk
One-hit[3]	Linear	High Risk

Source: Compiled by author from information in Epp, et al (1977).

[1]The probit model is based on the assumption that different individuals' sensitivities to disease-causing chemicals can be described with a bell-shaped or normal curve.

[2]Logit models assume that there are a given number of sites available for chemical bonding; when those sites are filled the risk curve levels off, resulting in logarithmic curves.

[3]The one-hit model assumes that a single exposure could cause disease and that there is a linear relationship between dose and response.

Figure 3.2 - Mathematical Models to Determine Risk

other mammals as a justification for the larger margin of safety.

Carcinogenic risk is generally reported in probabilistic terms, since it represents the probability of a particular level of exposure resulting in illness or death. This probability is based on the results of chemical exposure to samples of test animals, and so reflects probabilities for groups of individuals rather than specific individuals.

Teratogenic and fetotoxic risk is often reported as a margin of safety rather than in probabilistic terms. Margin of safety is estimated by dividing human exposure into the lowest test animal exposure which produced a significant number of birth defects or fetal deaths or into the highest no effect level of exposure to test animals. A value judgment then has to be made on whether the estimated margin of safety is adequate or safe; for seven of the eight case study pesticides, a figure of less than 100 is considered representative of substantial risk, and for Endrin anything below 500 was considered unacceptable.

The Measurement of Benefits. The concept of the benefits of pesticide use in risk-benefit analysis is far broader than the concept of benefits in cost-benefit analysis. Figure 3.3 compares the two different concepts. Essentially, benefits in risk-benefit analysis are really net benefits, including costs other than the risk of injury or death. In benefit-cost analysis, gross benefits are compared with costs. To facilitate discussion, benefits will hereafter be referred to as net benefits.

Theoretical discussion of the net benefits of pesticide use. Principles from benefit-cost analysis provide a framework for examining the net benefits of pesticide use. Net benefits can be discussed in terms of real net benefits, which represent true net gains to society, and pecuniary net benefits, which are redistributions of resources between individuals which result in no net gains to society.

Real impacts. Real impacts or net benefits can more specifically be described as the net benefits to society of using the pesticide over the next best pest control method. These real net benefits take the form of

The Concept of Real Benefits In Cost-Benefit Analysis ("Real Benefits")	The Concept of Real Benefits In Risk-Benefit Analysis ("Net Real Benefits")
1. Value of increased output of product, if any.	1. Value of increased output of product, if any.
2. Value of increased quality of product, if any.	2. Value of increased quality of product, if any.
3. Decreases in costs of producing original output.	3. Decreases in costs of producing original output.
4. Avoidance of capital losses, unemployment, or other costs of transferring resources in the event of pesticide restriction.	4. Avoidance of capital losses, unemployment, or other costs of transferring resources in the event of pesticide restriction.
5. Avoidance of regulatory costs.	5. Avoidance of regulatory costs.
6. Improvements in health and safety resulting from better nutrition due to cheaper food.	6. Improvements in health and safety resulting from better nutrition due to cheaper food.
7. Other real benefits of pesticide use.	7. Other real benefits of pesticide use.
	8. Costs of producing additional output.
	9. Costs of decreased quality of product, if any.
	10. Costs of pesticide use to the environment.
	11. Increases in costs of related production processes.
	12. Other real, non-risk costs of pesticide use.

Figure 3.3 - Different Conceptualizations of the Real Benefits of Pesticide Use

changes in output, quality, and/or production costs of the final product for which the pesticide is an input. Some real net benefits of pesticide use are not normally captured in the market for the output: these benefits might include improved health and safety resulting from better nutrition (due to less expensive food), fewer automobile accidents from view obstruction as a result of herbicide use, the avoidance of costs of transferring resources in the event of pesticide restriction, and the avoidance of regulatory costs.

The value in a competitive market of increased output or quality of a product that is attributable to the use of a pesticide can be measured by the willingness of society to pay for the increased output or quality. Assuming that the pesticide increases output or quality, Figure 3.4 illustrates the willingness of society to pay as being equal to A + B + C. That area is equal to the product of the change in quantity or quality and the new market price, plus the value of the consumers' surplus associated with the new production.

The decrease in production costs can also be depicted graphically, by D + E - C in Figure 3.5. The area describing the reduction in total costs is equal to the reduced costs resulting from a decrease in production without the pesticide (D + E), less the increased costs incurred in producing the additional output (C). Figure 3.5 is based on the assumption that production costs would fall; in reality, total costs could increase with the use of the pesticide.

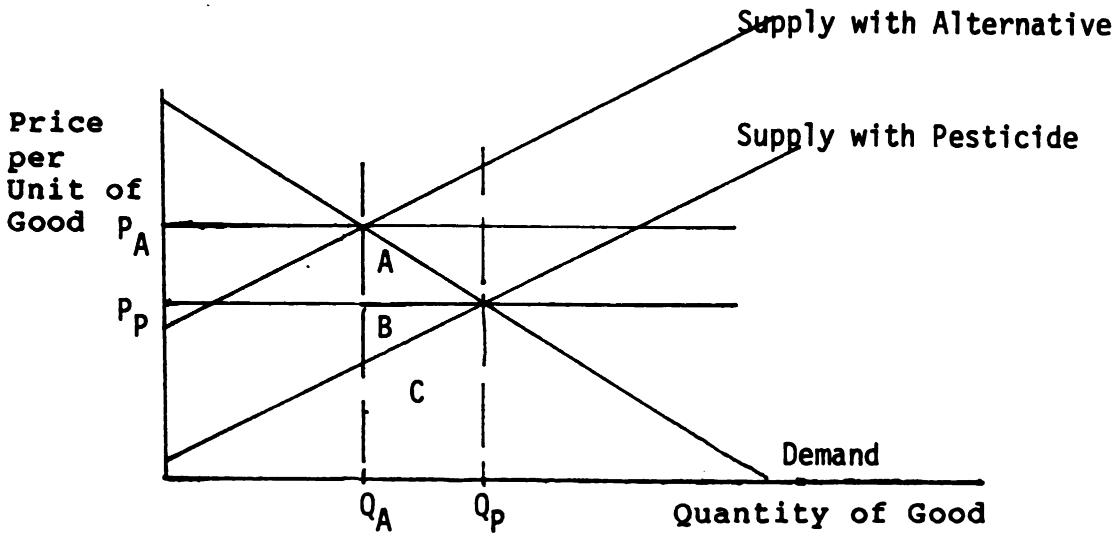

Figure 3.4 - Value of Increased Quantity or Quality of Output

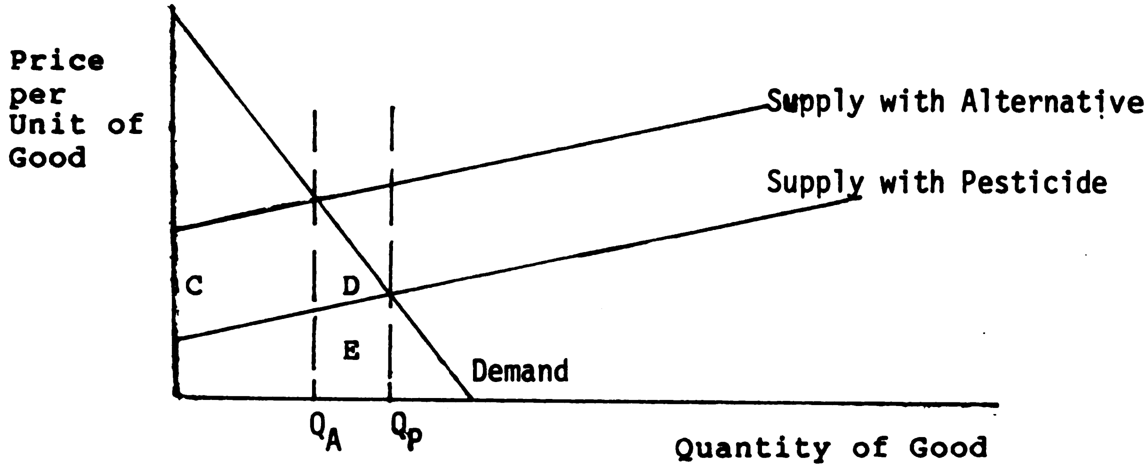

Figure 3.5 - Value of Reduced Production Costs

Since the value of increased output and decreased production costs is negotiated in the marketplace for the pest control inputs and the product, EPA may be able to obtain data on supply, demand and prices, although such data may not be easy to obtain. The market provides key information on real impacts. Input markets may also provide information on other real net benefits of pesticide use. Restriction or cancellation of pesticides would change the relative price structure and productivity of inputs which are substitutes for or complements to pesticides. Although the price changes themselves are pecuniary impacts (see discussion on pecuniary impacts below), the avoidance of any capital losses to input users, unemployment or underemployment of resources (due to immobility, noncompetitive labor markets, etc.) and any other costs of transferring resources in the event of pesticide cancellation in order to re-employ them are real net benefits of pesticide use. In the same manner, the avoidance of the real costs incurred in regulating the pesticide via the RPAR process also could be classified as real net benefits.

Also included under real net benefits, as the term is used in risk-benefit analysis, would be "non-risk" costs of pesticide use. The costs of purchasing and applying the pesticide are already included under changes in production costs. In addition, there may be increases in the costs of related production processes due to acute or chronic toxicity, phytotoxicity, air or water pollution, or soil erosion.

Some of the products for which production costs may increase include livestock, crops, recreation and fish. Finally, there are the environmental impacts other than those affecting human health and production processes, including the loss in value of environmental amenities resulting from death or injury of wildlife or environmental pollution.

Pecuniary impacts. Pecuniary impacts refer to those impacts which are transfers of income, wealth or utility between individuals or groups rather than net societal increases or decreases in income, wealth or utility. Examples of pecuniary impacts that may result from pesticide use include:

1. Decreases in output prices to producers who don't use the pesticide and to producers of substitute products, offset by savings to consumers.

2. Impacts on input markets (e.g., changes in relative prices) other than transfer costs, offset by impacts on buyers of inputs.

3. Impacts on markets for insurance and health care due to more or less illness, offset by impacts on consumers of those services.

Other examples of pecuniary impacts could be found, depending on the specific pesticide and its circumstances of use.

Distribution of impacts. The benefits and risks of pesticide use are distributed among many participants in and out of the marketplace. Voluntary risk (e.g., risk to pesticide applicators) may be better known to the risk-bearer, and thus may be borne in part by the risk-imposer in financial terms and by the risk-bearer in health and financial terms. If risk is involuntary and unknown, then the risk-bearers will probably be faced with all of the risk. Risk distributed among the risk-bearers may also be partly passed on to employers in the form of lower productivity, and to families and friends in the form of suffering, reduced longevity, etc.

Real net benefits are also distributed among various parties. The changes in value of production and production costs are enjoyed by producers who use the pesticide, producers who don't use the pesticide (who actually may suffer a decline in income if product prices fall) and consumers of the product. Improved safety and nutrition are enjoyed by the general public and are evidenced by improved health and productivity, although health care industries may experience reduced revenues. The avoidance of capital losses and transfer costs is of benefit to the owners of inputs and users of inputs, and probably consumers of the final product of those inputs. Taxpayers and regulated firms profit from the avoidance of regulatory costs. When the costs of related production processes increase due to pesticide toxicity, producers and consumers of those goods generally bear those costs. Finally, environmentalists and related groups suffer from environmental impacts of pesticide use.

The distribution of pecuniary impacts depends on the impact in question. As already mentioned, competitive market producers who don't use a pesticide benefit if the price of the product increases and pay if it falls (at least in terms of returns per unit). This is a pecuniary impact, as it is offset by prices paid by consumers. These same effects hold true for producers of substitutes for the final product. Producers of complementary products observe the opposite impacts: they benefit if the product price falls and pay if it increases. Market prices for other products, such as insurance and health care, may be affected by pesticide use and are distributed among the producers and the consumers of the product. Non-transfer cost impacts on owners of inputs, such as changes in relative and/or absolute prices of inputs, are offset by impacts on input buyers and ultimately on consumers of the product for which the inputs are used. Other pecuniary impacts are distributed similarly.

Impacts may be distributed disproportionately on a geographic basis, as well as among groups. Individuals in a particular region of the country may use more of a pesticide, consume greater amounts of pesticide residue, or own resources with less mobility. In addition, if pesticide use has macroeconomic implications, other individuals may be affected in different ways than outlined above. It is conceivable that the use of pesticides could have such a profound effect on the production of much of the nation's supply of a given commodity that employment, price levels, balance of payments, and other macroeconomic variables would change. Finally, the relationship of the economic system to political and social variables may result in societal changes.

PROBLEMS IN MEASURING IMPACTS

A conceptualization of the impacts of pesticide use was accomplished in the previous discussion and is summarized in Figure 3.6. The first section of this chapter pointed out some of the many difficulties in conceptualizing impacts. There are additional problems involved in measuring impacts once they have been conceptualized.

Risk is difficult to measure due to a lack of information on the response of humans to various doses and on human exposure to the pesticide. Extrapolation from high dose to low dose, from nonhumans to humans, and from a test system to actual environmental conditions is necessary in order to estimate risk. In addition, some method of estimating human exposure must be devised. In some instances, technology is not available for accurate measurement; in other cases, accurate measurement is too costly to perform. The result is that EPA either omits the information on risk from the regulatory decision or implements lower cost and technologically feasible strategies for developing dose response and exposure data. These strategies are discussed in Chapter 5.

I. Risks

A. Exposure to affected groups via various routes.
B. Toxicity of chemical.
C. Risk analysis.
D. Distribution among risk bearers, risk imposers, others.

II. Net Benefits

A. Real

1. Value of increased output of product.
2. Value of increased quality of output.
3. Decreases in costs of production of original output.
4. Costs of producing new output.
5. Improved health and safety resulting from better nutrition, fewer automobile accidents, etc.
6. Avoidance of: Capital losses to users of inputs, unemployment, or other costs of transferring resources.
7. Avoidance of costs of regulating pesticide.
8. Increases in costs of related production processes.
9. Environmental impacts other than risk and production process impacts.

B. Pecuniary

1. Changes in output prices to non-using producers.
2. Impacts on input markets.
3. Other.

C. Distribution of Benefits

1. Among groups.
2. Geographic.
3. Macroeconomic benefits.
4. Social/Political benefits.

Figure 3.6 - Summary of Conceptualization of Benefits and Risks

The measurement of net real benefits can also present problems for regulators. At best, information on changes in yield due to pesticide use are obtained from agricultural test plots. These sample plots may not coincide with actual environmental conditions in which crops are grown. It also may be difficult to obtain pesticide price and use data, impacts of quantity changes on product price, impacts of pesticide use on other inputs in the production process, etc. Net real benefits not accounted for in market prices are even more difficult to quantify, as are net real benefits accruing to groups other than the users of the pesticide and pecuniary impacts. The problem in measuring net benefits is considered by most economists to be one of costs rather than one of technology. As a result of limited budgets, EPA must again develop strategies for incorporating information on net real benefits in risk-benefit analyses. Some of these strategies are presented in Chapter 5.

Finally, distributions of impacts are difficult and costly to measure. Determining who gets what share of real and pecuniary impacts demands a knowledge of the general equilibrium nature of the economic system -- knowledge which is complex and expensive.

CHAPTER 4

METHODOLOGY

INTRODUCTION

The next step in the research, after examining theoretical literature on regulatory decision making and the risks and benefits of pesticide use, was to attempt to empirically describe the quality of information obtained by the EPA and to use measures of some of the variables suggested by the regulatory decision making literature to explain the quality of information. This chapter describes the choice of a data base, the measurement of explanatory variables, the measurement of dependent variables, and the measurement of correlation between the explanatory and dependent variables.

CHOICE OF DATA BASE

The decision was made to use case studies as the source of data on explanatory and dependent variables. It was felt that case studies would best describe the quality of information used by EPA in pesticide decision making. Using case studies from the same agency and governed by the same statute most likely eliminated some of the variation between cases, thus providing more certainty in the empirical results. Lave, in The Strategy of Social Regulation, conducts an analysis of regulatory processes with case studies. In the words of Crandall and Lave, "It is ironic that the evidence for the enhanced role of scientific data and analysis is a set of case studies -- soft, impressionistic material -- which is being used to suggest the value of hard analysis! But we know of no better way to illuminate the role of scientific evidence in the world of regulation."[31]

The cases chosen for study were the eight pesticides for which the RPAR process had been completed when the empirical work began in March of 1982: Chlorobenzilate, DBCP, Pronamide, Amitraz, 2,4,5-T, Silvex, Endrin and Dimethoate.[32]

There was also some discretion as to where to obtain the data for each case pesticide. The decision was to use the sets of printed public position documents generated as an output of the RPAR process. There is justification for the use of so-called "paper trails" in previous research. Maynard-Moody and McClintock[33] explain that different types of research should be used when analyzing different regulatory processes. They cite two variables, "outcome standards" and "causal understanding," that should be used to evaluate a regulatory process to determine how to conduct research of that process. In organizations theory, outcome standards refer to agency goals and causal understanding

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[31] Lester Lave, <u>The Strategy of Social Regulation</u> (Washington, D.C.: The Brookings Institution, 1981), p. 16.

[32] Since that time, 10 additional RPARs have been completed.

[33] Maynard-Moody and McClintock, pp. 644-666.

refers to the relationships between agency actions and results. If both are ambiguous, as one could definitely argue in the EPA's regulation of pesticides, then researchers need a methodology that does not assume rigid agency goals. The authors' suggestions? Case studies, among other things, and qualitative measurement that relies on observations, paper trails, and enabling legislation. "Where quantitative measurement is used," they write on page 651, "its purpose is to illuminate patterns of behavior in the program." The authors acknowledge that "By relying solely on reports, judgments about the evaluations were based only on written comments, and there may be differences between what actually happened and what was reported. It is possible that insights and problems that were important ... were not described. Nevertheless published reports are an accessible source of information that reflect, however imperfectly, the issues discussed." The authors' main point is that carefully designed studies of the "efficiency" of a regulatory process are not relevant when it is not even clear what the agency goals are.

Many other researchers have used paper trails in studies of agency decisions. The studies are often descriptive in nature; the researchers generally acknowledge that paper trails may constitute an incomplete picture of the regulatory process, but it is felt that the documents could improve understanding of the process.

The position documents describe information sources and measures of explanatory variables in a relatively consistent manner between pesticides (as well as between uses of a single pesticide), which made them ideal for comparison. They are also interesting from the standpoint of analyzing EPA's public record.

There is justification for using other sources of data, especially interviews with EPA officials and/or interest group representatives. Such interviews would have reflected participants' perceptions of the quality of EPA's information (which might not have always been accurate), as well as allowing the researcher to obtain more details on the EPA's data sources. However, time and financial constraints did not allow the exercise of this option.

MEASURING EXPLANATORY VARIABLES

Which Variables? The literature on regulatory decision making described in Chapter 2 pointed to a variety of variables that might explain decision making. It was decided to investigate the explanatory power of variables reflecting the incentives and power of different interest groups over the information-gathering portion of the decision making process.

Three major groups stand out as having a stake in pesticide decision outcomes: pesticide manufacturers, pesticide users, and risk-bearers. The principles of the Peltzman-type theories suggest that pesticide manufacturers might be able to influence the regulatory process because the major manufacturers are relatively few in number (thus reducing organization costs) and in many cases the stakes appear to be rather high due to the sale of large quantities of a pesticide by individual corporations.

Pesticide users are usually more dispersed in terms of numbers and distribution of impacts, although there are incidents of oligopoly (such as strawberry nursery stock growers in Delaware and Maryland, and pineapple growers in Hawaii).

Risk-bearers are likely to be even more dispersed. There is no formal organization to express the views of the millions of people consuming food with pesticide residues; there is not even a vocal organization for workers exposed to harmful pesticides. Furthermore, the risks are not at all well known to exposed sectors of the population and it is not apparent what they could do if they decided that the risk of being exposed exceeded the benefits.

To reflect the power of these interest groups over the decision making process, the following explanatory variables were chosen.

1) The stake of pesticide manufacturers in the outcome of the regulatory process, measured by the product of the retail price per unit of the pesticide and the units of pesticide used for a particular crop.

Thus, the researcher attempted to measure this variable for each use of each pesticide (86 uses in all). This measure was intended to proxy the relative value of different uses of a pesticide to the manufacturer. It is hypothesized that greater value of a pesticide use to manufacturers leads to more and better information on that use.

2) The stake of pesticide users (producers) in the outcome of the regulatory process, measured two ways: by the annual per acre user losses from pesticide cancellation for each use and by the annual total user losses from pesticide cancellation for each use. Again, this variable was measured for as many of the 86 uses as possible. It is hypothesized that a greater economic stake to producers leads to more and better information.

3) The percentage of total acres of a crop treated with the pesticide was also used as a measure of an explanatory variable. The measure was intended to proxy the number of users affected for each pesticide use. Stigler and Peltzman hypothesized that the more users, the greater the difficulty in organizing the political interest group.

But growers often have already-organized user groups, including the USDA, to represent them in the political process. Therefore, the hypothesis tested was that a larger percentage of the particular crop or use would result in better information because it would serve as a larger incentive for user groups to become involved. This hypothesis is not necessarily restricted to information on benefits. A similar argument can be made for risk information, since widespread use may spring risk-bearers' groups into action. In addition, risk-bearers may react to better information from users with increased information of their own.

4) The amount of risk is hypothesized to be positively related to the quality of information. However, this hypothesis is very difficult to measure for a particular use of a pesticide, or even between uses of a pesticide, because risk is usually constant per unit of exposure for a pesticide, and data on exposure and number of exposed persons are poor. Instead, the decision was made to use risk to predict the quality of information <u>between the different pesticides</u>. So, unlike the other explanatory variables, this variable was measured for each of the 8 pesticides rather than for each of the 86 uses. EPA's own ranking of the RPAR pesticides was used to measure risk, particularly in light of the following comment by Edwin Johnson, Director of EPA's Office of Pesticide Programs:

> "Pesticide law requires that both risks and benefits be considered in all decisions. But risk drives the process in terms of depth of analysis and allocation of agency resources. The greater the apparent or potential for risk, the more in-depth the analysis of both risks and benefits, the more resources devoted to the evaluation, and the greater the degree of public involvement and scrutiny accorded the decision." (Emphasis added).[34]

So according to the people who make the decisions, more and better information is gathered for pesticides with greater actual or perceived risk. In addition, the public (interest groups?) becomes more involved when there is a higher degree of actual or perceived risk.

How Measured? As mentioned previously, the EPA's published position documents served as the data base for the eight case study pesticides. The data for the explanatory variables did not always just "fall out" of the position documents. Rather, measures for the variables often had to be calculated.

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[34]Edwin L. Johnson, "Risk Assessment in an Administrative Agency." The American Statistician 36, no. 3, part 2 (August 1982): p. 233.

Value of pesticide use to manufacturers. The measure used to proxy the value of a pesticide use to the manufacturer was the quantity of pesticide used times the pesticide's retail price per unit. This measure was used purely for ranking the pesticide uses; it was assumed that the ratio of wholesale price to retail price is relatively constant between uses of a pesticide and that manufacturer costs per unit of the pesticide are constant for all uses. If these assumptions are correct, then the data provides an accurate picture of the relative economic importance of the different uses of the pesticide to manufacturers.

The time period chosen for measuring the quantity of pesticide used was one year. This caused some problems in the case of DBCP, because this nematocide is often applied on a three-year cycle. For those uses, the quantity was determined as the one-year average. In addition, amounts of pesticide used were sometimes described as "minor," "little," or "negligible." In such instances, the pesticide use was assigned an annual value to manufacturer of 100, which placed that use below the uses for which the values were calculated. Position documents 2/3 and supplementary benefits analyses were the sources of this data.

Retail prices for the pesticides were fairly easily found in the position documents 2/3. Occasionally, different forms of the pesticide were used for different uses, so there was more than one price for the pesticide.

Table 4.1 shows the value of uses of DBCP to manufacturers, as an example. Data for the other pesticides can be found in Appendix A.

Value of pesticide use to producers. Two measures were used to describe the economic stake of producers in uses of a pesticide: annual total user losses of pesticide cancellation and annual per acre user losses of pesticide cancellation. Again, data for both measures were obtained from the position documents (primarily PD 2/3s). Pesticide uses with qualitative descriptions such as "minor," "negligible," "little," "insignificant," or "small" were assigned a value of 100 for total costs and .25 for per acre costs, placing them in a lower ranking than those uses for which costs to producers could be calculated.

Table 4.1 Value to Manufacturers of Uses of DBCP

Use	Price of DBCP per pound ($)	Pounds used Annually	Value to Manufacturer
Soybeans	.67	12,378,000	8,293,260
Grapes	1.00	3,200,000	3,200,000
Almonds	.67	3,417,000	2,289,390
Vegetables/Melons/ Strawberries	.66	3,392,000	2,238,720
Peanuts	.67	3,195,000	2,140,650
Cotton	.66	2,700,000	1,782,000
Peaches/Nectarines	.66	1,823,000	1,203,180
Citrus	.62	1,292,000	801,040
Commercial Turf	.66	550,000	363,000
Plums	.67	452,000	302,840
Pineapple	.83	302,000	250,660
Home Lawns	.67	200,000	134,000
Other Berries	.67	92,000	61,640
Strawberry Nursery Stock	.67	16,000	10,720
Home Gardens	.67	5,000	3,350
Bananas	-	negligible	100
Apricots/Cherries/Figs	-	negligible	100
Ornamentals	-	unknown	?

The total losses measure was intended to depict the industry-wide net economic impact of pesticide cancellation, whereas per acre losses provided information on the approximate net impact of cancellation per producer. The former measure, if correlated with the quality of information, would lend credence to the hypothesis that producer groups provide information according to total dollars at stake. The latter measure would go along with Peltzman and Stigler's hypothesis that per capita economic stake helps drive the political process. The original intent was to report costs of cancellation per average-sized farm for each use of each pesticide, but such data were simply not available, so the per acre cost figures had to be used instead.

Again, the problem of multi-year application cycles, namely for DBCP, had to be solved. Annual averages were calculated when losses from pesticide cancellation were reported for multiple-year cycles.

Data were not always available for per acre user losses from pesticide cancellation because there were not always data on acres treated with the pesticide. When there were no quantitative or qualitative data, the use was not included in the analysis of correlation between per acre costs and quality of information. Table 4.2 and 4.3 show annual total and per acre costs of cancellation of DBCP, respectively. Data for other pesticides can be found in Appendix A.

Table 4.2 Total User Losses from Pesticide Cancellation for DBCP (Annual)

Use	Total Annual Costs ($)
Peaches/Nectarines	$ 26,890,000**
Soybeans	23,500,000
Grapes	21,670,000**
Vegetables/Melons/Strawberries	14,500,000
Citrus	8,950,000**
Almonds	8,834,000**
Peanuts	6,800,000
Pineapple	6,200,000*
Commercial Turf	2,200,000-5,600,000
Strawberry Nursery Stock	1,500,000-5,600,000
Plums	4,600,000**
Home Lawns	2,750,000
Cotton	2,600,000
Other Berries	1,000,000
Apricots, Figs, Cherries, Walnuts	"negligible" (100)
Bananas	"negligible" (100)
Home Gardens	"negligible" (100)
Ornamentals	?

* per year, after three years.

** annual averages based on three-year crop cycles.

Table 4.3 Annual Per Acre and Total User Losses from Pesticide Cancellation for DBCP

Use	Annual Total Costs ($)	Acres Treated	Per Acre Costs of Cancellation ($)
Strawberry Nursery Stock	$1,500,000 to 5,600,000	600	$2,500.00 to 9,333.00*
Pineapple	6,200,000	5,000	1,240.00*
Peaches/Nectarines	26,890,000	42,000	640.24*
Plums	4,600,000	9,000	511.00*
Commercial Turf	2,200,000 to 5,600,000	18,500	118.92 to 302.70*
Citrus	8,950,000	31,200	286.86*
Grapes	21,670,000	83,000	261.08*
Ornamentals	?	?	88.08 to 172.55
Almonds	8,834,000	71,000	124.42*
Home Lawns	2,750,000	31,250	88.00*
Vegetables/Melons/ Strawberries	14,500,000	374,000	38.77*
Soybeans	23,500,000	1,133,000	20.74
Peanuts	6,800,000	355,000	19.15*
Cotton	2,600,000	225,000	11.56*
Other Berries	1,000,000	600	.25
Home Gardens	"negligible"	?	.25
Apricots/Figs/ Cherries/Walnuts	"negligible"	"negligible"	.25
Bananas	"negligible"	"negligible"	.25

* Calculated by author

Percentage of producers affected. As previously mentioned, it was hypothesized that a higher percentage of affected producers would serve as an incentive for producer groups to involve themselves in the regulatory process. The best measure of percentage of producers affected was the percentage of total acres in the nation treated with the pesticide. The assumption was that the percentage of acres treated was directly related to the number of producers who use the pesticide.

If the percentage of acres treated was described as "very minor" or "little," a value of .01% of total acres treated was assigned to the use of the pesticide, which ranked the use below those uses for which quantitative estimates had been obtained.

In the case of endrin, the percentage of acres treated for "other vegetable seeds" was described as "like watermelon and conifers." The percentage for watermelon and conifer seeds was 100% and 90% respectively, so a value of 90% was assigned to other vegetable seeds.

If there were no qualitative or quantitative data on the percentage of acres treated, the use was not included in the data base. If crop cycles exceeded or were less than one year, the percent of the crop treated per cycle was used. Table 4.4 shows the percentage of acres treated, intended to proxy the percentage of affected producers, for DCBP. Data for other pesticides can be found in Appendix A.

Table 4.4 Percentage of Acres Treated with DBCP (Per Crop Cycle)

Use	Percent of Crop Treated
Strawberry Nursery Stock	100%
Vegetables/Melons/Strawberries	8.1% to 95%
Plums	70%
Almonds	54%
Pineapple	46%
Peaches/Nectarines	44%
Grapes	31%
Peanuts	23%
Citrus	7.9%
Soybeans	2.1%
Cotton	2.0%
Home Gardens	<0.5%
Other Berries	<0.1%
Apricots/Cherries/Figs/Walnuts	<0.1%
Bananas	<0.1%
Commercial Turf	?
Ornamentals	?
Home Lawns	?

Losses to risk-bearers. Although pesticide manufacturers and users gain from the use of a pesticide, some individuals lose -- namely, risk-bearing individuals and possibly nonusing producers. Data on losses to nonusers were not available, but there were meaningful data on risk for the eight pesticides. In fact, the data were EPA's own rankings of the eight pesticides according to various risk variables, which lended more credence to the testing of Edwin Johnson's statement that more risk leads to more information.

The ranking for Amitraz had to be calculated by the researcher, since it was not rated by EPA. Table 4.5 shows the relative risk calculation for Amitraz. EPA's ranking of the eight pesticides can be found in Table 4.6.

Table 4.5 Measuring Relative Risk for Amitraz

Criteria	Measure	Score
Total Production	up to 162,715 lbs active ingredient	0
Oncogenicity (Mammals)	positive	4
Other Chronic Toxicity (Mammals)	negative	0
Acute Toxicity (Mammals)	positive (p.1 of PD 1)	2
Fish and Wildlife Toxicity	negative (p.1 of PD 1)	0
Persistence	no evidence of persistence	0
Biomagnification and Bioaccumulation	no evidence	0
Environmental Mobility	drift	1
	TOTAL Risk Factor	7

Table 4.6 EPA's Pesticide Risk Ranking: Criteria Used to Determine Risk and Score for Each Pesticide*

Criteria	Score							
	Endrin	Chloro-benzilate	DBCP	Dimethoate	Silvex	2,4,5-T	Amitraz	Promanide
Total Production	2	1	3	0	3	3	0	0
Oncogenicity	4	4	4	4	0	0	4	4
Other Chronic Toxity to Mammals	0	0	0	0	1	1	0	0
Acute Toxicity to Mammals	3	1	2	1	0	0	2	0
Toxicity to Fish and Wildlife	3	1	2	1	0	0	0	0
Persistence	4	2	1	2	2	2	0	1
Biomagnification and Bioaccumulation	4	3	0	3	0	0	0	0
Environmental Mobility	1	1	1	1	1	1	1	1
TOTAL SCORE	21	13	13	12	7	7	7	6

*Higher numbers for scores on individual criteria and for total scores indicate greater risk.

Source: U.S.E.P.A. Office of Special Pesticide Reviews, "Project Manager Procedures Manual", Washington, D.C., 1976 (except for Amitraz, which was calculated by the author).

Problems in measuring explanatory variables. There were some problems in measuring the explanatory variables. Specifically, the "value to manufacturers" variable was proxied by using retail price times the quantity of the pesticide used annually. Within a pesticide, this measure presumed a constant relationship between wholesale and retail prices and a constant rate of return between uses of the pesticide. For comparison between pesticides, it presumed a constant rate of return.

For "annual total user losses from pesticide cancellation," data were often available for crop or application cycles rather than on an annual basis. In those instances, averages were calculated to reflect annual values. Averages may not have reflected the loss picture in a particular year, but they did provide a basis for overall comparison between uses of a pesticide.

For one pesticide, there was difficulty in calculating "annual per acre user losses." These data had generally been calculated by EPA, but in the case of DBCP, they had to be calculated by the researcher. This was accomplished by dividing "annual total user losses" by the estimated number of acres treated.

In the case of "percent of acres treated," the data were fairly attainable for crop or application cycles. There was no need to calculate the average annual percentage of acres treated, since the intent was to capture the proportion of producers affected in general rather than the proportion affected in a single year.

The EPA's risk ranking for the pesticides was considered to be relatively reliable. It reflects EPA's own perception of risk, which is most relevant since it was being used to test Johnson's hypothesis that more risk led to more and better information. The calculation of relative risk for Amitraz was not difficult, although the researcher was not completely sure of the values for biomagnification/ bioaccumulation and persistence, based on the information in the position documents. Phone calls to EPA indicated that Amitraz never had been ranked according to risk.

In general, there was a problem in measuring the explanatory variables with data from EPA's own risk benefit analyses. If EPA assigned qualitative or low values inaccurately, simply because there was no information, there may have been a bias introduced into the empirical work. For example, EPA may have described annual total costs of DBCP cancellation to banana producers as being "negligible" because there was no information rather than because there was information that DBCP use on bananas really was negligible. However, EPA often made a distinction between an unknown value and a negligible value for explanatory variables.

MEASURING DEPENDENT VARIABLES

Which Measured? The dependent variables in this research refer to the quality of information obtained by EPA to describe the various impacts of pesticide use. Chapter 3 was devoted to a description of the potential risks and benefits of pesticide use; this conceptualization was the basis for delineating and organizing the impacts which EPA calculated and could have calculated. EPA's consistency in measuring impacts across pesticides helped the researcher break the impacts apart into variables for which the EPA collected data. It was the quality of information obtained for these variables which served as the dependent variables. EPA's consistency was also important for the one explanatory variable (EPA's risk ranking) used to compare the quality of information between pesticides rather than between uses. Tables 4.7 and 4.8 describe typical sets of variables pertaining to risk and benefits for a pesticide. The goals in designing these sets were to cover the impacts that EPA measured, to make them broad enough to allow for comparisons between pesticides, and to make them specific enough to describe variation between uses of a pesticide.

These tables can serve as a comparison with Figure 3.5, which outlines the theoretical conceptualization of benefits and risks. In general, EPA spent virtually all of its resources measuring what most people would consider to be the major impacts -- risk analyses for the major groups (applicators and consumers, in particular), the benefits from increased value of production, and the benefits from reduced (or increased) pest control costs. Most of the pecuniary and distributional impacts were ignored for the eight pesticides, and some of the risk categories (especially farmworkers and exposure to spills and drift) also

Table 4.7 Typical Risk Variables for Which Quality of Information was Measured

Toxicity

Exposure, Human

- Consumers
  - Residues in food
  - Amount of food in diet
  - Percent of crop treated
  - Risk
- Ground Applicators
  - Dermal
    - Amount of pesticide exposure
    - Absorption of pesticide through skin
    - Duration of exposure
  - Inhalation
    - Amount of pesticide exposure
    - Absorption of pesticide
    - Duration of exposure
  - Dietary
    - Residues in food
    - Amount of food in diet
    - Percent of crop treated
  - Risk
    - Oncogenicity
    - Fetotoxicity/Reproductive Effects
    - Mutagenicity
- Aerial Applicators, Mixers and Loaders, Farmworkers, Persons exposed via drift, Persons exposed via spills, Flaggers
  - Same as for Ground Applicators

Exposure, Wildlife

- Decreases in Nontarget Species
  - Potential exposure
  - Lethal dose required to kill 50% of test animals (LD_{50})
  - Likelihood of exposure
  - Risk
- Acute Toxicity to Wildlife
  - Residues in food
  - LD_{50}
  - Amount of food consumed
  - Risk
- Fatality to Endangered Species
  - Exposure
  - LD_{50}
  - Risk

Table 4.8 Benefits Variables for Which Quality of Information was Measured

Changes in pest control costs due to pesticide cancellation
- Cost of pesticide per unit
- Amount of pesticide used per acre
- Acres treated with pesticide
- Cost of alternative pest control per unit
- Amount of alternative used per acre
- Acres that would be treated with alternative
- Acres that would be abandoned
- Per acre changes in pest control costs
- Total changes in pest control costs

Changes in yield due to pesticide cancellation
- Yield per acre with pesticide
- Yield per acre with alternative pest control
- Quality of product per acre with pesticide
- Quality of product per acre with alternative pest control
- Price per unit of product
- Per acre change in value of production
- Total change in value of production

Changes in other production costs

Impacts on producers of other goods

Distribution of impacts
- Users of pesticide
- Nonusers
- Marketers of product
- Consumers of product
- Pesticide manufacturers

Geographic distribution of impacts

Macroeconomic impacts

Social impacts

Probability of compliance with EPA restrictions

Cost of restrictions to users

were ignored for virtually all of the pesticides. In addition, the dietary exposure route was usually ignored for the non-consumer risk categories.

In summary, EPA never met the standard set forth in Chapter 3 for measuring the impacts of pesticide use -- many of the impacts were ignored or, at best, qualitatively discussed (mentioned might be a better word). How then, was the transition made from a theoretical conceptualization of impacts to a pragmatic description in Tables 4.6 and 4.7 of which "bits" EPA actually looked at in its position documents?

Mainly, the transition was made by carefully reading and rereading the position documents. Detailed study of the documents in chronological order (according to the date of publication of the PD 2/3s) revealed an incremental approach by EPA in determining which impacts of the different pesticide uses to measure, how to measure them, and sources of data.

How Measured? By far, the largest block of time in the empirical work was spent measuring the dependent variables (i.e., the quality of information for the variables which made up the impacts of pesticide use). Position documents were painstakingly read and reread to obtain first a broad picture of the impacts for each pesticide use and how they were measured and then a detailed picture of how the impacts were measured.

Impacts were initially listed on separate sheets of paper, with details on how each impact was measured by EPA. Based on this information, and after impacts were outlined, measurement scales were developed for each impact. These scales are depicted in Tables 4.9 to 4.19. The measurement scales were then applied to each impact for each use of each pesticide. The data were obtained by once more carefully reading the PD 2/3s and benefits analyses, and were coded by hand onto large sheets of paper. On the first reading, data were coded only for those impacts for which the quality of information (i.e., the information source) was fairly-well documented. This comprised approximately 2/3 of the data. The documents were scoured again to obtain data on the less well-documented impacts. Risk data were completely checked twice, due to the researcher's relative unfamiliarity with risk analysis and due to poor documentation of sources of information. Benefits data were thoroughly checked once; many of the data were obtained from the benefits analyses rather than the position documents. All together, nearly 8,000 pieces of data were obtained for 86 uses of the eight pesticides. Copies of the data are on file at Michigan State University Department of Agricultural Economics.

Table 4.9 Measurement Scale for Quality of Information: Toxicity

Each Unrebutted Animal Study	2 pts.
Each Unrebutted Epidemiological Study (Study of a Human Population)	5 pts.
Suggestive Evidence (e.g., Mutagenicity or Chemical Structures as Suggestive of Oncogenicity)	1 pt. for each category of evidence

Table 4.10 Measurement Scale for Quality of Information: Exposure

Residues in food, amount of food consumed, and percent of crop treated:

Ignored or not specifically mentioned	=	0 pts.
Qualitatively mentioned	=	1 pt.
Quantitative, assumed	=	2 pts.
Quantitative, expert opinion	=	3 pts.
Study, quantitative range	=	4 pts.
Study, quantitative point	=	5 pts.

Table 4.11 Measurement Scale for Quality of Information: Dermal and Inhalation Exposure

Amount of exposure, absorption rate, and duration of exposure:

Ignored or not specifically mentioned	=	0 pts.
Qualitatively mentioned	=	1 pt.
Quantitative, assumed	=	2 pts.
Quantitative, expert opinion	=	3 pts.
Study of similar pesticide, quantitative range	=	4 pts.
Study of similar pesticide, quantitative point	=	5 pts.
Study, quantitative range	=	6 pts.
Study, quantitative point	=	7 pts.

Table 4.12 Measurement Scale for Quality of Information: Risk Assessment

Ignored or not specifically mentioned	=	0 pts.
Qualitatively mentioned	=	1 pt.
Quantitative, range	=	2 pts.
Quantitative, point	=	3 pts.

Table 4.13 Measurement Scale for Quality of Information: Risk of Alternative Pest Control

Ignored or not specifically mentioned	=	0 pts.
Qualitatively mentioned	=	1 pt.
Quantitative	=	2 pts.

Table 4.15 Measurement Scale for Quality of Information: Significant Decreases in Nontarget Populations

Potential Exposure		
Ignored or not specifically mentioned	=	0 pts.
Qualitatively mentioned	=	1 pt.
Quantitative, assumed	=	2 pts.
Quantitative, expert opinion	=	3 pts.
Study of similar pesticide, quantitative range	=	4 pts.
Study of similar pesticide, quantitative point	=	5 pts.
Study of pesticide, quantitative range	=	6 pts.
Study of pesticide, quantitative point	=	7 pts.
Lethal Dose Required to Kill 50 Percent of Test Animals		
Ignored or not specifically mentioned	=	0 pts.
Quantitative, assumed	=	1 pt.
LD_{50} for similar species	=	2 pts.
LD_{50} for species	=	3 pts.
Likelihood of Exposure		
Ignored or not specifically mentioned	=	0 pts.
Qualitatively mentioned	=	1 pt.
Quantitative, assumed	=	2 pts.
Quantitative, expert opinion	=	3 pts.
Theoretical model, quantitative estimate	=	4 pts.
Study of similar pesticide, quantitative range	=	5 pts.
Study of similar pesticide, quantitative point	=	6 pts.
Study of pesticide, quantitative range	=	7 pts.
Study of pesticide, quantitative point	=	8 pts.
Risk		
Ignored or not specifically mentioned	=	0 pts.
Qualitatively mentioned	=	1 pt.
Quantitative, range	=	2 pts.
Quantitative, point	=	3 pts.

Table 4.16 Measurement Scale for Quality of Information: Fatality to Endangered Species

Concentration of Residues		
Ignored or not specifically mentioned	=	0 pts.
Qualitatively mentioned	=	1 pt.
Quantitative, assumed	=	2 pts.
Quantitative, expert opinion	=	3 pts.
Theoretical model, quantitative estimate	=	4 pts.
Monitoring similar species, quantitative range	=	5 pts.
Monitoring similar species, quantitative point	=	6 pts.
Monitoring species, quantitative range	=	7 pts.
Monitoring species, quantitative point	=	8 pts.
Lethal Doses Required to Kill 50 Percent of Test Animals		
Ignored or not specifically mentioned	=	0 pts.
Quantitative, Assumed	=	1 pt.
LD_{50} for similar species	=	2 pts.
LD_{50} for species	=	3 pts.
Risk		
Ignored or not specifically mentioned	=	0 pts.
Qualitatively mentioned	=	1 pt.
Quantitative, range	=	2 pts.
Quantitative, point	=	3 pts.

Table 4.17 Measurement Scale for Quality of Information: All Changes in Pest Control Costs and Changes in Value of Production Data Except Price

Ignored or not specifically mentioned	=	0 pts.
Qualitatively mentioned	=	1 pt.
Quantitative, assumed	=	2 pts.
Quantitative, expert opinion	=	3 pts.
Study or published data, quantitative range	=	4 pts.
Study or published data, quantitative point	=	5 pts.

Table 4.18 Measurement Scale for Quality of Information: Price

Ignored or not specifically mentioned	=	0 pts.
Qualitatively mentioned	=	1 pt.
Quantitative, assumed	=	2 pts.
Quantitative, expert opinion	=	3 pts.
Study, quantitative range	=	4 pts.
Study, quantitative point	=	5 pts.
Quantitative study, varies with quality of commodity	=	6 pts.
Quantitative study, varies with supply of commodity	=	7 pts.
Quantitative study, varies with quality and supply	=	8 pts.

Table 4.19 Measurement Scale for Quality of Information Per Acre Change in Pest Control Costs, Total Change in Pest Control Costs, Per Acre Change in Value of Production, Total Change in Value of Production, Change in Other Production Costs, Impacts on Producers of Other Goods, Distribution of Impacts (Users, Nonusers, Marketers, Consumers, Manufacturers), Geographic Impacts, Macroeconomic Impacts, Social Impacts, Degree of Compliance, Costs of Restrictions

Ignored or not specifically mentioned	=	0 pts.
Qualitatively mentioned	=	1 pt.
Quantitative, range	=	2 pts.
Quantitative, point	=	3 pts.

Table 4.20 Measurement Scale for EPA Decision

Decision		
Register pesticide	=	0 pts.
Register with restrictions	=	1 pt.
Cancel pesticide	=	2 pts.

Problems in Measuring Dependent Variables. The dependent variables were in some ways easier and in some ways harder to measure than the explanatory variables. They were easier because data were being generated rather than sought. If data were unavailable for the explanatory variables, they were unavailable -- the researcher could not go out and measure the acres of apples treated with Amitraz. Measurement of the dependent variables was up to the researcher, so there was more control over the quality of the data.

But measuring the dependent variables was difficult because EPA's documentation of information sources was often poor, there were about 8,000 pieces of data to collect, and the measurement scale for each dependent variable was good but not foolproof, which sometimes led to questions over the value to be assigned to a variable. In general, the benefits variables were easier to measure because of better documentation and the researcher's training in economics.

Specific comments on risk coding. Specific problems in measuring the risk variables can best be depicted by presenting some of the notes made during the measurement process. These notes are summarized in Table 4.21.

General comments on risk coding. The basic approach in coding the dependent risk variables was to strive for consistency within a pesticide over consistency between pesticides. Instead of being straightforward, the risk coding often ended up as a judgment call after all the information had been compiled. The goal in these situations was to make consistent judgment calls.

Table 4.21 Specific Problems in Measuring Dependent Risk Variables

Chlorobenzilate

- Assume that ground application exposure includes exposure from mixing and loading.

- Since absorption was estimated and does not change between routes of exposure, should it be coded for all routes? No, because in many cases those routes of exposure were not even mentioned.

- When there are inconsistencies between the text and tables, which should be followed? In case of farmworkers, go by text.

- Is there ever aerial application for cotton, fruits and nuts and "other?" Is there ever farmworker exposure for "other"? Assumed not.

- Assumed no dietary exposure from "other" uses.

- National Cancer Institute study on oncogenicity not reported because it had not been finalized.

- Toxicity (Adverse Reproductive Effects) was coded as 11 due to 5 studies and suggestive work (1 pt.).

- Residues in food coded as 2 because detection level was assumed even in the absence of any detected residues. Residues for Florida citrus also given 2 because an assumption was the limiting factor (even though other subcomponents of the data were of a higher quality than a 2).

- The data source for "food in diet" was simply undocumented.

- Duration of exposure was given a 3 because, although it was a worst-case assumption, it was based on USDA opinion.

- For drift, aerial applicators, noncitrus applicators and farmworkers, there was no mention of absorption and duration. The text simply said that there "could be exposure." Therefore, duration and absorption were coded as 0, with exposure getting a 1.

- Assumed that there could be aerial application for Arizona citrus even though no mention, because the text does not say that there is no citrus rust mite in Arizona (only citrus pest for which aerial application was used).

Amitraz

o Amitraz was exceptionally well-documented. The only note was that a 2 was assigned to absorption of the chemical, even though the position document mentioned a study on toxicological properties, because there was no documentation of how absorption rates were obtained.

2,4,5-T

o For toxicity, when studies only had preliminary results, they were assigned a 1. Position document 1 was used to code toxicity.

o For the percent of crop treated under dietary exposure, a 2 was coded, because EPA appeared to assume that all milk and meat had 2,4,5-T residues.

o Even though there appeared to be expert opinion on the amount of inhalation exposure to range and handsprayers, a 2 was coded because the expert appeared to have no basis for his statement. It appeared that his statement was an assumption.

o The amount of dermal exposure to range and handsprayers was given a 1 because, although Dow Chemical provided data, the data was not used by EPA and was difficult to interpret.

o The researcher was less confident of the risk data for 2,4,5-T than for other pesticides. Much of the data had to be obtained from position document 1 instead of the PD 2/3.

Pronamide

o Toxicity received a 3 due to one study and suggestive evidence (on nitrosamines).

Endrin

o Potential exposure to nontarget populations was assigned a 0 in spite of a reference to "environmental effects," because the reference was not specific enough to use as data.

o For Endrin use on bird perches and tree paint, exposure to bystanders was coded under exposure via drift.

DBCP

- Mixer and loader risk was often included in ground applicator exposure.
- Food residues for alfalfa reported for secondary products in the food chain (meat, milk, eggs).
- Reproductive effects risk analysis for some uses reported as margins-of-safety for individuals consuming quantities of residues, rather than as numbers of reproductive effects per 1000 population.
- Although quantitative risk analyses were obtained for many exposed groups and uses, there was no mention anywhere of the information used to determine the degree of absorption of inhaled pesticide. Therefore, zeroes were coded.
- For exposure from spill cleanup under the "other berries" use, the quantitative risk analysis may have only pertained to raspberries.

Dimethoate

- Mixer and loader risk was either determined for aerial spray mixers and loaders, or else was included in ground applicator exposure.
- The risk analysis for reproductive effects on consumers was coded as 3 because the margin-of-safety for individual consumers was quantified even though the number of adverse reproductive effects per 1,000 population was not.
- For alfalfa, food residues in secondary products (meat, milk, eggs) were reported.
- For lettuce ground applicator duration of dermal exposure, the separate benefits analysis was used to determine the quality of information. It appeared that EPA used an expert opinion on the number of lettuce ground applicators to estimate duration.

Silvex

- Risk information very sketchy in general.
- For dietary exposure in rice ("food in diet" variable), there was no indication of the source of the data, so the quality of information could not be measured.

Another general rule was that if a variable relevant to pesticide use was mentioned qualitatively, but without regard to a specific use of the pesticide, then a zero was coded for that use. This cut down on attempts to distinguish between the quality of qualitative data -- the measurement scale became cruder, but actual measurement became less crude. It was reasonable to code a zero because information without reference to use was of little or no help to EPA in decision making.

The rest of the measurement scale was more straightforward. The difficulty came in two major areas:

1) Finding EPA's data sources in the position documents.

2) Interpreting the quality of information when there was more than one component to a particular variable. For example, "duration of exposure" sometimes consisted of data on acres treated, time needed to spray one acre, and number of applicators. The rule in cases such as this was to use the "limiting factor" for coding; that is, to code the lowest-quality piece of information for "duration of exposure."

General comments on benefits coding. Benefits coding was easier because it was more familiar, but also because there tended to be better documentation of information sources. For each pesticide except Chlorobenzilate and Silvex, there was a benefits analysis which supplemented the Position Document 2/3. The additional documents provided a good deal of information that otherwise would not have been obtained.

The same basic rules used in the risk coding were applied to the benefits coding. There was one small variation in the "limiting factor" rule: if EPA obtained a number for a benefits variable, the researcher coded the quality of that number, even if it only represented those states or regions responding to a USDA/EPA survey. This decision was made because EPA generally reported the number as representative of the nation in Position Document 2/3, and because generally the number represented most of the product treated with the pesticide.

Before ending the discussion of dependent variable coding, it should be mentioned that the initial coding included all of the risk and benefits variables for each regulatory alternative considered by EPA. Since there were as many as seven alternatives for each use of a pesticide, this added several thousands of pieces of data to the initial coding. The idea had been to determine variations in the quality of information between regulatory options, but the data were terrible and often nonexistent. It did not appear that such an analysis would be meaningful, so the data were not checked in the secondary stages of coding.

MANIPULATING DATA FOR COMPARISON BETWEEN PESTICIDES

Testing Johnson's hypothesis that greater risk resulted in better information required ranking the pesticides (as opposed to their uses) according to the EPA's definition of risk and then comparing the quality of information between pesticides. The first task was certainly easier than the second.

The ranking according to risk was described earlier in this chapter. But how was the information on dependent variables put into a form that would be comparable between pesticides? The only answer was to average the data across uses for each risk and benefit variable to come up with one number per pesticide per dependent variable.

There were several problems with this approach. First, the number of uses varied from 28 (Dimethoate) to 2 (Amitraz). This meant that for Amitraz, the quality of information for one use carried far more weight than it did for Dimethoate. It is also possible that EPA had a far more manageable task in Amitraz than it did in Dimethoate, so it was able to obtain better information.

A second problem was that a few of the risk variables varied between pesticides. For example, Endrin was the only pesticide for which data on risk to nontarget organisms, wildlife and endangered species were obtained. The Dimethoate, Pronamide, Amitraz, Silvex and 2,4,5-T documents measured risk to two or more different types of ground applicators, and there was no way to know whether to compare handsprayers, tractor applicators, boom applicators, compressed air applicators. DBCP application did not even involve spraying. The decision was made to leave ground applicators out of the analysis of quality of information between pesticides.

A third general problem was that there was probably less consistency between pesticides than within each pesticide.

In short, more confidence should be placed in the results of the analysis of quality of information within a pesticide.

MEASURING CORRELATION BETWEEN DEPENDENT AND EXPLANATORY VARIABLES

For each pesticide, correlations were measured between four of the explanatory variables and the quality of each "bit" of risk and benefit information for each use of the pesticide. As a result, each pesticide has as many potential correlations as there were dependent variables for each of the four explanatory variables (value of pesticide use to manufacturers, percent of crop treated, annual per acre user losses from pesticide cancellation and annual total user losses from pesticide cancellation.

For the fifth explanatory variable, EPA's pesticide risk ranking, the correlation between the variable and the quality of each "bit" of risk and benefit information for each pesticide was measured. As a result, there were only as many correlations as there were dependent variables.

Why were the four "interest group" explanatory variables correlated with the quality of risk and benefit information for pesticide uses? There were several reasons for attempting to explain variation in the quality of information between uses of a single pesticide. First, it is a matter of control over the research setting. Variation between pesticides could be explained by a wide variety of variables, such as different levels of resources, different researchers, different costs of information, and, of course, different levels of interest group pressure. But within a single pesticide, most of those variables do not vary. Thus, there are fewer non-hypothesized reasons for variation in the quality of information between uses of a pesticide. In short, the research setting is more controlled.

Another reason for examining variation between uses rather than between pesticides is that there are some major difficulties in measuring dependent variables (quality of information) for a pesticide. These problems were discussed earlier in reference to the EPA's pesticide risk ranking explanatory variable. In general, the average quality of information across all uses of a pesticide may not accurately reflect the overall quality of information for the pesticide.

Finally, examining variation between uses of a pesticide is interesting from a research perspective. Interest group incentives vary at least as widely between uses as between pesticides. But constraints on decision-making presumably do not. As a result the research question becomes one of how EPA and interest groups allocate their scarce information resources between pesticide uses within the particular regulatory environment that is characteristic of an individual pesticide.

There are two widely-accepted statistics used to measure correlation between explanatory and dependent variables when one variable is measured cardinally and the other ordinally.

The first statistic to measure the relationship between an explanatory and a dependent variable is called multiserial correlation. This statistic assumes that one variable is measured ordinally and the other on an interval scale. It also assumes that the ordinal scale variables (in this research, the quality of information variables) would approximate a normal distribution if they could be measured more precisely on an interval scale and that there is a linear relationship between the explanatory and dependent variables. Basically, multiserial correlation accurately transforms the ordinal scale into an interval scale if the ordinal scale variables are normally distributed. Once this is done, an adapted version of "Pearson's r" is calculated to show the degree of correlation.

Goodman and Kruskal's coefficient of ordinal association (called the "gamma coefficient") can be used either when both variables are measured ordinally or when one is measured cardinally and the other ordinally. The gamma coefficient was chosen for this research for several reasons. First, the explanatory variables were measured crudely, and actually ordinally when the EPA described them qualitatively. Given that, it would probably be risky to consider them as being measured cardinally (which would be a requirement of multiserial correlation). Second, there is no reason to believe that the data for each dependent variable would approximate the normal distribution needed for accurate measures of correlation using multiserial correlation. The quality of information for a particular impact of pesticide use tended to be incremetal between uses of a pesticide (and thus, fairly constant), so there was not always a clustering of data points towards the center of the scale.

A third reason for choosing gamma is that the measure of correlation was intended to serve as a guide to the nature of the relationships between the quality of information and the various explanatory variables. Gamma serves that purpose; multiserial correlation provides a more precise measure that may not be justified by the data. Fourth, when testing Edwin Johnson's statement that risk drives the risk-benefit analysis, the explanatory variable ("risk of pesticide") and dependent variables were measured ordinally, so multiserial correlation could not be used. The use of gamma to measure the other hypotheses provided consistency in the research. In short, use of the more complex and precise multiserial correlation probably could not have been defended because of the quality of the data collected for explanatory and dependent variables.

A programmable calculator was used to calcuate the gamma coefficients in this research. The data for dependent and explanatory variables were entered by hand, and each gamma coefficient was checked at least once (at least three times if the first and second answers did not agree). To calculate gamma, pesticide uses were ranked from highest value to lowest value of a particular explanatory variable.

The formula to calculate the gamma coefficient is: (number of agreements in direction of changes for explanatory and dependent variables - number of inversions) ÷ (number of agreements + number of inversions). Gamma can range from -1.0 to +1.0; if there is no variation in the dependent variables, gamma is indeterminant and cannot be calculated. Examples of gamma coefficient calculations to explain variation between *uses* of a pesticide and to explain variation between *pesticides* can be found in Tables 4.22 and 4.23.

Once all of the gammas were calculated, they had to be evaluated. In general, non-zero gammas of less than .250 and greater than -.250 were considered to show very weak correlations, given the quality of the data. Tables in Chapters 5 and 6 show the frequencies of gammas with different values for each dependent variable. For the four variables explaining variation in the quality of information between pesticide *uses*, the tables also show the number of pesticides with primarily positive and negative gammas for risk and benefit categories. These summaries of the vast number of gammas calculated will serve as the basis for the evaluation and interpretation of the results.

SUMMARY

The methodology described in this chapter is complicated, not because of complex statistical techniques, but because of the amount of data, the measurement difficulties and the shortage of similar methodologies in previous research. What follows is a brief summary of the methodology used in this research.

Table 4.22 Calculation of Gamma Coefficient for Chlorobenzilate: Value of Pesticide Use to Manufacturers and Consumer Risk of Oncogenicity

Use	Value of Use to Manufacturers	Consumer Risk - Oncogenicity
Florida Citrus	$3,220,000	2
Texas Citrus	$406,000	3
Cotton	$212,550	not applicable
California Citrus	$30,000	3
Arizona Citrus	$24,000	3
Other	$100*	not applicable
Fruits and Nuts	?	3

* Value assigned for "little use"

Number of decreases in consumer risk of oncogenicity as value of use decreases: 0

Number of increases in consumer risk of oncogenicity as value of use decreases: 3

$$\text{Gamma} = \frac{0-3}{0+3} = \frac{-3}{3} = -1$$

Table 4.23 Calculation of Gamma Coefficient for EPA's Pesticide Risk Ranking and Consumer Risk of Oncogenicity

Pesticide	EPA Risk Ranking	Consumer Risk - Oncogenicity
Endrin	21	not applicable
Chlorobenzilate	13	2.8
DBCP	13	3.0
Dimethoate	12	1.0
Silvex	7	0.8
2,4,5-T	7	1.0
Amitraz	7	3.0
Pronamide	6	2.7

Number of decreases in consumer risk of oncogenicity as EPA risk ranking decreases: 10

Number of increases in consumer risk of oncogenicity as EPA risk ranking increases: 5

$$\text{Gamma} = \frac{10-5}{10+5} = \frac{5}{15} = .33$$

Explanatory variables were defined to reflect the incentives of interest groups to involve themselves in the political process. Four of the variables were measured for each use of each pesticide, using EPA's Position Document 2/3s. The fifth variable, "EPA's Risk Ranking", was measured for each pesticide with EPA data.

The dependent variables reflected the quality of EPA's information on risks and benefits for each use of each pesticide. Measurement scales were devised by reading EPA's position documents and benefits analyses, and values were then assigned to the variables.

Correlations between the explanatory variables and the dependent variables were measured by Goodman and Kruskal's coefficient of ordinal association ("gamma"). In order to make the dependent variables comparable with EPA's pesticide risk ranking which was only obtained for each pesticide, the quality of information was averaged across all uses of each pesticide. Thus, one gamma was calculated for each dependent variable. For the other four explanatory variables, gammas were calculated for each dependent variable and each pesticide, as correlation between explanatory variables and the quality of information for uses of a pesticide were estimated.

CHAPTER 5

RESULTS: QUALITY OF INFORMATION ON RISK OF PESTICIDE USE

INTRODUCTION

There are three main objectives of Chapter 5. First, there are some general comments and qualitative examples of EPA's risk assessment process. Second, the quality of EPA's risk information is summarized. And finally, the relationships between the explanatory variables, as measured, and the quality of EPA's risk information are summarized.

OVERVIEW OF EPA'S RISK ASSESSMENT PROCESS

EPA's risk assessments tend to be incremental in nature from one pesticide to another (although not to the same extent as the benefits assessments, due to differences in risk between pesticides). As a result, there are some general trends in the risk assessment process.

First, it is important to point out that EPA has a definite stake in protecting the findings of its preliminary risk analysis. The preliminary risk analysis initiates the RPAR process and often serves as the basis for the final risk assessment contained in Position Document 2/3. If the preliminary analysis is not correct in its projection of "unacceptable risk," then why was so much time (often two years or more at the rebuttal stage of the process) and money invested in studying the pesticide? Perhaps this accounts for the apparent antagonistic relationship between EPA and the registrants and EPA's own defensiveness, which are evident even on the pages of the public documents resulting from the RPAR process.

However, EPA's commitment to its preliminary risk analysis does not extend to doing in-house toxicity and exposure studies, at least for the eight case-study pesticides. No doubt this is due to a lack of appropriated funds, but it means that EPA has to rely on data from outside groups. When registrants submit exposure or toxicity data that would lower EPA's risk calculations, it does not seem to be greeted by EPA with the same enthusiasm as data that increases the risk calculations or benefits data from users. For example, when Dow Chemical Company provided information on applicator exposure to the herbicide 2,4,5-T during forestry applications, EPA supposedly used the information to revise its risk analysis. However, no evidence of revision could be found in the public documents. One of EPA's reservations in using the data was that the forestry use was not being considered in the 2,4,5-T RPAR, so extrapolation of the exposure data across uses would have to occur. However, EPA often uses exposure data from other pesticides, as well as other uses, in its risk analysis. The 2,4,5-T risk analysis was no exception. It may be relevant to point out that the 2,4,5-T RPAR was the most hotly contested of the eight case-study chemicals.

What about data from the groups which bear the risk? Risk-bearing groups are, in general, very diffuse, uninformed and unorganized. Information on exposure and toxicity of pesticides is very costly to obtain (often because such information has not yet been compiled). In addition, risk-bearing groups often contain large numbers of geographically-dispersed members, which results in high organization costs. The theories of Stigler and Peltzman would predict that these groups would gain little (or lose a lot) in the decision-making process due to their inability to impact regulators. However, as van Ravenswaay (1982) points out, these groups' political costs may be subsidized by "political entrepreneurs," (see also Wilson (1980)) who are able to influence decision-making. In the RPAR process, the two major political entrepreneurs for risk-bearing groups appear to be the Environmental Defense Fund (EDF) and the EPA itself. Part of the EPA's activism is built into the process -- since a determination of risk is needed to initiate the RPAR process, EPA has a stake in defending its risk findings. And while the environmental groups such as EDF are not highly visible during all regulatory activities for all pesticides, they may very well reserve their own limited resources for controversial, high-risk pesticides -- the very pesticides which they should have the most success in affecting regulatory outcomes.

Another characteristic of EPA's risk assessment process is the need to bound the problem and develop standard operating procedures in order to cope with the potentially infinite information requirements of pesticide regulation. van Ravenswaay and Hull (1981) describe many of EPA's standard operating procedures when they discuss strategies for meeting information requirements in food safety regulation. In estimating risk, EPA usually determines toxicity of a chemical from high-dosage animal tests rather than human studies. Margins of safety are used when extrapolating animal tests to humans, in case humans are more sensitive to a chemical than the test animals. Exposure to different groups of humans is estimated by using the same sources all of the time -- Food and Drug Administration "Market Basket Surveys" for pesticide residues in food, a small group of studies on applicator exposure (often data from other pesticides are used), data from registrants and user groups, and assumptions on exposure. Extrapolation of risk from high doses given to test animals to relatively low doses experienced by humans is accomplished by using mathematical models of dose-response. In all of the case studies for this research, EPA uses the model which usually results in the highest prediction of risk. The "one-hit" model assumes that very minimal doses of a chemical present some risk of chronic illness.

It is difficult to estimate the direction of the bias of these strategies on risk estimates. Risk estimation is characterized by such uncertainty that it is impossible to know whether EPA's estimates are high or low. EPA's inclination is definitely toward erring on the side of safety, but what if humans are much more sensitive to a chemical than animals? What if exposure estimates are too low? What about more sensitive members of the population or people with above-average exposure? It is conceivable that a risk estimate is too low even with EPA's bias toward safety.

Along with simplifying the information search, EPA also reduces or "bounds" problems, as suggested by Edmunds (1980). Problems are reduced by excluding certain impacts from consideration -- EPA excludes the impacts of pesticide use on chemical manufacturing workers (who are supposedly covered under the Occupational Safety and Hazard Act), exposure to other chemicals which may enhance or lower the impacts of the pesticide in question, certain relationships in the ecosystem, and other risk variables. All of this represents an effort by EPA to make the problem of pesticide regulation comprehensible and manageable. However, as will be pointed out in the next section, EPA's existing risk information still leaves a lot to be desired.

The internal structure of EPA's Office of Pesticide Programs (OPP) also reveals a lot about which impacts are included in risk-benefit analysis and which are not. The Hazard Evaluation Division within OPP, largely responsible for the risk assessment, is composed of a Toxicology Branch, an Environmental Fate Branch, a Residue Chemistry Branch and an Ecological Effects Branch. Figure 5.1 shows what is ideally accounted for by each branch, but in reality many impacts of pesticide use are excluded.

QUALITY OF EPA'S RISK INFORMATION

Table 5.1 summarizes the quality of more than 5,500 EPA risk data, as measured by the researcher. In addition to the data summarized, there are many other risk characteristics that EPA did not attempt to measure for any of the eight pesticides, as pointed out in Chapters 3 and 4.

Table 5.1 does not show high-quality information underlying EPA's risk assessments. In the three major measurement categories, EPA ignores risk variables in the great majority of cases. For the dietary exposure category, where 76.812 percent of the variables were not even mentioned, most of the zero scores resulted from EPA's failure to acknowledge dietary exposure as an additional residue source for ground applicators, mixers and loaders, pilots, ground crews, farmworkers, and persons exposed to spills or drift. But in the second and third categories, the zero scores resulted from EPA's failure to mention aspects of dermal and inhalation exposure and risk to various groups.

The minor categories do not vary much from the three major ones. Most of the measures are congregated around the zero and one scores.

Another tendency reflected in Table 5.1 is EPA's avoidance of quantitative range estimates, even for the risk measures. When quantitative estimates were made, they were

Component	HED Branch
Background	
Chemical and physical properties	Residue Chemistry
Environmental fate and persistence	Environmental Fate
Human exposure analysis	
Dermal	Environmental Fate
Respiratory	Environmental Fate
Dietary (food and water)	Residue Chemistry
Inhalation, penetration and absorption rates	Toxicology
Human health risk	
Cancer	CAG,* Toxicology
Acute toxicity	Toxicology
Other chronic toxicity	Toxicology
Ecological hazard	Ecological Effects

*Not a branch of HED.

Source: Environmental Studies Board Committee on Prototype Explicit Analyses for Pesticides, Regulating Pesticides (Washington, D.C.: National Research Council, 1980), p. 38.

Figure 5.1 Components of Pesticide Risk Assessment and Principal Organizational Responsibilities in the Office of Pesticide Programs

Table 5.1 Quality of Risk Information

Variables Measured	Measurement Scale	Meaning of Measure	Frequency	Percent of Total
-Dietary Exposure (Residues, Food in Diet, Percent Crop Treated)	5	quantitative, point	106	6.679%
	4	quantitative, range	0	0%
	3	expert opinion	94	5.923%
	2	assumption	134	8.444%
	1	qualitative	34	2.142%
	0	ignored	1219	76.812%
-Dermal & Inhalation Exposure (Amount, Absorption, Duration)	7	study of pesticide, point	88	3.039%
	6	study of pesticide, range	4	.138%
	5	study of similar situation, point	130	4.489%
-Residues & Amount of Food Consumed for Acute Toxicity to Wildlife	4	study of similar situation, range	4	.138%
	3	expert opinion	187	6.457%
	2	assumption	273	9.427%
-Potential Exposure for Nontarget Organisms	1	qualitative	201	6.941%
	0	ignored	2009	69.372%
-Risk (Consumers, Ground Applicators, Mixers & Loaders, Ground Crews, Drift, Spills, Pilots, Farmworkers, Wildlife, Nontarget Organisms, Endangered Species)	3	quantitative, point	172	14.576%
	2	quantitative, range	12	1.017%
	1	qualitative	429	36.356%
	0	ignored	567	48.051%
-LD_{50} (Wildlife, Nontarget Organisms, Endangered Species)	3	LD_{50}, species	3	11.538%
	2	LD_{50}, similar species	3	11.538%
	1	assumed	0	0%
	0	ignored	20	76.923%

Variables Measured	Measurement Scale	Meaning of Measure	Frequency	Percent of Total
-Risk of Alternative Pest Control Method	2	quantitative	0	0%
	1	qualitative	42	55.263%
	0	ignored	34	44.737%
-Likelihood of Exposure for Nontarget Organisms	8	study of pesticide, point	0	0%
	7	study of pesticide, range	2	12.500%
-Concentration of Residues for Endangered Species	6	similar situation, point	0	0%
	5	similar situation, range	0	0%
	4	theoretical model	1	6.250%
	3	expert opinion	0	0%
	2	assumed	0	0%
	1	qualitative	7	43.750%
	0	ignored	6	37.500%

almost always point estimates. This does not necessarily reflect greater precision in EPA's estimates and supporting data -- it could possibly reflect pressure from within and without the agency to come up with definite numbers to aid or justify decisions.

In general, it can be said that EPA's risk data for the eight case-study pesticides were not complete, and when present, not usually a result of quantitative studies of the pesticide. Instead, measurements tended to be based on expert opinions, assumptions, or studies of other chemicals.

CORRELATION BETWEEN EXPLANATORY VARIABLES AND QUALITY OF RISK INFORMATION VARIABLES

This portion of the Chapter examines the extent of correlation, as measured by gamma (G), between the hypothesized explanatory variables and the quality of information used by EPA to assess the risk of the 86 uses of the 8 pesticides. One of two results was found for each potential gamma. If there was no variation in the quality of risk information for all of a pesticide's uses that could be measured for a particular explanatory variable, then there was no G -- by definition, it was undefined. Otherwise, a G in the range of -1 to +1 was found.

Explanation of Tables. Although it would facilitate the analysis of the research findings, it would be misleading to use a single number to summarize all of these correlations. Instead, Tables 5.3 through 5.7 were devised from Tables 1 through 44 in Appendix B to summarize for each explanatory variable:

- o the numbers and values of gamma coefficients that could be calculated for exposure and risk, within each of nine risk categories.
- o when gamma coefficients could not be calculated (i.e., when there was no variation in the quality of risk data between uses of a pesticide), the quality of risk information for exposure and risk, within each of the nine risk categories.
- o the total possible numbers of gamma coefficients for risk and exposure, within each of the nine risk categories.
- o the number of pesticides for which one or more gamma coefficients could be calculated, for each of the nine risk categories. Unless otherwise noted, the number is the total out of a possible eight pesticides.
- o for each of the nine risk categories, the number of pesticides with primarily positive gammas, primarily negative gammas, and equal numbers of positive and negative gammas.

The nine risk categories are consumers, ground applicators, mixers and loaders, pilots, persons exposed to drift, farmworkers, persons exposed to spills, aerial ground crews and animals. Exposure refers to dietary exposure for consumers; dermal, inhalation and dietary exposure for the seven other human risk categories; and animal exposure. Risk refers to oncogenic, mutagenic, and fetotoxic and reproductive risk to humans, and animal risk.

In describing the values of the gammas that could be calculated, the following measurement scale was devised:

-1 to .-750

-.749 to -.500

-.499 to -.250

-.249 to 0

.001 to .250

.251 to .500

.501 to .750

.751 to 1

This particular measurement scale was chosen in part because the researcher felt that gammas between the values of -.249 and +.250 could not be considered strongly positive or negative, given the limitations in measuring explanatory and dependent variables. Tables 5.3 through 5.7 show the frequency of gamma values for exposure and risk within each of the nine risk categories.

Gammas that could not be calculated were designated with a "--". Since this reflects no variation in the quality of information between uses of a pesticide, the number in parentheses shows the quality of information for all uses of a pesticide that can be measured for the particular explanatory variable. When a "--(x)" is left blank for a risk category (as opposed to showing a zero), the number in the parentheses is not included in the measurement scale for those particular risk or exposure variables. In addition, "--(?)" means that the quality of information for at least half of the uses of the pesticide could not be determined.

The "total possible G" line in each table is the sum of the gammas that could be calculated and those that could not be calculated. It is useful because it shows how often (or perhaps, how seldom) there was variation in the quality of information between uses so that gammas could actually be calculated.

The lower half of each table reflects the number of pesticides that showed positive, negative or ambiguous relationships between the explanatory variable and the quality of information for each of the nine risk categories. This was determined by simply summing the positive and negative gammas and comparing the two sums. These figures show whether a large number of positive gammas in a risk category reflect many positive gammas for one pesticide, or a positive trend for several pesticides. It is the positive trend for several pesticides that will reflect the kind of correlation that was hypothesized between the explanatory variable and the quality of information for a particular risk category.

In the body of the table, the numbers in parentheses denote the frequency of "lower range" gammas in each of the eight ranges for the value of gamma. Lower range and upper range gammas occur because for some pesticides, the uses could only be measured in ranges for the explanatory variables. Using the high point of the range to rank uses within a pesticide according to one of the explanatory variables led to different values for gamma than if the low point of the range was used. Therefore, "lower range" and "upper range" gammas must be reported.

Table 5.2 is also useful in interpreting the results found in Tables 5.3 through 5.6. This table shows the total number of uses of each pesticide, and the number of uses that can be measured for each of four explanatory variables. Gammas based on very few uses of a pesticide are not as reliable as gammas based on most uses. For example, for the "value of use to manufacturer" variable only 3 of 11 uses of Endrin could be measured. Therefore, all gammas measuring the correlations between the value of Endrin uses to manufacturers and the quality of Endrin risk/benefit information are based on only three uses of the pesticide. On the other hand, 17 of 18 DBCP uses could be measured according to value of uses to manufacturers. Presumably, the DBCP gammas would be more reliable than the Endrin gammas.

Findings for Value of Pesticide Use to Manufacturers. The explanatory variable "value of a pesticide use to manufacturer" is intended to proxy the likelihood of manufacturers to become vigorously involved in the information-gathering phase of the regulatory process. Pesticide manufacturers seem to fit the Stigler/Peltzman mold for a group that can impact the regulatory process. There are generally

Table 5.2 Number of Uses Measured for Each Pesticide According to Explanatory Variables

Pesticide	Number of Uses Evaluated by EPA	Number of Uses Measured According to: Value of Use to Manufacturers	Percent of Crop Treated	Per Acre User Losses from Pesticide Cancellation	Total User Losses from Pesticide Can.
DBCP	18	17	15	18	17
Dimethoate	28	24	20	27	24
Endrin[2]	11	3	10	7	7
Pronamide[1]	10	10[1]	9[1]	5	6
Chlorobenzilate	7	6	7	6	5
Silvex	7	2	5	6	6
2, 4, 5-T	3	3	2	3	2
Amitraz	2	2	2	2	2
Total Uses Measurable	86	67	70	74	69

1 The pesticide Pronamide has 10 uses, 5 of which are uses on lettuce which vary only by geography. In measuring "value of use to manufacturer" and "percent of crop treated," all 5 lettuce uses were grouped together as one. When counting the number of uses of Pronamide measured according to those two variables, the researcher counted all 5 lettuce uses, even though they were collapsed into one use.

2 The pesticide Endrin has 11 uses. However, for benefit purposes, EPA sometimes split the "small grains" use into minor pests and major pests. For the purposes of determining how many uses were evaluated for each explanatory variable, the researcher counted the two "sub-uses" for small grains as one use.

Table 5.3 Summary of Correlations between Quality of Risk Data and Value of Pesticide Use to Manufacturer

Number of Gamma (Numbers in parentheses denote lower range figures)

Value of G	Consumers Exposure	Consumers Risk	Ground Applicators Exposure	Ground Applicators Risk	Mixers and Loaders Exposure	Mixers and Loaders Risk	Pilots Exposure	Pilots Risk	Persons Exposed to Drift Exposure	Persons Exposed to Drift Risk	Farmworkers Exposure	Farmworkers Risk	Persons Exposed to Spills Exposure	Persons Exposed to Spills Risk	Aerial Ground Crews Exposure	Aerial Ground Crews Risk	Animals Exposure	Animals Risk
-1 to -.750	2	3	0	0	1	1	4	1	2	1	0	0	1	1	0	0	3	2
-.749 to -.500	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-.499 to -.250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-.249 to 0	0	0	13	0	0	0	0	0	0	0	3	0	0	0	0	0	1	0
.001 to .250	1	0	9	6	7	3	0	0	0	0	0	0	0	0	0	0	0	0
.251 to .500	0	0	8	3	0	0	9	3	2	2	0	0	0	0	9	3	0	0
.501 to .750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
.751 to 1	1	1	25	7	11	3	0	0	8	2	0	0	0	0	7	2	3	1
Subtotal	4	4	56	16	19	7	13	4	12	5	3	0	1	1	16	5	7	3
— (7)			1		2		0		0		2 (1)		0		0		0	
— (6)			0		0		0		0		0 (0)		0		0		0	
— (5)	4		1		1		2		1		1 (1)		0		0		0	
— (4)	0		0		0		0		0		0 (0)		0		0		0	
— (3)	1	3	2	1	0	1	0	1	0	0	2 (2)	1 (0)	0	1	0	0	1	0
— (2)	4	0	4	0	7	0	4	0	1	0	2 (2)	0 (0)	3	0	0	0	0	0
— (1)	5	7	0	1	0	1	4	2	2	3	3 (4)	7 (8)	0	1	0	0	0	0
— (0)	1	0	26	2	44	6	31	4	46	4	59 (59)	6 (6)	67	11	37	6	0	0
— (?)	5	0	9	0	8	0	0	0	1	0	0 (0)	0 (0)	1	0	1	0	0	0
Subtotal	20	10	43	4	62	8	41	7	51	7	69	14	71	13	38	6	1	0
Total Possible G	24	14	99	20	72	14	54	11	63	12	72	14	72	14	54	11	8	3

Number of Pesticides

	Consumers	Ground Applicators	Mixers and Loaders	Pilots	Persons Exposed to Drift	Farmworkers	Persons Exposed to Spills	Aerial Ground Crews	Animals
for which G could be calculated for exposure and/or risk	5	6	4	2 (of a possible 6)	3 (of a possible 7)	1	1	2 (of a possible 6)	1 (of a possible 1)
with primarily positive G's	3	6	3	1	2	0	0	2	0
with primarily negative G's	2	0	1	1	1	0	1	0	1
with equal numbers of positive and negative G's	0	0	0	0	0	1	0	0	0

Table 5.4 Summary of Correlations between Quality of Risk Data and Percent of Crop Treated

Number of Gamma (Numbers in parentheses denote lower range figures)

Value of G	Consumers Exposure	Consumers Risk	Ground Applicators Exposure	Ground Applicators Risk	Mixers and Loaders Exposure	Mixers and Loaders Risk	Pilots Exposure	Pilots Risk	Persons Exposed to Drift Exposure	Persons Exposed to Drift Risk	Farmworkers Exposure	Farmworkers Risk	Persons Exposed to Spills Exposure	Persons Exposed to Spills Risk	Aerial Ground Crews Exposure	Aerial Ground Crews Risk	Animals Exposure	Animals Risk
-1 to -.750	0 (0)	2	25 (24)	5	10	1	0	0	0	0	3	1	0	0	0	0	0	0
-.749 to -.500	1 (1)	0	0 (0)	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1
-.499 to -.250	0 (0)	0	4 (4)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
-.249 to 0	3 (4)	1	16 (16)	6	7	3	9	3	0	0	0	0	0	0	9	3	3	1
.001 to .250	0 (0)	0	4 (4)	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
.251 to .500	1 (1)	1	0 (0)	0	1	1	2	0	1	0	0	0	1	1	0	0	2	1
.501 to .750	0 (0)	0	0 (0)	0	0	0	2	1	1	1	0	0	1	0	0	0	0	0
.751 to 1	3 (2)	0	9 (10)	5	1	1	2	0	3	2	4	2	0	0	0	0	0	0
Subtotal	8	4	58	18	19	7	15	4	5	3	7	3	2	1	9	3	8	3
— (7)			1		2		0		0		2 (1)		0		0		0	
— (6)			0		0		0		0		0 (0)		0		0		0	
— (5)	4 (3)		1		1		2		3		1 (1)		0		2		0	
— (4)	0 (0)		0		0		0		0		0 (0)		0		0		0	
— (3)	1 (1)	3	2	1	0	1	0	1	0	0	2 (2)	1 (0)	0	1	0	0	0	0
— (2)	4 (4)	0	4	0	7	0	4	0	3	0	2 (2)	0 (0)	3	0	2	0	0	0
— (1)	2 (2)	7	0	1	0	1	2	2	5	5	3 (4)	7 (8)	0	1	3	2	0	0
— (0)	1 (1)	0	24	0	44	6	31	4	46	4	55 (55)	3 (3)	66	11	37	6	0	0
— (?)	4 (5)	0	9	0	8	0	0	0	1	0	0 (0)	0 (0)	1	0	1	0	0	0
Subtotal	16	10	41	2	62	8	39	7	58	9	65	11	70	13	45	8	0	0
Total Possible G	24	14	99	20	81	15	54	11	63	12	72	14	72	14	54	11	8	3

Number of Pesticides

	Consumers	Ground Applicators	Mixers and Loaders	Pilots	Persons Exposed to Drift	Farmworkers	Persons Exposed to Spills	Aerial Ground Crews	Animals
for which G could be calculated for exposure and/or risk	6	7	4	2 (of a possible 6)	2 (of a possible 7)	3	1	1 (of a possible 6)	1 (of a possible 1)
with primarily positive G's	2	3	2	1	2	2	1	0	0
with primarily negative G's	2	4	2	1	0	1	0	1	1
with equal numbers of positive and negative G's	2	0	0	0	0	0	0	0	0

Table 5.5 Summary of Correlations between Quality of Risk Data and Annual Per Acre User Losses

Number of Gamma (Numbers in parentheses denote lower range figures)

Value of G	Consumers Exposure	Consumers Risk	Ground Applicators Exposure	Ground Applicators Risk	Mixers and Loaders Exposure	Mixers and Loaders Risk	Pilots Exposure	Pilots Risk	Persons Exposed to Drift Exposure	Persons Exposed to Drift Risk	Farmworkers Exposure	Farmworkers Risk	Persons Exposed to Spills Exposure	Persons Exposed to Spills Risk	Aerial Ground Crews Exposure	Aerial Ground Crews Risk	Animals Exposure	Animals Risk
-1 to -.750	0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (2)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
-.749 to -.500	1 (0)	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (1)
-.499 to -.250	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	11 (0)	3 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0)	1 (0)	9 (0)	3 (0)	0 (1)	0 (0)
-.249 to 0	2 (1)	0 (0)	25 (16)	4 (4)	1 (0)	1 (0)	0 (2)	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (1)	0 (1)	0 (0)	0 (0)	2 (1)	1 (0)
.001 to .250	1 (1)	1 (0)	13 (20)	6 (6)	7 (8)	3 (4)	2 (11)	1 (4)	0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (9)	0 (3)	1 (2)	2 (2)
.251 to .500	0 (3)	0 (1)	9 (11)	5 (3)	0 (0)	0 (0)	0 (2)	0 (0)	3 (2)	3 (2)	2 (4)	0 (2)	0 (0)	0 (0)	0 (0)	0 (0)	2 (4)	0 (0)
.501 to .750	0 (0)	0 (0)	0 (0)	0 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (1)	0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3 (0)	0 (0)
.751 to 1	3 (2)	0 (0)	1 (1)	1 (1)	1 (1)	1 (1)	2 (0)	0 (0)	8 (8)	2 (2)	2 (0)	2 (0)	0 (0)	0 (0)	7 (7)	2 (2)	0 (0)	0 (0)
Subtotal	8	3	48	16	9	5	15	4	12	5	7	3	1	1	16	5	8	3
— (7)			1		2		0		0		2 (1)		0		0		0	
— (6)			0		0		0		0		0 (0)		0		0		0	
— (5)	4		5		5		2		1		1 (1)		0		0		0	
— (4)	0		0		0		0		0		0 (0)		0		0		0	
— (3)	1	4	2	2	0	2	0	1	0	0	2 (2)	1 (1)	0	1	0	0	0	0
— (2)	4	0	6	0	9	0	4	0	1	0	2 (2)	0 (0)	3	0	0	0	0	0
— (1)	2	7	2	2	2	2	2	2	2	3	3 (4)	7 (8)	0	1	0	0	0	0
— (0)	1	0	24	0	44	6	31	4	46	4	55 (55)	3 (3)	67	11	37	6	0	0
— (?)	4	0	11	0	10	0	0	0	1	0	0 (0)	0 (0)	1	0	1	0	0	0
Subtotal	16	11	51	4	72	10	39	7	51	7	65	11	71	13	38	6	0	0
Total Possible G	24	14	99	20	81	15	54	12	63	12	72	14	72	14	54	11	8	3

Number of Pesticides

	Consumers	Ground Applicators	Mixers and Loaders	Pilots	Persons Exposed to Drift	Farmworkers	Persons Exposed to Spills	Aerial Ground Crews	Animals
for which G could be calculated for exposure and/or risk	5	6	3	2 (of a possible 6)	3 (of a possible 7)	3	1	2 (of a possible 6)	1 (of a possible 1)
with primarily positive G's	4	5	2	1	3	2	0	1	1
with primarily negative G's	1	0	0	0	0	1	1	0	0
with equal numbers of positive and negative G's	0	1	1	1	0	0	0	1	0

Table 5.6 Summary of Correlations between Quality of Risk Data and Annual Total User Losses

Number of Gamma (Numbers in parentheses denote lower range figures)

Value of G	Consumers Exposure	Consumers Risk	Ground Applicators Exposure	Ground Applicators Risk	Mixers and Loaders Exposure	Mixers and Loaders Risk	Pilots Exposure	Pilots Risk	Persons Exposed to Drift Exposure	Persons Exposed to Drift Risk	Farmworkers Exposure	Farmworkers Risk	Persons Exposed to Spills Exposure	Persons Exposed to Spills Risk	Aerial Ground Crews Exposure	Aerial Ground Crews Risk	Animals Exposure	Animals Risk
-1 to -.750	0	2	0 (0)	0	0	0	0	0	0	0	3	1	0	0	0	0	0 (0)	0
-.749 to -.500	0	0	1 (1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0 (0)	0
-.499 to -.250	0	0	0 (4)	0	0	0	0	0	0	0	0	0	0	0	0	0	0 (0)	0
-.249 to 0	3	0	15 (11)	2	0	0	9	3	0	0	0	0	1	1	9	3	2 (2)	0
.001 to .250	1	0	11 (11)	7	8	4	0	0	1	0	0	0	0	0	0	0	0 (1)	2
.251 to .500	1	1	0 (0)	0	0	0	2	0	0	0	0	0	0	0	0	0	2 (1)	1
.501 to .750	0	0	0 (0)	0	0	0	2	1	1	1	0	0	0	0	0	0	2 (3)	0
.751 to 1	3	0	21 (21)	7	1	1	2	0	3	2	4	2	0	0	0	0	2 (1)	0
Subtotal	8	3	48	16	9	5	15	4	5	3	7	3	1	1	9	3	8	3
— (7)			1		2		0		0		2 (1)		0		0		0	
— (6)			0		0		0		0		0 (0)		0		0		0	
— (5)	4		5		5		2		3		1 (1)		0		2		0	
— (4)	0		0		0		0		0		0 (0)		0		0		0	
— (3)	1	4	2	2	0	2	0	1	0	0	2 (2)	1 (0)	0	1	0	0	0	0
— (2)	4	0	6	0	9	0	4	0	3	0	2 (2)	0 (0)	3	0	2	0	0	0
— (1)	2	7	2	2	2	2	2	2	5	5	3 (4)	7 (8)	0	1	3	2	0	0
— (0)	1	0	24	0	44	6	31	4	46	4	55 (55)	3 (3)	67	11	37	6	0	0
— (?)	4	0	11	0	10	0	0	0	1	0	0 (0)	0 (0)	1	0	1	0	0	0
Subtotal	16	11	51	4	72	10	39	7	58	9	65	11	71	13	45	8	0	0
Total Possible G	24	14	99	20	81	15	54	11	62	12	72	14	72	14	54	11	8	3

Number of Pesticides

	Consumers	Ground Applicators	Mixers and Loaders	Pilots	Persons Exposed to Drift	Farmworkers	Persons Exposed to Spills	Aerial Ground Crews	Animals
for which G could be calculated for exposure and/or risk	5	6	3	2 (of a possible 6)	2 (of a possible 7)	3	1	1 (of a possible 6)	1 (of a possible 1)
with primarily positive G's	4	4	3	1	2	2	0	0	1
with primarily negative G's	1	2	0	1	0	1	0	1	0
with equal numbers of positive and negative G's	0	0	0	0	0	0	1	0	0

few major manufacturers of a pesticide (meaning low organization costs) and the financial stakes can be very high. Stigler and Peltzman have hypothesized that the more the regulated parties have at stake, the more they will affect the regulatory process. In this research, it is hypothesized that manufacturers of a pesticide will improve the quality of information on the benefits and risks of the more valuable uses of that pesticide. Likewise, it is hypothesized that the manufacturers will spend less time and fewer resources in attempts to gather information on risk for less valuable uses of the pesticide.

The results do not, in general, support these hypotheses. For seven of the nine risk categories, a vast majority of the gammas could not be calculated (that is, the quality of information in those categories did not usually vary between uses of the various pesticides). The two risk categories for which a majority of gammas could be calculated, ground applicators and animals, showed two different results.

The ground applicator category showed 25 of 42 positive gammas in the .751 to 1 range, which indicates strong positive correlations. Only 14 gammas were not positive, of which 13 were in the -.249 to 0 range. Furthermore, all six of the pesticides for which one or more gammas could be calculated had primarily positive gammas. Ground applicator risk is the most important risk category in EPA's studies, with the possible exception of consumer risk.

The animal risk category showed mixed results for the one pesticide to which it applied, Endrin. There were equal numbers of strongly negative and strongly positive gammas, and the remaining gamma was in the -.249 to 0 range. As a result, Endrin just barely ended up in the primarily negative group for the animal risk category.

About all that can really be said for the remaining risk categories is that gamma could not usually be calculated. When it could not, the quality of information across all uses of a pesticide was usually zero (i.e., the risk was ignored), except for consumers. This is partly because dietary exposure for all non-consumer human risk categories was usually ignored.

Thus, the hypothesized relationship was not supported by empirical results. Quality of risk data tended not to vary at all, and when it did, the results were ambiguous when compared with the value of pesticide uses to manufacturers. What could cause these results? One potential cause could be that manufacturers do not <u>want</u> to see better information in EPA's risk analyses. Vague or poor information could result in a better regulatory outcome for manufacturers. A second potential explanation is that pesticide manufacturers are unable to impact EPA's risk analyses. This explanation would seem to fly in the face of Peltzman and Stigler's work. A third potential explanation is that the manufacturers allocated their scarce resources towards securing better information on ground applicator risk because EPA spends most of its resources on that risk category. This would make even more sense if the manufacturers perceived that EPA based its decisions on findings of ground applicator risk. The manufacturers may simply feel that they get the most value for their information expenditures by concentrating on the high-risk ground applicator category, and then saving the rest of their resources for improving the quality of benefits information.

Findings for Percent of Crop Treated. The "percent of crop treated" explanatory variable is intended to proxy the number of pesticide users affected by EPA's regulatory actions. It is hypothesized in this research that as a larger number or proportion of users are affected, the quality of risk information will increase as those users impact the regulatory process. Stigler and Peltzman might argue that the organization costs of larger groups might hinder the ability of the groups to affect the process, but it is hypothesized that the presence of political entrepreneurs such as USDA and well-organized user groups eliminates organization costs.

Once again, the results do not seem to support the hypothesis. The only risk categories for which a majority of the total possible gammas could be calculated were ground applicators and animals. When G could not be calculated, the quality of risk information was usually zero for every risk category except consumers (that is, the particular exposure or risk variable was usually ignored by EPA).

The numbers of pesticides with primarily positive, negative or mixed gammas did not suggest a particular relationship between the percent of crop treated and the quality of risk data for any of the nine risk categories.

What could cause these results? Perhaps pesticide users do not necessarily want to improve risk information, especially if better information is perceived as leading to more restrictions on pesticides. Pesticide users may also be ground applicators and the profit motive may overrule any desire to see stronger information and regulations to reduce ground applicator risk. Users certainly have a better handle on benefits information, so they may focus their efforts in that direction, instead of trying to influence risk information. Finally, EPA probably attempts to defend its risk analysis from external information that undermines the findings. This should be more true for risk than for benefit information because USDA has major responsibility for preparing the benefits analysis.

Although the overall results showed no clear trend when G could be calculated, that was not the case for individual pesticides. Some pesticides showed primarily positive Gs for a risk category, others showed primarily negative Gs and still others showed equal numbers of positive and negative Gs. The two pesticides with the most measurable uses for percent of crop treated showed opposite results. The percent of DBCP uses treated was positively correlated with the quality of DBCP risk information for the three risk categories for which DBCP Gs could be calculated. On the other hand, Dimethoate showed negative Gs for the five risk categories for which Gs could be calculated. Apparently, the percent of crop treated influenced risk information within some pesticides, but not others.

But the overwhelming result for this explanatory variable was that there usually was no variation in the quality of risk information between pesticide uses. In general, when there was no variation, the quality of information was zero. Thus, EPA tended to ignore many aspects of risk.

Findings for Annual Per Acre User Losses. The "annual per acre user losses" variable was intended to proxy potential per capita user losses from pesticide cancellation. In accordance with the Stigler and Peltzman theories, it is hypothesized that attempts to influence the regulatory process, and thus the quality of risk information, will increase as per acre user losses increase.

The results, as shown in Table 5.5, are somewhat more positive than for the previous explanatory variables. For all risk categories except persons exposed to spills, there appears to be some relationship between per acre user losses and quality of risk information. One good reason for these results could be that EPA gathers good information to defend the risk of those pesticide uses with higher potential per capita user losses. Greater economic benefits presumably mean fewer restrictions for a pesticide use, unless EPA can show a greater likelihood of risk. Another potential explanation which is more in keeping with Stigler and Peltzman is that pesticide users become more involved in the regulatory process as per capita stakes increase, resulting in better risk information for the uses with higher annual per acre user losses.

But still, in most cases, there was no variation between pesticide uses in the quality of risk information. More often than not, EPA ignored risk variables -- the quality of risk information for pesticide uses that could be measured according to annual per acre user losses was not good.

Findings for Annual Total User Losses. The final explanatory variable to describe variation in the quality of information between uses of a pesticide was "annual total user losses." This variable is intended to measure the potential industry-wide impacts of pesticide cancellation. The hypothesis is that as the aggregate value of a pesticide use to users increases, the quality of risk information will increase as pesticide users or their political entrepreneurs become involved in the regulatory process. It should be noted that there is a difference between per acre and total user losses. It is often the case that a low-volume, low total user losses use of a pesticide has high per acre user impacts. Examining both variables can provide insight into whether EPA and pesticide advocates react more to aggregate or individual economic impacts.

The results in Table 5.6 are similar to the results for annual per acre user losses. Based on numbers of pesticides with primarily positive Gs, there appears to be a positive correlation between annual total user losses and quality of information for six of the nine risk categories, and for the two major categories (consumers and ground applicators). In addition, where there are pesticides with primarily negative Gs, the negative Gs are almost always in the weakly negative -.249 to 0 range.

Again, EPA may seek to obtain better risk information when it knows the risk findings will be balanced against high potential benefits of a pesticide use. Likewise, the pesticide users themselves will encourage better information if they feel that the information will result in findings of lower risk. If the latter explanation is true, it appears that the user groups can overcome any political organization costs in many instances -- this could reflect the presence of political entrepreneurs or already-organized user groups. However, it is possible that organization costs prevented user groups from having an even larger impact on the quality of information; hence, the failure to see more positive Gs.

As for all of the other variables, G could not be calculated in most cases due to no variation between uses in the quality of risk information. When G could not be calculated, the quality of risk information tended to be zero.

Findings For EPA's Risk Ranking. One explanatory variable was used to predict differences in the quality of information between pesticides, as opposed to uses of a pesticide. That variable was the relative risk of each pesticide as measured by EPA's own risk ranking method. The intent of measuring the correlation between the EPA risk ranking and the quality of risk information was to test EPA Office of Pesticide Programs Chief Edwin Johnson's statement that the quality of the agency's risk-benefit analyses is determined by a pesticide's relative risk.

Table 5.7 shows the results for this explanatory variable. There were some difficulties in averaging the quality of risk information across pesticides, mainly because risk categories were not consistent between pesticides. For example, gamma could not even be calculated for the ground applicator risk category, because several of the pesticides had more than one type of ground applications. Supporting tables for Table 5.7 can be found in Appendix B (Tables 37 through 44).

The results were a mixed bag. There were five risk categories showing primarily positive gammas, and two showing primarily negative. Across all risk categories, 25 of 45 positive gammas were in the weakly positive quartile (.001 to .250). Very few gammas could not be calculated (13 of 78 total gammas). Seven of those 13 occurred in toxicity and the risk portion of each risk category because only one pesticide, Dimethoate, was considered to have a risk of mutagenicity -- therefore, there could be no variance in the

Table 5.7 Summary of Correlations between EPA's Risk Ranking and the Average Quality of Risk Information

(Numbers in parentheses denote a second type of mixers and loaders)

Number of Gammas

		Consumers		Pilots		Persons Exposed to Drift		Farmworkers		Aerial Ground Crews		Persons Exposed to Accidents		Mixers & Loaders	
Value of G	Toxicity	Exposure	Risk	Exposure	Risk	Exposure	Risk	Exposure	Risk	Exposure	Risk	Exposure	Risk	Exposure	Risk
-1.0 to -.750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-.749 to -.500	1	0	0	0	0	4	0	0	0	0	0	0	0	1	0
-.499 to -.250	1	1	0	0	0	0	0	0	0	0	0	0	0	3 (2)	0
-.249 to 0	0	1	0	3	0	0	2	0	0	0	0	0	0	2 (3)	1
.001 to .250	0	0	0	6	0	2	0	5	0	8	0	0	0	3	1
.251 to .500	0	1	2	0	2	1	0	2	1	0	2	0	0	0	0
.501 to .750	0	0	0	0	0	0	0	1	0	1	0	2	0	0	0
.751 to 1.0	0	0	0	0	0	0	0	0	1	0	0	2	2	0	0
——	1	0	1	0	1	0	1	0	1	0	1	5	1	0	1
Total Possible G	3	3	3	9	3	7	3	8	3	9	3	9	3	9	3
Primary Sign of Gammas															
positive			x	x	x			x	x	x	x	x	x		
negative		x				x	x							x	
equal number of positive and negative															x

quality of information. The other five that could not be calculated under risk from accidents and spills represented average quality of information of zero across all pesticides.

In short, Johnson's hypothesis is not supported. There could be several reasons for this. One is that he could be just plain wrong. Another could be the method of testing his hypothesis or the data constraints in this research. A third possibility is that EPA does the best it can in obtaining risk information, but it is forced to work under the technological constraints hampering all risk assessments. A final explanation could be that risk does drive EPA's information-gathering process -- within the constraints of interest group pressure, a la Stigler and Peltzman. Johnson may be right about the internal workings of EPA, but he may be less than fully aware of the external constraints on agency operations.

Summary: Correlation Between Explanatory Variables and Quality of Information on Risk. In general, the hypothesized relationships between the explanatory variables and the quality of risk information did not hold up well. In fact, some of the evidence even showed results opposite of what was expected. And in many cases, the information was uniformly bad.

Some of the major reasons why these general results may have occurred include:

- Interest groups, such as pesticide manufacturers and users, may not want better risk information. Therefore, they will not try to influence the information gathering process, other than to try to sabotage it.
- The risk assessment methodology is often more art than science. This could be one cause of the poor risk information.
- The EPA may not have the necessary budget to obtain good data. In general, EPA only receives toxicity data from pesticide manufacturers. Exposure data are EPA's responsibility, and they can be very costly to obtain. Even if manufacturers do provide exposure data, EPA may discount the value of those data.
- Interest groups may prefer to allocate their scarce resources toward improving benefits information, in the hope that better information on a pesticide use's benefits will lead to less stringent regulations. The manufacturers and users may feel that they have a much better chance of making an impact on the benefits side than on the risk side. The results outlined in Chapter 6 would seem to support this hypothesis.

CHAPTER 6

RESULTS: QUALITY OF INFORMATION ON BENEFITS OF PESTICIDE USE

The EPA relies heavily on professionals from USDA, state agencies, and land-grant universities in the preparation of the benefits analysis. This chapter explores the quality of the information contained in the benefits analyses, and provides some insight into the power of different groups to influence the quality of information.

GENERAL OBSERVATIONS ON EPA'S BENEFITS ANALYSES

Various groups provide input via the comment process and other informal mechanisms on the benefits of pesticide use. EPA often uses this input, especially when the groups are pesticide user groups. Several examples can be cited to illustrate this point.

In the case of the pesticide Endrin, the agency stated in position documents that undefended uses of the pesticide were to be canceled -- the apparent assumption was that if a use was undefended, there must be no benefits from that particular use of the pesticide. This, of course, ignores what Peltzman, Stigler and others have worked so hard to point out -- that there are costs of using the political process.

In the case of Chlorobenzilate, a similar attitude was present with the use of the pesticide on citrus fruit in Arizona. Although Arizona citrus growers face similar pest problems and growing conditions as growers in Texas, EPA initially canceled Chlorobenzilate use on Arizona citrus, while retaining its use, with restrictions, in Texas. EPA's reason for the Arizona decision, as reported in position document 2/3, was that there must be no benefits of use since Arizona growers did not respond to a USDA survey on the subject. Upon protest from USDA and the eventual receipt of information from Arizona, EPA reconsidered and decided to allow restricted use of Chlorobenzilate in Arizona. It is possible that EPA was attempting to appease groups opposed to Chlorobenzilate by canceling the "use of least resistance" -- in this case, use by a small group of producers with potentially high costs of articulating preferences to EPA. Only when USDA played the role of political entrepreneur was the use of Chlorobenzilate on Arizona citrus salvaged.

Another example of user impact on the regulatory process involves a small group of users of the nematocide DBCP with high per capita benefits of use and an already-existing political organization called the Pineapple Growers Association of Hawaii (PGAH). PGAH provided information on the risks and benefits of DBCP use on pineapple, which EPA used extensively in its risk-benefit analysis. While many uses of the pesticide were canceled, the use on pineapple was registered with restrictions. Of course, the registration may have been approved for reasons other than PGAH's dialog with EPA. This example not only illustrates the potential influence of a user group on the quality of information in a pesticide risk-benefit analysis, but it is also a fine example of an already-organized interest group with access to the regulatory process.

EPA simplifies its information search by bounding the problem and the variables to be measured (as pointed out in Chapter 3). For example, the economic impacts of pesticide cancellation on pesticide manufacturers are either excluded or only briefly touched upon in EPA's benefits analysis. Total compliance with proposed restrictions is always assumed, and "expert opinions" are heavily relied upon as a source of data. Changes in prices of agricultural products and in related goods, resulting from pesticide regulation, as well as changes in prices of inputs other than the pesticide, are often dismissed.

As with risk analysis strategies, it is difficult to estimate the impact of these strategies on the accuracy of EPA's benefits information. The assumption of total compliance overstates the costs of pesticide regulation, but this may be compensated for by EPA's failure to quantify the effects of price changes. Also, EPA has a tendency to implicitly attribute all potential losses in benefits due to cancellation to pesticide users without acknowledging that consumers and pesticide manufacturers will absorb some of those losses. This overstates the benefits of pesticide use to user groups although it does not result in an overstatement of total benefits.

Again, the internal structure of EPA's Office of Pesticide Programs sheds some light on the impacts included in EPA's Benefits Studies. The Benefits and Field Studies Division of OPP is responsible for the benefits analyses, and contains an Animal Sciences and Index Branch, a Plant Sciences Branch and an Economic Analysis Branch. Figure 6.1 shows what is ideally accounted for by each branch.

THE QUALITY OF EPA'S BENEFITS INFORMATION

Table 6.1 summarizes the quality of information obtained by EPA for its benefits analyses for the eight case study pesticides.

The data for the two major benefits categories measuring changes in pest control costs and value of production were noticeably clustered around the lower end of the quality of information scale. Well over half of the variables were either ignored or only qualitatively mentioned. Another 35.9 percent of the variables were quantified on the basis of assumptions or, in most cases, expert opinions. Only 6.1 percent of the 773 pieces of data were based on some sort of study. It is obvious that EPA does not usually rely on or conduct studies on the benefits of pesticide use.

The prices of goods for which the pesticides are an input were measured on a different scale than the other variables. Prices were ignored more than half of the time,

Component	BFSD Branch: Insecticides/ Rodenticides	BFSD Branch: Herbicides/ Fungicides
Current use analysis		
EPA registrations of RPARs and alternatives	ASIB[a]	PSB[b]
Recommendations for use of RPAR and alternatives	ASIB	PSB
Use of RPAR and alternatives	EAB[c]	EAB
Performance evaluation of RPAR and alternatives		
Pest infestation and damage	ASIB	PSB
Comparative performance evaluation	ASIB	PSB
Use impact analysis (projected change in use)	EAB	EAB
Economic impact analysis		
Impact on production cost	EAB	EAB
Impact on volume produced	EAB	EAB
Impact on consumer prices	EAB	EAB
Aggregated economic impact	EAB	EAB
Limitations of analysis	EAB	EAB

[a] Animal Sciences and Index Branch.
[b] Plant Sciences Branch.
[c] Economic Analysis Branch.

Source: Environmental Studies Book Committee on Prototype Explicit Analyses for Pesticides, Regulating Pesticides (Washington, D.C.: National Research Council, 1980), p. 38.

Figure 6.1 Components of Pesticide Benefit Analysis (for a given site) and Principal Organizational Responsibilities in the Office of Pesticide Programs

Table 6.1 Summary of Quality of Benefits Information

Variables	Measurement Scale	Meaning of Measure	Frequency	% of Total
- Cost of Pesticide/Unit - Use/A of Pesticide	0	Ignored	241	31.177%
- Acres Treated - Cost of Alternative/Unit	1	Qualitatively mentioned	207	26.779%
- Use/A of Alternative - Acres Treated w/Alternative	2	Quantitative, assumed	34	4.398%
- Acres Abandoned - Yield/A with Pesticide	3	Quantitative, expert opinion	244	31.565
- Yield/A with Alternative - Quality/A with Pesticide - Quality/A with Alternative	4	Quantitative, based on study or published data, range	0	0%
	5	Quantitative, based on study or published data, point	47	6.080%
- Price of Good	0	Ignored	31	52.542%
	1	Qualitatively mentioned	3	5.085%
	2	Quantitative, assumed	0	0%
	3	Quantitative, expert opinion	0	0%
	4	Quantitative, study, range	0	0%
	5	Quantitative, study, point	20	33.898%
	6	Quantitative, varies with quality of commodity	3	5.085%
	7	Quantitative, varies with supply of commodity	1	1.695%
	8	Quantitative, varies with quality and supply	1	1.695%

Table 6.1 Summary of Quality of Benefits Information (Continued)

Variables	Measurement Scale	Meaning of Measure	Frequency	% of Total
- Per Acre Change in Pest Control Costs	0	Ignored	671	49.338%
- Total Change in Pest Control Costs	1	Qualitative	386	28.382%
- Per Acre Change in Value of Production	2	Quantitative, range	34	2.500%
- Total Change in Value of Production	3	Quantitative, point	269	19.779%
- Change in Other Production Costs				
- Impacts on Producers of Other Goods				
- Distribution of Impacts				
- Geographic Impacts				
- Macroeconomic Impacts				
- Social Impacts				
- Compliance				
- Costs of Restrictions				

but when they were not ignored, they were generally based on some type of a study. However, variation of price with quality and/or supply of the good was rarely considered.

Finally, several variables were measured on a 0-3 scale. These variables were either summary variables (changes in pest control costs, changes in value of production) or else they were poorly documented so that all that could really be said was that they were ignored, qualitatively measured or quantitatively measured. Once again, nearly half of these variables were ignored. Another 28.3 percent were only qualitatively mentioned. Only 22.3 percent of the 1459 pieces of data were quantified.

CORRELATION BETWEEN EXPLANATORY VARIABLES AND THE QUALITY OF INFORMATION ON BENEFITS

This section of the Chapter examines the extent of correlations, as measured by gamma, between the hypothesized explanatory variables and the quality of information used by EPA to assess the benefits of the 86 uses of the eight pesticides. There were 244 potential gammas for each explanatory variable, but one of two results were found. If there was no variation in the quality of benefits information between all uses of a pesticide, gammas could not be calculated. Otherwise, a gamma within the range of -1 to +1 was calculated. Of the total 976 potential gammas for four explanatory variables, 274 of them could not be calculated.

The following tables 6.2 through 6.5 are of the same format as tables 5.3 through 5.6. Each table represents a summary of the correlations between one explanatory variable and the quality of EPA's benefits data. For each explanatory variable one of the tables shows:

- o The numbers and values of the gamma coefficients that could be calculated for each of five benefits categories.
- o The quality of information within each of the five benefits categories when gamma coefficients could not be calculated (i.e., when there was no variation in the quality of benefits data between uses of a pesticide).
- o The total potential numbers of gamma coefficients within each of the five benefits categories.
- o The number of pesticides for which one or more gamma coefficients could be calculated for each of the five benefits categories. Unless otherwise noted, the number is the total out of a possible eight pesticides.
- o The number of pesticides with primarily positive gammas, primarily negative gammas, and equal numbers of positive and negative gammas.

The benefits data are delineated according to five benefits categories: changes in pest control costs, changes in value of production, other socioeconomic impacts, distribution of impacts, and compliance costs. In the tables, they are arranged from left to right in decreasing order of importance in EPA's benefits analyses.

The same measurement scale used in tables 5.3 through 5.6 was used to describe the values of the gammas that could be calculated for the quality of benefits data. That scale is:

-1 to -.750

-.749 to -.500

-.499 to -.250

-.249 to 0

.001 to .250

.251 to .500

.501 to .750

.751 to 1

Also, as in tables 5.3 through 5.6, gammas that could not be calculated due to a lack of variation in quality of benefits data were designated with "--". The number in parentheses shows the quality of benefits information across all uses of a pesticide that could be measured for a particular explanatory variable. The "total possible G" line is the sum of the gammas that could be calculated and those that could not.

The lower half of each table depicts the number of pesticides that showed positive, negative or ambiguous relationships between the explanatory variable and the quality of information for each of the five benefits categories. The figures show whether a large number of positive gammas in a benefits category reflect many positive gammas for _one_ pesticide, or a positive trend for _several_ pesticides. The latter would reflect the kind of correlation hypothesized for the explanatory variable and the quality of benefits information.

Once again, Table 5.2 should be used to show the number of uses of each pesticide that could be measured for each of the four explanatory variables. Supporting tables for Tables 6.2 through 6.5 can be found in Appendix B (Tables 45 through 67).

Findings for Value of Pesticide Use to Manufacturers. The intent of using the value of a particular pesticide use to the manufacturers as an explanatory variable was to proxy the likelihood of manufacturers to get involved in the regulatory process, due to their potential losses from regulation of the pesticide use. The hypothesis was that the quality of information would improve as the value of a pesticide use to the manufacturers increased.

The results shown in Table 6.2 seem to support this hypothesis. For all of the benefits categories except "compliance costs," a majority of the gammas could be calculated. When there was no variation in the quality of benefits information and G could not be calculated, the predominant quality of information ranged from three (expert opinion) for the major category of "changes in pest control costs" to zero (ignored) for the minor categories of "other socioeconomic impacts" and "distribution of impacts."

Most pesticides for which gamma could be calculated showed predominantly positive gamma coefficients across all

Table 6.2 Summary of Correlations Between Quality of Benefits Data and Value of Pesticide Use to Manufacturer

Value of G	Changes in Pest Control Costs	Changes in Value of Production	Other Socio-Economic Impacts	Distribution of Impacts	Compliance Costs
		Number of Gamma			
-1.0 to -.750	5	9	3	4	0
-.749 to -.500	0	0	2	0	0
-.499 to -.250	0	3	2	1	0
-.249 to 0	3	3	1	2	0
.001 to .250	1	7	3	3	0
.251 to .500	5	8	4	1	0
.501 to .750	4	6	1	0	0
.751 to 1.0	26	23	9	11	2
Subtotal	44	59	25	22	2
— (8)		0			
— (7)		0			
— (6)		0			
— (5)	0	0			
— (4)	0	0			
— (3)	13	7	1	1	2
— (2)	0	0	0	0	0
— (1)	5	6	1	6	5
— (0)	2	6	13	11	3
— (?)	8	2	0	0	0
Subtotal	28	21	15	18	10
Total Possible G	72	80	40	40	12
		Number of Pesticides			
for which G could be calculated	7	8	7	7	2 of a pos. 6
with primarily positive G's	5	5	5	6	2
with primarily negative G's	1	3	0	1	0
with equal numbers of positive & negative G's	1	0	2	0	0

five risk categories. Only three pesticides ever showed primarily negative or equal numbers of positive and negative gammas: Endrin, Amitraz and Silvex. For Endrin, only 3 (of a possible 11) uses could be measured according to value to manufacturer. Amitraz and Silvex each had only two measurable uses. So all of the pesticides with larger numbers of measurable uses, including Dimethoate and DBCP with 24 and 17 measurable uses respectively, showed primarily positive gammas across all five benefit categories.

If these results occurred because pesticide manufacturers are able to influence the regulatory process, then manufacturers must be convinced that improving benefits information will help them achieve more favorable regulatory outcomes for high-value uses of a pesticide. But there could be other reasons for the correlation between value to manufacturers and quality of benefits information. One is that benefits information is easy to obtain, relative to risk information, and so EPA chooses to expend its limited resources on good benefits information for higher-value uses. This does not seem likely if EPA is serving as a political entrepreneur for risk-bearers; in that case, the agency would probably want to avoid extensive information on benefits. However, USDA's control over the benefits analyses may have some impact on what EPA would like to see. A second alternative explanation for the positive correlation is that better benefits information may already be developed and available for the higher-value uses.

Findings for Percent of Crop Treated. The explanatory variable "percent of crop treated" was intended to proxy the number of users of a pesticide that would be affected by a regulatory action. The hypothesis was that the quality of benfits information would improve as the number of users increased, because political entrepreneurs (namely, USDA and user groups) would become more active in the process if a greater proportion of their constituencies were affected.

Table 6.3 shows the results of the empirical testing of this hypothesis. The results support the hypothesis except in the "other socioeconomic impacts" benefits category. In that category, there are equal numbers of positive and negative gammas, and equal numbers of pesticides with primarily positive and primarily negative gammas. For all five of the benefits categories, the pesticides with primarily negative Gs and equal numbers of positive and negative Gs range from Dimethoate (20 measurable uses) to 2,4,5-T and Amitraz (2 measurable uses). They are not exclusively the two and three measurable use-pesticides, as is the case for the value of use to manufacturers explanatory variable.

Once again, a majority of the possible gammas can be calculated in all benefits categories except for the "compliance costs" category. And once again, the quality of information ranges from zero to three when gamma cannot be calculated.

The same types of alternative explanations described in the last section could explain the correlation for this

Table 6.3 Summary of Correlations Between Quality of Benefits Data and Percent of Crop Treated

Value of G	Changes in Pest Control Costs	Changes in Value of Production	Other Socio-Economic Impacts	Distribution of Impacts	Compliance Costs
	Number of Gamma (Numbers in parentheses denote lower range figures)				
-1.0 to -.750	4 (4)	9 (9)	2 (2)	2 (2)	0
-.749 to -.500	0 (0)	0 (0)	1 (1)	1 (1)	0
-.499 to -.250	2 (2)	5 (5)	4 (3)	3 (3)	1
-.249 to 0	1 (1)	2 (2)	4 (4)	1 (1)	0
.001 to .250	5 (4)	14 (11)	1 (2)	4 (4)	1
.251 to .500	10 (14)	9 (13)	4 (4)	4 (4)	0
.501 to .750	8 (6)	5 (5)	2 (2)	2 (1)	0
.751 to 1.0	16 (15)	19 (18)	4 (4)	6 (7)	1
Subtotal	46	63	22	23	3
— (8)		0			
— (7)		0			
— (6)		0			
— (5)	0	0			
— (4)	0	0			
— (3)	14	9	2	2	2
— (2)	0	0	0	0	0
— (1)	1	2	2	4	4
— (0)	1	4	14	11	3
— (?)	10	2	0	0	0
Subtotal	26	17	18	17	9
Total Possible G	72	80	40	40	12
	Number of Pesticides				
for which G could be calculated	8	8	7	8	2 of a pos. 6
with primarily positive G's	5	6	3	5	1
with primarily negative G's	1	2	3	2	0
with equal numbers of positive & negative G's	2	0	1	1	1

explanatory variable. First, the hypothesized relationship could be true. Second, EPA (or USDA) may decide on its own to pursue good information for those uses with a high proportion of users. Third, better benefits information may already be available for the high percentage uses.

Findings for Annual Per Acre User Losses. The "annual per acre user losses" explanatory variable was intended to be an approximate measure of per capita user losses. The hypothesized relationship is that the quality of benefits information will improve as per capita losses increase, because individual users will have more at stake and will therefore attempt to influence the regulatory process.

Table 6.4 summarizes the empirical results. The results are similar to those in Table 6.2 for the value of a pesticide use to manufacturers, but they are even more positive in the two major benefits categories, "changes in pest control costs" and "changes in value of production." A majority of the Gs that can be calculated are positive for all five categories, and most of those are .251 or greater. In addition, most of the pesticides for which one or more gammas can be calculated show primarily positive gammas across all benefits categories. When pesticides do show primarily negative or equal numbers of positive and negative gammas, they usually either have few measurable uses or few measurable gammas, or both.

As for the previous two explanatory variables, a majority of the possible gammas cannot be calculated for "compliance costs." Also, most gammas can't be calculated for

Table 6.4 Summary of Correlations Between Quality of Benefits Data and Annual Per Acre User Losses

Value of G	Changes in Pest Control Costs	Changes in Value of Production	Other Socio-Economic Impacts	Distribution of Impacts	Compliance Costs
	Number of Gamma (Numbers in parentheses denote lower range figures)				
-1.0 to -.750	2 (2)	7 (7)	2 (1)	1 (1)	0 (0)
-.749 to -.500	0 (0)	0 (0)	0 (2)	0 (0)	0 (0)
-.499 to -.250	0 (1)	2 (1)	1 (0)	1 (0)	0 (1)
-.249 to 0	1 (0)	3 (2)	4 (4)	4 (5)	0 (1)
.001 to .250	5 (2)	9 (6)	2 (2)	2 (2)	0 (0)
.251 to .500	9 (11)	15 (14)	5 (5)	2 (3)	1 (0)
.501 to .750	7 (11)	8 (17)	1 (2)	3 (3)	1 (0)
.751 to 1.0	24 (21)	17 (14)	8 (7)	6 (5)	1 (1)
Subtotal	48	61	23	19	3
— (8)					
— (7)					
— (6)					
— (5)	1	1			
— (4)	0	0			
— (3)	14	9	2	2	2
— (2)	0	0	0	0	0
— (1)	0	3	2	8	4
— (0)	1	2	13	11	3
— (?)	8	4	0	0	0
Subtotal	24	19	17	21	9
Total Possible G	72	80	40	40	12
		Number of Pesticides			
for which G could be calculated	8	8	7	7	2 of a pos. 6
with primarily positive G's	6	6	5	5	1
with primarily negative G's	1	2	2	0	0
with equal numbers of positive & negative G's	1	0	0	2	1

"distribution of impacts." The quality of information when gamma cannot be calculated ranges from zero (ignored) to five (quantitative point estimate based on a study or published data).

The fact that there was a strong positive correlation between the proxy for per capita user losses and the quality of benefits information lends credence to the Stigler/ Peltzman theory that per capita economic impacts motivate individuals to organize in an effort to affect regulatory outcomes. Although the existence of the positive correlation does not prove that (or any of the other) hypothesis, it certainly supports the theory.

Findings for Annual Total User Losses. The last variable used to explain variation between uses of a single pesticide was "annual total user losses." This variable was meant to describe the aggregate annual losses for all users, as compared to the "per acre user losses" variable intended to capture individual user losses. The relationship between total user losses and quality of information was expected to be a positive one, reflecting the expected participation of pesticide users (or their political entrepreneurs) in the regulatory process as potential economic losses increase.

Table 6.5 shows that, again, most gammas could be calculated except for compliance costs and distribution of impacts. When gamma could not be calculated, the quality of information ranged from zero to five. In the two major categories, changes in pest control costs and changes in

Table 6.5 Summary of Correlations Between Quality of Benefits Data and Annual Total User Losses

Value of G	Changes in Pest Control Costs	Changes in Value of Production	Other Socio-Economic Impacts	Distribution of Impacts	Compliance Costs
	Number of Gamma (Numbers in parentheses denote lower range figures)				
-1.0 to -.750	2 (2)	7 (7)	0	1 (1)	0
-.749 to -.500	0 (0)	0 (0)	1	1 (1)	0
-.499 to -.250	0 (0)	2 (2)	2	0 (0)	0
-.249 to 0	0 (0)	2 (2)	4	3 (3)	0
.001 to .250	4 (3)	4 (5)	2	1 (2)	0
.251 to .500	9 (12)	13 (14)	5	3 (5)	1
.501 to .750	8 (5)	10 (7)	3	4 (1)	0
.751 to 1.0	21 (22)	18 (19)	4	5 (5)	2
Subtotal	44	56	21	18	3
— (8)		0			
— (7)		0			
— (6)		0			
— (5)	1	1			
— (4)	0	0			
— (3)	18	12	3	3	2
— (2)	0	0	0	0	0
— (1)	0	3	3	8	4
— (0)	1	4	13	11	3
— (?)	8	4	0	0	0
Subtotal	28	24	19	22	9
Total Possible G	72	80	40	40	12
	Number of Pesticides				
for which G could be calculated	8	8	7	7	2 of a pos. 6
with primarily positive G's	6	6	4	5	2
with primarily negative G's	0	2	1	1	0
with equal numbers of positive & negative G's	2	0	2	1	0

value of production, the quality of information was usually three (expert opinion) or better when gamma could not be calculated due to no variation between uses. But in the three minor categories, the quality of information was usually zero (ignored) or one (qualitative measurement).

The results for gammas that could be calculated were similar to those for per acre user losses in Table 6.4. Gammas were usually positive for all five benefits categories, and most pesticides showed primarily positive gammas. At first blush, the correlation summarized in Table 6.4 for per acre user losses appears to be stronger. But when one looks at the two major benefits categories, which far outweigh the three minor categories in terms of EPA's time and the importance of the information to the regulatory process, the annual total user losses variable appears to have slightly greater explanatory power. The pesticides with primarily negative gammas and equal numbers of positive and negative gammas in the two major benefits categories were Amitraz and 2,4,5-T, both of which had only two measurable uses for annual total user losses.

This result does not quite match the Stigler/Peltzman theory that per capita economic stake determines attempts to influence the regulatory process. But one possible explanation for the slightly stronger explanatory power of aggregate user losses is that USDA and already-existing user groups are political entrepreneurs for pesticide users. These political entrepreneurs may be more sensitized to react to an aggregate figure reflecting losses to all users, rather than data on individual impacts.

Findings for EPA's Risk Ranking. Once again, Edwin Johnson's statement that the risk of a pesticide drives the regulatory process was tested. In order to test the hypothesis, EPA's risk ranking for each pesticide was used as the explanatory variable. The quality of benefits information for a pesticide was measured by averaging the information quality across all uses of the pesticide.

The results of this test can be found in Table 6.6. Averaging the quality of information data across uses was easier for benefits than for risk, so the benefits results are probably somewhat more reliable. Supporting tables for Table 6.6 can be found in Appendix B (Tables 69 through 73).

To put it simply, there was absolutely no indication the Johnson statement holds true for benefits information. All of the possible gammas could be calculated, and most of them were negative. The negative gammas were clustered around the two least negative ranges for gamma (-.249 to 0 and -.499 to -.250).

None of the five benefits categories showed primarily positive gammas -- the two major categories were very predominantly negative and the three minor categories showed equal numbers of positive and negative gammas.

This is a very interesting result. It makes sense that Johnson's statement would test out to be true, given the strong correlations already shown between interest group

Table 6.6 Summary of Correlations between EPA's Pesticide Risk Ranking and the Average Quality of Benefits Information

Number of Gammas

Value of G	Changes in Pest Control Costs	Changes in Value of Production	Other Socioeconomic Impacts	Distribution of Impacts	Compliance Costs
-1.0 to -.750	0	0	0	0	0
-.749 to -.500	1	3	0	1	0
-.499 to -.250	5	3	1	0	1
-.249 to 0	3	2	2	2	0
.001 to .250	0	2	0	1	0
.251 to .500	0	0	0	0	1
.501 to .750	0	0	2	0	0
.751 to 1.0	0	0	0	1	0
----	0	0	0	0	0
Total Possible G	9	10	5	5	2

Primary Sign of Gammas

	Changes in Pest Control Costs	Changes in Value of Production	Other Socioeconomic Impacts	Distribution of Impacts	Compliance Costs
positive					
negative	x	x			
equal number of positive and negative			x	x	x

"propensity to participate" and the quality of benefits information. But why the negative results for the two major risk categories? Could it be that interest groups are pragmatic, and decide not to put as much pressure on EPA's benefits analyses when pesticide risk is high? Participation in the regulatory process can be costly, so it would be wise of the interest groups (and their political entrepreneurs) to save their scarce political and economic resources for pesticide regulatory processes where they think they can win.

Findings for All of the Explanatory Variables and EPA's Decisions on Pesticide Registration. The ultimate goal for interest groups trying to affect the regulatory process is obtaining a favorable pesticide registration decision from the EPA. Table 6.7 summarizes the correlation between EPA decisions and the four variables used to explain variation between uses of a pesticide. A supporting table for Table 6.7 is found in Appendix B (Table 68). The results bode well for the interest groups and ill for the EPA.

Decisions varied between measurable uses for only four of the eight pesticides, so the "decision-explanatory variable" gamma could only be calculated for those four (DBCP, Amitraz, Endrin, Chlorobenzilate). When decisions did not vary, all uses were registered with restricted use or sent to administrative hearings.

When gamma could be calculated, it was virtually always positive, indicating a positive relationship between the

Table 6.7 Summary of Correlations between EPA Pesticide Registration Decisions and Four Explanatory Variables

Number of Gammas
(Numbers in parentheses denote lower range Gs)

Explanatory Variable:

Value of Gamma	Value of Use to Manufacturers	Percent Crop Treated	Annual per Acre User Losses	Annual Total User Losses
-1.0 to -.750	0	0 (0)	0 (0)	0
-.749 to -.500	0	0 (0)	0 (0)	0
-.499 to -.250	0	0 (0)	0 (0)	0
-.249 to 0	1	1 (0)	0 (0)	1
.001 to .250	0	0 (0)	0 (0)	0
.251 to .500	1	0 (1)	1 (2)	0
.501 to .750	0	1 (1)	2 (1)	1
.751 to 1.0	2	2 (2)	1 (1)	2
——	4	4 (4)	4 (4)	4
Total Possible G	8	8	8	8

Number of Pesticides
(Numbers in parentheses denote lower range Gs)

for which G could be calculated	4	4 (4)	4	4
with positive G	3	3 (4)	4	3
with negative G	1	1 (0)	0	0
with G = 0	0	0 (0)	0	1

four explanatory variables and EPA decisions. For example, the data show that as the value of a pesticide use to the manufacturers increases, EPA is more likely to fully register that use in three of the four pesticides for which gamma could be calculated.

The apparent success of pesticide manufacturers and users in influencing EPA's decisions is further emphasized by the gamma calculated to show the correlation between EPA's pesticide risk rankings and the average decisions made for each pesticide. That gamma was calculated to be -.368, indicating that the more risky pesticides, determined by EPA's own standards, are <u>not</u> the most regulated pesticides.

<u>Summary: Correlation Between Explanatory Variables and Quality of Information on Benefits</u>. The differences between the empirical results for risk and benefit information are like night and day. For some reason, the empirical results in this reseach indicate that pesticide manufacturers and users seem far better able (or willing) to affect EPA's benefits analyses than its risk analyses. Some of the reasons for this disparity in results might include:

- o Pesticide users and manufacturers want risk information to remain as incomplete and vague as possible, because they do not think they will be able to rebut EPA's preliminary risk findings.
- o EPA serves as a political entrepreneur for risk bearers, and so has managed to insulate itself from user and manufacturer pressure to improve exposure

and risk data for the most important use of a pesticide.

- Pesticide users and manufacturers have decided to channel their limited political and financial resources toward the benefits side of the equation, because they feel that they can accomplish more by improving benefits information.
- USDA (and perhaps some well-organized user and manufacturer groups) serves as a political entrepreneur for pesticide users, and possibly manufacturers. Since USDA seems to oversee the benefits analysis, it channels RPAR resources into good benefits data for the most important pesticide uses.

The empirical results also indicate that EPA's pesticide risk ranking does an ambiguous job of explaining the variation in the quality of risk data between pesticides, and a terrible job of explaining the variation in the quality of benefits data. Why is this so, when Edwin Johnson so confidently claims that risk drives the information gathering process? Again, there are several possibilities. Johnson may simply be wrong. Or perhaps some flaw in the empirical work has resulted in arguable findings. A third possibility is that Johnson perceives that risk drives the process from his perch within the agency. But maybe EPA's pesticide regulation is really driven by external constraints including interest group pressure, and the process is only driven by risk within those constraints. In the case of benefits, the USDA-pesticide user liaison may be so powerful that it overshadows EPA's internal constraints.

In summary, the strong correlation between the explanatory variables and the quality of benefits information does not necessarily prove that interest groups affect EPA's information search during pesticide regulation. But the empirical results certainly lend a good deal of support to various theories of interest group power.

CHAPTER 7

CONCLUSIONS

OVERVIEW OF RESEARCH

In a broad sense, this research was an effort to gain some insight into EPA's regulation of pesticides. The specific objective, as noted in Chapter 1, was to provide systematic, empirical information about EPA's information-gathering activities in the Rebuttable Presumption Against Registration (RPAR) process. The quality of EPA's risk and benefit information was empirically described, and hypotheses on interest group pressure were tested.

To briefly review the structure of this thesis, theories of regulatory decision making and a conceptualization of pesticide risks and benefits were described in Chapters 2 and 3. In Chapter 4, the methodology for the empirical work was outlined. Scales were developed to depict the quality of various pieces of risk and benefit information for each use of each pesticide. EPA documents were used to measure the quality of information variables, which served as the dependent variables in the research. Explanatory variables were also quantified from EPA documents. Four of the explanatory variables measured the incentive for pesticide users or manufacturers to become involved in the regulation of a pesticide use; the fifth ranked the eight case study pesticides according to EPA's own determination of risk in an effort to explain differences in the quality of information between <u>pesticides</u>. Thus, correlations between the four "interest group" explanatory variables and quality of information were measured for each pesticide, while the EPA risk ranking variable was used to explain variation across all of the pesticides.

SUMMARY OF RESULTS

The results of the empirical work can be found in Chapters 5 and 6. There were four major findings:

- All five explanatory variables showed mixed results when correlated with the quality of risk information. The variables could not be considered to be highly correlated with the quality of risk information in either a positive or a negative way.
- The four "interest group" variables (value of pesticide to manufacturers, percent of crop treated, per acre user losses, and total user losses) showed positive correlations with the quality of benefits information. The strongest showings came from the per acre user losses and total user losses variables, intended to proxy the per capita losses and industry-wide losses from pesticide cancellation. The EPA pesticide risk ranking variable showed positive and negative correlations with the quality of benefits information, so the relationships could not be determined.

- EPA failed to measure or even mention many of the risk and benefits variables. When risk data were quantified, the sources tended to be assumptions, expert opinions, or studies of other pesticides instead of studies of the pesticide in question. For benefits data, there was a great reliance on expert opinions and assumptions. EPA usually quantified the major risk and benefit categories, such as consumer and ground applicator exposure and risk, changes in pest control costs, and changes in value of production. But the remaining categories were generally ignored or only qualitatively mentioned. Overall, EPA's information was not good and risk information was poorer than benefits information.

- It appears that interested parties were able to affect EPA's decisions. The four "interest group" variables did a good job of explaining EPA's decisions. As the economic stake of users and manufacturers for a particular pesticide use increased, so did the likelihood of an EPA decision to register or conditionally register that use. It seems that pesticide users and manufacturers were able to obtain decisions that minimized their losses, possibly at the expense of risk bearers (especially given that a <u>negative</u> correlation exists between stringency of decisions and EPA's pesticide risk rankings.)

ANALYSIS OF RESULTS

Value Judgments in Pesticide Regulation. There are many assumptions made, but not highlighted, in EPA's risk-benefit analysis. Some of these value judgments were carried over into this research in order to analyze EPA's activities. The first that comes to mind is the definition of benefits, costs (subtracted from benefits to obtain net benefits) and risk. EPA's definition of these parameters affects the issues addressed, how they are measured, and ultimately, how those issues are resolved. But perhaps more importantly, this definition of net benefits and risk assumes a particular distribution of property rights. It is usually the status quo distribution of rights that is assumed by EPA as a gauge to measure net benefits and risk, and this assumes that the status quo is the best set of rights.

Other value judgments used by EPA in its analysis include assumptions necessary to quantify human risk and to judge the acceptability of that risk. As Wessel (1980) suggests, science itself is valueless, but the use of science requires value judgments.

On the net benefits side, EPA makes a value judgment as soon as it aggregates user losses from pesticide regulation (or disaggregates into per acre user losses). Assuming that additional dollars are of equal value to all pesticide users or that average per acre losses even begin to reflect individual differences makes the analysis far less predictive of real human impacts. In addition, EPA often fails to consider the value or distribution of certain economic impacts.

These value judgments are necessary for EPA to simplify its analyses, or for technical reasons. However, the failure to acknowledge the assumptions can be misleading to participants in and students of the agency's regulatory process.

Correlation Between Variables. One of the most striking results in the empirical work was the lack of correlation between the "interest group" explanatory variables and the quality of risk information, and the strong correlation of the variables with the quality of benefits information. At first glance, the benefits results are consistent with the hypothesized relationships, but the risk results are not. However, when considering the characteristics of EPA's regulatory process, the risk results may not seem so inconsistent after all.

The EPA is largely responsible for the preparation of the risk analysis. Although there is a great deal of reliance on outside research to estimate exposure and toxicity, it is still up to the EPA to choose which information to use and how to compile it into a risk analysis. A different group of players has responsibility for the benefits analyses. USDA and land-grant university specialists team up with EPA economists to obtain the data for the preliminary benefits analyses. USDA seems to have primary responsibility for the analyses, which end up as fairly polished USDA publications. For the case study pesticides for which they were published, the benefits analyses were used virtually verbatim in EPA's final position documents.

One of the theorists cited in Chapter 2, James Q. Wilson, refers to the participation of "political entrepreneurs" in the regulatory process. EPA appeared to assume this role in representing risk bearers for the eight case-study pesticides. Because of this agency role, EPA was expected to have some control over the amount and quality of risk data. The results seem to show this by reflecting no relationship between pesticide users' and manufacturers' incentives and the quality of risk information.

Another possible explanation for the risk results is that the hypotheses may not have accurately reflected the relationship between better risk information and regulatory outcomes favorable to pesticide users and manufacturers. In fact, manufacturers and users may have felt that better information would be harder to challenge, and would lead to greater restrictions on pesticide use.

The theories and hypotheses in Chapter 2 seemed to adequately explain the quality of benefits information. In fact, the relationships between per acre user losses and total user losses and the quality of benefits data may have been especially strong because the USDA served as a political entrepreneur for pesticide users. USDA and state agricultural experts provided most of the benefits information, and there is no doubt that their constituencies were made up of pesticide users. And EPA's allegiance to pesticide users seemed to decline with the quality of benefits information, as was demonstrated for Arizona citrus growers using Chlorobenzilate and the minor Endrin uses. Thus, there was a real incentive for pesticide users and their political entrepreneurs to provide good benefits information.

The fact that EPA's pesticide risk ranking did not correlate positively with the average quality of risk and benefit information does not conflict with the hypotheses at all -- it simply suggests that EPA does not have complete control over the regulatory process. In fact, based on the results for the other four explanatory variables, it appears that pesticide users and manufacturers have greater control over the benefits information. The quality of risk information did show a slightly greater correlation with EPA's risk ranking than the benefits information, which indicates that EPA is better able to influence risk information.

Finally, there was a strong positive correlation between the four "interest group" explanatory variables and EPA's pesticide registration decisions, meaning that a pesticide use was more likely to be fully registered as its importance to manufacturers and users increased. But for the EPA pesticide risk ranking variable, EPA restrictions increased as risk decreased. This suggests that it is pesticide users and manufacturers who determine regulatory outcomes. EPA may be able to influence the quality of risk information to a very small degree, but the quality of benefits information appears to be influenced by interest group politics. More importantly, so do pesticide decisions, which are the regulatory bottom line.

EPA: Vote-Maximizer or Budget-Maximizer? In Chapter 2, there were several hypotheses on the expected differences in results if EPA was a vote-maximizing or budget-maximizing agency. This section addresses those hypotheses.

Predicted results for vote-maximizing agency.

1. Does costly information found in EPA's position documents support powerful groups? The risk information obtained by EPA did not appear to support pesticide users or manufacturers who are most likely the politically powerful groups. On the other hand, benefits information did appear to support those groups. However, since EPA prepared the risk analysis but not the benefits analysis, the answer to this question must be no, contrary to what would be expected if EPA were a vote-maximizing agency.

2. Did EPA's assumptions favor powerful groups? In general, the answer would again have to be no. Risk assumptions tended to be worst cases, which certainly do not favor pesticide manufacturers and users. When benefits data were unknown, the impacts were usually ignored, resulting in lower benefits estimates. There were some notable exceptions: the failure to account for dietary exposure in most non-consumer risk categories, and assumptions of total

compliance with proposed regulations. But in most cases, the assumptions did not favor the powerful groups.

3. Was there some information favoring opposing groups? Although we would expect otherwise if EPA was a vote-maximizer, risk information almost always seemed to favor risk-bearers. Risk bearers would not be expected to be powerful because of uncertainty of risk and high organization costs, yet EPA ignored most toxicity and exposure information reflecting lower risk.

4. Were there assumptions or costly information favoring opposing groups? Again, the answer is yes, even though the vote-maximizing theories would suggest otherwise. EPA often made assumptions favoring risk bearers. Examples included using the one-hit model to determine risk and assumptions of tolerance levels when residues in food could not be found.

Based on the answers to these four questions, it would be hard to claim that EPA maximized votes during its information search. However, the final pesticide registration decisions may have been a different story, since they seemed to favor the powerful groups.

<u>Predicted results for budget-maximizing agency</u>.

1. Did EPA challenge information from powerful groups? EPA definitely expended a great deal of energy and resources in challenging pesticide manufacturers' risk rebuttal information. On the other hand, EPA did not generally challenge information showing extensive benefits of pesticide use.

2. Did EPA's assumptions favor its role in regulating pesticides? Certainly some of the risk assumptions, such as assuming maximum allowable residues in food crops and using conservative "one-hit" risk models, resulted in higher risk estimates and a stronger role for EPA in pesticide regulation. EPA's own rules in triggering and implementing the RPAR process also seemed to protect that role, requiring toxicity (but not exposure) information to initiate the process, challenging manufacturer's toxicity data, and requiring manufacturer benefits of pesticide use to be ignored.

3. Did EPA expend resources to obtain information to protect its role? In general, EPA did not conduct its own studies -- the agency usually relied on risk data from government or academic studies or pesticide manufacturers, exposure data from studies of other pesticides, and benefits data from USDA. However, EPA definitely spent a lot of time and money on the RPAR process, which is structured to strengthen EPA's role in pesticide regulation.

4. Did EPA force powerful groups to provide pro-EPA information or make it costly for them to provide anti-EPA information? The great bulk of the toxicity data, which incriminated the pesticide and triggered the RPAR process, was provided by pesticide manufacturers so that they could register a chemical. Information to dispel preliminary risk findings was costly for manufacturers because it had to be

provided in the adversarial rebuttal process. And information on the benefits of pesticides to manufacturers was almost infinitely costly since it could not be considered in the RPAR process. However, information on benefits to pesticide users appeared to be relatively easy to inject into the RPAR process, in spite of the fact that this type of information challenged stringent pesticide regulations. Again, this could have been a result of EPA's lack of control over the benefits analyses.

These four indicators suggest that EPA might have been a budget-maximizing agency during the information gathering stage of the RPAR process. The regulatory program appeared to be structured in a way that supported a role for EPA in pesticide regulation.

Summary: EPA Incentives and Recommendations to Achieve Change. If budget maximization is one of the goals that drives EPA's regulation of pesticides, operating within the constraints of limited agency resources is certainly another. Knowledge of these two agency goals, and of the impact of pesticide producers, users and risk-bearers on the attainment of these goals, can help in designing the regulatory program to achieve different results.

If EPA strives to obtain better information for higher-risk pesticides, as Edwin Johnson intimates, then the agency should look at mechanisms to improve risk information (if that information shows higher risk) and ways of increasing the relative power of risk-bearing groups.

Since EPA's constituency for purposes of justifying its budget requests is probably risk-bearing groups, the goal of budget maximization is consistent with dedicating more resources to high-risk pesticides. This is evidenced by the answers to the questions in the previous section. The problem is not EPA's intentions; it is the financial and political constraints of regulatory life. Changing those constraints is not easy. It would involve attempts to obtain more funding for toxicity and exposure studies conducted within the EPA or by another agency. Alternatively, existing law could be amended to require pesticide manufacturers to provide more data.

Increasing the relative power of risk-bearing groups could take the form of reducing the organization costs of such groups (i.e., subsidizing and encouraging the formation of groups) and reducing the costs of articulating risk-bearer preferences in the regulatory process (e.g., surveying risk-bearers, collecting better exposure data, holding public hearings in areas where the pesticide is heavily used). Another way to increase the relative power of risk-bearers is to decrease the power of adversarial groups, such as pesticide manufacturers and users. USDA is doubtless the primary voice for pesticide users, and it appears that this role prevents EPA from achieving more stringent regulation of higher-risk pesticides. As a result, EPA could re-evaluate its relationship with USDA. In general, reducing opportunities to voice concerns will decrease the political clout of pesticide users and manufacturers.

THE ROLE OF INFORMATION: IMPLICATIONS FOR ECONOMIC POLICY ANALYSIS

The bottom line for participants in the RPAR process is their impact on the decision and ultimate outcome of the process. Given that pesticide users and manufacturers apparently affect the quality of benefits information and, to a lesser extent, risk information, how does this translate into an impact on decisions?

There are a couple of general statements that can be made about EPA's pesticide decisions. Once an RPAR has been issued, EPA is unlikely to fully register a product, because a decision outcome is needed which justifies the time and resources expended on the decision-making process. Also, even the best information does not point to a clear decision for EPA. The risk of pesticide use is too uncertain for a calculation of the net benefits of alternative policies. Even if net benefits could be calculated, there is no reason to believe that EPA would find the answer, or the assumptions on which it is based, politically acceptable. It was pointed out in Chapter 2 that EPA may have goals other than maximizing some normative measure of net social welfare.

Given these two general conclusions, can information influence decision outcomes? It is evident from reading the position documents that the risk-benefit information does help to determine outcomes. The information helps EPA determine who is at most risk, who benefits the most, which methods of application cause the most exposure, and other characteristics of pesticide use. This is of use in helping

EPA to develop alternative courses of action and choose between them. Risk-benefit analysis then, helps the EPA to clarify issues and determine effective risk-reduction policies. This explains the efforts of different interest groups to provide risk and benefit information.

To some extent, information may also be used as a justification for previously-made decisions. Decisions in the RPAR process are predetermined in the sense that once an RPAR is issued, there is almost always an implicit decision to restrict the pesticide to some extent. As a result, much of EPA's information search is devoted to sustaining risk findings. But this does not negate the conclusion that the specifics of the regulatory alternatives, and to some degree the choice between those alternatives, are determined by risk and benefit information rather than vice versa.

In support of that conclusion, there was a strong correlation between the explanatory variables and EPA's decisions, as described in Table 6.7 in Chapter 6. Larger values for the explanatory variables resulted in fewer restrictions, with the exception of the EPA pesticide risk ranking variable. That variable showed a substantial negative correlation with EPA decisions (i.e., as risk increased, restrictions decreased), once again indicating that the RPAR process is not driven by EPA's perception of risk.

Some students of regulation have proposed the theory that regulation is just a facade -- that it actually protects the regulated by preventing more stringent regulation.

While the results of this research, taken out of context, may support such a theory, the reality appears to be somewhat different. EPA does not appear to be working for pesticide manufacturers and users. Instead, it appears that these groups and their political entrepreneurs simply "outmuscle" EPA and risk-bearers in the regulatory process. Although EPA's regulatory style is severely cramped by the regulated, it seems to be neither the goal of the agency nor the intent of the regulatory design to protect pesticide manufacturers and users. Likewise, the very presence of EPA and organized risk-bearers no doubt tempers the style of the regulated groups. Information on risk does impact regulatory outcomes, and as Peltzman suggests, the regulated groups do not get everything they want from the regulatory process.

In summary, there is a use for risk-benefit information in pesticide regulation. Although decisions do not fall out of the risk-benefit information, the information does provide some guidance to EPA on how to reduce risks. This is not the extensive role for information envisioned by many policy analysts, but it does seem to result in risk reduction and improved public safety.

IMPLICATIONS OF FINDINGS FOR PROPOSED REGULATORY REFORMS

The Bush Task Force Reforms. There have been rumblings in Washington, ever since the Reagan administration took office, of implementing a major overhaul of the RPAR process. The most concrete proposals emanated from directives from Vice President George Bush's task force on regulatory reform. A new "Special Review" process has been proposed. The name change is the smallest difference between the current and proposed processes.

Some of the major changes include:

- o Notifying pesticide manufacturers before the process begins, and utilizing their input to determine which uses (as opposed to all uses) should be reviewed. EPA would continue to review the critical minor uses, apparently because it is recognized that manufacturers would have little interest in defending those uses.
- o Relying on manufacturers for exposure data.
- o Attempting to negotiate use restrictions after exposure data were obtained.
- o If no solution was reached, and if EPA's top management agreed that the risk exists, the Scientific Advisory Panel would review the risk data, and USDA would review and comment on a benefits analysis prepared by manufacturers.
- o Assuming that the special review continued, negotiations would be initiated between EPA and the manufacturers to try to reach a risk-reducing solution.

- Only if negotiations failed would a USDA benefits analysis and EPA document outlining regulatory options be prepared, with USDA, SAP and public comment.
- Additional negotiations, with a final decision document if negotiations failed.
- Relying on risk assessments from other agencies and offices when possible.
- Revising RPAR "risk triggers" to account for exposure and negative studies, with the effect of making it more difficult to initiate the special review.

Based on the results of this research, how do these proposed reforms affect the process and the role of interest groups in the process? EPA makes it clear that the reforms are intended to allow more negotiated settlements, reduce paperwork, and otherwise streamline the process. But this also means less power for interest groups other than pesticide manufacturers and less public scrutiny of the process. Research such as the type contained in this thesis would probably be precluded, since there would be no paper trails.

Giving pesticide manufacturers control over exposure data would undoubtedly change the outcome of the process. Whereas the quality of risk information was shown to be poorly correlated with the value of the pesticide to manufacturers, this would almost certainly change when manufacturers gained control of the exposure information search. And the current strong correlation between the value of a pesticide use to manufacturers and EPA decisions should become even stronger.

Consultations with manufacturers over which uses should be reviewed, without using completed risk and benefits analyses, may eliminate pesticide users from the process. In many cases, uses that are valuable to manufacturers will also be important to users, but for some uses this will not be the case. As a result, lower correlations between pesticide user variables and risk information should be expected for some uses.

The use of informal contacts and negotiations between EPA and pesticide manufacturers will also change the balance of power in the process, particularly if EPA is not as committed to defending risk-bearers. Much of the process will no longer be documented, and the nature of a negotiated solution means that EPA will not have to defend its decision on other than political grounds. Actually, most of the defending will occur during the risk analysis.

The revision of the risk triggers should result in fewer pesticides being considered for special review. The assumption here by the Bush task force is that some pesticides that do not pose a risk are being regulated due to broad risk triggers.

If EPA is pro-manufacturer, as it appears to be (relatively speaking) under the Reagan administration, then this process should save time and money and be easier for pesticide manufacturers. But if EPA is anti-manufacturer, as it has been in the past and is certain to be at some point in the future, attempts to negotiate may be futile and the process may be as drawn out as it is now, albeit with less documentation.

If decisions were made based on risk information only, or on risk and benefits information provided by manufacturers, the regulatory outcome would probably be different than it is now. Solutions would be biased toward manufacturers' perceptions of risk and benefits, and the final choice for each pesticide use would most likely be highly correlated with values of the uses to manufacturers.

To describe changes in pesticide regulation since 1981, even without formal changes in the RPAR process, Table 7.1 shows activity before and after that date. The table shows that since 1981, more pesticides have been returned to the registration process without restrictions or with negotiated restrictions, fewer RPAR's have been issued, fewer manufacturers have voluntarily agreed to cancel their product and more RPAR's have been completed.

National Academy of Sciences Recommendations. In the book Regulating Pesticides (Environmental Studies Board Committee on Prototype Explicit Analyses for Pesticides, 1980), several recommendations are suggested to improve the RPAR process. The panel of economists and natural scientists recommended that:

Table 7.1 Changes in Pesticide Regulation Since President Reagan's Inauguration

RPARs Issued (according to date of PD1 publication)	
January 21, 1981 - September 1983	0
April 1978 - January 20, 1981	10
Voluntary Cancellations (according to date of publication)	
January 21, 1981 - September 1983	2
April 1978 - January 20, 1981	5
Pesticides Returned to Registration (according to date returned)	
January 21, 1981 - September 1983	14
April 1978 - January 21, 1981	5
RPARs Completed (according to date of PD4 publication)	
January 21, 1981 - September 1983	10
April 1978 - January 21, 1981	7

Source: Compiled from data in "Status Report on Rebuttable Presumption Against Registration (RPAR) or Special Review Chemicals, Registration Standards or Data Call-In Programs" (U.S. Environmental Protection Agency Office of Pesticide Programs, Washington, D.C., September, 1983).

- The OPP should prioritize pesticides according to toxicity of active ingredients and extent of use, and regulate pesticides in order of prioritization.
- Alternative pest control methods should be identified early in the review process. If any of those alternatives are potentially hazardous, they should be removed from the prioritization and reviewed as quickly as possible.
- The OPP should not try to generate numerical risk estimates when there are no reliable human epidemiological data. Instead, OPP should "rank" pesticide risk relative to other pesticides, and the risk of alternative regulatory schemes should be presented in terms of dosage.
- EPA staff should observe actual application, formulation, and study of the RPAR pesticides.
- OPP should estimate the "economic lifetime" of the RPAR pesticides, and estimate risk and benefits accordingly.
- OPP should present exposure estimates as a range, with the low point reflecting the most likely degree of exposure, and the high point reflecting the maximum potential exposure.
- OPP should not include the effects of pesticide regulations on net farm income resulting from crop price changes in its benefits analyses, because these changes are offset by consumers.

- The OPP should establish a Benefits Review Panel of experts to review the benefits analyses. Members of that panel should be involved at the outset of the benefits analysis.

Unlike the Bush task force recommendations, which focus on ways to cut the costs and length of the RPAR process, the NAS proposals are centered around a quest for better information. The relevant question is: will these proposals lead to improved decision making?

It has already been noted that information does not seem to help choice-making, but it may help the EPA to develop alternative solutions. Several of the NAS recommendations would shed additional light on potential risk reduction methods. Identifying alternative pest control methods that may also be hazardous, ranking alternative regulatory schemes according to dosage, and observing actual application procedures may all help to clarify regulatory options for EPA. But some of the other recommendations, those that call for refinement in aggregate risk or benefit calculations, may not be of as much value to the agency in its decision-making. No matter how precise the calculation of net benefits and risks, EPA still must make value judgments when weighing benefits against risks in decision making.

DIRECTIONS FOR FUTURE RESEARCH

There are many areas of pesticide regulation that can still be investigated. An obvious topic of research suggested by the previous section is to attempt to duplicate the research for the new Special Review process if it is implemented.

Other suggestions revolve around improving the current research:

- o Include more case studies now that more RPARs have been completed.
- o Improve measurement of quality of information variables by interviewing personnel from EPA, manufacturers, pesticide user groups, and risk-bearing groups or their political entrepreneurs.
- o Improve measurement of explanatory variables by going outside of the position documents for variable specification and measurement, and possibly develop additional variables for risk-bearing groups.
- o Use econometric modeling if data is good enough to justify such a methodology. Such a procedure would tell more about the relationships between explanatory and dependent variables and would highlight model specification problems, if any.
- o Focus on stages of the regulatory process other than information search.

Given adequate time and resources, this research could be expanded upon in order to find out more about EPA's regulation of pesticides. But the research has accomplished a great deal in terms of describing the information search portion of the RPAR process and providing estimates of interest group influence on that portion of the process.

APPENDICES

APPENDIX A

RANKING OF PESTICIDE USES ACCORDING TO FOUR EXPLANATORY VARIABLES

APPENDIX A

Ranking of Pesticide Uses According to Four Explanatory Variables

Table A1. Ranking of Uses for Each Pesticide According to Value of Pesticide Use to Manufacturers

Pesticide	Use	Value to Manufacturers
Pronamide	Lettuce	$2,091,000 to 4,182,000
	Alfalfa	$2,084,000
	Ornamentals	$420,750
	Berries	$240,570
	Turf	$205,425
	Sugarbeet Seed	> $64,350
Silvex	Rangeland	$750,000
	Rice	$11,000
	Apples	?
	Noncrop Uses	?
	Pears	?
	Prunes	?
	Sugarcane	?
2,4,5-T	Rangeland	$6,750,000
	Rice	$1,650,000
	Noncrop Uses	$800,000
Amitraz	Pears	$3,047,414
	Apples	$1,129,480
Chlorobenzilate	Florida Citrus	$3,220,000
	Texas Citrus	$406,000
	Cotton	$212,550
	California Citrus	$30,000
	Arizona Citrus	$24,000
	Other	"Little Use" (assigned value of $100)
	Fruits/Nuts	?
Endrin	Small Grains	$1,380,000
	Orchards	$152,800
	Cotton	$149,910
	Alfalfa	?
	Bird Perches	?
	Conifer Seeds	?
	Ornamentals	?
	Sugarcane	?
	Tree Paint	?
	Vegetable Seeds	?
	Watermelon Seeds	?

DBCP	Soybeans	$8,293,260
	Grapes	$3,200,000
	Almonds	$2,289,390
	Vegetables/Melons/Strawberries	$2,238,720
	Peanuts	$2,140,650
	Cotton	$1,782,000
	Peaches/Nectarines	$1,203,180
	Citrus	$801,040
	Commercial Turf	$363,000
	Plums	$302,840
	Pineapple	$250,660
	Home Lawns	< $134,000
	Other Berries	$61,640
	Strawberry Nursery Stock	$10,720
	Home Gardens	< $3,350
	Bananas	"Negligible" (assigned value of $100)
	Apricots, Cherries, Figs	"Negligible" (assigned value of $100)
	Ornamentals	?
Dimethoate	Sorghum	$2,831,370
	Citrus	$2,067,768
	Corn	$1,920,000
	Cotton	$1,690,648
	Tomatoes (Fresh)	$1,323,576
	Dry Beans	$1,081,404
	Alfalfa	$627,750
	Grapes	$617,014
	Livestock Premises	$552,552
	Tomatoes (Process)	$544,050
	Pecans	$226,533
	Snap Beans (Fresh)	$198,090
	Apples	$162,000
	Snap Beans (Process)	$151,258
	Safflower	$105,507
	Lettuce	$71,982
	Soybeans	$51,000
	Brocolli	$47,988
	Tobacco	$3,648
	Citrus Blackfly	< $3,203
	Forest Seed Orchards	$1,698
	Peppers	≥ $837
	Wheat	"Minor Use" (assigned value of $100)
	Pears	"Negligible use" (assigned value of $100)
	Ornamentals	?
	Turnips	?
	Swiss Chard	?
	Cabbage	?

Table A2. Ranking of Uses for Each Pesticide According to Annual Total User Losses from Pesticide Cancellation

Pesticide	Use	Total Annual User Losses
Pronamide	Lettuce (Salinas)	$10,097,068
	Lettuce (Maria)	$2,429,724
	Alfalfa	$2,333,775
	Lettuce (Imperial)	$1,305,390
	Lettuce (Other CA)	$784,100
	Lettuce (AZ)	455,655
	Berries	?
	Ornamentals	?
	Turf	?
	Sugarbeet Seed	?
2,4,5-T	Rangeland	$16,406,000
	Rice	5,517,000
	Noncrop Areas	?
Silvex	Sugarcane	$3,800,00 to $10,100,000
	Prunes	$1,800,000
	Apples	$1,000,000
	Rangeland	"Small" (assigned value of $100)
	Rice	"Not Significant" (assigned value of $100)
	Noncrop Uses	"Not Significant" (assigned value of $100)
	Pears	?
Amitraz	Pears	$8,271,000
	Apples	$-410,070
Chlorobenzilate	Florida Citrus	$27,177,600
	California Citrus	$2,280,200
	Texas Citrus	$240,400
	Cotton	≤ $125,000
	Fruits & Nuts	≤ $69,000
	Arizona Citrus	?
	Other	?
Endrin	Small Grains (Major Uses)	$14,700,000 to 15,400,000
	Orchards	$2,645,000 to 5,336,000
	Conifer Seeds	$3,000,000
	Cotton	$717,850
	Sugarcane	$4,600
	Alfalfa	~ 0
	Ornamentals	~ 0
	Watermelon Seeds	?
	Other Vegetable Seeds	?
	Tree Paint	?
	Bird Perches	?
	Small Grains (Minor Uses)	?

DBCP	Peaches/Nectarines	$26,890,000
	Soybeans	$23,500,000
	Grapes	$21,670,000
	Vegetables/Melons/Strawberries	$14,500,000
	Citrus	$8,950,000
	Almonds	$8,834,000
	Peanuts	$6,800,000
	Pineapple	$6,200,000
	Commercial Turf	$2,200,000 to $5,600,000
	Strawberry Nursery Stock	$1,500,000 to $5,600,000
	Plums	$4,600,000
	Home Lawns	$2,750,000
	Cotton	$2,600,000
	Other Berries	$1,000,000
	Apricots, Figs, Etc.	"Negligible" (assigned value of $100)
	Bananas	"Negligible" (assigned value of $100)
	Home Gardens	"Negligible" (assigned value of $100)
	Ornamentals	?
Dimethoate	Grapes	$9,900,000
	Corn	$8,030,000
	Tomatoes (Fresh)	$3,900,000
	Snap Beans (Fresh)	$3,600,000
	Dry Beans	$1,800,000
	Cotton	$1,730,000
	Alfalfa	$1,726,000
	Brocolli	$1,270,000
	Pecans	$745,800
	Citrus	≥ $551,000
	Citrus Blackfly	$234,500
	Snap Beans (Process)	$130,800
	Apples	$90,000
	Safflower	$34,000
	Livestock Premises	$30,900
	Tobacco	$5,600
	Peppers	≥ $2,700 to $-1,700
	Lettuce	≥ $400 to $-121,500
	Wheat	"Minor" (assigned value of $100)
	Pears	"Minor" (assigned value of $100)
	Forest Seed Orchards	$-337.50 to $-675
	Soybeans	$-21,600
	Tomatoes (Process)	$-371,000
	Sorghum	$-608,000
	Cabbage	?
	Swiss Chard	?
	Turnips	?
	Ornamentals	?

Table A3. Ranking of Uses for Each Pesticide According to Annual Per Acre User Losses from Pesticide Cancellation

Pesticide	Use	Per Acre User Losses
Pronamide	Lettuce (Salinas)	$54 to $408
	Lettuce (Maria)	$54 to $402
	Lettuce (Imperial)	$50 to $55
	Lettuce (Other California)	$50 to $55
	Alfalfa	$8.05 to $38.14
	Lettuce (Arizona)	?
	Berries	?
	Ornamentals	?
	Turf	?
	Sugarbeet Seed	?
2,4,5-T	Rice	$14.00
	Rangeland	$11.00
	Noncrop	"Little" (assigned a value of $.25)
Silvex	Prunes	$222.00
	Sugarcane	$40.00 to $-1.50
	Apples	$20.00
	Rangeland	"Small" (assigned a value of $.25)
	Rice	"Insignificant" (assigned a value of $.25)
	Noncrop Uses	"Little" (assigned a value of $.25)
	Pears	?
Chlorobenzilate	Citrus (California)	$90.00
	Citrus (Florida)	$47.00
	Citrus (Texas)	$4.72
	Cotton	≤ $3.20
	Fruits and Nuts	≤ $2.88
	Citrus (Arizona)	"Insignificant" (assigned a value of $.25)
	Other Uses	?
Amitraz	Pears	$170.20
	Apples	$-7.89
Endrin	Orchards	$34.00 to $69.00
	Small Grains (Major Uses)	$33.00 and $1.66 to $1.94
	Conifer Seeds	$20.00
	Sugarcane	$9.20
	Cotton	$4.70
	Alfalfa	~ 0
	Ornamentals	~ 0
	Watermelon Seeds	?
	Other Vegetable Seeds	?
	Tree Paint	?
	Bird Perches	?
	Small Grains (Minor Uses)	?

DBCP	Strawberry Nursery Stock	$2,500 to $9,333
	Pineapple	$1,240
	Peaches/Nectarines	$640.24
	Plums	$511
	Commercial Turf	$118.92 to $302.70
	Citrus	$288.70
	Grapes	$261.08
	Ornamentals	$88.08 to $172.55
	Almonds	$124.42
	Home Lawns	$88.00
	Vegetables/Melons/Strawberries	$38.76
	Soybeans	$20.74
	Peanuts	$18.18
	Cotton	$11.56
	Other Berries	"Little" (assigned value of $.25)
	Home Gardens	"Negligible" (assigned value of $.25)
	Apricots, Figs, Etc.	"Negligible" (assigned value of $.25)
	Bananas	"Negligible" (assigned value of $.25)
Dimethoate	Snap Beans (Fresh)	$76.70
	Brocolli	$74.15
	Tomatoes (Fresh)	$43.50
	Livestock Premises	$19.70
	Pecans	$14.34
	Corn	$12.52
	Lettuce	$7.57 to $-.02
	Apples	$7.00
	Dry Beans	$6.81
	Peppers	$6.70 to $-4.14
	Cabbage	$3.87 to $-2.77
	Grapes	$3.83
	Snap Beans (Process)	$3.60
	Citrus	≥ $3.58
	Alfalfa	$.70 to $3.51
	Tobacco	$3.48
	Citrus Blackfly	$2.15
	Swiss Chard	$1.05 to $-4.37
	Turnips	$1.05 to $-4.37
	Safflower	$1.04
	Cotton	$.71
	Wheat	"Minor" (assigned a value of $.25)
	Pears	"Negligible" (assigned a value of $.25)
	Sorghum	$-.55
	Soybeans	$-1.27
	Forest Seed Orchards	$-2.25 to $-4.50
	Tomatoes (Process)	$-12.37
	Ornamentals	?

Table A4. Ranking of Uses for Each Pesticide According to Percent of Crop Treated

Pesticide	Use	Percent of Crop Treated
Chlorobenzilate	Florida Citrus	67%
	Texas Citrus	50%
	Arizona Citrus	5%
	California Citrus	1.6%
	Fruits and Nuts	1.0%
	Cotton	.41%
	Other	"Little" (assigned value of .01%)
Endrin	Watermelon Seeds	100%
	Conifer Seeds	90% of direct seeded acres
	Other Vegetable Seeds	"Like Conifer and Watermelon" (assigned value of 90%)
	Orchards	11.2%
	Small Grains (Major Uses)	9.2%
	Cotton	< 2.0%
	Sugarcane	< 0.2%
	Tree Paint	"Confidential-Very Minor" (assigned value of .01%)
	Alfalfa	~ 0%
	Ornamentals	~ 0%
	Bird Perches	?
	Small Grains (Minor Uses)	?
Pronamide	Sugarbeet Seed	90.00%
	Lettuce	55.00%
	Berries	54.00%
	Ornamentals	5.50%
	Alfalfa	0.44%
	Turf	?
Amitraz	Pears	60.1%
	Apples	10.0%
Silvex	Prunes	80%
	Sugarcane	15%
	Apples	10%
	Rice	0.08%
	Rangeland	0.01%
	Pears	?
	Noncrop Uses	?
2,4,5-T	Rice	12%
	Rangeland	0.1%
	Noncrop uses	?

DBCP	Strawberry Nursery Stock	100%
	Vegetables/Melons/Strawberries	< .1% to 95%
	Plums	70%
	Almonds	54%
	Pineapple	46%
	Peaches/Nectarines	44%
	Grapes	31%
	Peanuts	23%
	Citrus	7.9%
	Soybeans	2.1%
	Cotton	2.0%
	Home Gardens	< 0.5%
	Other Berries	< 0.1%
	Apricots, Cherries, Figs	< 0.1%
	Bananas	< 0.1%
	Ornamentals	?
	Commercial Turf	?
	Home Lawns	?
Dimethoate	Tomatoes (Fresh)	83.00%
	Brocolli	33.00%
	Grapes	30.60%
	Lettuce	20. to 25.%
	Safflower	22%
	Beans	21%
	Pecans	17%
	Cotton	14%
	Citrus	12%
	Tomatoes (Fresh)	10%
	Forest Seed Orchards	4%
	Sorghum	3%
	Apples	2.60%
	Alfalfa	1%
	Tobacco	< 1%
	Citrus Blackfly	< 1%
	Corn	0.60%
	Pears	< 0.50%
	Wheat	0.37%
	Soybeans	0.03%
	Livestock Premises	?
	Peppers	?
	Cabbage	?
	Swiss Chard	?
	Turnips	?
	Ornamentals	?

APPENDIX B

CORRELATIONS BETWEEN EXPLANATORY VARIABLES AND QUALITY OF INFORMATION

APPENDIX B

Correlations Between Explanatory Variables and Quality of Information

Table B1. Correlations between Value of Pesticide Uses to Manufacturers and Quality of Information on Consumer Risk, as Measured by Gamma

	Gamma					
	Exposure			Risk		
Pesticide	Residues	Food in Diet	Percent Crop Treated	Oncogen	Reproductive/ Fetotoxin	Mutagen
Pronamide	—(2)[1]	—(?)	—(?)	1	n/a[2]	n/a
Silvex	—(1)	—(1)	—(1)	—(1)	—(1)	n/a
2,4,5-T	—(1)	—(1)	—(0)	—(1)	—(1)	n/a
DBCP	—(3)	—(?)	1	—(3)	—(1)	n/a
Chlorobenzilate	—(2)	—(?)	—(5)	-1	-1	n/a
Endrin	-1	—(?)	-1	n/a	-1	n/a
Amitraz	—(5)	—(5)	—(2)	—(3)	n/a	n/a
Dimethoate	—(2)	—(5)	.162	—(1)	—(3)	—(1)

[1]For all tables in Appendix B, the symbol "—(x)" means that no gamma could be calculated because there was no variation in the quality of information between uses of a pesticide. The quality of information for all uses is designated by the number in parentheses ("x" above).

[2]For all tables in Appendix B, the symbol "n/a" means "not applicable".

Table B2. Correlations between Value of Pesticide Uses to Manufacturers and Quality of Information on Ground Applicator Risk, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorp-tion	Dura-tion	Amount	Absorp-tion	Dura-tion	Resi-dues	Food in Diet	% Crop Treat	Onco-gen	Reproduc-tive/Feto-toxin	Muta-gen
Pronamide												
Handsprayers	1	—(?)	1	1	—(?)	1	1	—(?)	—(?)	1	n/a	n/a
Commercial Application	1	—(?)	1	1	—(?)	1	1	—(?)	—(?)	1	n/a	n/a
Silvex	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
2,4,5-T												
Handsprayers	1	1	1	1	—(0)	1	1	1	—(0)	1	1	n/a
Tractor Appl.	1	1	1	1	—(0)	1	1	1	—(0)	1	1	n/a
DBCP	—(2)	—(2)	-.556	—(7)	—(0)	1	—(0)	—(0)	—(0)	1	—(1)	n/a
Chlorobenzilate	.5	.5	.5	.5	.5	.5	—(0)	—(0)	—(0)	.5	.5	n/a
Endrin	.333	0	0	.333	0	0	—(0)	—(0)	—(0)	n/a	.333	n/a
Amitraz	—(5)	—(2)	—(3)	—(?)	—(2)	—(3)	—(0)	—(0)	—(0)	—(3)	n/a	n/a
Dimethoate												
Boom & C.A.	-.056	-.056	-.056	-.056	-.056	-.056	-.056	-.056	-.056	.130	.130	.130
Air Blast	.118	.067	.067	.118	.067	.067	.067	.067	.067	.130	.130	.130

Table B3. Correlations between Value of Pesticide Uses to Manufacturers and Quality of Information on Mixer and Loader Risk, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
Pronamide												
Commercial	1	—(?)	1	1	—(?)	1	1	—(?)	—(?)	1	n/a	n/a
Handsprayers	1	—(?)	1	1	—(?)	1	1	—(?)	—(?)	1	n/a	n/a
Silvex	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
2,4,5-T	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
DBCP	—(2)	—(2)	—(2)	—(7)	—(0)	1	—(0)	—(0)	—(0)	1	—(1)	n/a
Chlorobenzilate	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Endrin	—(0)	—(0)	—(0)	-1	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	-1	n/a
Amitraz	—(7)	—(2)	—(2)	—(5)	—(2)	—(2)	—(0)	—(0)	—(0)	—(3)	n/a	n/a
Dimethoate	—(0)	.126	.126	—(0)	.126	.126	.126	.126	.126	.126	.126	.126

Table B7. Correlations between Value of Pesticide Uses to Manufacturers and Quality of Information on Risk to Persons Exposed to Spills, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorp-tion	Dura-tion	Amount	Absorp-tion	Dura-tion	Resi-dues	Food in Diet	% Crop Treat	Onco-gen	Reproduc-tive/Feto-toxin	Muta-gen
Pronamide	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	n/a
Silvex	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
2,4,5-T	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
DBCP	—(2)	—(2)	—(2)	—(?)	—(0)	—(0)	—(0)	—(0)	—(0)	—(3)	—(1)	n/a
Chlorobenzilate	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Endrin	-1	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	-1	n/a
Amitraz	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	n/a
Dimethoate	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)

Table B5. Correlations between Value of Pesticide Uses to Manufacturers and Quality of Information on Risk to Persons Exposed to Drift, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
Pronamide	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	n/a
Silvex	—(1)	—(0)	—(0)	—(1)	—(0)	—(0)	—(0)	—(0)	—(0)	—(1)	—(1)	n/a
2,4,5-T	1	1	1	1	—(?)	1	1	1	—(0)	1	1	n/a
DBCP	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Chlorobenzilate	.5	—(0)	—(0)	.5	—(0)	—(0)	—(0)	—(0)	—(0)	.5	.5	n/a
Endrin	-1	-1	—(0)	1	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	-1	n/a
Amitraz	—(5)	—(0)	—(2)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(1)	n/a	n/a
Dimethoate	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)

Table B6. Correlations between Value of Pesticide Use to Manufacturers and Quality of Information on Farmworker Risk, as Measured by Gamma

Gamma

	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
Pronamide	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	n/a
Silvex	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
2,4,5-T	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
DBCP	—(0)	—(0)	—(0)	—(7or1)	—(0)	—(0)	—(0)	—(0)	—(0)	—(3or1)	—(1)	n/a
Chlorobenzilate	—(1)	0	0	0	—(0)	—(0)	—(0)	—(0)	—(0)	—(1)	—(1)	n/a
Endrin	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	—(0)	n/a
Amitraz	—(7)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(1)	n/a	n/a
Dimethoate	—(1)	—(3)	—(0)	—(1)	—(2)	—(0)	—(2)	—(5)	—(3)	—(1)	—(1)	—(1)

Table B9. Correlations between Value of Pesticide Uses to Manufacturers and Quality of Information on Animal Risk, as Measured by Gamma

	Gamma										
	Decrease in Nontarget Populations				Acute Toxicity to Wildlife				Risk to Endangered Species		
Pesticide	Potential Exposure	LD_{50}	Probability of Exposure	Risk	Residues	LD_{50}	Amount Food Consumed	Risk	Exposure	LD_{50}	Risk
Endrin	-1	-1	-1	-1	0	—(3)	1	-1	1	1	1
All others	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table B10. Correlations between Percent of Crop Treated and Quality of Information on Consumer Risk, as Measured by Gamma

	Gamma					
	Exposure			Risk		
Pesticide	Residues	Food In Diet	Percent Crop Treated	Oncogenicity	Reproductive Effects	Mutagenicity
DBCP:						
Upper Range G	—(3)	—(?)	1	—(3)	—(1)	n/a
Lower Range G	—(3)	—(?)	0	—(3)	—(1)	n/a
2,4,5-T	—(1)	—(1)	—(0)	—(1)	—(1)	n/a
Pronamide	—(2)	—(?)	—(?)	0	n/a	n/a
Amitraz	—(5)	—(5)	—(2)	—(3)	n/a	n/a
Silvex	0	-.5	1	—(1)	—(1)	n/a
Dimethoate:						
Upper Range G	—(2)	—(5)	-.208	—(1)	—(3)	—(1)
Lower Range G	—(2)	—(?)	-.208	—(1)	—(3)	—(1)
Chlorobenzilate	—(2)	—(?)	—(5)	-1	-1	n/a
Endrin	.429	1	-.143	n/a	.429	n/a

Table B11. Correlations between Percent of Crop Treated and Quality of Information on Ground Applicator Risk, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorp-tion	Dura-tion	Amount	Absorp-tion	Dura-tion	Resi-dues	Food in Diet	% Crop Treat	Onco-gen	Reproduc-tive/Feto-toxin	Muta-gen
Chlorobenzilate	1	1	1	1	1	1	—(0)	—(0)	—(0)	1	1	n/a
Endrin	.111	-.333	-.375	.111	-.333	-.375	—(0)	—(0)	—(0)	n/a	.111	n/a
DBCP												
Upper Range G	—(2)	—(2)	-1	—(7)	—(0)	1	—(0)	—(0)	—(0)	1	—(1)	n/a
Lower Range G	—(2)	—(2)	1	—(7)	—(0)	1	—(0)	—(0)	—(0)	1	—(1)	n/a
2,4,5-T												
Handsprayer	-1	-1	-1	-1	—(0)	-1	-1	-1	—(0)	-1	-1	n/a
Tractor Application	-1	-1	-1	-1	—(0)	-1	-1	-1	—(0)	-1	-1	n/a
Pronamide												
Handsprayer	-1	—(?)	-1	-1	—(?)	-1	-1	—(?)	—(?)	-1	n/a	n/a
Commercial Application	-1	—(?)	-1	-1	—(?)	-1	-1	—(?)	—(?)	-.5	n/a	n/a
Amitraz	—(5)	—(2)	—(3)	—(?)	—(2)	—(3)	—(0)	—(0)	—(0)	—(3)	n/a	n/a
Silvex	1	—(0)	—(0)	1	—(0)	—(0)	—(0)	—(0)	—(0)	1	1	n/a
Dimethoate:												
Boom & Compressed Air:												
Upper Range G	-.114	-.114	-.114	-.114	-.114	-.114	-.114	-.114	-.114	-.034	-.034	-.034
Lower Range G	-.149	-.149	-.149	-.149	-.149	-.149	-.149	-.149	-.149	-.056	-.056	-.056
Air Blast:												
Upper Range G	.083	-.1	-.1	.083	-.1	-.1	-.1	-.1	-.1	-.034	-.034	-.034
Lower Range G	.083	-.1	-.1	.083	-.1	-.1	-.1	-.1	-.1	-.056	-.056	-.056

Table B12. Correlations between Percent of Crop Treated and Quality of Information on Mixer and Loader Risk, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
Pronamide												
Commercial	-1	—(?)	-1	-1	—(?)	-1	-1	—(?)	—(?)	-.5	n/a	n/a
Handsprayer	-1	—(?)	-1	-1	—(?)	-1	-1	—(?)	—(?)	-1	n/a	n/a
Amitraz	—(7)	—(2)	—(2)	—(5)	—(2)	—(2)	—(0)	—(0)	—(0)	—(3)	n/a	n/a
Silvex	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
DBCP												
Upper Range	—(2)	—(2)	—(2)	—(7)	—(0)	1	—(0)	—(0)	—(0)	1	—(1)	n/a
Lower Range	—(2)	—(2)	—(2)	—(7)	—(0)	1	—(0)	—(0)	—(0)	1	—(1)	n/a
2,4,5-T	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Chlorobenzilate	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Endrin	—(0)	—(0)	—(0)	.333	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	.333	n/a
Dimethoate												
Upper Range G	—(0)	-.172	-.172	—(0)	-.172	-.172	-.172	-.172	-.172	-.172	-.172	-.172
Lower Range G	—(0)	-.195	-.195	—(0)	-.195	-.195	-.195	-.195	-.195	-.195	-.195	-.195

Table B13. Correlations between Percent of Crop Treated and Quality of Pilot Risk Information, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
Chlorobenzilate	—(1)	—(0)	—(0)	—(1)	—(0)	—(0)	—(0)	—(0)	—(0)	—(1)	—(1)	n/1
Endrin	.6	.333	1	.6	.333	1	—(0)	—(0)	—(0)	n/a	.6	n/a
DBCP												
Upper Range G	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Lower Range G	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2,4,5-T	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Amitraz	—(5)	—(2)	—(2)	—(5)	—(2)	—(2)	—(0)	—(0)	—(0)	—(3)	n/a	n/a
Silvex	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Pronamide	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Dimethoate												
Upper Range G	-.025	-.025	-.025	-.025	-.025	-.025	-.025	-.025	-.025	-.025	-.025	-.025
Lower Range G	0	0	0	0	0	0	0	0	0	0	0	0

Table B14. Correlations between Percent of Crop Treated and Quality of Information on Risk to Persons Exposed to Drift, as Measured by Gamma

	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
Pronamide	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	n/a
Amitraz	—(5)	—(0)	—(2)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(1)	n/a	n/a
Silvex	—(1)	—(0)	—(0)	—(1)	—(0)	—(0)	—(0)	—(0)	—(0)	—(1)	—(1)	n/a
DBCP	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2,4,5-T	—(1)	—(5)	—(2)	—(5)	—(?)	—(2)	—(1)	—(1)	—(0)	—(1)	—(1)	n/a
Chlorobenzilate	1	—(0)	—(0)	1	—(0)	—(0)	—(0)	—(0)	—(0)	1	1	n/a
Endrin	.733	.333	—(0)	.833	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	.733	n/a
Dimethoate	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)

Table B15. Correlations between Percent of Crop Treated and Quality of Farmworker Risk Information, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
Chlorobenzilate	—(1)	1	1	-1	—(0)	—(0)	—(0)	—(0)	—(0)	—(1)	—(1)	n/a
Endrin	-1	—(0)	—(0)	-1	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	-1	n/a
DBCP	—(0)	—(0)	—(0)	—(7or1)	—(0)	—(0)	—(0)	—(0)	—(0)	—(3or1)	—(1)	n/a
Pronamide	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	n/a
Amitraz	—(7)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(1)	n/a	n/a
Silvex	1	—(0)	—(0)	1	—(0)	—(0)	—(0)	—(0)	—(0)	1	1	n/a
2,4,5-T	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Dimethoate	—(1)	—(3)	—(0)	—(1)	—(2)	—(0)	—(2)	—(5)	—(3)	—(1)	—(1)	—(1)

Table B16. Correlations between Percent of Crop Treated and Quality of Information on Persons Exposed to Spills, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
Pronamide	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	n/a
Amitraz	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	n/a
Silvex	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
DBCP	—(2)	—(2)	—(2)	—(?)	—(0)	—(0)	—(0)	—(0)	—(0)	—(3)	—(1)	n/a
2,4,5-T	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Dimethoate	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)
Chlorobenzilate	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Endrin	.333	—(0)	—(0)	.750	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	.333	n/a

Table B17. Correlations between Percent of Crop Treated and Quality of Information on Aerial Ground Crew Risk, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
Dimethoate												
Upper Range G	-.025	-.025	-.025	-.025	-.025	-.025	-.025	-.025	-.025	-.025	-.025	-.025
Lower Range G	0	0	0	0	0	0	0	0	0	0	0	0
Chlorobenzilate	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Endrin	—(0)	--(0)	—(0)	—(0)	--(0)	—(0)	—(0)	—(0)	—(0)	n/a	—(0)	n/a
2,4,5-T	—(1)	—(5)	—(2)	—(5)	—(?)	—(2)	—(1)	—(1)	—(0)	—(1)	—(1)	n/a
DBCP	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Pronamide	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Amitraz	--(0)	--(0)	—(0)	—(0)	--(0)	--(0)	—(0)	—(0)	—(0)	—(0)	n/a	n/a
Silvex	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a

Table B18. Correlations between Percent of Crop Treated and Quality of Information on Animal Risk, as Measured by Gamma

	Gamma										
	Decrease in Nontarget Populations				Acute Toxicity to Wildlife				Risk to Endangered Species		
Pesticide	Potential Exposure	LD_{50}	Probability of Exposure	Risk	Residues	LD_{50}	Amount Food Consumed	Risk	Exposure	LD_{50}	Risk
Endrin	.158	-.333	-.2	0	.259	0	.36	.368	-.5	-.2	-.5
All others	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table B19. Correlations between Annual Per Acre User Losses from Cancellation and Quality of Information on Risk to Consumers, as Measured by Gamma

	Gamma					
	Exposure			Risk		
Pesticide	Residues	Food In Diet	Percent Crop Treated	Oncogenicity	Reproductive Effects	Mutagenicity
Pronamide	—(2)	—(?)	—(?)	—(3)	n/a	n/a
2,4,5-T	—(1)	—(1)	—(0)	—(1)	—(1)	n/a
Silvex:						
Upper Range	0	-.5	1	—(1)	—(1)	n/a
Lower Range	.5	-1	1	—(1)	—(1)	n/a
DBCP:						
Upper Range	—(3)	—(?)	1	—(3)	—(1)	n/a
Lower Range	—(3)	—(?)	1	—(3)	—(1)	n/a
Chlorobenzilate	—(2)	—(?)	—(5)	-.5	-.5	n/a
Endrin:						
Upper Range	.143	1	-.429	n/a	.143	n/a
Lower Range	.429	0	.143	n/a	.429	n/a
Dimethoate:						
Upper Range	—(2)	—(5)	0	—(1)	—(3)	—(1)
Lower Range	—(2)	—(5)	.5	—(1)	—(3)	—(1)
Amitraz	—(5)	—(5)	—(2)	—(3)	n/a	n/a

Table B20. Correlations between Annual Per Acre User Losses from Cancellation and Quality of Information on Ground Applicator Risk, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorp-tion	Dura-tion	Amount	Absorp-tion	Dura-tion	Resi-dues	Food in Diet	% Crop Treat	Onco-gen	Reproduc-tive/Feto-toxin	Muta-gen
Pronamide:												
Commercial	—(5)	—(?)	—(?)	—(5)	—(?)	—(?)	—(2)	—(?)	—(?)	—(3)	n/a	n/a
Handsprayers	—(5)	—(?)	—(1)	—(5)	—(?)	—(1)	—(2)	—(?)	—(?)	—(1)	n/a	n/a
2,4,5-T:												
Handsprayers	0	0	0	0	—(0)	0	0	0	—(0)	0	0	n/a
Tractors	0	0	0	0	—(0)	0	0	0	—(0)	0	0	n/a
Silvex:												
Upper Range	.143	—(0)	—(0)	.143	—(0)	—(0)	—(0)	—(0)	—(0)	.333	.333	n/a
Lower Range	.429	—(0)	—(0)	.429	—(0)	—(0)	—(0)	—(0)	—(0)	.667	.667	n/a
DBCP:												
Upper Range	—(2)	—(2)	.4	—(7)	—(0)	1	—(0)	—(0)	—(0)	1	—(1)	n/a
Lower Range	—(2)	—(2)	.4	—(7)	—(0)	1	—(0)	—(0)	—(0)	1	—(1)	n/a
Chlorobenzilate	.5	.5.	.5	.5	.5	.5	—(0)	—(0)	—(0)	.5	.5	n/a
Endrin:												
Upper Range	.467	.111	0	.467	.111	0	—(0)	—(0)	—(0)	n/a	.467	n/a
Lower Range	.333	.111	0	.333	.111	0	—(0)	—(0)	—(0)	n/a	.333	n/a
Dimethoate:												
Upper Range:												
Boom & C/A	-.026	-.026	-.026	-.026	-.026	-.026	-.026	-.026	-.026	.085	.085	.085
Air Blast	.176	.2	.2	.176	.2	.2	.2	.2	.2	.085	.085	.085
Lower Range:												
Boom & C/A	.053	.053	.053	.053	.053	.053	.053	.053	.053	.195	.195	.195
Air Blast	.176	.2	.2	.176	.2	.2	.2	.2	.2	.195	.195	.195
Amitraz	—(5)	—(2)	—(3)	—(?)	—(2)	—(3)	—(0)	—(0)	—(0)	—(3)	n/a	n/a

Table B21. Correlations between Annual Per Acre User Losses from Cancellation and Quality of Information on Risk to Mixers and Loaders, as Measured by Gamma

Pesticide	Exposure: Dermal Amount	Exposure: Dermal Absorption	Exposure: Dermal Duration	Exposure: Inhalation Amount	Exposure: Inhalation Absorption	Exposure: Inhalation Duration	Exposure: Dietary Residues	Exposure: Dietary Food in Diet	Exposure: Dietary % Crop Treat	Risk: Oncogen	Risk: Reproductive/Fetotoxin	Risk: Mutagen
Pronamide												
Commercial	—(5)	—(?)	—(?)	—(5)	—(?)	—(?)	—(2)	—(?)	—(?)	—(3)	n/a	n/a
Hand-sprayers	—(5)	—(?)	—(1)	—(5)	—(?)	—(1)	—(2)	—(?)	—(?)	—(1)	n/a	n/a
2,4,5-T	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Silvex	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
DBCP:												
Upper Range	—(2)	—(2)	—(2)	—(7)	—(0)	1	—(0)	—(0)	—(0)	1	—(1)	n/a
Lower Range	—(2)	—(2)	—(2)	—(7)	—(0)	1	—(0)	—(0)	—(0)	1	—(1)	n/a
Chlorobenzilate	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Endrin:												
Upper Range	—(0)	—(0)	—(0)	-.2	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	-.2	n/a
Lower Range	—(0)	—(0)	—(0)	.2	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	.2	n/a
Amitraz	—(7)	—(2)	—(2)	—(5)	—(2)	—(2)	—(0)	—(0)	—(0)	—(3)	n/a	n/a
Dimethoate:												
Upper Range	—(0)	.091	.091	—(0)	.091	.091	.091	.091	.091	.091	.091	.091
Lower Range	—(0)	.250	.250	—(0)	.250	.250	.250	.250	.250	.250	.250	.250

Table B22. Correlations between Annual Per Acre User Losses from Cancellation and Quality of Information on Pilot Risk, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
Pronamide	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2,4,5-T	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Silvex	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
DBCP	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Chlorobenzilate	—(1)	—(0)	—(0)	—(1)	—(0)	—(0)	—(0)	—(0)	—(0)	—(1)	—(1)	n/a
Endrin:												
Upper Range	.2	-.333	1	.2	-.333	1	—(0)	—(0)	—(0)	n/a	.2	n/a
Lower Range	.2	.333	0	.2	.333	0	—(0)	—(0)	—(0)	n/a	.2	n/a
Amitraz	—(5)	—(2)	—(2)	—(5)	—(2)	—(2)	—(0)	—(0)	—(0)	—(3)	n/a	n/a
Dimethoate:												
Upper Range	-.353	-.353	-.353	-.353	-.353	-.353	-.353	-.353	-.353	-.353	-.353	-.353
Lower Range	.050	.050	.050	.050	.050	.050	.050	.050	.050	.050	.050	.050

Table B23. Correlations between Annual Per Acre User Losses from Cancellation and Quality of Information on Risk to Persons Exposed to Drift, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
Pronamide	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	n/a
2,4,5-T	1	1	1	1	—(?)	1	1	1	—(0)	1	1	n/a
Silvex:												
Upper Range	—(1)	—(0)	—(0)	—(1)	—(0)	—(0)	—(0)	—(0)	—(0)	—(1)	—(1)	n/a
Lower Range	—(1)	—(0)	—(0)	—(1)	—(0)	—(0)	—(0)	—(0)	—(0)	—(1)	—(1)	n/a
DBCP	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Chlorobenzilate	.5	—(0)	—(0)	.5	—(0)	—(0)	—(0)	—(0)	—(0)	.5	.5	n/a
Endrin:												
Upper Range	.455	-.2	—(0)	1	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	.455	n/a
Lower Range	.636	.2	—(0)	.778	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	.636	n/a
Amitraz	—(5)	—(0)	—(2)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(1)	n/a	n/a
Dimethoate	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)

Table B24. Correlations between Annual Per Acre User Losses from Cancellation and Quality of Information on Risk to Farmworkers, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorp- tion	Dura- tion	Amount	Absorp- tion	Dura- tion	Resi- dues	Food in Diet	% Crop Treat	Onco- gen	Reproduc- tive/Feto- toxin	Muta- gen
Pronamide	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	n/a
2,4,5-T	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Silvex:												
Upper Range	1	—(0)	—(0)	1	—(0)	—(0)	—(0)	—(0)	—(0)	1	1	n/a
Lower Range	.333	—(0)	—(0)	.333	—(0)	—(0)	—(0)	—(0)	—(0)	.333	.333	n/a
DBCP:												
Upper Range	—(0)	—(0)	—(0)	—(7or1)	—(0)	—(0)	—(0)	—(0)	—(0)	—(3or1)	—(1)	n/a
Lower Range	—(0)	—(0)	—(0)	—(7or1)	—(0)	—(0)	—(0)	—(0)	—(0)	—(3or1)	—(1)	n/a
Chlorobenzilate	—(1)	.5	.5	-.5	—(0)	—(0)	—(0)	—(0)	—(0)	—(1)	—(1)	n/a
Endrin:												
Upper Range	-1	—(0)	—(0)	-1	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	-1	n/a
Lower Range	-1	—(0)	—(0)	-1	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	-1	n/a
Amitraz	—(7)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(1)	n/a	n/a
Dimethoate:												
Upper Range	—(1)	—(3)	—(0)	—(1)	—(2)	—(0)	—(2)	—(5)	—(3)	—(1)	—(1)	—(1)
Lower Range	—(1)	—(3)	—(0)	—(1)	—(2)	—(0)	—(2)	—(5)	—(3)	—(1)	—(1)	—(1)

Table B25. Correlations between Annual Per Acre User Losses from Cancellation and Quality of Information on Risk to Persons Exposed to Spills, as Measured by Gamma

Gamma

Pesticide	Exposure: Dermal Amount	Exposure: Dermal Absorption	Exposure: Dermal Duration	Exposure: Inhalation Amount	Exposure: Inhalation Absorption	Exposure: Inhalation Duration	Exposure: Dietary Residues	Exposure: Dietary Food in Diet	Exposure: Dietary % Crop Treat	Risk: Oncogen	Risk: Reproductive/Fetotoxin	Risk: Mutagen
Pronamide	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	n/a
2,4,5-T	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Silvex	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
DBCP	—(2)	—(2)	—(2)	—(?)	—(0)	—(0)	—(0)	—(0)	—(0)	—(3)	—(1)	n/a
Chlorobenzilate	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Endrin:												
Upper Range	-.333	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	-.333	n/a
Lower Range	0	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	0	n/a
Amitraz	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	n/a
Dimethoate	—(0)	—(0)	—(0)	—(0)	--(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)

Table B26. Correlations between Annual Per Acre User Losses from Cancellation and Quality of Information on Risk to Aerial Ground Crews, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
Pronamide	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2,4,5-T	1	1	1	1	—(?)	1	1	1	—(0)	1	1	n/a
Silvex	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
DBCP	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Chlorobenzilate	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Endrin	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	—(0)	n/a
Amitraz	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	n/a
Dimethoate:												
Upper Range	-.353	-.353	-.353	-.353	-.353	-.353	-.353	-.353	-.353	-.353	-.353	-.353
Lower Range	.050	.050	.050	.050	.050	.050	.050	.050	.050	.050	.050	.050

Table B27. Correlations between Annual Per Acre User Losses from Cancellation and Quality of Information on Animal Risk, as Measured by Gamma

	Gamma										
	Decrease in Nontarget Populations				Acute Toxicity to Wildlife				Risk to Endangered Species		
Pesticide	Potential Exposure	LD_{50}	Probability of Exposure	Risk	Residues	LD_{50}	Amount Food Consumed	Risk	Exposure	LD_{50}	Risk
Endrin:											
Upper Range	.333	-.2	.125	.077	.647	.667	.733	.231	0	.5	-.2
Lower Range	.333	.2	.250	.077	.412	.333	.333	.231	-.333	0	-.6
All Others	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table B28. Correlations between Annual Total User Losses from Cancellation and Quality of Information on Risk to Consumers, as Measured by Gamma

	Gamma					
	Exposure			Risk		
Pesticide	Residues	Food In Diet	Percent Crop Treated	Oncogenicity	Reproductive Effects	Mutagenicity
Pronamide	—(2)	—(?)	—(?)	—(3)	n/a	n/a
2,4,5-T	—(1)	—(1)	—(0)	—(1)	—(1)	n/a
Silvex	0	0	1	—(1)	—(1)	n/a
DBCP:						
Upper Range	—(3)	—(?)	1	—(3)	—(1)	n/a
Lower Range	—(3)	—(?)	1	—(3)	—(1)	n/a
Chlorobenzilate	—(2)	—(?)	—(5)	-1	-1	n/a
Endrin:						
Upper Range	.429	1	-.143	n/a	.429	n/a
Lower Range	.429	1	-.143	n/a	.429	n/a
Amitraz	—(5)	—(5)	—(2)	—(3)	n/a	n/a
Dimethoate						
Upper Range	—(2)	—(5)	.108	—(1)	—(3)	—(1)
Lower Range	—(2)	—(5)	.162	—(1)	—(3)	—(1)

Table B29. Correlations between Annual Total User Losses from Cancellation and Quality of Information on Risk to Ground Applicators, as Measured by Gamma

	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
Pronamide:												
Commercial	—(5)	—(?)	—(?)	—(5)	—(?)	—(?)	—(2)	—(?)	—(?)	—(3)	n/a	n/a
Handsprayers	—(5)	—(?)	—(1)	—(5)	—(?)	—(1)	—(2)	—(?)	—(?)	—(1)	n/a	n/a
2,4,5-T:												
Handsprayers	1	1	1	1	—(0)	1	1	1	—(0)	1	1	n/a
Tractors	1	1	1	1	—(0)	1	1	1	—(0)	1	1	n/a
Silvex	-.143	—(0)	—(0)	-.143	—(0)	—(0)	—(0)	—(0)	—(0)	0	0	n/a
DBCP:												
Upper Range	—(2)	—(2)	-.556	—(7)	—(0)	1	—(0)	—(0)	—(0)	1	—(1)	n/a
Lower Range	—(2)	—(2)	-.556	—(7)	—(0)	1	—(0)	—(0)	—(0)	1	—(1)	n/a
Chlorobenzilate	1	1	1	1	1	1	—(0)	—(0)	—(0)	1	1	n/a
Fndrin:												
Upper Range	.2	-.111	-.2	.2	-.111	-.2	—(0)	—(0)	—(0)	n/a	.2	n/a
Lower Range	.067	-.333	-.4	.067	-.333	-.4	—(0)	—(0)	—(0)	n/a	.067	n/a
Amitraz	—(5)	—(2)	—(3)	—(?)	—(2)	—(3)	—(0)	—(0)	—(0)	—(3)	n/a	n/a
Dimethoate:												
Upper & Lower Ranges:												
Boom & C/A	-.008	-.008	-.008	-.008	-.008	-.008	-.008	-.008	-.008	.099	.099	.099
Air Blast	.235	.133	.133	.235	.133	.133	.133	.133	.133	.099	.099	.099

Table B30. Correlations between Annual Total User Losses from Cancellation and Quality of Information on Risk to Mixers and Loaders, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
Pronamide:												
Commercial	—(5)	—(?)	—(?)	—(5)	—(?)	—(?)	—(2)	—(?)	—(?)	—(3)	n/a	n/a
Handsprayers	—(5)	—(?)	—(1)	—(5)	—(?)	—(1)	—(2)	—(?)	—(?)	—(1)	n/a	n/a
2,4,5-T	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Silvex	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
DBCP:												
Upper Range	—(2)	—(2)	—(2)	—(7)	—(0)	1	—(0)	—(0)	—(0)	1	—(1)	n/a
Lower Range	—(2)	—(2)	—(2)	—(7)	—(0)	1	—(0)	—(0)	—(0)	1	—(1)	n/a
Chlorobenzilate	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Endrin:												
Upper Range	—(0)	—(0)	—(0)	.2	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	.2	n/a
Lower Range	—(0)	—(0)	—(0)	.2	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	.2	n/a
Amitraz	—(7)	—(2)	—(2)	—(5)	—(2)	—(2)	—(0)	—(0)	—(0)	—(3)	n/a	n/a
Dimethoate:												
Upper Range	—(0)	.092	.092	—(0)	.092	.092	.092	.092	.092	.092	.092	.092
Lower Range	—(0)	.059	.059	—(0)	.059	.059	.059	.059	.059	.059	.059	.059

Table B31. Correlations between Annual Total User Losses from Cancellation and Quality of Information on Risk to Pilots, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
Pronamide	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2,4,5-T	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Silvex	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
DBCP	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Chlorobenzilate	—(1)	—(0)	—(0)	—(1)	—(0)	—(0)	—(0)	—(0)	—(0)	—(1)	—(1)	n/a
Endrin:												
Upper Range	.6	.333	1	.6	.333	1	—(0)	—(0)	—(0)	n/a	.6	n/a
Lower Range	.6	.333	1	.6	.333	1	—(0)	—(0)	—(0)	n/a	.6	n/a
Amitraz	—(5)	—(2)	—(2)	—(5)	—(2)	—(2)	—(0)	—(0)	—(0)	—(3)	n/a	n/a
Dimethoate:												
Upper Range	-.174	-.174	-.174	-.174	-.174	-.174	-.174	-.174	-.174	-.174	-.174	-.174
Lower Range	-.119	-.119	-.119	-.119	-.119	-.119	-.119	-.119	-.119	-.119	-.119	-.119

Table B32. Correlations between Annual Total User Losses from Cancellation and Quality of Information on Risk to Persons Exposed to Drift, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
Pronamide	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	n/a
2,4,5-T	—(1)	—(5)	—(2)	—(5)	—(?)	—(2)	—(1)	—(1)	—(0)	—(1)	—(1)	n/a
Silvex	—(1)	—(0)	—(0)	—(1)	—(0)	—(0)	—(0)	—(0)	—(0)	—(1)	—(1)	n/a
DBCP	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Chlorobenzilate	1	—(0)	—(0)	1	—(0)	—(0)	—(0)	—(0)	—(0)	1	1	n/a
Endrin:												
Upper Range	.636	.2	—(0)	.778	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	.636	n/a
Lower Range	.636	.2	—(0)	.778	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	.636	n/a
Amitraz	—(5)	—(0)	—(2)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(1)	n/a	n/a
Dimethoate	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)

Table B33. Correlations between Annual Total User Losses from Cancellation and Quality of Information on Risk to Farmworkers, as Measured by Gamma

Gamma

	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
Pronamide	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	n/a
2,4,5-T	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Silvex	1	—(0)	—(0)	1	—(0)	—(0)	—(0)	—(0)	—(0)	1	1	n/a
DBCP	—(0)	—(0)	—(0)	—(7or1)	—(0)	—(0)	—(0)	—(0)	—(0)	—(3or1)	—(1)	n/a
Chlorobenzilate	—(1)	1	1	-1	—(0)	—(0)	—(0)	—(0)	—(0)	—(1)	—(1)	n/a
Endrin	-1	—(0)	—(0)	-1	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	-1	n/a
Amitraz	—(7)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(1)	n/a	n/a
Dimethoate	—(1)	—(3)	—(0)	—(1)	—(2)	—(0)	—(2)	—(5)	—(3)	—(1)	—(1)	—(1)

Table B34. Correlations between Annual Total User Losses from Cancellation and Quality of Information on Risk to Persons Exposed to Spills, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorp-tion	Dura-tion	Amount	Absorp-tion	Dura-tion	Resi-dues	Food in Diet	% Crop Treat	Onco-gen	Reproduc-tive/Feto-toxin	Muta-gen
Pronamide	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	n/a
2,4,5-T	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Silvex	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
DBCP	—(2)	—(2)	—(2)	—(?)	—(0)	—(0)	—(0)	—(0)	—(0)	—(3)	—(1)	n/a
Chlorobenzilate	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Endrin:												
Upper Range	0	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	0	n/a
Lower Range	0	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	0	n/a
Amitraz	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	n/a
Dimethoate	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)

Table B35. Correlations between Annual Total User Losses from Cancellation and Quality of Information on Risk to Aerial Ground Crews, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
Pesticide	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
Pronamide	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2,4,5-T	—(1)	—(5)	—(2)	—(5)	—(?)	—(2)	—(1)	—(1)	—(0)	—(1)	—(1)	n/a
Silvex	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
DBCP	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Chlorobenzilate	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a
Endrin	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	—(0)	n/a
Amitraz	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	—(0)	n/a	n/a
Dimethoate:												
Upper Range	-.174	-.174	-.174	-.174	-.174	-.174	-.174	-.174	-.174	-.174	-.174	-.174
Lower Range	-.119	-.119	-.119	-.119	-.119	-.119	-.119	-.119	-.119	-.119	-.119	-.119

Table B36. Correlations between Annual Total User Losses from Cancellation and Quality of Information on Animal Risk, as Measured by Gamma

	Gamma										
	Decrease in Nontarget Populations				Acute Toxicity to Wildlife				Risk to Endangered Species		
Pesticide	Potential Exposure	LD_{50}	Probability of Exposure	Risk	Residues	LD_{50}	Amount Food Consumed	Risk	Exposure	LD_{50}	Risk
Endrin:											
Upper Range	.333	-.2	0	.231	.647	.833	.733	.385	.333	1	.2
Lower Range	.2	-.2	-.125	.077	.529	.667	.6	.385	.333	1	.2
All Others	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table B37. Correlations Between EPA's Pesticide Risk Ranking and Quality of Information on Consumer Risk, as Measured by Gamma

	Gamma					
				Risk		
	Residues	Food in Diet	Percent Crop Treated	Oncogen	Reproductive/ Fetotoxin	Mutagen
G	-.048	-.273	.294	.333	.333	—

Table B38. Correlations between EPA's Pesticide Risk Ranking and Quality of Information on Pilot Risk, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
G	.167	.111	0	.167	0	0	.2	.2	.2	.429	.5	—

Table B39. Correlations between EPA's Pesticide Risk Ranking and Quality of Information on Risk to Persons Exposed to Drift, as Measured by Gamma

Gamma

	Exposure									Risk		
	Dermal			Inhalation			Dietary					
	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
G	.176	.333	-.500	.067	—	-.500	-.500	-.500	—	-.091	-.111	—

Table B40. Correlations between EPA's Pesticide Risk Ranking and Quality of Information on Farmworker Risk, as Measured by Gamma

Gamma

	Exposure									Risk		
	Dermal			Inhalation			Dietary					
	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
G	.1	.5	.667	.455	.143	—	.143	.143	.143	1	.273	—

Table B41. Correlations between EPA's Pesticide Risk Ranking and Quality of Information on Aerial Ground Crew Risk, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
G	.2	.2	.2	.556	.2	.2	.2	.2	.2	.5	.429	—

Table B42. Correlations between EPA's Pesticide Risk Ranking and Quality of Information on Risk to Persons Exposed to Accidents and Spills, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat	Oncogen	Reproductive/Fetotoxin	Mutagen
G	.833	.667	.667	1	—	—	—	—	—	1	.8	—

Table B43. Correlations between EPA's Pesticide Risk Ranking and Quality of Information on Ground Mixer and Loader Risk, as Measured by Gamma

	Gamma											
	Exposure									Risk		
	Dermal			Inhalation			Dietary					
	Amount	Absorption	Duration	Amount	Absorption	Duration	Residues	Food in Diet	% Crop Treat.	Oncogen	Reproductive/Fetotoxin	Mutagen
G	-.467	.143	-.222	-.2	-.273	-.263	-.538	.143	.143	-.067	.250	—
			-.111*			-.158*						

* Additional G values resulting from more than one type of ground application for Pronamide.

Table B44. Correlations between EPA's Pesticide Risk Ranking and Quality of Information on Pesticide Toxicity, as Measured by Gamma

	Gamma		
	Toxicity		
	Oncogenicity	Fetotoxicity/Reproductive	Mutagenicity
G	-.333	-.667	—

Table B45. Correlations between Value of Pesticide Uses to Manufacturers and Quality of Information on Changes in Pest Control Costs from Pesticide Cancellation, as Measured by Gamma

	Gamma								
Pesticide	Cost of Pesticide /Unit	Use/A of Pesticide	Acres Treated	Cost of Alterna-tive/Unit	Use/A of Alterna-tive	Treated with Alterna-tive	Acres Abandoned	Change in per Acre Pest Control Costs	Total Change in Pest Control Costs
Chloroben-zilate	—(?)	1	1	1	.818	.500	—(0)	.833	.833
Endrin	-1	1	—(3)	0	—(3)	-1	1	-1	-1
Pronamide	0	—(?)	—(?)	—(?)	—(1)	1	.600	.818	.818
Amitraz	—(3)	—(3)	—(3)	-1	—(3)	—(3)	1	—(3)	—(3)
2,4,5-T	—(3)	—(3)	1	—(3)	—(3)	1	0	1	1
Dimethoate	.478	1	.184	.478	1	.378	.500	.724	.675
DBCP	.887	.862	1	1	1	.844	.632	.807	.807
Silvex	—(?)	—(?)	—(?)	—(1)	—(?)	—(1)	—(0)	—(1)	—(1)

Table B46. Correlations between Value of Pesticide Uses to Manufacturers and Quality of Information on Changes in Value of Production from Pesticide Cancellation, as Measured by Gamma

	Gamma									
Pesticide	Yield /A of Pest-icide	Yield /A of Alter-native	Quality /A of Pest-icide	Quality /A of Alter-native	Acres Treated with Pest-icide	Acres Treated with Alter-native	Acres Abandoned	Price of Good	Per Acre Change in Value of Pro-duction	Total Change in Value of Pro-duction
Chloroben-zilate	.250	.250	.778	.778	1	.500	—(0)	—(0)	1	1
Endrin	1	-1	.333	-.333	—(3)	-1	1	-1	0	0
Pronamide	—(1)	1	—(0)	—(0)	—(?)	1	.600	1	1	1
Amitraz	-1	-1	-1	-1	—(3)	—(3)	1	1	—(3)	—(3)
2,4,5-T	1	1	-.333	-.333	1	1	0	1	—(3)	—(3)
Dimethoate	.207	.162	.126	.126	.184	.378	.500	1	.352	.352
DBCP	.565	.571	.476	.476	1	.844	.632	.950	.653	.653
Silvex	—(1)	—(1)	-1	-1	—(?)	—(1)	—(0)	—(0)	—(1)	—(1)

Table B47. Correlations between Value of Pesticide Uses to Manufacturers and Quality of Information on Other Socio-Economic Impacts, as Measured by Gamma

	Gamma				
	Other Socio-Economic Impacts				
Pesticide	Change in Other Production Costs	Impacts on Producers of Other Goods	Geographic Impacts	Macroeconomic Impacts	Social Impacts
Chlorobenzilate	.667	1	—(0)	—(0)	—(0)
Endrin	-1	-1	1	1	0
Pronamide	.333	1	1	—(0)	—(0)
Amitraz	—(1)	—(0)	—(3)	—(0)	—(0)
2,4,5-T	1	1	1	—(0)	—(0)
Dimethoate	.200	.304	.427	-.305	-.432
DBCP	.267	.250	.140	-.625	-.625
Silvex	—(0)	-1	1	—(0)	—(0)

Table B48. Correlations between Value of Pesticide Uses to Manufacturers and Quality of Information on Distribution of Impacts of Pesticide Cancellation, as Measured by Gamma

	Gamma Distribution of Impacts				
Pesticide	Users	Nonusers	Marketers of Product	Consumers of Products	Pesticide Manufacturers
Chlorobenzilate	1	—(0)	1	1	—(0)
Endrin	-1	0	-1	-1	-1
Pronamide	.818	—(0)	1	1	—(0)
Amitraz	—(3)	1	—(1)	—(1)	—(0)
2,4,5-T	1	0	1	1	—(0)
Dimethoate	.440	—(0)	.143	—(1)	—(0)
DBCP	.914	.100	.209	-.440	—(0)
Silvex	—(1)	—(0)	—(1)	—(1)	—(0)

Table B49. Correlations between Value of Pesticide Uses to Manufacturers and Quality of Information on Compliance with Proposed Restrictions, as Measured by Gamma

	Gamma	
Pesticide	Degree of Compliance	Costs of Compliance
Chlorobenzilate	—(0)	—(1)
Endrin	1	—(1)
Pronamide	—(0)	—(1)
Amitraz	1	—(3)
2,4,5-T	n/a	n/a
Dimethoate	—(0)	—(1)
DBCP	—(1)	—(3)
Silvex	n/a	n/a

Table B50. Correlations between Value of Pesticide Uses to Manufacturers and Pesticide Registration Decisions, as Measured by Gamma

Pesticide	Gamma for Decision
Chlorobenzilate	.500
Endrin	1
Pronamide	—
Amitraz	1
2,4,5-T	—
Dimethoate	—
DBCP	-.143
Silvex	—

Table B51. Correlations between for Percent of Crop Treated and Quality of Information on Changes in Pest Control Costs from Pesticide Cancellation, as Measured by Gamma

	Gamma								
Pesticide	Cost of Pesticide /Unit	Use/A of Pesticide	Acres Treated	Cost of Alterna-tive/Unit	Use/A of Alterna-tive	Acres Treated with Alterna-tive	Acres Abandoned	Change in per Acre Pest Control Costs	Total Change in Pest Control Costs
Chloroben-zilate	—(?)	1	1	.714	.867	.333	—(0)	.647	.647
Endrin	.154	.571	.462	.333	1	.333	.111	.0	.3125
Pronamide	—(?)	—(?)	—(?)	—(?)	—(1)	-1	-1	-.333	-.333
Dimethoate:									
Upper Range G	.263	.778	.048	.263	.778	.243	.094	.407	.407
Lower Range G	.263	.778	.071	.263	.778	.279	.094	.457	.457
Amitraz	—(3)	—(3)	—(3)	-1	—(3)	—(3)	1	—(3)	—(3)
2,4,5-T	—(3)	—(3)	-1	—(3)	—(3)	—(3)	1	—(3)	—(3)
Silvex	—(?)	—(?)	—(?)	—(?)	—(?)	1	.667	1	1
DBCP:									
Upper Range G	.590	1	1	1	1	.800	.423	.556	.556
Lower Range G	.500	.950	.939	1	1	.702	.360	.490	.490

Table B52. Correlations between Percent of Crop Treated and Quality of Information on Changes in Value of Production from Pesticide Cancellation, as Measured by Gamma

	Gamma									
Pesticide	Yield /A of Pest-icide	Yield /A of Alter-native	Quality /A of Pest-icide	Quality /A of Alter-native	Acres Treated with Pest-icide	Acres Treated with Alter-native	Acres Abandoned	Price of Good	Per Acre Change in Value of Pro-duction	Total Change in Value of Pro-duction
Chlorobenzilate	.200	.200	.833	.833	1	.333	—(0)	—(0)	1	1
Endrin	.333	.176	-.034	-.172	.462	.333	.111	.333	.0625	.118
Pronamide	—(1)	-.333	—(0)	—(0)	—(?)	-1	-1	-1	-.333	-.333
Dimethoate:										
Upper Range G	.406	.155	.128	.128	.048	.243	.094	1	.307	.307
Lower Range G	.446	.211	.154	.154	.071	.279	.094	1	.360	.360
Amitraz	-1	-1	-1	-1	—(3)	—(3)	1	1	—(3)	—(3)
2,4,5-T	—(3)	—(3)	1	1	-1	—(3)	1	-1	—(3)	—(3)
Silvex	—(1)	1	-.333	-.333	—(?)	1	.667	1	1	1
DBCP:										
Upper Range G	.722	.692	.111	.111	1	.800	.423	1	.643	.643
Lower Range G	.410	.564	.333	.333	.939	.702	.360	.920	.542	.542

Table B53. Correlations between Percent of Crop Treated and Quality of Information on Other Socio-Economic Impacts, as Measured by Gamma

	Gammma				
	Other Socio-Ecnomic Impacts				
Pesticide	Change in Other Production Costs	Impacts on Producers of Other Goods	Geographic Impacts	Macroeconomic Impacts	Social Impacts
Chlorobenzilate	1	1	—(0)	—(0)	—(0)
Endrin	.125	.333	.385	-.125	.600
Pronamide	-1	-.333	-.333	—(0)	—(0)
Dimethoate:					
Upper Range G	.270	—(0)	.565	-.365	-.162
Lower Range G	.270	—(0)	.565	-.365	-.135
Amitraz	—(1)	—(0)	—(3)	—(0)	—(0)
2,4,5-T	-1	—(1)	—(3)	—(0)	—(0)
Silvex	—(0)	-.500	0	—(0)	—(0)
DBCP:					
Upper Range G	-.308	.286	-.111	1	1
Lower Range G	-.231	.385	.085	1	1

Table B54. Correlations between Percent of Crop Treated and Quality of Information on Distribution of Impacts of Pesticide Cancellation, as Measured by Gamma

	Gamma				
	Distribution of Impacts				Pesticide
Pesticide	Users	Nonusers	Marketers of Product	Consumers of Products	Manufacturers
Chlorobenzilate	1	—(0)	1	1	—(0)
Endrin	.034	.217	.161	.375	-.111
Pronamide	-.333	—(0)	.500	-.333	—(0)
Dimethoate:					
Upper Range G	.281	—(0)	.356	—(1)	—(0)
Lower Range G	.326	—(0)	.311	—(1)	—(0)
Amitraz	—(3)	1	—(1)	—(1)	—(0)
2,4,5-T	—(3)	1	-1	-1	—(0)
Silvex	1	—(0)	-.667	—(1)	—(0)
DBCP:					
Upper Range G	.608	.680	.161	-.364	—(0)
Lower Range G	.545	.950	.037	-.263	—(0)

Table B55. Correlations between Percent of Crop Treated and Quality of Information on Estimated Compliance with Proposed Restrictions, as Measured by Gamma

	Gamma	
Pesticide	Degree of Compliance	Costs of Compliance
Chlorobenzilate	—(0)	—(1)
Endrin	.111	-.417
Pronamide	—(0)	—(1)
Dimethoate	—(0)	—(1)
Amitraz	1	—(3)
2,4,5-T	n/a	n/a
Silvex	n/a	n/a
DBCP	—(1)	—(3)

Table B56. Correlations between Percent of Crop Treated and Pesticide Registration Decisions, as Measured by Gamma

Pesticide	Gamma for Decision
Chlorobenzilate	1
Endrin	.742
Pronamide	—
Dimethoate	—
Amitraz	1
2,4,5-T	—
Silvex	—
DBCP:	
Upper Range G	-.111
Lower Range G	.455

Table B57. Correlations between Annual Per Acre User Losses and Quality of Information on Changes in Pest Control Costs from Pesticide Cancellation, as Measured by Gamma

	Gamma								
Pesticide	Cost of Pesticide /Unit	Use/A of Pesticide	Acres Treated	Cost of Alterna- tive/Unit	Use/A of Alterna- tive	Acres Treated with Alterna- tive	Acres Abandoned	Change in per Acre Pest Control Costs	Total Change in Pest Control Costs
Amitraz	—(3)	—(3)	—(3)	-1	—(3)	—(3)	1	—(3)	—(3)
Chlorobenzilate	—(?)	—(?)	—(5)	1	1	1	—(0)	1	1
Endrin:									
Upper Range G	.455	1	.6	.5	1	.231	.667	.250	.444
Lower Range G	.636	.75	.6	.333	1	.538	-.333	.500	.556
Dimethoate:									
Upper Range G	.826	.667	-.028	.826	.667	.228	.152	.341	.311
Lower Range G	.826	.250	.341	.826	.250	.581	.283	.670	.667
Pronamide	—(?)	—(?)	—(?)	—(?)	—(3)	—(?)	-1	—(3)	—(3)
2,4,5-T	—(3)	—(3)	.333	—(3)	—(3)	1	1	1	1
Silvex:									
Upper Range G	1	1	1	—(?)	1	1	.75	1	1
Lower Range G	1	1	1	—(?)	1	.455	1	.333	.333
DBCP:									
Upper Range G	.520	.821	.692	1	1	.459	.238	.333	.326
Lower Range G	.520	.821	.723	1	1	.568	.333	.417	.411

Table H58. Correlations between Annual per Acre User Losses from Pesticide Cancellation and Quality of Information on Changes in Value of Production from Pesticide Cancellation, as Measured by Gamma

Pesticide	Gamma: Yield /A of Pest-icide	Yield /A of Alter-native	Quality /A of Pest-icide	Quality /A of Alter-native	Acres Treated with Pest-icide	Acres Treated with Alter-native	Acres Abandoned	Price of Good	Per Acre Change in Value of Pro-duction	Total Change in Value of Pro-duction
Amitraz	-1	-1	-1	-1	—(3)	—(3)	1	1	—(3)	—(3)
Chlorobenzilate	-.200	-.200	1	1	—(5)	1	—(0)	—(0)	—(1)	—(1)
Endrin:										
Upper Range G	.636	.467	.412	.176	.600	.231	.667	1	.333	.333
Lower Range G	.091	.600	.059	.294	.600	.538	-.333	.714	.200	.200
Dimethoate:										
Upper Range G	.172	.049	.343	.343	-.028	.228	.152	.778	.160	.160
Lower Range G	.488	.395	.566	.566	.341	.581	.283	.778	.605	.605
Pronamide	—(?)	—(3)	-1	-1	—(?)	—(?)	-1	—(?)	—(3)	—(3)
2,4,5-T	1	1	.333	.333	.333	1	1	.333	—(3)	—(3).
Silvex:										
Upper Range G	—(1)	1	-.333	-.333	1	1	.750	1	1	1
Lower Range G	—(1)	1	.429	.429	1	.455	1	1	.111	.111
DBCP:										
Upper Range G	.386	.484	.556	.556	.692	.459	.238	.583	.429	.429
Lower Range G	.465	.570	.644	.644	.723	.568	.333	.750	.524	.524

Table B59. Correlations between Annual Per Acre User Losses from Pesticide Cancellation and Quality of Information for Other Socio-Economic Impacts, as Measured by Gamma

	Gamma				
Pesticide	Change in Other Production Costs	Impacts on Producers of Other Goods	Geographic Impacts	Macroeconomic Impacts	Social Impacts
Amitraz	—(1)	—(0)	—(3)	—(0)	—(0)
Chlorobenzilate	.333	.600	—(0)	—(0)	—(0)
Endrin:					
Upper Range G	.400	0	.857	.400	.800
Lower Range G	.600	.400	.429	0	1
Dimethoate:					
Upper Range G	.043	.769	.324	-.109	-.400
Lower Range G	.326	.769	.454	.036	-.145
Pronamide	-1	—(1)	—(3)	—(0)	—(0)
2,4,5-T	0	1	1	—(0)	—(0)
Silvex:					
Upper Range G	—(0)	-1	.333	—(0)	—(0)
Lower Range G	—(0)	-.5	-.556	—(0)	—(0)
DBCP:					
Upper Range G	-.0625	.765	.010	1	1
Lower Range G	0	.765	.010	1	1

Table B60. Correlations between Annual Per Acre User Losses from Pesticide Cancellation and Quality of Information on Distribution of Impacts of Pesticide Cancellation, as Measured by Gamma

Pesticide	Gamma Distribution of Impacts: Users	Nonusers	Marketers of Product	Consumers of Products	Pesticide Manufacturers
Amitraz	—(3)	1	—(1)	—(1)	—(0)
Chlorobenzilate	—(1)	—(0)	—(1)	—(1)	—(0)
Endrin:					
Upper Range G	.412	.714	.529	.529	-.333
Lower Range G	.294	.429	.647	.647	0
Dimethoate:					
Upper Range G	.229	—(0)	.057	—(1)	—(0)
Lower Range G	.631	—(0)	.014	—(1)	—(0)
Pronamide	—(3)	—(0)	1	—(1)	—(0)
2,4,5-T	1	1	0	0	—(0)
Silvex:					
Upper Range G	1	—(0)	-.750	—(1)	—(0)
Lower Range G	.111	—(0)	-1.000	—(1)	—(0)
DBCP:					
Upper Range G	.375	.754	-.208	-.077	—(0)
Lower Range G	.475	.846	-.094	-.077	—(0)

Table B61. Correlations between Annual Per Acre User Losses from Pesticide Cancellation and Quality of Information on Compliance with Proposed Restrictions, as Measured by Gamma

	Gamma	
Pesticide	Degree of Compliance	Costs of Compliance
Amitraz	1	—(3)
Chlorobenzilate	—(0)	—(1)
Endrin:		
Upper Range G	.667	.273
Lower Range G	-.333	-.091
Dimethoate	—(0)	—(1)
Pronamide	—(0)	—(1)
2,4,5-T	n/a	n/a
Silvex	n/a	n/a
DBCP	—(1)	—(3)

Table B62. Correlations between Annual Per Acre User Losses from Pesticide Cancellation and Pesticide Registration Decisions, as Measured by Gamma

Pesticide	Gamma for Decision
Amitraz	1
Chlorobenzilate	.500
Endrin:	
Upper Range G	.692
Lower Range G	.385
Dimethoate	—
Pronamide	—
2,4,5-T	—
Silvex	—
DBCP	.571

Table B63. Correlations between Annual Total User Losses from Pesticide Cancellation and Quality of Information on Changes in Pest Control Costs from Pesticide Cancellation, as Measured by Gamma

	Gamma								
Pesticide	Cost of Pesticide /Unit	Use/A of Pesticide	Acres Treated	Cost of Alterna-tive/Unit	Use/A of Alterna-tive	Acres Treated with Alterna-tive	Acres Abandoned	Per Acre Change Pest Control Costs	Total Change in Pest Control Costs
Amitraz	—(3)	—(3)	—(3)	-1	—(3)	—(3)	1	—(3)	—(3)
Chlorobenzilate	—(?)	—(?)	—(5)	—(3)	1	.500	—(0)	1	1
Endrin:									
Upper Range G	.455	1	.733	.667	1	.231	1	.250	.765
Lower Range G	.455	1	.867	.667	1	.385	1	.250	.882
Dimethoate:									
Upper Range G	.478	.619	.024	.478	.619	.439	.475	.500	.431
Lower Range G	.478	.429	.072	.478	.429	.451	.475	.448	.431
Pronamide	—(?)	—(?)	—(?)	—(?)	—(3)	—(?)	.200	—(3)	—(3)
2,4,5-T	—(3)	—(3)	1	—(3)	—(3)	—(3)	-1	—(3)	—(3)
Silvex	1	1	1	—(?)	1	.818	.500	1	1
DBCP:									
Upper Range G	.760	.895	.963	1	1	.651	.653	.728	.728
Lower Range G	.765	.895	.963	1	1	.651	.632	.732	.732

Table B64. Correlations between Annual Total User Losses from Pesticide Cancellation and Quality of Information on Changes in Value of Production from Pesticide Cancellation, as Measured by Gamma

	Gamma									
Pesticide	Yield /A with Pesticide	Yield /A with Alternative	Quality /A with Pesticide	Quality /A with Alternative	Acres Treated	Acres Treated with Alternative	Acres Abandoned	Price of Good	Per Acre Change in Value of Production	Total Change in Value of Production
Amitraz	-1	-1	-1	-1	—(3)	—(3)	1	1	—(3)	—(3)
Chlorobenzilate	0	0	1	1	—(5)	.500	—(0)	—(0)	—(1)	—(1)
Endrin:										
Upper Range G	.636	.333	.529	.294	.733	.231	1	.714	.467	.467
Lower Range G	.636	.200	.412	.176	.867	.385	1	.429	.333	.333
Dimethoate:										
Upper Range G	.268	.179	.429	.429	.024	.439	.475	.778	.296	.296
Lower Range G	.305	.231	.462	.462	.072	.451	.475	.778	.352	.352
Pronamide	—(?)	—(3)	—(0)	—(0)	—(?)	—(?)	.200	—(?)	—(3)	—(3)
2,4,5-T	—(3)	—(3)	-1	-1	1	—(3)	-1	1	—(3)	—(3)
Silvex	—(1)	1	-.250	-.250	1	.818	.500	1	.778	.778
DBCP:										
Upper Range G	.626	.639	.857	.857	.963	.651	.653	.900	.595	.595
Lower Range G	.626	.639	.857	.857	.963	.651	.632	.900	.595	.595

Table B65. Correlations between Annual Total User Losses from Pesticide Cancellation and Quality of Information on Other Socio-Economic Impacts of Pesticide Cancellation, as Measured by Gamma

Pesticide	Change in Other Production Costs	Gamma Impacts on Producers of Other Goods	Geographic Impacts	Macroeconomic Impacts	Social Impacts
Amitraz	—(1)	—(0)	—(3)	—(0)	—(0)
Chlorobenzilate	.750	1	—(0)	—(0)	—(0)
Endrin:					
Upper Range G	.400	.200	1	.400	.600
Lower Range G	.200	.400	1	.400	.600
Dimethoate:					
Upper Range G	.450	-.217	.322	-.432	-.411
Lower Range G	.450	-.217	.275	-.368	-.347
Pronamide	.200	—(1)	—(3)	—(0)	—(0)
2,4,5-T	1	—(1)	—(3)	—(0)	—(0)
Silvex	—(0)	-.600	.636	—(0)	—(0)
DBCP:					
Upper Range G	0	1	.304	-.067	-.067
Lower Range G	0	1	.304	-.125	-.125

Table B66. Correlations between Annual Total User Losses from Pesticide Cancellation and Quality of Information on Distribution of Impacts from Pesticide Cancellation, as Measured by Gamma

	Gamma				
	Distribution of Impacts				Pesticide
Pesticide	Users	Nonusers	Marketers of Product	Consumers of Products	Manufacturers
Amitraz	—(3)	1	—(1)	—(1)	—(0)
Chlorobenzilate	—(1)	—(0)	—(1)	—(1)	—(0)
Endrin:					
Upper Range G	.529	.714	.529	.529	0
Lower Range G	.412	.571	.412	.412	0
Dimethoate:					
Upper Range G	.344	—(0)	.277	—(1)	—(0)
Lower Range G	.392	—(0)	.244	—(1)	—(0)
Pronamide	—(3)	—(0)	-.200	—(1)	—(0)
2,4,5-T	—(3)	-1	1	1	—(0)
Silvex	1	—(0)	-.500	—(1)	—(0)
DBCP:					
Upper Range G	.826	.424	.143	0	—(0)
Lower Range G	.826	.400	.116	0	—(0)

Table B67. Correlations between Annual Total User Losses from Pesticide Cancellation and Quality of Information on Compliance with Proposed Restrictions, as Measured by Gamma

Pesticide	Gamma: Degree of Compliance	Gamma: Costs of Compliance
Amitraz	1	—(3)
Chlorobenzilate	—(0)	—(1)
Endrin:		
Upper Range G	1	.455
Lower Range G	1	.273
Dimethoate	—(0)	—(1)
Pronamide	—(0)	—(1)
2,4,5-T	n/a	n/a
Silvex	n/a	n/a
DBCP	—(1)	—(3)

Table B68. Correlations between Annual Total User Losses from Pesticide Cancellation and Quality of Information on Pesticide Registration Decisions, as Measured by Gamma

Pesticide	Gamma for Decision
Amitraz	1
Chlorobenzilate	1
Endrin	.692
Dimethoate	—
Pronamide	—
2,4,5-T	—
Silvex	—
DBCP	0

Table B69. Correlations between EPA's Pesticide Risk Ranking and Quality of Information on Changes in Pest Control Costs, as Measured by Gamma

	Gamma
Cost of Pesticide/Unit	0
Cost of Alternative/Unit	0
Use/A of Pesticide	-.417
Use/A of Alternative	-.478
Acres Treated with Pesticide	-.455
Acres Treated with Alternative	-.083
Acres Abandoned if Pesticide Banned	-.250
Per Acre Change in Pest Control Costs	-.500
Total Change in Pest Control Costs	-.417

Table B70. Correlations between EPA's Pesticide Risk Ranking and Quality of Information on Changes in Value of Production, as Measured by Gamma

	Gamma
Yield/A of Pesticide	-.130
Yield/A of Alternative	-.583
Quality/A of Pesticide	.167
Quality/A of Alternative	.167
Acres Treated with Pesticide	-.455
Acres Treated with Alternative	-.083
Acres Abandoned if Pesticide Banned	-.250
Price of Good	-.250
Per Acre Change in Value of Production	-.500
Total Change in Value of Production	-.500

Table B71. Correlations between EPA's Pesticide Risk Ranking and Quality of Information on Other Socio-Economic Impacts, as Measured by Gamma

	Gamma
Changes in Other Production Costs	0
Impacts on Producers of Other Goods	-.043
Geographic Impacts	-.250
Macroeconomic Impacts	.647
Social Impacts	.647

Table B72. Correlations between EPA's Pesticide Risk Ranking and Quality of Information on Distribution of Impacts, as Measured by Gamma

Distribution of Impacts	Gamma
To Users	-.500
To Nonusers	.111
To Marketers of Product	0
To Consumers of Product	-.091
To Manufacturers	1

Table B73. Correlations between EPA's Pesticide Risk Ranking and Quality of Information on Compliance, as Measured by Gamma

	Gamma
Degree of Compliance	.273
Costs of Compliance	-.400

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