Policy For Plenty: Measuring the Benefits of Policy-oriented Social Science Research

George W. Norton and Jeffrey Alwang

May 1997
SP 97-6

Virginia Tech
Dept. of Agricultural and Applied Economics

Policy For Plenty: Measuring the Benefits of Policy-oriented Social Science Research*

by

George W. Norton and Jeffrey Alwang**

* Paper presented at the Symposium on Measuring the Benefits of Policy-Oriented Social Science Research, April, 5, 1997 at the International Food Policy Research Institute, Washington, DC.

** Professor and associate professor, respectively, Department of Agricultural and Applied Economics, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.

Policy for Plenty: Measuring the Benefits of Policy-oriented Social Science Research

Economists have made important contributions to our understanding of the impacts of natural-science and technology-oriented agricultural research. They have made far fewer contributions to our understanding of the benefits of social science research, especially policy research. The need to evaluate policy research arises from two primary sources. First, as budgets tighten, requests increase from public decisionmakers for evidence of research impacts, including the impacts of policy research. Second, assessing the value of policy research programs can help guide the allocation of resources to programs with the highest expected payoffs.

These two sources of demand for policy evaluation imply a need to assess both past and proposed research. The purpose of this essay is to suggest practical methods for providing ex post and ex ante assessments of policy research programs. It reviews the nature of the evaluation problem, draws lessons from previous attempts to assess social science research, develops a conceptual framework for policy evaluation, and suggests a measurement approach consistent with economic theory. Finally it applies the suggested approach to two examples of policy research. The approach, which relies on economic surplus analysis, is designed to be conceptually sound yet cognizant of the time and resource constraints typically imposed on an evaluation effort. It stresses the importance of identifying the counterfactual, i.e., what would have or will happen without the policy research, and of addressing the uncertain nature of key parameters.

Nature of the problem

Conceptually, the output of policy research is information. However, unlike information generated by natural science research, which is often imbedded in technologies, information produced by policy research is usually imbedded in institutions. Many of the benefits of policy research emanate from the reduced cost of welfare-improving institutional change. Ruttan has argued that the demand for social science research is derived from the demand for institutional change or for improved institutional performance (Ruttan, 1984). Certainly that characterization is accurate for most policy research, although part of the demand for policy research comes from groups motivated by self interest as opposed to improvements in overall societal welfare. Ruttan also has noted that our knowledge of the sources of supply of and demand for institutional change remains limited, notwithstanding the contributions of institutional economists. Expanding that knowledge should help in assessing the benefits of policy-oriented social science research.

Supply of Policy Change

In measuring the contribution of research to the supply of policy change, issues such as how to apportion credit to the multiple factors affecting a particular policy change, how to assess causality between research and the implementation of a policy, and how to measure impacts that may not be reflected in the marketplace are crucial to the evaluation. Apportioning credit can be difficult because several pieces of research may contribute to a single policy change. And, basic research on theory and methods contribute to the success of policy research and are part of the research cost. The greater the availability of basic research, the lower the cost of designing improved policies and the more likely the policy prescriptions will be correct. There is also a

complementarity between policy research and policy dialogue with either one less effective without the other.

It is difficult to ascertain if an institutional change is due to social science research or to some other source of information or purely to political pressure. This is the causality problem. In other words, what is the counterfactual? What would have occurred without the policy research? There is perhaps more certainty in linking a yield change to plant breeding research than an institutional change to policy research. The importance of political pressure to policy change implies a need to consider political economy issues in policy evaluation.

The failure of the market to value the research results is a problem with certain types of research aimed at technical change as well, but may affect a higher proportion of policy research benefits. However as we will note below, discovering ways to use markets to value as much of policy research as possible is one of the keys to its evaluation. Nonmarket assessment tools can be called upon when necessary.

Finally, issues related to timing of policy research and data quality must also be considered. Timing is important because of the time value of money, because advice offered after a policy decision is made can be worth very little, and because timeliness influences the likelihood of adoption of recommended changes. And, the better the data, the more reliable the results of policy research. As Lindner (1986) points out, when policy research is wrong, the misinformation generated can do significant harm.

Demand for Policy Change

An understanding of the demand for policy change is particularly important when undertaking ex ante evaluation of policy research. While one can observe ex post whether policies have been adopted and can measure their effects, ex ante evaluations require estimation of the demand for policy change and hence the likelihood of policy adoption. Some of the key issues influencing the demand for policy change are (a) per capita income growth(or decline), (b) changes in product and factor markets including the degree of disequilibria in those markets, (c) constraints on institutional change imposed by ideology, religion, and tradition, (d) short-run political changes and budgeting pressures, and (e) transactions costs and collective action. Many of these issues were identified by Ruttan, but must be considered case by case as research programs are evaluated. For example, per capita income growth can increase the demand for environmental amenities but since the demand varies by country, the value placed on those amenities needs to be measured to compute research benefits. As the demand for amenities grows, so too does the payoff to policy research that can influence those amenities. As another example, economic development implies a rise in the value of human time which can be a powerful force for institutional change (Schultz,1968). The relationship between the rising value of time and the demand for policy change is complex, but the demand for policies that influence human capital formation is particularly relevant, such as education, research, health, and nutrition policies.

Changes or disequilibria in product and factor markets as a result of technical change, population and income growth, and other sources can have a major influence on the demand for institutional

change (Schultz,1975, Bonnen,1983, Ruttan). Policy changes represent lagged accommodations to institutional stresses and strains brought about by disequilibria or secular changes in these markets. Policy research and extension can speed up the institutional change to accommodate the disequilibria. For example, as economic development proceeds, labor migrates from agricultural to non-agricultural employment because (a) the income elasticity of demand for food is less than the income elasticity of demand for nonagricultural goods and services, (b) rural population growth rates tend to be higher than urban population growth rates, (c) technical change in agriculture tends to reduce the demand for labor in many cases, and (d) educational opportunities and demand for human capital are higher in urban areas. The result is chronic income and adjustment problems in agriculture until quite late in the development process. These problems often create a demand for policies to address rural poverty while keeping the price of food low to the swelling urban masses.

Ideology, religion, and tradition may reduce the demand for policy change (Ruttan), while a change in political climate can stimulate such a demand. The result is that both the timing and the level of demand for policy research can be severely constrained for long periods of time or be ratcheted up rapidly.

The presence of transactions costs, combined with the possibility for collective action imply that the relative political power of interest groups will influence the direction of policy change and the likelihood of policy adoption. Transactions costs and collective action also therefore influence both the distribution and the efficiency effects of policies, making at least a rough

assessment of the magnitude of transactions costs and the relative strengths of interest groups relevant to ex ante assessment of policy research.

The interaction between factors influencing the supply of and demand for institutional change determines the potential value of the policy research. As market disequilibria, growing divergence between private and social costs, and other factors shift the demand outward, higher returns to such research result. Examination of factors contributing to the shifts provide clues about these returns. The presence of multiple social objectives also affects how policies are valued.

Multiple objectives

Social science research can be directed at measuring or changing the behavior of economic agents such as producers and consumers or at influencing the decisions of public officials such as policymakers. Policy-oriented social science research is clearly aimed at the latter group, the decisions of which in turn influence the behavior of individual economic agents. Public officials are confronted with the need to employ policy levers to address a set of multiple social objectives. The policy levers need to be identified and so too do the comparative advantages of particular policies in addressing specific objectives. Policy research can play an important role in this regard.

Major objectives of research generally center around societal goals of growth, equity, and security. A primary objective of agricultural research in most societies is to raise overall

economic growth through improvements in agricultural productivity and efficiency. Policy research can potentially contribute to this objective by improving allocative efficiency and reducing externalities that cause social costs to diverge from private costs. It can also inform about policies that reduce transactions costs that constrain economic growth. A second broad objective in many societies is to assist low income groups or to otherwise influence the income distribution in a manner that favors a particular group or factor of production[1]. Policy changes can be potent tools for addressing such an objective, much more so than research that produces new technologies, although technological change certainly can affect income distribution. Policy research is used to measure these distributional impacts and provides information about how best to achieve distributional goals. A third objective is one of reducing risk. This risk may relate to health and safety, food security, prices, production, or income. Policy research has been aimed at developing institutional mechanisms to reduce risk in an economically efficient manner.

The presence of multiple policy objectives increases the diversity of the types of research conducted and complicates evaluation. It implies that it will be difficult to assess the aggregate benefits of policy research without identifying the types of policy research conducted or proposed and without explicitly identifying the social objectives being targeted by the policies themselves. This identification is also needed if the evaluation is to estimate the tradeoffs involved when particular objectives are targeted by policy research. Multiple objectives and diversity of policy research complicate the use of econometric methods for assessing aggregate

[1] Policies also can create opportunities for rent seeking and have unintended distributional effects in favor of specific groups. For example, marketing or credit policies intended to protect small producers or consumers may, in fact, primarily benefit large producers.

benefits of policy research. If assessment focuses instead on specific research programs or projects, a premium is placed on identifying or projecting the paths of information flows that eventually lead to policy decisions.

Lessons from previous evaluations of social science research

The relatively few previous quantitative evaluations of social science research have assessed the contributions of marketing, price analysis and outlook, or management research to the efficiency objective. Methods employed include economic surplus, decision theory, and econometric approaches. Previous studies have focused on how publicly provided information alters producer behavior. None attempted to evaluate policy research, but do offer some guidance as to how one might approach such an evaluation.

The economic surplus approach has been used in several studies to evaluate the net benefits of more accurate outlook and price information (Hayami and Peterson, 1972; Bullock, 1976; Freebairn, 1976, a, b; Bradford and Kelegian, 1977, 1978; Norton and Schuh, 1981, Thabet, Ray, and Bullock, 1983). Benefits of research leading to more accurate outlook and price information are illustrated in the simple static case in Figure 1.

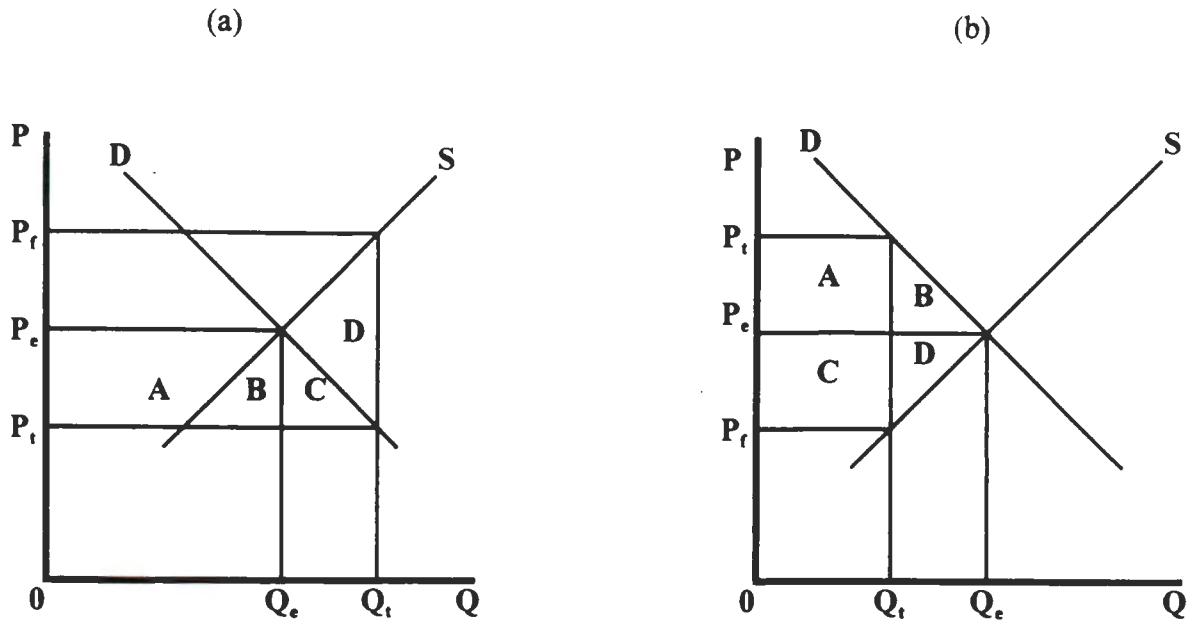

Figure 1. Welfare effects when price is overestimated (a) or underestimated (b)

When producers estimate the price of the commodity to be P_f, which is above the equilibrium price P_e, they produce a quantity of Q_t which is larger than the equilibrium quantity Q_e. The resulting price is P_t and the resulting change in net economic surplus is A + B + C - (A + B + C + D) = - D. Likewise when producers underestimate price (Figure 1b), the change in net economic surplus is - (A + B) + (A - D) = - (B + D). Bearing in mind the well known limitations of economic surplus measures, if social science research leads to price forecasts that are closer to P_e, then net social losses will be reduced. Most studies noted above separate the cases where production as opposed to only inventory adjustments can occur and some consider cross-commodity effects. They derive expressions for calculating expected welfare effects on producers, consumers, and society as a whole. Freebairn (1976,a,b), for example, does all of the above when evaluating the welfare effects of more precise knowledge about factors causing shifts in the demand for and supply of agricultural commodities. He assumes that prices are

formed rationally (in the Muth sense), and compares perfect forecast prices to rational (but inaccurate) forecast prices in supply decisionmaking.

One attraction of the economic surplus approach to valuing public information produced by social science research is that it generates economic benefit measures that are directly comparable to benefit measures traditionally generated for production research. This advantage would be as true for policy-oriented research as it is for price outlook research. One question is how to operationalize the approach. Decision theory helped operationalize the valuing of outlook information. Let's consider how it was used and whether it might also be useful for policy research evaluation.

Cyert and Degroot (1974) have argued, in valuing information, that it is important to identify the process that describes how expectations lead to an equilibrium. They suggest a Bayesian decision making process through which learning takes place in the market, having the effect of continually modifying the prior probability distribution with which the firm starts. Prior distributions can be assigned to all parameters wherever they appear in the model, including parameters on the price variables. Bradford and Kelegian (1977, 1978) and Norton and Schuh (1981) build on this idea and apply Bayesian decision theory to evaluate outlook and price information. In effect they argue that the rational expected price is arrived at through Bayesian learning, but that learning results not only from observing market behavior but from public outlook and price information. This information not only causes speculative inventory holders to revise their prior probability distribution, but affects the commodity price distribution. These changes are evaluated using the economic surplus approach. The value of the information is the

difference between maximum utility with and without outlook information. Bradford and Keligian (1978) implement their model for the case of wheat crop forecasting in the United States. Norton and Schuh consider the case of soybean outlook information provided each year by University of Minnesota economists and compare the value of the information to the cost of research.

The decision theory approach explicitly considers the fact that the value of information is related to uncertainty. Uncertainty is summarized by the dispersion of individuals' subjective probability distributions over possible states of the world (Hirschleifer, 1973). Information consists of events tending to change these probability distributions[2]. One difficulty with using decision theory is estimating the subjective probabilities in the prior and posterior situations. Norton and Schuh assumed that subjective priors were based on historical probabilities of price movements for the previous 15 years. Conditional probabilities were determined by comparing past outlook projections with actual states of nature that occurred. These probabilities were then used to calculate posterior probabilities using Bayes formula.[3]

[2] The decision theory approach can be summarized as follows: A variety of actions are open to the decisionmaker, $a_1, a_2, \ldots a_m$. Several states of nature $S_1, S_2, \ldots S_n$ are also possible and the decisionmaker has some knowledge of the likelihood (prior probability) of such states occurring, $P(S_i)$. With a given amount of knowledge, the decisionmaker will choose the action a_i which maximizes his or her expected utility. The expected utility of the jth action is $\sum_i u(a_j \mid S_i)P(S_i)$. Now if additional information, $Z_1, Z_2, \ldots Z_m$ becomes available to the decisionmaker and he or she has knowledge of the probability of the information coming true, i.e., $P(Z_j \mid S_i)$, by Bayes theorem, $P(S_i \mid Z_j) = P(S_i)P(Z_j \mid S_i) / \sum_i P(S_i)P(Z_j \mid S_i)$. The revised expected value of a_j is now $\sum_j u(a_j \mid S_j)P(S_i \mid Z_j)$. The value of information is the difference between the maximum utility with and without the information and this can be compared with the cost of obtaining the information.

[3] They also assumed that the utility function was linear so that maximizing expected profits was equivalent to maximizing expected utility (Eidman, Carter, and Dean, 1967).

In the policy research arena, decision theory is likely only to be useful for evaluating policy research specifically aimed at reducing risk. While other policies may serve to stabilize prices, their primary objectives are usually more related to efficiency improvements or income transfers. Even when evaluating risk-reducing policies, it is a strong assumption that economic agents behave as though their priors are updated according to Bayes theorem.

Alternative means for valuing information that do not rely on Bayes theorem are provided by Antonovitz and Roe (1982, 1985) in the case of price uncertainty and by Roe and Nygaard (1980) in the case where the parameters of the underlying technology are not known with certainty. These studies rely on the notions that producers allocate resources based on their subjective estimates of prices and of the underlying technology, and that these estimates are not entirely accurate. They suggest means for valuing information based on "subjective" and "actual" or "more informed" production and/or profit functions, and provide one ex post and two ex ante measures of the value of information. As with the decision theory approach, value of information generated for the individual firm can be translated into a measure of the value of information to society using the economic surplus approach.

The procedures suggested by Antonovitz and Roe were used by Norton (1987) to evaluate research and extension in farm management and marketing. A profit function model for U.S. agriculture was estimated with expected prices based on futures prices so that expected profits could be calculated. Actual prices were then substituted into the estimated profit function so that allocative error (value of information) could be calculated. The allocative error was regressed on variables for agricultural marketing, management, and price analysis research; extension;

education; and the coefficient of variation of prices so that the contribution of a subset of agricultural economics research and extension to reducing allocative error could be estimated. Only the extension significantly reduced allocative error.

This econometric approach is applicable to evaluating policy research, since policies announced before planting can reduce allocative error due to the reduced range of uncertainty about prices. However, policies that establish prices above or below free competitive equilibrium levels will result in deadweight losses and the effects of policy research on reducing those losses will still be missed by such an econometric approach. And, research that focuses on this latter set of policies is more prevalent than research aimed at reducing price risk.

Simpler econometric approaches have also been applied to evaluating farm management research, for example by directly including farm management expenditures as a separate variable, along with other research and extension variables, in a production or profit function model (e.g. Evenson, 1978). One could envision including a similar policy expenditure variable or a publication count variable (number of policy articles published) in such a model, but again there would be many drawbacks to the approach. First, policies are of many different types and are aimed at multiple objectives, so it is unlikely that anything significant would be picked up using an aggregate policy variable in a profit function. Production function estimation is not likely to be useful because policy research does little to shift the production function, except perhaps through an influence on technology adoption rates. Also one would like to measure impacts with respect to each objective; a production or profit function approach usually only addresses the efficiency objective. Second, many of the effects on reducing deadweight losses due to reduced

policy distortions and on reducing externalities would be missed in such an approach, and reductions in allocative error are affected by factors besides policy research. Third, it would be difficult to use cross-sectional data because of geographical spillovers of most policies. Time-series data are limited in many countries. Fourth, it would be difficult to specify what should be included in a policy variable; e.g. what about macroeconomic policies? If one included a broad set of policies in a publication count variable, using, say, a cross-country data set, the analysis would still miss key costs involved in policy dialogue and the variable would not provide a link to the cost side of policy research. In other words, even if one did estimate a cross-country production function and picked up a significant effect of a policy variable, it would be difficult to link the effect back to research, and there would be legitimate concern that such significance was only spurious. In addition, such an aggregate analysis would not help in evaluating specific policy research programs or in allocating resources among types of policy research.

Conclusions that emerge from previous social science evaluation efforts are that the econometric approach is not likely to help much and the decision theory approach would only be of limited use. The latter is particularly hampered by the fact that decisionmakers directly influenced by policy research are public officials and bureaucrats for whom priors are difficult to estimate. However, the decision theory approach highlights the importance of considering the uncertain nature of the parameters in whatever approach is used. The diversity of types of policies and multiple policy objectives dictate disaggregate assessment of individual policies or classes of policies. Disaggregation of policy impacts by societal objectives is usually necessary as well. The economic surplus approach is better suited for this type of analysis than are other approaches, is capable of incorporating subjective estimates of parameters, and generates results

that can be compared with each other and with results from evaluations of production-oriented research. The section that follows presents a framework, based on economic surplus analysis, for evaluating policy-oriented social science research.

Suggested framework for measuring the benefits of policy research

Evaluation of policy research requires assessing the value of policy changes and either (a) determining the contribution of policy research to those changes, for ex post assessment, or (b) estimating the likelihood that a proposed policy change will be adopted, for ex ante assessment. Several tasks are involved in policy research evaluation; among others, classifying policies into different types, identifying objectives behind the different types, defining the relevant geographic areas of influence for the policies, tracing the paths between policy research and policy changes, calculating the benefits of the policies in an economic surplus framework, accounting for appropriate research costs, and calculating the net present value of research aimed at improving efficiency or distributing benefits to particular groups. The tasks can be grouped into four basic components: defining the problem, compiling the data, analyzing the data, and interpreting the results[4]. Each of these components is described below with particular attention devoted to how the benefits of policy research can be measured for each of several types of policy research.

[4] These steps are similar to the five steps laid out by Alston, Norton, and Pardey (1995). They include a fifth step called "measuring K" which is subsumed here under compiling the data.

Defining the Problem

Key issues in defining the problem include identifying the objectives for the evaluation, defining the scope of the analysis including the policy research programs to be evaluated, identifying the objectives for the policies, tracing the path from the policy research to the actual or projected policy change, and deciding how the economic benefits will be measured in a market model.

Evaluation objectives -- The objectives for the evaluation provide the terms of reference for the study. For example, the purpose may be to estimate the rate of return to one or more research programs to justify support for policy research. Or, it may be to provide information to help decide how to allocate research resources among existing or new research programs. The former may be more likely to involve ex post analysis and the latter ex ante analysis. The evaluation may involve both policy and non-policy research programs.

Defining policy research programs -- Early in the evaluation it is necessary to define the policy research programs to be evaluated. For ex post analysis, the list may be relatively short, but for ex ante or priority setting analysis, the list can be fairly long, with implications for the degree of detail possible in assessing each program. For example, one can not complete a detailed analysis of the impacts of every policy in the process of projecting the benefits of the research, but a rough assessment of policy impacts will be needed.[5]

[5] Even for ex post analysis it may be necessary to select a sample of policy programs to evaluate. The sample may be selected randomly to increase the credibility of the evaluation results, or it may make sense to evaluate those programs that represent the largest research investments. For ex ante work, it is likely that the cost and difficulty of the evaluation process will force it to focus on the largest potential policy programs/projects.

An illustrative list of policy research programs is provided in Table 1. Suggestions for measuring the benefits of each of these programs using economic surplus analysis is provided in a later section. Fortunately, for some policy research studies to be evaluated ex post, economic surplus analysis has been used in the research itself to estimate policy impacts. In those cases, policy research evaluation may be able to make use of those estimates and focus more on identifying the timing and extent of policy adoption and accounting for research costs. For other studies, including all ex ante ones, economic surplus calculations do not exist and hence it is necessary to conceptualize and measure the surplus benefits as part of the impact assessment.

Table 1. Illustrative list of policy research programs

Price analysis and marketing
Macroeconomic analysis and trade
Income transfer and food security policies
Credit policies
Research policies
Environmental policies
Rural development policies
Labor policies
Land policies

Policy objectives -- Once the alternative programs are identified, the next step is to discuss with "clients" for the evaluation - perhaps the research director or research council - the social objectives that the policy research was or will be intended to impact. As discussed earlier, the growth or efficiency objective may be a key objective, but for policy research there are often distribution or security objectives as well. Efficiency effects usually will need to be estimated even if the primary interest is how income is distributed, if for no other reason to demonstrate the opportunity costs of addressing non-efficiency objectives with the policy instrument.

Policy path -- Because of the complexity of the policy process it can be useful to trace out the path from the policy research to the implementation of a policy change.[6] While this path will have unique features for every piece of policy research, an illustrative path is presented in Figure 2. First, policy research itself can have several dimensions which may include estimation of key economic parameters such as price and income elasticities that are then used in estimating or projecting the effects of specific policies. In other cases, elasticity estimates may exist and are simply drawn upon for the analysis or not used at all. There is some probability that the research will succeed in generating useful policy recommendations. If it does generate recommendations, there is a probability of policy implementation that is affected by a host of factors including interest group lobbying, timing, government ideology, the distribution of benefits and costs, donor pressure, and other constraints. In many cases, perceptions of benefits and costs are as important to probability of adoption as actual benefits and costs. Key political economy issues that come into play are the relative political power of affected interest groups and the size and

[6] The authors would like to thank Veronica Jacobsen for suggesting this step.

distributions of benefits.

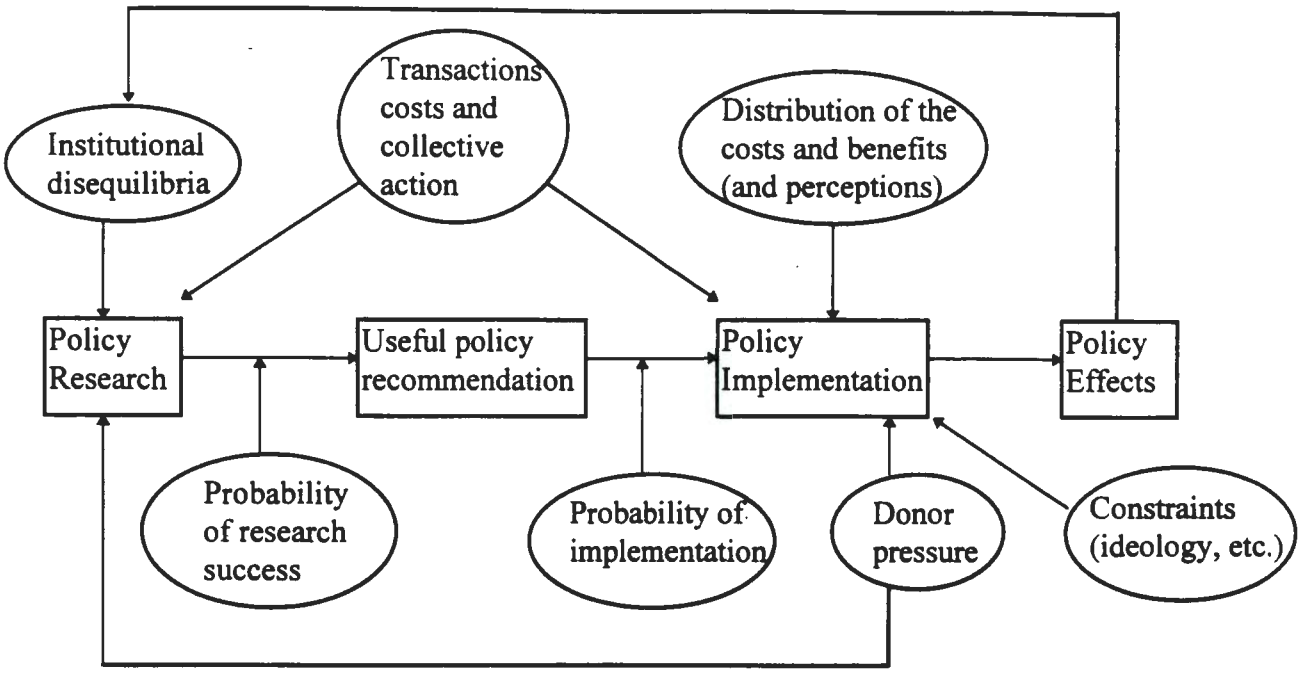

Figure 2. Illustrative path from policy research to policy impacts

If the evaluation of the policy research is ex post, tracing out this path should help identify who should be interviewed to assess whether there was any causal link between the policy research and the eventual implementation of a policy. Indeed, it may even be needed to help assess whether a policy change in fact occurred and if so the nature of its effects. If the policy research evaluation is ex ante, tracing out the path should help in assessing the probabilities of research success and of implementation of recommendations. If research has just been completed, tracing the path should help in assessing the likely policy adoption. It should also help in apportioning credit for a policy change and in deciding what costs to include.

Defining benefit measures -- Measuring the benefits of policy research in terms of changes in economic surplus is the most practical and perhaps the only feasible alternative given the issues raised above[7]. However economic surplus analysis can be applied with different levels of detail. For ex post analysis of a limited set of policy research programs, and certainly for major research programs, detailed market models can be defined just as they often are for evaluating non-policy research. For ex ante analysis, particularly of several programs as is often the case in priority setting analyses, crude models will probably suffice. In either case, the key question is how one measures the benefits using such models, both in aggregate and their distribution, for the major types of policy research. To begin to answer this question, brief examples are provided for each of the nine illustrative categories of policy research listed in Table 1. Two, more-detailed, examples are discussed and applied empirically later in the paper.

Price analysis and marketing -- Price and marketing analysis encompasses a wide range of policy studies aimed at assessing effects of distortions in input and output markets, of provision of marketing services, and of diversification policies. Many price and marketing studies spill over into policy areas related to trade, income, and food security as well. Evaluating the economic benefits of price and marketing policies entails first defining the specific focus of the policy studies and conceptualizing the nature of the benefits. For example, if a country had in place a price ceiling on imports of rice to protect domestic consumers (P_c in Figure 3 which is below the world price P_w) and a policy research study recommended its removal to reduce deadweight loss associated with the policy, the direct benefits due to gains in economic

[7] For a discussion of the advantages and disadvantages of economic surplus as a welfare measure, see Mishan (1981), Just, Hueth, and Schmitz (1982), and Alston, Norton, and Pardey (1995).

efficiency can be roughly estimated or can taken from the study. In Figure 3, these benefits would be calculated as area cde (the government cost for which neither producers or consumers receive benefits) plus an estimate of the marginal cost of taxation, say 15 percent of adeh if the government made up the production deficit through an import subsidy (or area $P_w deP_c$ if the government employs a two-price scheme). The area cde = .5 K^2 P_c Q_4 n, where K = (P_w - P_c)/P_c and n is the absolute value of the elasticity of demand. The area adeh can be obtained by simply multiplying (P_w - P_c) by the quantity of imports. Assuming that the research has already been completed and the policy change has occurred, those conducting the policy research assessment would then need to follow the steps suggested later in this paper to incorporate the estimated surplus in an ex post impact evaluation. If the policy research is being proposed, or if it has been completed but suggested changes have not yet been adopted, a somewhat different set of steps is proposed below; this set focuses on the factors influencing the probability of adoption.

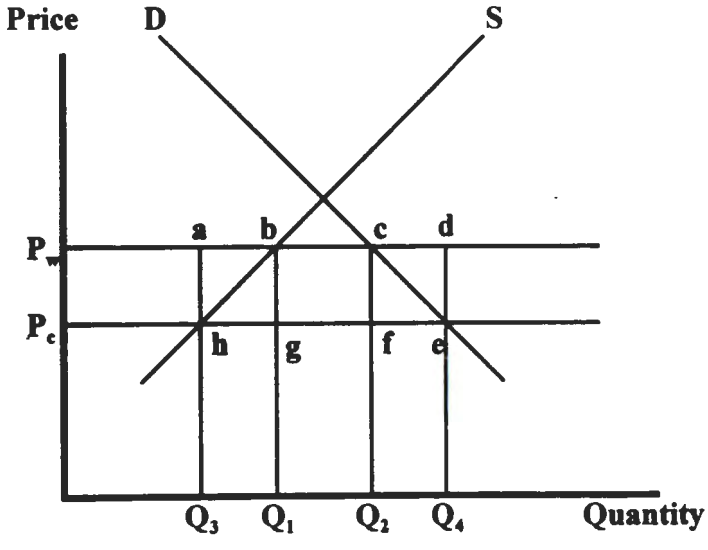

Figure 3. Measuring benefits of price policy research

Macroeconomic analysis and trade -- Over the past 20 years, economists have conducted a variety of studies to assess the effects of macroeconomic and trade policies on performance of the agricultural sector and on net social benefits. They have studied effects of direct policies such as export taxes and subsidies, import tariffs and quotas, exchange rate manipulations, regional integration, etc. Probably to a greater extent in this area than in any other study, these analyses calculate potential economic benefits associated with the policy change or at least the degree of distortion in prices (e.g. Krueger, Schiff, and Valdez, 1987). These quantitative estimates can be used to calculate economic surplus benefits associated with policy research, again focusing on the change in deadweight losses associated with the policy change. Efficiency and distribution effects of any of the macroeconomic and trade policies mentioned above can be directly measured in a partial-equilibrium excess-demand excess-supply framework and in many cases have been included in the policy analysis. Or if the degree of subsidy or tax is presented in the results, these can be readily incorporated in a rough economic surplus calculation to assess the potential effects of the policy change.

Income transfer and food security policies -- Policy research has not focused exclusively on growth effects but has also considered efficient means of transferring income to and assuring food security for the poor, particularly for small-scale farmers and the urban poor. Economic surplus analysis can be used to evaluate the benefits of policy research on topics such as targeted food subsidy programs, income transfer programs, famine prevention policies, nutrition monitoring, and analysis of intrahousehold income distribution. For example, policy research has been conducted to assess the economic and nutritional impacts of targeted food subsidy schemes in Sri Lanka (Edirisinghe, 1987), the Philippines (Garcia and Pinstrup-Andersen, 1987), and

many other countries (e.g. Pinstrup-Andersen, 1988). Many of these studies focus on the cost effectiveness of policies as an income-transfer or stabilizing program as opposed to an efficiency-improving program. The effects of these studies could be assessed ex post through follow-up evaluations to see to what degree study recommendations were implemented. If the recommendations were followed, in addition to assessing distribution or risk reducing effects of the policy implementation, an assessment could be made of the labor productivity effects due to improved nutrition with shifts estimated in the supply curve for major commodities such as rice. In each case these effects could be measured in economic surplus terms.

Other studies have called for improved food security through increased regional integration (e.g. Koester, 1986 for Eastern and Southern Africa). Many of the countries involved have clearly not heeded the policy advice, but some policy changes have occurred and given the small amount of resources generally spent on a policy research program, even small successes can yield high returns if the research contributes to the policy change. For example, Zimbabwe has begun to play a role as a regional stabilizing force for Southern Africa maize markets and handles part of its own highly variable production problem by relying partly on import purchases in deficit years rather than trying to maintain a huge grain reserve. This behavior is consistent with advice provided by earlier policy research. Efficiency gains from a stabilization policy that relies partly on trade can be demonstrated in an economic surplus framework.

Credit Policies -- Research on rural finance policy has clearly identified the overriding importance of credit availability and the hidden costs and distribution effects of subsidized credit (Adams, Graham, and Von Pischke,1984). It has also clarified benefits and costs of specialized

financial institutions aimed at the poor such as the Grameen Bank in Bangladesh to provide guidance to others who may want to try to duplicate the program elsewhere (Hossain, 1988). The effects of a general subsidized credit program can be measured in part as (a) deadweight losses due to the marginal cost of taxation associated with the income transfer and loan loss components, and (b) the effects of reduced adoption of new technologies as a result of reductions in general availability of credit due to the decapitalization of the credit system. Research on the Grameen Bank has shown that this specialized credit program has met a distribution objective, but because its success does depend on a government subsidy, expansion of the program and its duplication elsewhere will depend on the willingness of governments or international agencies to subsidize it. This research result has undoubtedly caused more realistic assessments by others considering potential programs of this type and probably avoided financial losses that might have been incurred without the research. Measuring this type of benefit in an economic surplus framework is not simple, but one could assume that one credit program failure of average or below average size has been avoided and calculate the benefits as the loss savings.

Research Policies -- Several topics have been undertaken in research policy in recent years: for example, assessing the merits of alternative financing arrangements for agricultural research and of increased autonomy for research systems within developing countries. Other topics in this area include optimal size and location of research stations, emphasis on different types of research, the linkage between research and technology transfer institutions, and the role of research versus other policy instruments. The benefits of most research policy research can be conceptualized as resulting from a shift in the supply curve for agricultural products due to increased production and adoption of improved technologies. For example, the benefits of research policy research can

be measured as area abcd = $P_w Q_0 K(1 + .5Ke)$ in the small open-economy model in Figure 4 where K is the proportionate shift down in the supply curve and e is the elasticity of supply. Formulas for calculating the benefits of other market scenarios are found in Alston, Norton, and Pardey, Chapters 4 and 5.

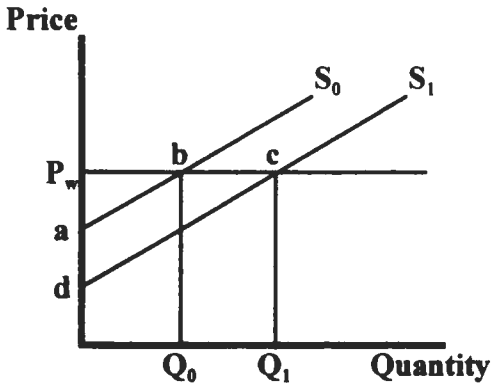

Figure 4. Measuring benefits of research policy research

Environmental Policies -- Environmental policy research can address a variety of environmental issues such as soil erosion, deforestation, water quality, wildlife preservation, maintenance of biological diversity, farm worker health, and so on. Much of the research involves policies aimed at reducing externalities and the benefits of the policy research are thus not priced in the market. The benefits can nevertheless be conceptualized in a market model in which the marginal social cost curve lies above the marginal private cost curve and the research serves to bring the two curves closer together. In Figure 5 the social cost of the externality is area abc = $.5P_w Q_p Ke$ where $K = (b - c)/P_w$. The change in net social benefits of environmental policies can be measured as a reduction in this area.

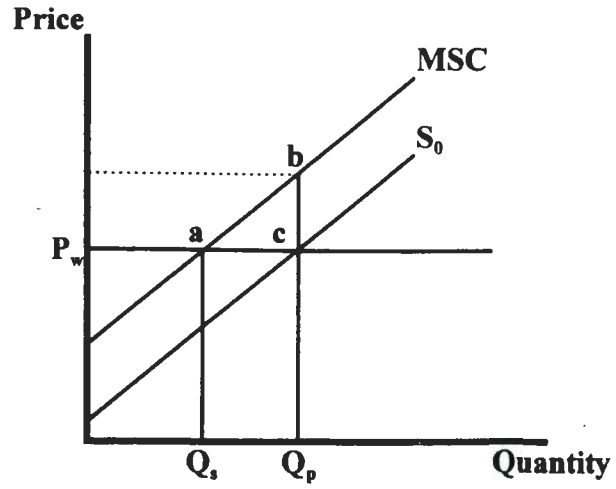

Figure 5. Measuring benefits of environmental policy research

Estimating the marginal social cost of a particular activity and the impact of a proposed policy change (e.g., regulation, tax, subsidy) on that cost or estimating the willingness to pay to reduce an environmental hazard is often at the heart of a piece of environmental policy research. Therefore an evaluation of this research, if it is ex post, can involve taking the estimated change in MSC or the physical change and the willingness to pay for that change and use it as input into the evaluation as well. For ex ante evaluation, rough projections on MSC or willingness to pay would need to be made, based on expert opinion or other studies.

Rural Development Policies -- These policies include infrastructure development, rural service provision, and targeted development programs (e.g., growth poles, integrated rural development programs). In nearly all cases, the impact of the policy (usually a public investment) can be conceptualized as a shift in the rural aggregate supply function. Agglomeration effects and fiscal stimuli from the programs can also lead to dramatic shifts in aggregate demand within the region in question. The policy analysis often involves documenting or measuring these shifts, and the

analyst is faced with issues such as how to aggregate (how to define the market for aggregate output), to identify data sources, and so on.

Antle (1983), for example, uses cross-country data on agricultural production to measure the effects of infrastructure on aggregate agricultural supply. Surplus measurements could be conducted using this information and other information about demand elasticities. Ahmed and Hossain (1980) use microeconomic data from villages in Bangladesh and estimate the effects of infrastructure on productivity and a number of other outcomes. Their analysis includes the demand shifts mentioned above. While the authors do not use these general equilibrium effects in a surplus model, their study contains all the information to do so. In the case of large-scale social investments or targeted interventions to effect rural development, measurement and control become critical issues. Often, productivity effects are delayed for many years following the investment: short-term impacts from money spent on the projects should be distinguished from longer-term productivity effects. Control cases are also needed to ensure that measured productivity changes are due to the investment; villages or other areas without such investments should be monitored as part of the studies.

Labor Policies -- Analyses of labor policies often focus on the markets directly influenced by the policies. The impacts of policies affecting the supply (e.g. human capital, migration) of and demand (incentives for capital investment, public works, etc.) for labor can be measured as changes in economic surplus in labor markets. When research recommendations are adopted, shifts in the supply or demand curves can be measured along with the resulting surplus changes. In practice, these shifts are measured or inferred as a part of the research, and ex-post

examination of whether the shift actually occurred following the policy change is rare. Policy research also examines policy-induced distortions in the labor market such as minimum wages, regulated employment conditions, and employment taxes. The policy analysis in these cases will often measure the surplus effects directly, or provide the requisite information for such measurement. Examples of some such analyses are found in Mazumdar (1989). In other cases, the impact of labor policies on earnings or productivity is examined. There is a large body of literature examining public and private returns to schooling (see Glewwe, 1990, and the regular reviews in *World Development* by Psacharopolous). These studies often use shifts in productivity or earnings to measure these returns, and hence treatment within a surplus framework is straightforward.

Land Policies -- Land policy research often involves recommendations for redefinition of property rights for efficiency reasons, equity reasons, or both. Two topics that have perhaps received the greatest amount of attention are (a) design of institutional changes to reduce problems associated with open-access resources and (b) policies for implementing land reform. Ill-defined property rights can cause significant efficiency losses, in the first case due to misuse of the resource and in the second case due to implications for transactions costs and collective action, which can give a small group inordinate political power to distort technical and institutional change away from the most efficient path (de Janvry and Sadoulet, 1987). Equity implications also come into play. For both policy topics, many of the benefits can be conceptualized as shifts in supply curves due to productivity increases in agriculture. For example, if redefined property rights as a result of policy research reduce overgrazing in a particular country, livestock productivity should be improved which can be measured as shifts in

the supply curves for particular types of livestock. In addition, the marginal private cost curve should move closer to the marginal social cost curve as the externality associated with overgrazing is reduced. If land reform redistributes political power as well as land, more appropriate technologies should be produced and adopted and the marginal product of labor in particular is likely to increase. Again the result should be manifest in supply curve shifts, although measurement and assessing causality would be difficult.

Compiling the Data

Compiling the market- and research-related data is the most time-consuming component of the evaluation. The modeling strategy and scope of analysis influence data requirements. Prices and quantities produced or consumed, elasticities for corresponding markets, and a discount rate for capital budgeting will be required for virtually any evaluation. Data on prices and quantities of exports and imports, exchange rates, and information on government policies(in addition to the one(s) being evaluated) will be required for some analyses. Methods for obtaining these basic market-related data are described in Alston, Norton, and Pardey (pp. 314-326).

Information on potential per unit cost changes, likelihood of policy implementation, length of research and implementation lags, and so on is needed. This information is needed to help measure surplus changes due to shifts in supply or marginal social cost curves due to reductions in deadweight losses as policy-related price lines move following implementation of policy research results. Compiling this information is equivalent to the effort required to estimate the per unit cost reduction (typically referred to as K) that is estimated when evaluating

technology-oriented research. For ex post evaluation, the policy research itself may have already completed part of the task. If not, and for all ex ante evaluations, it will be necessary to draw on people's subjective estimates (either as individuals or in some type of Delphi or other consensus approach) of per unit cost reductions, probabilities of policy implementation, time lags, geographical influence of the policy recommendations, and so on.

Interviews can be helpful for eliciting this information just as they often are for eliciting K from scientists and extension workers. The interview questions must be carefully structured to get at the counterfactual of what would have happened or will happen without the policy research. The idea is not to survey a large number of people but to contact the most knowledgeable people for each question. The most knowledgeable people may differ for different questions. For example, policy decisionmakers may give the best information on the likelihood of policy change in light of existing political pressures and the costs of implementing the policies. However, economists knowledgeable about the current degree of disequilibria in resource use, basic research results available on elasticities, data availability, the actual or likely cost of the research, and the quality of the policy researchers involved, are the most suited for answering several of the questions. Examples of questions are provided later in the paper.

For ex post analysis, an attempt can be made to talk to people involved in the policy decision to determine the influence of the research. There is likely to be a tradeoff in terms of the time and cost spent locating and interviewing people, and the quality of the evaluation. For ex ante analysis, it may be possible to assess what the historical probabilities have been for factors such as policy adoption, in order to place rough bounds on the future probabilities. For example, the

probability of adopting results of research calling for a land reform may be relatively low, while the probability of adopting results of price policy research may be somewhat higher. It may be useful to ask policy makers or staffers how large the total benefits must be before the opposition of interest groups can be overriden.

Incorporating uncertainty -- Uncertainty of parameter estimates argues for gathering information in a way that will allow for incorporating a distribution around those estimates. It is suggested for simplicity that a triangular distribution be used for the key uncertain parameters such as the probability of policy adoption, the probability that policy research contributed to an observed policy change, or the projected per unit cost reduction[8]. If this approach is used, information would be collected in the elicitation process on the most likely, minimum, and maximum values for the parameters. For example, let z be a random variable, say the probability of policy adoption, for which the highest, modal, and lowest values have been elicited. Its cumulative density function (CDF) is given by two quadratic CDF segments that meet at the mode so that

$$F(z) = (z - z_l)^2 / (z_h - z_l)(z_m - z_l) \qquad z_l \le z < z_m \qquad (1)$$

$$F(z) = 1 - (z_h - z)^2 / (z_h - z_l)(z_h - z_m) \qquad z_m \le z \le z_h \qquad (2)$$

where $F(z_i)$ represents the probability that $z \le z_i$ and the subscripts m, l, and h refer to most likely, lowest, and highest values. As discussed by Anderson, Dillon, and Hardaker (pp. 268-269, it is analytically convenient to equate F(z) with a uniform variate, u, with a probability density function f(u), as shown in panel c of Figure 6. Because u and F(z) each lie between zero and one,

[8] Anderson, Dillon, and Hardaker (1977), Anderson and Dillon (1992), Scobie and Jacobsen (1992), and Alston, Norton, and Pardey (1995) have described the approach first used by Sprow (1967) to evaluate research using triangular distribution functions and Monte Carlo methods.

it is possible to determine the z value for any particular u that is drawn from the uniform distribution by using the following equations:

$$z = z_l + [u\,(z_h - z_l)\,(z_m - z_l)]^{0.5} \qquad \text{if } 0 \le u \le (z_m - z_l) / (z_h - z_l) \tag{3}$$

$$z = z_h - [(1 - u)\,(z_h - z_l)\,(z_h - z_m)]^{0.5} \qquad \text{if } (z_m - z_l) / (z_h - z_l) \le u \le 1. \tag{4}$$

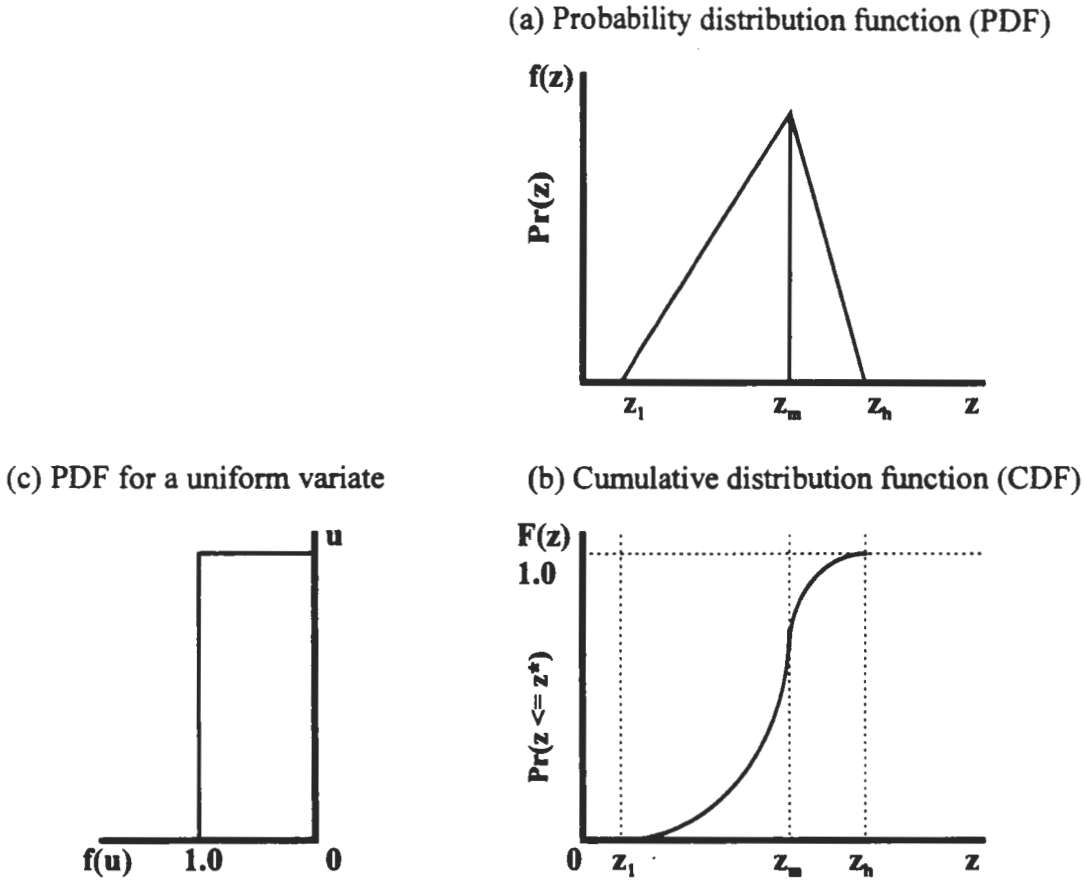

Figure 6. The triangular probability distribution (adapted from Anderson, Dillon , and Hardaker (1977) and Scobie and Jacobsen (1992))

A uniform variate is equally likely to take any value between zero and one. For each uncertain parameter, uniform variates, say 200 of them, can be generated and included in equations (3) and (4) to give multiple estimates of the parameter. These estimates can be included in the appropriate economic surplus formula derived for the policy assessment, thereby generating

multiple estimates of economic surplus.[9] These estimates can then be included in net present value (NPV) and internal rate of return (IRR) formulas, and measures of central tendency (e.g. mean or mode) and of dispersion (e.g. variance or coefficient of variation) can be calculated. An example of applying this approach is provided later in this paper.

Analyzing the data

Analysis of data for evaluating the impacts of policy-oriented social science research includes (a) combining the data and applying the economic surplus formulas derived for the specific policy research assessment, (b) applying capital budgeting methods to the streams of benefits and costs, and (c) using the results to help justify programs or choose among program alternatives.

Applying economic surplus formulas -- Once the basic data have been collected and summarized, they can be incorporated in spreadsheet templates for each policy research program. These spreadsheets will contain the elasticities, economic surplus formulas, capital budgeting formulas, random uniform variates for uncertain parameters, and so on. Examples of such spreadsheets for policies that involve shifts in supply curves (perhaps due to effects on technology adoption) are found in Alston, Norton, and Pardey, pp. 380-385.[10] A key component of the formulas in that specific type of spreadsheet is the per unit cost reduction (K) that combines multiplicatively the maximum supply shift, the probability of research success, the adoption rate, and any research depreciation (see Alston, Norton, and Pardey, p. 360).

[9] The simulation becomes more complex if covariance is assumed across parameters.

[10] A number of other computer programs are also available in addition to spreadsheets, for example the menu-driven DREAM© model developed at ISNAR and maintained at IFPRI and the RE4 model developed at the Australian Centre for International Agricultural Research (ACIAR).

For economic surplus formulas that calculate reductions in deadweight losses or marginal social costs due to policy research, the spreadsheet formulas will need to be tailored to the specific type of policy as described earlier. For ex ante analysis, a key parameter will be the probability of adopting the policy recommendations, net of the probability of adopting the particular policy irrespective of the research. For ex post analysis, a key parameter is the probability that the research contributed to the policy change. Regardless of the specific type of policy, the spreadsheet can be used to calculate changes in total economic surplus and its distribution.

Capital budgeting -- The economic surplus formulas are used to calculate annual flows of policy research benefits and costs (including implementation costs). Cost/benefit measures such as the NPV and IRR are then used to derive a summary statistic that considers the opportunity cost of the investment over time. These measures can be applied to total surplus measures or to benefits and costs accruing to particular groups.

When calculations of individual program impacts are made in ex post assessments, IRR's will often be calculated so that comparisons can be made against alternative public investments. However, when research programs are being ranked (policy research and other research programs) for priority setting purposes, NPV's are preferred because they can be normalized to consider the size of the research program. If NPV's of net benefits are divided by the corresponding present values of costs, a benefit cost ratio is obtained that can be used to rank policy programs while taking into account the size of the program (Alston, Norton, and Pardey, p. 364).

Using the results -- If IRR's are calculated for the policy research program (s), these values can be used to assess the merits of the investments and to compare against alternative public investments. If NPV's are calculated just for current levels of research expenditures, research programs could be ranked and the decision about which programs to fund would involve moving down the list until funds were exhausted or until negative returns were encountered.

Unfortunately the ranked NPV's do not provide information about what would happen if funds were reallocated from low to high NPV programs. There are rarely constant returns to scale in research programs so that, in general, average NPV's do not equal marginal NPV's. Lack of constant returns to scale make it necessary to forecast the economic surplus values and NPV's under various (at least two) levels of research funding in order to make such reallocation decisions. One suggestion is to conduct ex ante evaluations under the current level of research funding plus or minus say 30 percent.

Often, distributional objectives are relevant for agricultural policies, implying that an extra unit of income to a specific group (say small farmers) is weighted more than an extra unit of income to the average person. If distributional objectives are relevant for the policies being evaluated, it can be useful to assess (a) whether the distributional objectives are being met by the policy, and (b) the opportunity cost in terms of sacrificed total benefits of the research program if additional weight is placed on the specified groups. This assessment is complicated by the fact that agricultural research aimed at generating new technologies usually has a comparative advantage in achieving the efficiency objective as compared to distributional or other objectives. In order

to make it politically feasible to focus technology research on efficiency, it may be necessary to focus agricultural policies on distributional objectives so that the public expenditure program as a whole meets both efficiency and distributional objectives.

Interpreting the results

Interpreting for clients the results of policy research assessments that include distributions around uncertain parameters, economic surplus calculations, and IRR and/or NPV calculations under various levels of research funding can be a challenge. Avoiding unnecessary jargon in explanations is of course recommended, but it is essential that clients understand how uncertainty, causality, and the complementarity of policy research with other research and with policy dialogue were handled. Explanations of how results can be used for allocation decisions at the margin is usually important for ex ante work and how the rates of return can be compared against alternative public investments is usually important for ex post assessment. If the probability of adoption is highly uncertain, one can also calculate the probability of adoption that will generate the rate of return equal to the rate of alternative public investments and then ask if that probability is likely to hold.

A technique that has proven useful in presenting results of other types of ex ante research evaluations that involve multiple objectives is likely to be useful as well for ex ante policy evaluations. This technique involves presenting a research portfolio first with all weight placed on the efficiency objective. Then, new portfolios are presented with successively higher weights placed on one or more of the distributional objectives to demonstrate the income trade-offs

involved when weights are place on non-efficiency objectives. Decision makers can then make research allocations with information on opportunity costs.

Two examples using these concepts to evaluate returns to policy research help illustrate the feasibility of the method. The first example, policy research on deforestation in the Brazilian Amazon, was chosen because of the global magnitude of the problem and the accessibility of information in the public record. The second example, tax and exchange rate policies influencing pesticide prices in the Philippines, was chosen because it illustrates an evaluation for which the policy benefits must be projected into the future. Both of these examples are merely illustrative, as key parameters were obtained from fewer sources than one would normally use for such an analysis.

Example of measuring benefits from policy research: policies associated with deforestation in the Brazilian Amazon

Policies associated with accelerated deforestation in the Brazilian Amazon represent an important area of policy research that began in the early 1980s. LANDSAT satellite imagery that became widely available in the 1980s showed that deforestation began in the 1960s following construction of the Brazilia-Belem and other highways. This deforestation accelerated sharply in the 1970s, raising concern about its impacts on local economic sustainability and global environmental quality. Anecdotal evidence indicated that part of the deforestation was related to policies encouraging the expansion of the agricultural frontier, and research began looking at the policy-deforestation linkages.

Studies by Browder (1985), Binswanger (1991), and Mahar (1984), as well as by Brazilian researchers at EMBRAPA found that agricultural and economic policies created distortions that led to inefficient expansion of agriculture and uneconomic logging. Binswanger and Mahar categorized some of the policies creating these distortions. Agricultural income was largely exempt from federal taxation, creating incentives to engage in agriculture as a means of sheltering other income. Land allocation and titling policies ensured that squatters were granted titles, and titles were normally given for up to three times the amount of the land that was cleared. Land taxes declined with the intensity of use of the land, and forest land was considered to be unused. These tax rules created incentives for uneconomic forest clearing since pasture land was considered an intensive land use. Agricultural credit policies were also linked to deforestation as land title was needed to secure loans and titling was made conditional on "land improvements," which in practice meant land clearing. All three tax policies and the credit policy created indirect incentives for additional land clearing and shifted the demand for farmland to the right (Binswanger, Mahar). Panterritorial pricing of inputs and fuel subsidies contributed to inefficient expansion of agriculture to remote areas, and also shifted the demand for farmland rightward.

In addition to indirect incentives, direct tax incentives were provided by SUDAM[11] for livestock development projects. The tax incentives were originally designed to support industrial development in the Amazon, but in 1966 eligibility was expanded to include agricultural projects. By 1985, 950 projects were approved by SUDAM for tax credits; 631 of these were for

[11] Superintendencia do Desenvolvimento da Amazonia, the regional development agency for the Amazon.

livestock development projects (Mahar). Several authors note that without tax credits, livestock development had a negative real rate of return[12] (Binswanger; Browder), and conclude that the SUDAM incentives were directly responsible for as much as 10 percent of total deforestation in the Brazilian Amazon. Several other tax credits also encouraged deforestation to a greater or lesser extent; these credits and their impacts on deforestation were examined in detail by Binswanger and Mahar. Evaluating this completed policy research provides an example of how policy research aimed at an environmental issue with global implications can be assessed.

Defining the Problem

It was argued above that the key issues in defining the problem are identifying the objectives for the evaluation, defining the scope of the policy program to be evaluated, identifying objectives for the policies, tracing the policy research path, and defining how the economic benefits will be measured in a market model.

The objective for the policy research evaluation in this case is to determine, ex post, the benefits from the research on policies affecting deforestation of the Brazilian Amazon. The objectives of the initial policy research were to determine how the policies contributed to resource misallocation by creating incentives for uneconomic deforestation. The researchers also suggested means for reforming the policies. The policies themselves had multiple objectives

[12] Recent evidence (Schneider, 1995) shows that cattle ranching may not be as uneconomic as early authors concluded. Schneider shows that much of ranch population consists of smaller establishments that probably did not avail of the direct subsidies. Distorting incentives other than the direct subsidies(e.g., titling procedures) did, however, benefit even these smaller establishments, so that the policies stimulated the demand for farmland.

including increased settlement in outlying areas to relieve population pressures in other parts of the country, expansion of the agricultural frontiers, and others.

The value of research can be considered by tracing the impact of research findings on policy decisions: How were policies changed as a result of the research and what was the value of these changes? To do so, evidence is needed on how deforestation was affected following the policy changes, and how much of the policy change was itself due to the research findings.

The path of the policy research flowed from public perception of a disequilibrium, through the policy research itself, to the ultimate outcome-change in the offensive policies (Figure 7). The critical steps in conducting the evaluation are to measure the benefits of the change, and determine what portion of the policy change is attributable to the research.

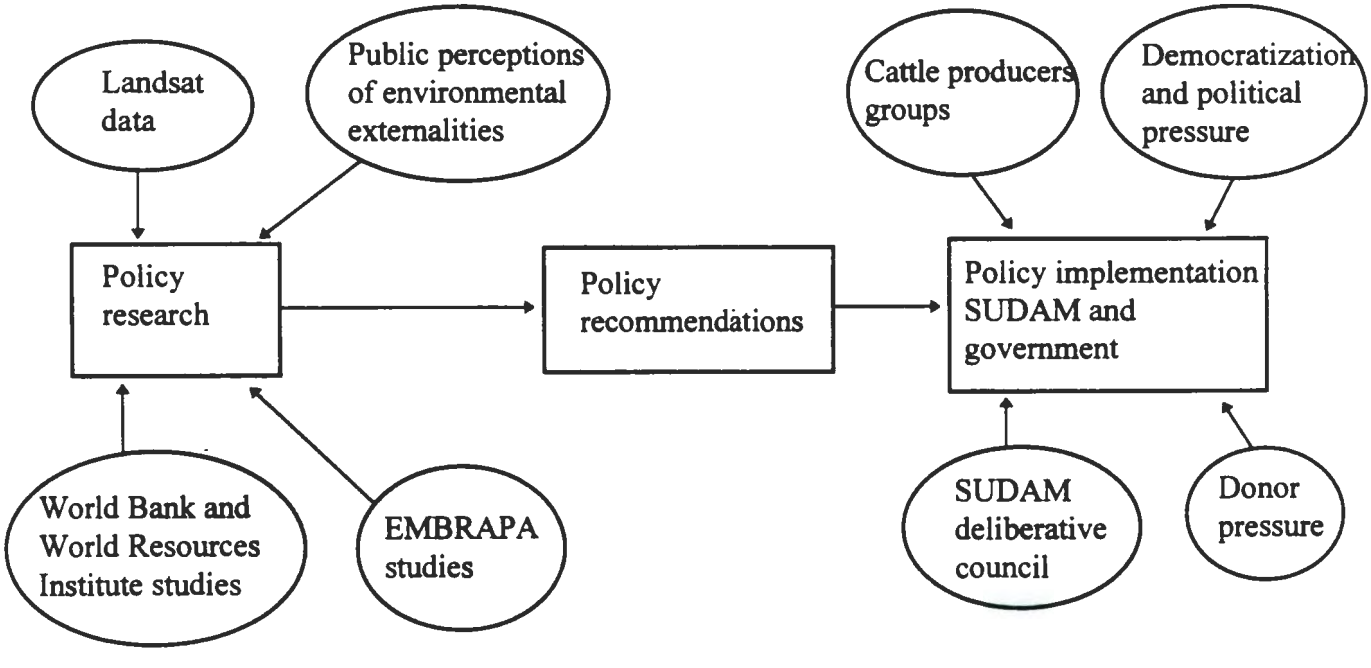

Figure 7. Policy path for Amazon policy research

Defining how the benefits will be measured -- The first issue is to determine which market to examine. There are a number of alternatives: the product market (mostly beef, but other aternatives such as lumber exist), the factor market (land), or through non-market valuation techniques. The studies suggest that deforestation was largely a by-product of the demand for farm and pasture land, and that this demand was stimulated by the policies. It thus becomes convenient to measure the effects of the policies through their effect in the land market. The policy-induced distortions affect the land market by shifting market demand for and supply of farmland away from their social optima.

The socially optimal demand schedule for cleared land in Brazil reflects the marginal social benefits associated with increased farmland. The "private" or market demand (reflecting the marginal private benefit schedule) diverges from the social benefit schedule because of policies such as direct subsidies, tax credits, income tax exemptions, and others. These policies increase the demand for cleared land above its socially optimal level, raising the equilibrium price and quantity. By raising the equilibrium price, the policies are said to be capitalized into the price of land. Such capitalization leads to some of the equity effects discussed by Binswanger. The effect of the policies is shown in Figure 8. Private demand (D_p) is found to the right of socially optimal demand (D_s). Q_0, P_0 would have prevailed in the market, but the policies lead to a greater equilibrium quantity (Q_P) of cleared land and price (P_P) of land. The loss to society resulting from the policy is represented by the triangle abc; this triangle is a deadweight loss incurred by taxpayers.[13] In order to measure the magnitude of the deadweight loss, equilibrium quantities

[13] This deadweight loss can be thought of as the "cost" to society of achieving other objectives, such as slower population growth in cities.

and prices need to be known, as well as land supply and demand elasticities and the magnitude of the policy-induced demand shift.

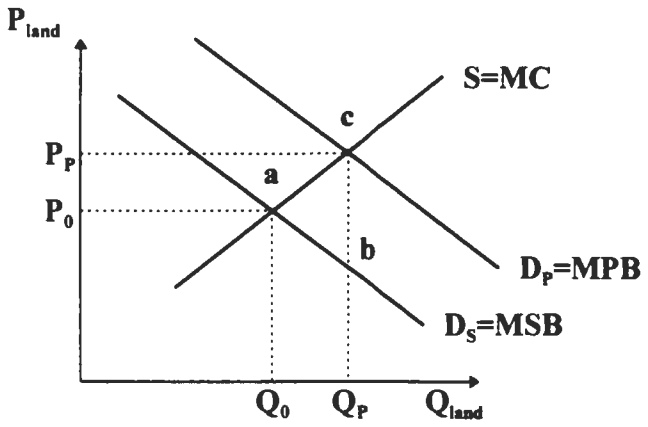

Figure 8. Land market effects of policies that encouraged use of farm and pasture land in Brazilian Amazon.

Measurement of the deadweight loss due to the policies is complicated by external costs associated with deforestation. Most of the policy analyses implied that these costs were significant, but did not explicitly address them in the analysis. Some of these costs are: off-farm costs due to soil erosion and siltation, on-farm costs related to poor soil quality as a result of this erosion[14], carbon loading in the atmosphere due to burning of the felled forest, loss of biodiversity, and the option value associated with the loss of rainforest. These externalities cause the marginal social cost associated with the supply of cleared farmland to diverge from the private cost curve. In Figure 9, the private equilibrium (which is observed in the market) occurs at point c, with quantity Q_p and price P_p. The social optimum occurs at point f (Q_s, P_s). The deadweight loss associated with the policy distortions given the externalities would be the

[14]This cost can be considered an externality because of poor information on the part of the soil user/owner of the land.

triangle ebf. When the policies are removed, the equilibrium price and quantity will be found at point a (P_o, Q_0), since social costs still diverge from private costs. The surplus change from removal of the subsidy is area abeg, which is the measure of benefits from policy research.

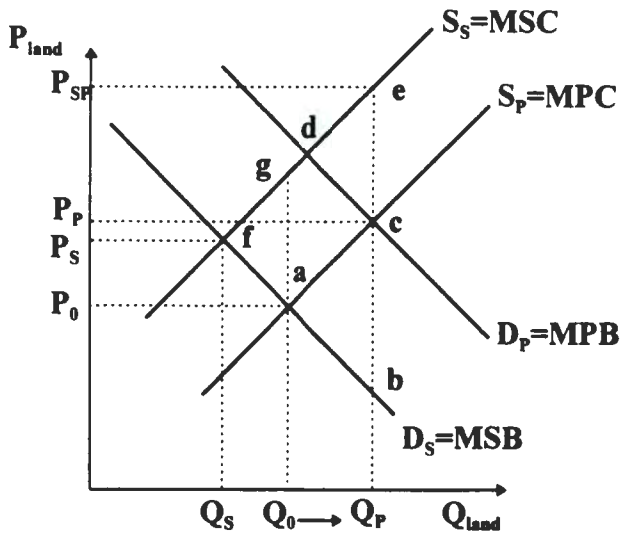

Figure 9. Externality effects of clearing farmland in the Brazilian Amazon.

The divergence between social and private marginal cost must be considered in benefit calculation, because even though the policy did not shift the marginal social cost curve, the magnitude of benefits from the policy change is affected by these externalities (see Figure 9). When such externalities are present, measured benefits of policy research depend on the focus of analysis. If, for example, we are interested in benefits to residents of Brazil, we would measure external costs only as they are incurred by Brazilians. The share of total global costs of carbon loading in the atmosphere, biodiversity preservation, and maintenance of rain forest for option or use values borne by Brazilians will be substantially lower than global social costs.

The formulas for measuring the surplus changes are as follows. Referring to Figure 9, define

$K = (c-b)/P_p$
$K' = (e-c)/P_P$

The total change in economic surplus is:

$$CTS = .5KP_p(Q_p - Q_0) + K'P_p(Q_p - Q_0)^{15} \quad (5)$$

This formula is used in the analysis below.

Compiling the Data

The data are taken from a number of sources. The equilibrium price of land, taken from Ozorio de Almeida and Campari, was US$219[16]. This price is from sample surveys and is reasonably representative of average land prices in the legal Amazon (Schneider). A minimum estimate is used of the divergence between marginal private costs and marginal social costs of deforestation (the distance ce in Figure 9). The minimum value of carbon sequestration per hectare of Amazonian rainforest[17] is estimated to be $272, and the minimum value of the cost associated with maintenance of biodiversity is estimated to be $20 (this is a lower-bound estimate obtained by synthesizing information in Pearce and Moran, 1994). Without including local external costs associated with loss of soil quality, siltation, etc., the minimum estimated social cost is $292, yielding an external cost of $73($292 - 219) per hectare.

[15] In many cases, it is necessary to derive the formula in terms of one existing quantity (say Q_p). In the present case, estimates have been made of $Q_p - Q_0$ in the policy analysis and this can be used in the analysis, removing the need for elasticities.

[16] All values are in 1991 dollars.

[17] This value is based on Fearnside's (1992) estimate of 16 tons of carbon for the average hectare in the legal Amazon, and Fankhauser's (1994) low estimate of $20/ton global warming damage costs. This figure is close to Schneider's $245 minimum estimate in a range that goes up to $28,300 per hectare.

The distance bc in Figure 9 is computed using historical data on subsides and deforestation. Mahar cites landset data showing that between 1970 and 1988, 569,000 KM^2 had been deforested (599,000 - 30,000). Between 1987 and 1988, approximately 23,100 KM^2 were deforested for a total of 545,900 KM^2 deforested from 1970-1987 (World Resources Institute). During this time, approximately $3704.3 million ($1991) in subsides had been provided to approved projects and farmers in the region.[18] The subsidy for land clearing was thus $67.86 per hectare (3704.3 ÷54.59).

Research impact on policy change--The effects of research on Brazilian policy cannot be understood in isolation. During the late 1980s, there was considerable public pressure for policy changes to protect the environment, and stronger pressure towards a more open political process (Foresta, 1991). The military dictatorship ended with formation of the New Republic in 1985, and Jose Sarney, the president until 1990, began institutional changes that on the surface were friendly to the environment. The 1989 Constitution contained an entire chapter dedicated to the environment, and has been called the most advanced text for environmental protection in the world. Included in the constitution is a declaration that the legal Amazon (encompassing approximately 445 million hectares) is an area of national heritage. Concurrent with the popular movement towards increased environmental protection, many of the policies associated with deforestation began to be examined. There is evidence that many of the offending policies were changed.

[18] Data taken from table 1.3 in Schneider, assuming 4 percent of livestock credit went to the Northern Region and a subsidy of $364.4 million for 1970. Dollar figures are inflated from $1990 to $1991 using a 3 percent inflation rate.

Interviews with researchers were conducted to gain insights into the impact of the research on policy changes. Three basic questions were asked, with a summary of the responses below:

Q1: How have the policies that were found to be related to inefficient land clearing for cattle ranching been changed?

A1: The respondents, and other sources, indicated that SUDAM began to enforce a moratorium on subsidies to cattle ranches by the late 1980s, and that all direct fiscal subsidies for cattle ranching were eliminated by 1992. National tax laws were reformed in the early 1990s, closing the loophole that allowed agricultural income to be exempted from federal taxes. Credit programs have been reformed to a lesser extent, but their contribution to total demand for ranch land is probably now negligible. Input pricing reforms were undertaken.

Q2: In your estimation, how much deforestation would have occurred had the policies not changed?

A2: There is consensus that deforestation has continued. Recent evidence is that cattle ranching may not be as uneconomic as early authors concluded. Schneider shows that much of the Amazon ranch population consists of smaller establishments that probably did not avail of the direct subsidies. Hecht (1993) notes that much of the current high rates of deforestation are associated with a dynamic that may have started with the subsidies for the large ranches, but now has taken on a life of its own. Deforestation may have been jump started with the policy errors, but its solution is now more complicated. Estimates are that removing the policies have reduced deforestation about 15 percent.

Q3: How much influence did the research have on the policy change? That is, had the policy research not occurred, what is the likelihood that the policy change would have occurred anyway?

A3: Browder is uncertain about the role of policy and suggests referring to the minutes of the Deliberative Council of SUDAM. Binswanger noted that his research was widely disseminated in 1987. For instance, his paper was reprinted in the Journal de Brazil. He states that "it was deeply influential in the World Bank as well and the emphasis on policy reform to reduce deforestation was integrated into Bank doctrine". None of the researchers was willing to attach a quantitative estimate to the proportional influence of the research on policy change. After consulting secondary sources, we estimate that the policy research contributed about 10 percent to the decisions to change the policies. This is a rough estimate, however, and is subjected to sensitivity analysis in the calculations below.

Analyzing the data

It is estimated that .6 percent of the Amazon area is currently deforested on a annual basis (World Resources Institute). The total estimated area of the Brazilian Amazon is 445 million hectares (Schneider), and therefore deforestation consumes about 2.31 million hectares per year. If the policy removal reduced deforestation about 15 percent per year, about 346,000 ha. of land is not deforested each year due to the policy change. Therefore, $Q_p - Q_0 = 346{,}000$ in Figure 9. This number is combined with the external costs of $73 per hectare (ec), the per-unit subsidy of $67.86 per hectare (bc), the 10 percent estimate for the policy contribution, and the economic surplus formula in a spreadsheet to calculate the benefits of the policy research. The avoided surplus loss due to the policy change is estimated for a 15 year period, from 1992, by which time most of the policy change had occurred, through 2007. A 5% discount rate is used and the NPV of benefits calculated.

The total discounted surplus loss avoided due to the policy research is estimated at approximately $42 million. The external costs associated with deforestation account for about 68 percent of the surplus loss; deadweight losses (excluding social costs) from the policies average about $11.7 million per year. The social losses are incurred by all citizens of the world (recall that we use the costs associated with atmospheric carbon loading to measure the social costs). The $11.7 million per year are losses to Brazilians alone. Because no information was gathered on the costs of the research, no rate of return is calculated.

Because the key parameters in this analysis came from secondary sources rather than expert opinion, distributions around the parameters are not calculated. However, sensitivity analysis is performed to test the importance of the 10 percent assumption for the contribution of the research to the policy decision. Because the nondiscounted benefits are equal each year, the variables in the spreadsheet are multiplicatively related, and research costs are not considered, the benefits are simply halved if the 10 percent assumption is halved, or $21 million over the 15 years at the 5% discount rate.

Interpreting the Results

Policy research on Amazon deforestation appears to have earned very high returns with major international spillovers even if it only had a small effect on the decision to change the policy. This example also illustrates the public good nature of many environmental policies, clearly justifying the research support provided by the World Bank and WRI. The example illustrates how returns to policy research can differ sharply depending on from whose perspective the analysis is performed. The appropriate costs to include in assessing the benefit of the policy research will depend on this perspective as well.

Example 2: measuring benefits from policy research: pesticide policies in the Philippines

Several studies in recent years have indicated overuse of pesticides, particularly in highly toxic chemistries, in Philippine rice and vegetable production (e.g. Rola and Pingali, 1993; Antle and

Pingali, 1994; Pingali and Roger, 1995; Lazaro et al., 1995). In attempts to remedy this situation, the Philippine government has (a) empowered its Fertilizer and Pesticide Authority (FPA) to ban or otherwise regulate pesticides, (b) set up an advisory committee to the FPA to make recommendations on pesticide policy, and (c) established integrated pest management (IPM) programs in rice and vegetables. Development and adoption of IPM practices appear to hold the greatest long-term promise for reducing pesticide use while enhancing producer profits, but incentives for adopting IPM practices depend in part on their relative profitability compared to pesticides.

Pesticide prices in the Philippines are influenced by tax and subsidy policies. Therefore a vegetable IPM project in the Philippines recently conducted an analysis of direct and indirect pricing policies affecting pesticides used on vegetables (a) to predict whether current policies pose a constraint to IPM adoption as practices are developed, and (b) if so, to provide information to the FPA and its advisory committee as they make and implement pesticide policies. Evaluating this completed policy research project provides an example of how policy research aimed at pricing policies and environmental policies can be assessed. Each of the evaluation components identified in the conceptual framework for policy evaluation presented above is included in this example.

Defining the Problem

The objective of the evaluation is to estimate the net present value of the vegetable-pesticide policy research project, undertaken by Tjornhom (1995) and others, in order to demonstrate the

feasibility of such a policy research evaluation. The policy research to be evaluated was a relatively focused project but cut across the categories of price analysis, macroeconomic analysis, and environmental policy analysis listed in Table 1. The major direct policies assessed by the pesticide policy project were import tariffs and value-added taxes that served the dual purposes to the Philippine government of raising revenues and reducing incentives for pesticide use. The major indirect policy was an overvalued exchange rate which put downward pressure on inflation and subsidized both producers who used imported inputs and consumers. An indirect effect was to subsidize an input, pesticides, that creates an environmental externality, but certainly the creation of the externality was not the intent of the policy. The policy research led by Tjornhom was aimed at reducing any policy-induced environmental externality.

The path from the pesticide policy research to eventual policy effects is diagrammed in Figure 10.

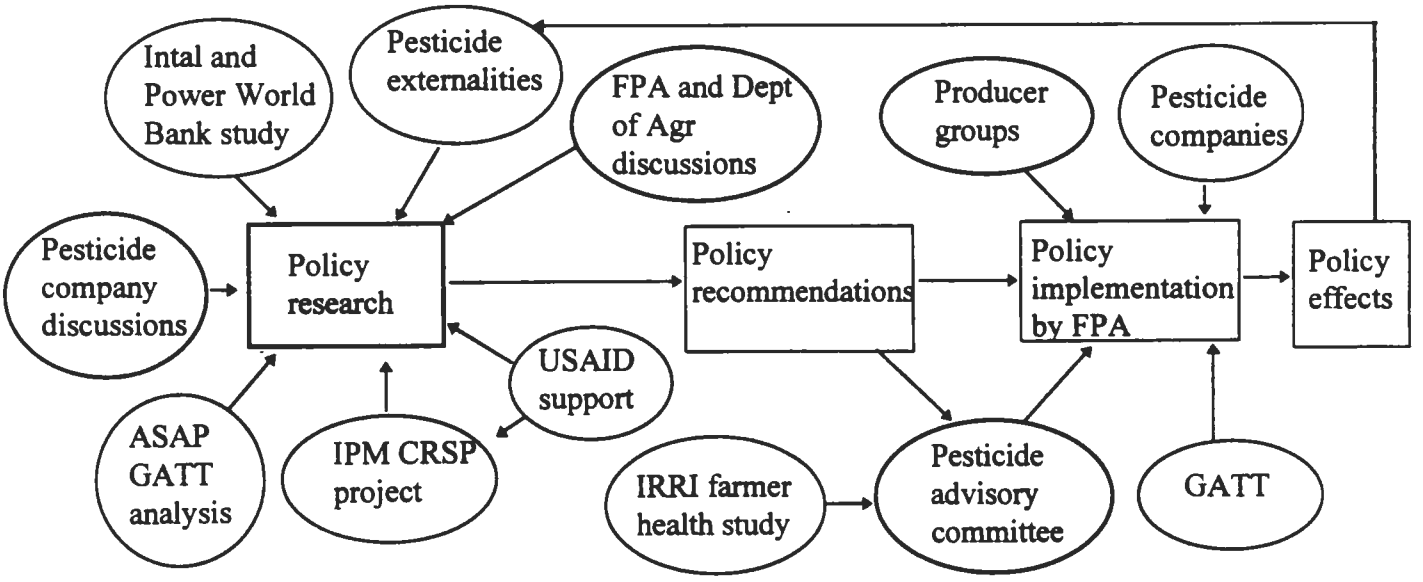

Figure 10. Pesticide policy research path

The pesticide policy research drew upon previous economic studies such as Intal and Power (1991) who calculated the degree of subsidy or tax for several agricultural commodities in the Philippines during the 1980s. The research benefited from data provided by and discussions with FPA, pesticide company representatives, Department of Agriculture personnel, and economists on the agribusiness support project funded by USAID. The pesticide policy research itself was funded under the USAID-supported IPM Collaborative Research Support Program (IPM CRSP) that supports collaborative research among the Philippine Rice Research Institute, U.S. universities, the University of Philippine-Los Banos, and the International Rice Research Institute. The research took 18 months to produce its findings and recommendations and researchers have since entered into policy dialogue with a member of the pesticide advisory committee, FPA, and others. The policy research recommendations came close on the heels of a separate research project on rice that was aimed at assessing farmer health effects of pesticides and their policy implications.

The basic results of the vegetable-pesticide policy project found that the nine primary pesticides used on vegetables in the Philippines were subsidized approximately 6% based on a net direct tax of about 12% and an indirect subsidy due to exchange rate overvaluation of 18%. Policy recommendations are to maintain the direct pesticide taxes (tariff and value-added taxes) and to follow policies that reduce the overvaluation of the Philippine peso. No policy decisions have yet been made and hence the policy research evaluation is partly ex post and partly ex ante.

Defining how the benefits will be measured -- The net benefits of vegetable-pesticide policy research would be manifested through (a) reduced environmental externalities compared to what would occur if the direct taxes on pesticides were reduced or removed, (b) efficiency losses due to the tax, (c) increased efficiency gain and reduced environmental damage due to any reduction in the exchange rate overvaluation, and (d) increased adoption of IPM practices that lower the marginal social cost curve associated with vegetable production. The retail pesticide market for the nine pesticides monitored in the analysis is modeled in Figure 11.[19] The marginal private cost of supplying the pesticides, not including any taxes or exchange rate overvaluation which subsidize the imported active ingredients in the pesticides, is represented by MPC_0. The marginal social cost curve with no taxes or exchange rate effects is MSC_0, which lies above MPC_0 because of the social (environmental and health) costs associated with the pesticides. The effect of the exchange rate overvaluation is to shift MPC_0 to MPC_e which increases the social costs. The tariff and value-added tax on pesticides (and active ingredients) shifts MPC_e back to MPC_T, reducing the social costs. The pesticide policy research estimated the vertical distance between MPC_e and MPC_T to be about 12% of the retail price (P_T).

[19] The market can be modeled as closed economy because almost all of the pesticide imports come in as active ingredients that is then formulated into pesticides for use in the country but not traded.

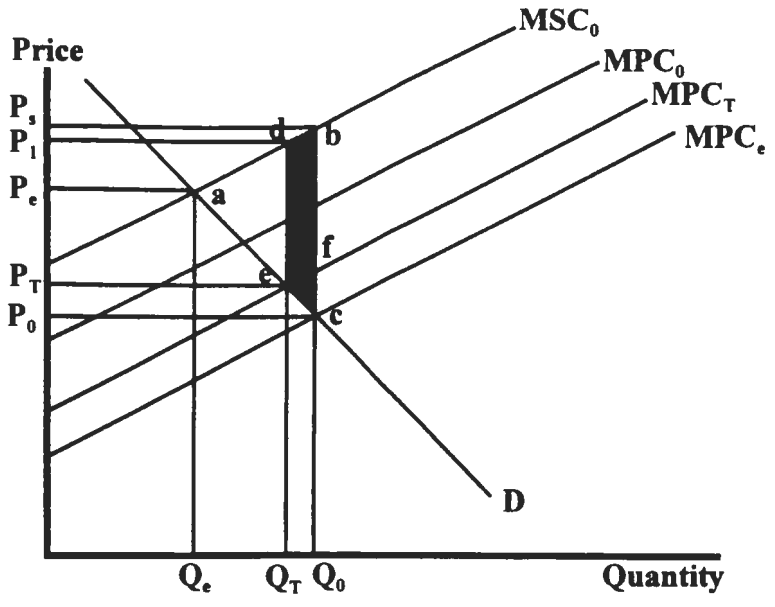

Figure 11. Measuring the marginal social cost of pesticide taxes and subsidies.

In evaluating the policy research which recommended continuation of the direct taxes and reduction of exchange rate overvaluation, it appears that the policy research is not likely to influence the latter. The difference between the actual exchange rates and equilibrium free market exchange rates is due to a broad set of policy distortions rather than an overt policy action. Therefore it can be assumed that the research may only influence the direct tax policy. The net social benefits of the policy recommendation to maintain the current tax policy rather than reduce the taxes on pesticides can be measured as area abc - ade = dbce minus the efficiency loss due to the policy distortion (efc). The net benefits considering both the environmental and efficiency effects = abc - ade - efc = dbfe.

In the long run, development and adoption of IPM practices would reduce the marginal social cost of vegetable production as a result of substituting other pest management practices for pesticides. This effect could be modeled in the vegetable market as a shift down in the marginal

social cost curve of vegetable production or in the pesticide market as a shift back in the demand for pesticides. Because the net effect of current tax policy on IPM adoption is likely to be relatively small, it is ignored in the present evaluation. Therefore the pesticide policy evaluation will focus on measuring dbfe which can be measured by the formula:

$$CTS = P_T Q_T Z n K'$$

where CTS = change in total economic surplus

Q_T = pesticide quantity with overvalued exchange rate and taxes in place

P_T = pesticide price with overvalued exchange rate and taxes in place

K' = per unit marginal social cost of the pesticide as a proportion of P_T

K = per unit direct tax as a proportion of P_T

$Z = Ke/(e+n)$ = proportionate reduction in price from P_T to P_0

n = absolute value of the price elasticity of demand for the pesticides

e = price elasticity of supply for the pesticides

Derivation of this formula makes use of the fact that $Q_0 = Q_T(1 + Zn)$.

Compiling the data

Data on quantities and prices for the nine pesticides analyzed in the policy research are presented in Tjornhom. For the evaluation, the total quantity and weighted average price can be used. These are calculated to be 254,291 kilos and 253 pesos or $10.50 per kilo. Given the current absence of alternative pest management practices, the demand for the pesticides is likely to be relatively inelastic. Supply is likely to be relatively elastic as more active ingredients can be imported as needed, subject to short-run capacity constraints in the Philippine plants that

formulate the pesticides. The Tjornhom study estimated the demand elasticity to be -0.5 and the supply elasticity to be around one, which may be an underestimate of the supply elasticity but is used in the evaluation below. Based on the policy research, the proportionate direct tax is estimated to be 12% of P_T.

The marginal social cost associated with pesticide use compared to the marginal private cost is perhaps the most difficult item to estimate. Any research evaluation will need to draw upon secondary sources of information for such an estimate because obtaining it from primary sources such as contingent valuation surveys or hedonic methods would imply a research project itself. Expert opinion is a questionable source for such an estimate as well. A recent study by Pingali, Marquez, and Polis assessed the effects of insecticide use on health costs and found that those costs increased by roughly a half percent for each percent increase in insecticide dosage. That was enough to offset any profits earned by the farmer in applying the pesticide to rice. And, their figure did not include chronic health costs or other environmental effects. While it is clear that pesticides are currently more profitable on vegetables than on rice, it is difficult to estimate the marginal social cost of applying the pesticides. In this situation it seems reasonable to use a conservative estimate of the MSC and then to conduct sensitivity analysis to assess the returns to the policy research under alternative assumptions on the MSC. For the initial analysis below, the marginal social cost of pesticides is assumed to be 20% of the average price of the pesticides. The effect of reducing this assumption to 10% is then examined.

Because the research has just been completed and the results not yet adopted, it is necessary to gather expert opinion on the likelihood of implementation of policy recommendations and any

time lags involved. Three or more people knowledgeable about the policy issue should be interviewed if possible. For this example only two people were interviewed and were asked:

Q1: What is your most likely estimate (percent probability) that the direct taxes on pesticides will be maintained by the Philippine government decisionmakers, as recommended in the pesticide policy report. What is your lowest likely estimate? Highest probability estimate? Why?

A1: 70%, 20%, 100%. The most likely estimate is based on the role that an economist on the pesticide advisory committee may play in carrying the recommendation to the government. Also, there is increasing public pressure to reduce health effects of pesticides. While lobbying by the pesticide industry creates pressure to remove the taxes, farmers usually do not recognize that the pesticide price has the tax included and therefore they have not protested the tax. Also the tax generates revenue.

Q2: How long is it likely to take for adoption (an explicit policy decision) to occur?

A2: Two years.

Q3: What is your most likely estimate (percent probability) that the tax policy would have been maintained irrespective of the research? Lowest likely estimate? Highest probability estimate? Why?

A3: 60%, 20%, 70%. Pressure is already on the government to reduce environmental and health effects of pesticides, and the tax generates revenue.

Q4: When do you believe that sufficient IPM practices will be available for and adopted on vegetables so that use of the identified pesticides will decline, irrespective of tax/subsidy policy?

A4: 10 years.

Data on policy research costs are needed as well as a discount rate to use in capital budgeting. Research costs in this example are relatively easy to estimate due to the focused nature of the project. Approximately $40,000 was spent over 18 months including personnel, travel, data collection, supplies, communications, administration, etc. An additional $5000 is likely to be spent on policy dialogue. The real discount rate is estimated to be 5 percent.

Analyzing the Data

The data generated above and the economic surplus formula are incorporated in a spreadsheet to calculate the net benefits of the policy research project. The spreadsheet includes the probability of policy adoption with a triangular probability distribution, and a Monte Carlo simulation is used to generate a distribution of economic surplus, NPV, and IRR values. Incorporating parameter uncertainty in this way provides a confidence interval around the expected value. A simpler approach to the evaluation would be to average the low, medium, and high values for the adoption parameter to obtain its expected value for use in the analysis. That approach could be used if a very large number of programs were being evaluated and a quicker analysis were needed.

For the current study, two hundred uniform variates were generated and included in equations 3 and 4 to give 200 estimates of the probability of policy adoption, which were then included in the economic surplus equation so that 200 estimates of NPV and IRR were calculated. The mean value of the NPV was $134, 203 with a 95 percent confidence interval of $11,017.[20] The mean value of the IRR was 29 percent with a 95 percent confidence interval of 1.5 percent.

The 29 percent rate of return is at the low end of the range often cited in research evaluation studies. However, assumptions used in the present analysis may be a bit conservative, especially the assumption that tax policy only affects the nine most important pesticides on vegetables.

[20] This confidence interval assumes that only the probability of adoption is uncertain. Of course, this procedure could have been followed with triangular distribution around other parameters as well, and a joint probability distribution and confidence interval developed.

Rates of return for specific projects can be expected to vary greatly with a few very high payoff projects and programs and several which yield very little. One purpose of ex ante evaluation is to increase the proportion of high returns in the policy research portfolio.

Due to the uncertainty of the 20% assumption for the marginal social cost of pesticides, a 10% figure was also assumed and the benefits recalculated. This change reduced the estimated mean NPV to $48,726 with a 95% confidence interval of $5,509 and an estimated IRR of 16%.

Interpreting the results

While only a simplified example, the pesticide policy research evaluation illustrates the feasibility of evaluating policy research projects using the economic surplus approach. A similar approach could be used for a portfolio of possible policy projects or programs. Incorporation of the risk component for various parameters becomes even more important for such a evaluation, as does the need to conduct the evaluation under two or three alternative levels of funding for each program as discussed above. The pesticide policy research evaluation did not calculate distributional effects of the policy recommendations, but it would not be difficult to do so.

Conclusions and implications

Measuring the benefits of policy-oriented social science research is difficult because (a) the diversity of types and objectives of agricultural policies requires, at a minimum, an analysis that is disaggregated by major type of policy, (b) causality between the research and policy change is nearly always uncertain for completed policy research, (c) predicting adoption of policy

recommendations is highly uncertain for ex ante evaluation of policy research, (d) the complexity of policy impacts usually implies that evaluation is forced to use approximate measures lest the evaluation of each policy research program or project become a major policy research project itself, and (e) the benefits of certain types of policy research generate benefits that are not priced in the market. These difficulties render any aggregate econometric analysis of the benefit of policy research highly suspect, but do not preclude the use of economic surplus analysis. Bayesian decision theory may be a useful approach for valuing information provided by certain types of social science research programs that impact on decisions of individual economic agents whose priors can be estimated. However for policy analysis aimed at government decision makers, decision theory is of little use.

The use of economic surplus analysis for policy evaluation has the advantages of facilitating (a) evaluation of diverse types of policies, (b) assessment of distributional effects of policy research, (c) generation of results that are directly comparable to evaluations of technology-oriented research, (d) calculation of ex post or ex ante research benefits, and (e) assessment that is consistent with economic theory. In some cases, the surplus measures may be rough, but the more such evaluations are completed, the shorter the learning curves for those attempting future policy research evaluations.

The uncertain nature of many of the parameters used in a policy research evaluation dictates a need for carefully structured questions posed face-to-face with those most knowledgeable about the policy process and the proposed or completed research. In some cases, ex post analysis or historical documents may provide benchmarks or guideposts for certain parameters, just as it

does (or should) for technology-oriented research evaluation. However, the inevitable parameter uncertainty in policy-oriented social science research places a special premium on including distributions around those parameters and conducting analysis that generates confidence intervals. Sensitivity analysis for key parameters is also recommended.

For ex ante analysis, learning something about the level of disequilibria in the affected markets as well as the political costs of adopting policy changes can help in predicting policy adoption and the value of the research. The greater the disequilibria in resource use, the greater the potential efficiency gains from relieving the policy or other institutional constraints causing the disequilibria. An excellent example is the large efficiency gains in Chinese agriculture following the change in its property rights system and other policy changes after 1978. It is no coincidence that the fastest growing economies in the world are relatively poor. Lower-income countries are farther from reaching their economic potential than wealthier countries. Thus, when a poor country is able to reduce institutional constraints that have caused economic disequilibria, it can really take off (Olson, 1996).

The political costs of making a decision can greatly affect the odds that policy advice will be followed. Those costs are influenced by the political power of interest groups which, in turn, is influenced by the cost of collective action. The latter depends in part on the size and homogeneity of interests of the groups, with relatively small homogeneous groups often exercising substantial power. Also, the larger the potential total benefits associated with a policy change, the greater the likelihood of adoption. Understanding why a society adopts its policies is crucial for predicting whether a proposed piece of policy research will succeed in changing them.

Fortunately, a large body of literature has developed on this topic with respect to agriculture (e.g., Anderson and Hayami, 1986; de Janvry and Sadoulet, 1989; Roe and Pardey, 1991). However we should have no illusions about the difficulty of quantitative ex ante policy evaluation. The uncertainty surrounding estimated benefits will inevitably be high.

It is clear that policy changes are almost always dependent on multiple factors including multiple policy studies. Apportioning credit is difficult, but not impossible in most cases. For ex post analysis, examining the extent to which the policy research was fed into a policy dialogue with decisionmakers can be helpful. Even good applied policy research often ends up only in journals with little or no impact unless the policy dialogue was explicitly pushed.

Modeling the market effects of policies graphically and in surplus formulas is important, but certainly not the most difficult aspect of the evaluation. The most difficult aspect is gathering information that allows one to assess as carefully as possible the counterfactual for ex post policy research (what would have happened to the supply and demand curves without the research) and the probability of adopting policy recommendations for ex ante research. Despite this difficulty, it appears that quantitative evaluations of policy research are feasible using carefully structured economic surplus analysis if the methods include means for considering parameter uncertainty.

References

Adams, D.W., D.H. Graham, and J.D. von Pischke, *Undermining Rural Development with Cheap Credit* (Boulder, CO: Westview Press, 1984).

Ahmed, R. and M. Hossain, *Developmental Impact of Rural Infrastructure in Bangladesh*, Research Report Number 83, International Food Policy Research Institute, Washington, DC, 1980.

Alston, J.M., G.W. Norton, and P.G. Pardey, *Science Under Scarcity: Principles and Practice for Agricultural Research Evaluation and Priority Setting*, (Ithaca, NY: Cornell University Press, 1995).

Anderson, J.R., J.L. Dillon, and J.B. Hardaker, *Agricultural Decision Analysis,* (Ames, IA: Iowa State University Press, 1977).

Anderson, K. and Y. Hayami, *The Political Economy of Agricultural Potection,* (Sidney: Allen and Unwin, 1986).

Antle, J.M., "Infrastructure and Aggregate Agricultural Productivity: International Evidence," *Economic Development and Cultural Change*, 31(1983): 609-619.

Antle, J.M. and P.L. Pingali, "Pesticides, Productivity, and Farmer Health: A Philippine Case Study," *Amer. J. Agr. Econ.*, 76(1994): 418-430.

Antonovitz, F. and T. Roe, "Measure of the Value of Information for the Competitive Firm Under Price Uncertainty," Staff Paper P82-28, Dept of Agr and Applied Economics, University of Minnesota, 1982.

Antonovitz, F. and T. Roe, "A Producer's Willingness to Pay for Information Under Price Uncertainty: Theory and Application," *Southern Economic Journal*, 52(1985): 382-391.

Binswanger, H.P., "Brazilian Policies that Encourage Deforestation in the Amazon," *World Development*, 19(1991): 821-829.

Bonnen, J.T., "Historical Sources of U.S. Agricultural Productivity: Implications for R&D Policy and Social Science Research," *American Journal of Agricultural Economics*, 65(1983): 958-966.

Bradford, D.F. and H.H. Kelegian, "The Value of Crop Forecasting with Bayesian Speculation: Theory and Empirical Results," *Bell J. Econ.*, 9(1978): 123-144.

Bradford, D.F. and H.H. Kelegian, "The Value of Crop Forecasting in a Market System: Some Theoretical Issues," *Rev. of Econ Studies*, 44(1977): 519-531.

Browder, J.O., "Subsidies, Deforestation and the Forest Sector in the Brazilian Amazon," report to the world Resources Institute, 1985.

Bullock, J.B., "Social Costs Caused by Errors in Agricultural Production Forecasts," *American J. Agr. Econ.*, 58(1976): 76-80.

Cyert, R.M. and M. H. DeGroot, "Rational Expectations and Bayesian Analysis," *J. Pol. Econ.*, 82(1974): 521-536.

De Janvry, A. and E. Sadoulet, "The Political Feasibility of Rural Poverty Reduction" Giannini Foundation Paper, Univ. of California-Berkeley, 1989.

De Janvry, A., E. Sadoulet, and M. Fafchamps, "Agrarian Structure, Technological Innovations, and the State," Working Paper No. 442, Dept of Agr and Res Econ, University of California-Berkeley, July 1987.

Edirisinghe, N., "The Food Stamp Scheme in Sri Lanka: Costs, Benefits, and Options for Modification," Research Report 58, International Food Policy Research Institute, Washington, DC, March 1987.

Eidman, V.R., G.W. Dean, and H.O.Carter, "An Application of Statistical Decision Theory to Commercial Turkey Production," *J. Farm Econ.*, 49(1967): 852-868.

Evenson, R.E., "A Century of Productivity Change in U.S. Agriculture: An Analysis of the Role of Invention, Research, and Extension," Center Disc. Paper No. 296, Econ. Growth Center, Yale University, August 1978.

Fankhauser, S., "The Social Costs of Greenhouse Gas Emissions: An Expected Value Approach," *The Energy Journal*, 2(1994): 157-184.

Fearnside, P.M., "Forest Biomass in Brazilian Amazonia: Comments on the Estimate by Brown and Lugo," *Intersciencia*, (1992):

Foresta, R.A., *Amazon Conservation in the Age of Development*, (Gainesville: University of Florida Press, 1991).

Freebairn, J.W., "The Value of Distribution of the Benefits of Commodity Price Outlook Information," *Economic Record*, 52(1976a): 199-212.

Freebairn, J.W., "Welfare Implications of More Accurate National Forecast Prices," *Aust. J. Agr Econ.*, 20(1976b): 92-102.

Garcia, M. and P. Pinstrup-Andersen, "The Pilot Food Price Subsidy Scheme in the Philippines: Its Impact on Income, Food Consumption, and Nutritional Status," Research Report 61, International Food Policy Research Institute, Washington, DC, August 1987.

Glewwe, P., "Schooling, Skills, and the Returns to Government Investment in Education," LSMS Working Paper No. 76, The World Bank, Washington, DC, 1990.

Goodland, R.J.A. and H.S. Irwin, *Amazon Jungle: Green Hell to Red Desert: An Ecological Discussion of the Environmental Impact of the Highway Construction Program in the Amazon Basin*, (New York: Elsevier Scientific Publishing, 1975).

Hayami, Y. and W. Peterson, "Social Returns to Public Information Services: Statistical Reporting of U.S. Farm Commodities," *Amer Econ Rev.*, 62(1972): 119-130.

Hecht, S.B., "The Logic of Livestock and Deforestation in Amazonia," *Bioscience*, 43(1993): 687-695.

Hirschleifer, J., "Where are We in the Theory of Information?," *Amer Econ Rev.*, 63(1973): 31-39.

Hossain, M., "Credit for Alleviation of Rural Poverty: The Grameen Bank in Bangladesh," Research Report 65, International Food Policy Research Institute, Washington, DC, February 1988.

Intal, P.S. and J.H. Power, "The Philippines," in A.O. Krueger, M. Schiff, and A. Valdes (eds) *The Political Economy of Agricultural Pricing Policy: Asia, Volume 2* (Washington, DC: The World Bank, 1991).

Just, R.E., D.L. Hueth, and A. Schmitz, *Applied Welfare Economics and Public Policy* (Englewood Cliffs, NJ: Prentice Hall, Inc., 1982).

Koester, U., "Regional Cooperation to Improve Food Security in Southern and Eastern African Countries," Research Report 53, International Food Policy Research Institute, Washington, DC, July 1986.

Lazaro, A.A., K.L. Heong, B. Canapi, V. Gapud, and G.W. Norton, "Farmers' Pest Management Knowledge, Attitudes, and Practices in San Jose, Philippines: A Baseline Survey," IPM CRSP Working Paper 95-2, Virginia Tech, Blacksburg, VA, September 1995.

Lindner, R. "Toward a Framework for Evaluating Agricultural Economics Research," Presidential Address, Australian Agricultural Economics Society, Adelaide, February 1986.

Mahar, D.J., "Deforestation in Brazil's Amazon Region: Magnitude, Rate, and Causes," Ch. 7 in Gunter Schramm and Jeremy J. Warford (eds.), *Environmental Management and Economic Development* (Baltimore, MD: Johns Hopkins University Press, 1989).

Mazumdar, D., *Microeconomic Issues of Labor Markets in Developing Countries: Analysis and Policy Implications*, EDI Seminar paper no. 40, Economic Development Institute of the World Bank, Washington, DC, 1989.

Mishan, E.J., *Introduction to Normative Economics* (New York: Oxford University Press, 1981).

Muth, J.F., "Rational Expectations and the Theory of Price Movements," *Econometrica*, 29(1961): 315-335.

Nordhaus, W., "A Sketch of the Economics of the Greenhouse Effects," *Amer. Econ. Rev.*, 81(1991): 146-150.

Norton, G.W., "Evaluating Social Science Research in Agriculture," in W.B. Sundquist (ed.) *Evaluating Agricultural Research and Productivity*, Misc. Pub. 52-1987, MN Agr Exp Station, University of Minnesota, 1987, pp. 177-193.

Norton, G.W. and G.E. Schuh, "Evaluating Returns to Social Science Research: Issues and Possible Methods," in G.W. Norton et al. ed., *Evaluation of Agricultural Research*, Misc. Pub. 8-1981, MN Agr Exp Station, April 1981.

Olson, M., Jr., "Big Bills Left on the Sidewalk: Why Some Nations are Rich and others are Poor", *J. of Econ. Perspectives,* 10 (Spring, 1996): 3-24.

Ozorio de A. and A. Luisa and J.S. Campari, *Sustainable Settlement in the Brazilian Amazon* (New York: Oxford University Press, 1995).

Pearce, D. and D. Moran, *The Economic Value of Biodiversity* (London: Earthscan Publications, 1994).

Pearce, D. and N. Myers, "Economic Values and the Environment of Amazonia," Ch. 15 in David Goodman and Anthony Hall (eds.) *The Future of Amazonia* (New York: St. Martin's Press, 1990).

Pingali, P.L. and P.A. Roger, *Impacts of Pesticides on Farmer Health and the Rice Environment* (Norwell, MA: Kluwer Academic Pub., 1995).

Pinstrup-Andersen, P. (ed), *Food Subsidies in Developing Countries* (Baltimore: Johns Hopkins University Press, 1988).

Roe, T. and D. Nygaard, Wheat, Allocation Error and Risk, Northern Tunisia, University of Minnesota Economics Development Center Bulletin V, March 1980.

Roe, T.L. and P.G. Pardey. "Economic Policy and Investment in Rural Public Goods: A Political Economy Perspective", in P.G. Pardey, J. Roseboom, and J.R. Anderson (eds.) *Agricultural Research Policy: International Quantitative Perspectives,* (Cambridge: Cambridge Univ. Press, 1991).

Rola, A.C. and P.L. Pingali, *Pesticides, Rice Productivity, and Farmers' Health: An Economic Assessment* (Los Banos, Philippines: International Rice Research Institute, 1993).

Ruttan, V.W., "Social Science Knowledge and Institutional Challenge," *Amer J. Agr Econ.*, 66(1984): 549-559.

Schneider, R.R., "Government and the Economy on the Amazon Frontier," Environment Paper No. 11, The World Bank, Washington, DC, 1995.

Schultz, T.W., "The Value of the Ability to Deal with Disequilibria," *J. Econ Lit.*, 13(1975): 827-846.

Schultz, T.W., "Institutions and the Rising Economic Value of Man," *Amer J. of Agr Econ.*, 50(1968): 1113-22.

Scobie, G.M. and V. Jacobsen, *Allocation of R&D Funds in the Australian Wool Industry*, Hamilton, New Zealand: Dept of Economics, University of Waikato, 1992.

Sprow, F.B., "Evaluation of Research Expenditures Using Triangular Distribution Functions and Monte Carlo Methods," *Industrial and Engineering Chemistry*, 59(July 1967): 35-38.

Thabet, B., D.E. Ray, and J.B. Bullock, "On Extending the Conceptual Basis for Estimating the Information Value of USDA Production and Price Reports," paper presented at the Southern Agricultural Economics Association meetings, Atlanta, GA, February 7, 1983.

Tjornhom, J.D., "Assessment of Policies and Socioeconomic Factors Affecting Pesticide Use in the Philippines," M.S. Thesis, Virginia Tech, 1995.

World Resources Institute, *World Resources, 1994-95: A Guide to the Global Environment* (New York: Oxford University Press, 1994).