Staff Paper

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Where Can Progress be Made?

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Abstract

The purpose of this paper is to report on the current state of economic evaluations for sanitary and phytosanitary (SPS) regulations affecting food and agricultural trade. The paper reviews current theoretical and econometric advances and limitations in modeling SPS regulations, particularly in dealing with biological and environmental uncertainty. By systematizing limitations of current approaches for evaluation, and comparing them with approaches used in the public health arena, the paper identifies problematic areas, and suggests steps for immediate analytical and policy progress.

Introduction

Food trade conveys the risk of introducing invasive species to areas previously free of them. Such risk has motivated the worldwide adoption of Sanitary and Phytosanitary (SPS) policies designed to impede unintentional negative consequences of transmissions. A recent report by Pimentel et al. (2005) estimated there are about 50,000 invasive species in the United States, causing losses adding up to almost $120 billion per year. Although acknowledged as necessary, SPS regulations can also be established as disguised barriers to trade (e.g., Hillman, 1978, 1991) with significant consequences for the ability of developing countries to participate in world markets. In the U.S., the Animal and Plant Health Inspection Service (APHIS) is the government agency in charge of protecting the country against the entry of exotic pests[1] while maintaining its goal of maximizing the economic benefits of trade.[2] A crucial issue for food trade is the optimality of SPS regulations. A food trade policy could be considered optimal when it maximizes the benefit of trade while minimizing the associated pest risk. To achieve this dual optimization goal, SPS regulations need to be enacted under sound pest risk and economic evaluations. Failure to include the economic dimension into the design of SPS regulations may yield non-optimal policies (Orden, et al., 2001).

Despite such recognition about the relevance of economic theory in devising optimal food trade policies, economic evaluations of SPS regulations have usually been considered unnecessary or limited in scope. In the U.S., Executive Order 12866 aimed to increase the role of economic analysis in rulemaking, but only for regulations which may have an annual effect on the economy of $100 million or more.[3] Further, most economic evaluations of SPS regulations fail to fully internalize the pest risk they are evaluating. There have been limited attempts to internalize pest risk into econometric models. Orden and Romano (1996) were the first to model stochastic supply of a good with such stochasticity determined by the estimated probability of pest infestation. Unfortunately, these efforts have been either scarce, incomplete, or inconsistently applied.

In the international arena, the Food and Agriculture Organization (FAO) has been publishing since 1995 the International Standards for Phytosanitary Measures (ISPM) to guide the enactment of SPS regulations. In April 2004, FAO published ISPM No. 11: *Pest risk analysis for quarantine pests, including analysis of environmental risks and living modified organisms* (FAO, 2004). Section 2.3.2 is devoted to the "Analysis of Economic Consequences." This document established broad guidelines for the economic evaluation of SPS regulations. ISPM No. 11 signals the importance of taking all sources of risk into account in order to produce appropriate analyses. It also emphasizes the need to use appropriate discount rates to bring economic estimates to a present value. Unfortunately, the document is somewhat vague and short, lacking detail and precisions, beginning with what do the document understands by "appropriate" (for instance, the document calls for the need to take time into account when performing economic evaluations of SPS regulations, but does not indicate what such a time frame should be.)

Thus, despite some broad US and international policy guidance, the economics of proposed SPS regulations tend to be evaluated based on criteria that are vague or ill-defined. As a result, economic models for evaluating SPS regulations are built and applied with criteria that vary from case to case, in many instances depending on the evaluator's technical preferences and beliefs. There is no universally accepted economic standard against which the quality of SPS policies can be contrasted and evaluated. By using the U.S. regulatory process as an example, the objectives of this paper are 1) to systematize the array of biological and technical problems associated with the economic evaluation of SPS regulations; and 2) to identify those areas for which research may yield immediate results.

This paper is organized as follows. The next section briefly describes APHIS' regulatory process. Sources of risks are identified and regulatory constraints described. The next section reviews how current economic evaluations of SPS regulations deal with such risks and constraints. Limitations and failures in current approaches are described. The last section discusses the relevancy of current analytical limitations, while identifying areas with greater potential for immediate progress.

APHIS Regulatory Process

Figure 1 depicts a broadly defined schematic for consideration of a policy change to allow product entry from the perspective of the U.S. regulatory agency. APHIS has a legal mandate to protect U.S. agriculture and natural resources including prevention of invasive species infestation.[4] The decision-making process starts with a request for regulatory change by a candidate exporter (top of Figure 1). Regulatory agencies in the exporting country will normally submit their own Pest Risk Assessment [PRA] to support the application for policy change under consideration. For APHIS, the PRA presented by its foreign counterpart conveys two sources of uncertainty. On one hand, there is uncertainty related to the biology of the invasive species in their new environment (biological uncertainty).[5] On the other hand, there is a uncertainty linked to the scientific capability of the candidate exporter and the level of trust and confidence achieved by inter-agency relationships (regulatory uncertainty) (Thornsbury and Romano, 2002). As suggested by Thornsbury and Romano (2002), it is likely that the level of confidence/trust on the foreign agencies and their PRA would influence the design and implementation of SPS regulations by the domestic agency. For instance, there is some evidence suggesting that regulatory uncertainty might be in part responsible for the recent surge in multi-step SPS regulations such as a Systems Approach (SA),[6] which has been linked to the enactment of the regionalization principle[7] (Vo, T. Supervisory Economist, USDA APHIS. Personal communication, 2004.). Because a typical SA-based SPS regulations has most of its multiple safety measures implemented in the foreign country before shipment, it could be argued that their enactment is influenced by regulatory uncertainty on the ability of the foreign agency to enforce safety protocols for the movement of goods within their country. Unfortunately, to our knowledge, the concept of regulatory uncertainty has not been taken into consideration by economist in evaluating SA and other multi-step SPS regulations.

APHIS' initial assessment addresses what if anything, has changed to warrant consideration of a policy adjustment. After initial consideration, there are two possible immediate outcomes for the request. APHIS may reject the importer's petition for further consideration and keep the ban in place. Another possibility is for APHIS to consider product entry under a safety protocol. The continued process to implement this second alternative (the one relevant to this paper) is shown in detail in Figure 1. At this stage it is customary for APHIS officials to evaluate foreign PRA results against the scientific literature. Once the process of identification is complete, APHIS undertakes its own PRA.

In principle, three distinct targets of invasion risk are investigated as part of the PRA: the risk to domestic production, the risk to natural ecosystems (environment), and the risk to public health.[8] The risk to domestic production (e.g., the risk exotic pests may pose to domestic food) is the most common source of dispute among interest groups, and hence often the analytical focus. Many of these risks are complex in nature and therefore difficult to evaluate by economists. Exotic pests may pose a risk to one or more domestic products and enter the importing country through multiple pathways, each with different biological and market conditions. Some negative consequences from phytosanitary problems are realized not in biological destruction of the host, but in damage to the quality of product available for sale. Figure 1 also acknowledges the possibility that the pest infestation may have an impact not only on supply, but also on demand. For instance, labeling and other additional information may create demand shifts attributable to SPS regulation that should be included in an assessment.

Although less frequently debated in public, the other two sources of risk (environment and public health) should not be dismissed. As directed by the U.S. National Environmental Policy Act (42 USC, 4321-4347) the risk that exotic pests may impose to the environment is never overlooked by APHIS. In some cases the environmental concern alone has motivated the enactment of regulations to stop the entry of foreign commodities. For instance, environmental concerns forced APHIS to ban the entry of Rhododdendrum sp. from The Netherlands in 1993 (this rule is currently under revision) (Romano and Orden, 1997; Romano, 1998)

The potential risk invasive species may pose to human health may also be critical. In general, only extreme, controversial cases such as those involving arsenic in Chilean grapes or the Mad Cow disease controversies have explicitly included public health risk in economic analyses. Economic consequences of both environmental and human health risks associated with food trade are very important and, if realized, may obscure the economic impact of any pest infestation on domestic production. Figure 1, for simplicity, presents in detail the alternatives for only the latter case.

Figure 1 shows three factors with direct impact on the risk and uncertainty of pest invasion: spatial dispersion, mechanism of spread, and control methods. A critical consideration should be the spatial distribution of both the host target(s) and existing invasive species. Among the common policy measures applied to reduce this source of risk is the imposition of designated ports of entry for the exporter, and regional restrictions on where imports can be shipped once they enter the country. The efficacy of these restrictions is moderated in part by mechanisms of dispersion the invasive species may adopt. Invasive species with greater capacity for movement and dispersion pose a higher risk to domestic products against which more stringent policy restrictions may be enacted. The availability and efficacy of control mechanisms once a pest outbreak has occurred may also influence the design and adoption of the SPS regulation. Ideally, any pest outbreak would able to be contained and its negative biological and economic impact would be considered negligible. It could be argued that, under such ideal conditions, there would be no need for any SPS measure at all, since the cost of enacting and enforcing such regulations would be greater than the efficient and inexpensive measures of control. On the other hand, it might be possible that once a pest is established, no countermeasure is available or feasible. For these cases pest risk would be catastrophic to domestic production. In reality, most cases tend to fall between these extremes, allowing for measures of both pre- and post-infestation control to be implemented. Although largely overlooked in the past, economists have recently succeeded in capturing the impact of some of these measures in their evaluations (e.g., Cook and Fraser, 2002; Peterson et al., 2004; Knowler and Barbier, 2005).

Unfortunately, pest dissemination, potential establishment, control, and/or eradication are all post-invasion concerns that are rarely included in economic evaluations. Most economic evaluations oversimplify these scenarios, ignore post-invasion development, and concentrate only on the risk of pest infestation. To some extent, this limited focus stems from the legal mandates directing policymakers to focus specifically on the entry of invasive species.[9]

After taking into account all sources of risk and uncertainty (biological and regulatory uncertainty), APHIS draft a PRA. It is usually here where economists enter the regulatory process. Figure 1 list important attributes used by economists in their evaluation of SPS regulations: market conditions for the domestic crops under consideration and the legal framework associated to the pest risk. These factors do not have a direct influence on reducing either biological risk or uncertainty; however, they are crucial to economic analysis and risk management. For instance, the possibility of a compensatory scheme for affected producers or other interest groups may have important economic consequences for the involved parties and should be taken into account in economic evaluations. Also, the legal environment in which the SPS regulation would operate influences the levels of risk and uncertainty that are acceptable for the regulators. For instance, the WTO allows its members to define their own level of “tolerable” risk, but mandates consistency in application across SPS regulations. Unfortunately, the inclusion of all these factors in economic analysis presents technical difficulties that have not been systematically addressed.

Ideally, the outcome of the economic evaluations, together with comments received by biologists and interest parties on the proposed draft, should help produce a revised, improved PRA. A final PRA is finally published and a risk management scheme is set in place.

Technical issues in economic evaluation

This section reviews issues raised in section 2.3.2 of FAO's ISPM-11 (Analysis of economic consequences).[10] Strengths and limitations are discussed. Suggestions for strengthening consistency are introduced.

Analytical framework: domestic vs. international

An initial analytical question regarding the evaluation of SPS regulations involves the scope for such evaluation. A general framework to analyze impacts of non-tariff trade barriers among all trade partners was developed by Roberts et al. (1999). The authors studied the impact of SPS regulations at the macro level, focusing on their impact on large and small producers, exporters, and importers. A similar criterion was followed by the ISPM-11, which guides evaluators to study the impact of a SPS regulation on each vulnerable market.

In the US, the U.S. Office of Management and Budget (OMB, 1992) mandates federal agencies to focus only on the domestic economy in conducting economic evaluations: "*Analyses should focus on benefits and costs accruing to the citizens of the United States in determining net present value. Where programs or projects have effects outside the United States, these effects should be reported separately*." For simplicity, the rest of this paper follows the OMB directive and focus only to the economic impact of SPS regulations in the US.

Analytical framework: industry vs. societal points of view

Traditionally, economic evaluation of SPS regulations has focused only on potential negative impacts to domestic production from a pest infestation. Consumer interests are only included as a potential negative reaction (i.e.: demand reduction) due to lower quality of product available for sale (domestic) or loss in third-country market share (international). The ISPM-11 calls attention to the potential gains from trade – in particular the gains to consumers from imported products – in the evaluation of quarantine laws. Recent studies have provided estimates of these gains and shown that the benefits of trade may exceed expected costs due to pest risks in some cases but not always (Calvin and Krissoff, 1998; Paaarlberg and Lee, 1998; James and Anderson, 1998; Ordenet al., 2001; Brown et al., 2002; Knowler and Barbier, 2005).

Several other papers have examined conceptual and pragmatic dimensions of the relationship between risk evaluation and cost/benefit analysis of quarantine decisions (Roberts, 2000; Roberts 2001; Snape and Orden, 2001, Maskus and Wilson, 2001; Josling et al., 2003). Section 2.3.2.3 of the ISPM-11 suggests the application of partial equilibrium techniques to estimate the welfare impact of a SPS regulation. Welfare analyses as those suggested by the ISPM-11 have already been applied in some evaluations (e.g., Orden and Romano 1996; Glauber and Narrod 2001; Cook, 2001; Brown et al., 2002, Bakshi, 2003). The Pareto efficient criterion states that a public policy should be desirable as long as at least one person is made better off and no one is made worse off. Unfortunately, this standard is rarely achieved in agricultural trade (as in most real-life situations). Domestic producers of the goods targeted by the SPS regulations would often be on the losing side of the policy if these goods are allowed to enter the country. An alternative, more pragmatic approach is based on the Kaldor-Hicks criterion, in which a policy is defined as welfare-improving if those who gain from the change could fully compensate the losers, with at least one winner still being better off. Orden and Romano (1996) had indeed applied the Kaldor-Hicks criterion to their evaluation of the entry of Mexican avocados into the US.

However, it is important to remember that the Kaldor-Hicks criterion is essentially a mechanism to test if the SPS policy will yield larger social benefits than social costs, for no actual compensatory scheme for the losers of the enacted policy is required. Orden and Romano (1996) did not consider any compensation scheme in their evaluation of avocados imports. However, the possibility of considering a compensatory scheme for affected producers or other interest groups may not be discarded (for instance, the ongoing controversy over compensation to Florida homeowners from mandatory destruction of backyard citrus trees to prevent the spread of citrus canker (Florida Department of Agriculture & Consumer Services v. Haire, 836 So. 2d 1040, 1060 (Fla.4th DCA 2003).)

Despite the growing recognition on the need for economic models that consider the economic of the SPS regulations on all involved agents, the building of such comprehensive models has been hampered by incomplete information. Missing information on the risk the invasive species poses to the environment and human health is present in many SPS regulations. The ISPM-11 guidelines deal with this limitation for modeling building by bluntly ignoring it: "*Environmental effects and consequences considered should result from effects on plants…. However, the regulation of plants solely on the basis of their effects on other organisms or systems (e.g. on human or animal health) is outside the scope of this standard* (ISPM-11, page 22)." This limitation is discussed in more detail later in this manuscript.

Cost-benefit, cost-effective, or cost-utility analysis

The literature of policy evaluation shows a fairly large number of methodologies designed to estimate the value of a regulation. Cost-benefit and cost-effectiveness are the two most common. In comparing these methods, the Office of Management and Budget (OMB, 1992) suggests: "*Benefit-cost analysis is recommended as the technique to use in a formal economic analysis of government programs or projects. Cost-effectiveness analysis is a less comprehensive technique, but it can be appropriate when the benefits from competing alternatives are the same or where a policy decision has been made that the benefits must be provided.*" In the public health arena, because costs are normally easier and less controversial to estimate than benefits, CEA is often the preferred mechanism of analysis (e.g., estimating the expected cost for implementing a vaccination program is easier/less controversial to obtain than an estimation of the value of saved human lives). The opposite seems to occur in most SPS regulations. In food and agricultural trade, benefits are typically easier to estimate than the expected costs. Trade benefits based on the expected price reduction due to the availability of imports are relatively easier/less controversial to estimate than the economic impact of an invasive species on a new environment. Thus, in comparison to the public health arena, the relative ease of estimating benefits for most SPS regulations makes their absence from economic evaluations the most common source of analytical bias (and a source for trade disputes).

An exception to the relative easiness of estimating benefits in the agricultural trade arena constitutes those SPS regulations in which the invasive species not only poses a risk to domestic production, but also to human health or the environment (e.g., those related to Mad Cow disease). For the evaluation of SPS cases like these, economists may take a look at approaches used in the public health arena, where the use of Cost-Utility Analysis (CUA) has become a valuable analytical alternative. CUA is used in the public health arena as an intermediate approach between CEA and CBA. CUA aims to find the least costly approach to achieve a unity gain in quality-adjusted life expectancy.

Measuring costs and benefits

The OMB (1992) claims that the principle of willingness-to-pay (WTP) "*provides an aggregate measure of what individuals are willing to forego to obtain a given benefit*." Market-based measures (e.g., prices) constitute ideal starting points for WTP estimations; however, for cases where prices are not available (e.g., human life, environment), economic analyses must resort on alternative approaches.[11] These methods are not free of criticism. For instance, existence values estimated during the Exxon Valdez oil spill in Prince William Sound Alaska entailed value loss in the order of several billion dollars, which some analysts deemed unreasonably large (Carson et al, 1994). Although SPS cases like those are uncommon, controversies regarding the valuation methodology to be applied may arise and its implications should be considered.

Risk and Uncertainty

Until the late 1990s, economists evaluated SPS regulations by treating them as another fixed barrier to trade. Risk was either ignored in the earlier studies or allowed to enter the model as another static scenario in sensitivity analyses. Romano and Orden (1996) and Paaarlberg and Lee (1998) were the first to internalize the risk of pest infestation. Glauber and Narrod (2001) extended the analysis to account for multiple-step policies. According to their notation, a stochastic measure of welfare is displayed in equation (1)

$$(1) \qquad EW(\Phi) = p(\Phi)W_D(\Phi) + (1 - p(\Phi))W_N(\Phi) - C(\Phi)$$

Where W_D is total welfare with a pest infestation, W_N is total welfare with no infestation, EW is expected welfare under SPS policy Φ given the probability of an outbreak $p(\Phi)$ and the cost of implementing the policy $C(\Phi)$. Then, an optimal SPS policy Φ^* can then be defined so that the marginal change in welfare that results from the optimal policy is equal to the cost of implementing the policy

$$p'(W_D - W_N) = C' - [pW_D' + (1-p)W_N']. \quad (2)$$

Typically, estimates of $p(\Phi)$ are viewed as measures of the risk associated with SPS regulation. However, risk can be expressed in ways other than $p(\Phi)$. The way risk is expressed may affect the outcome of the analysis. For instance, in section 3.1., the ISPM-11 allows for pest risk to be expressed indexed to estimated economic losses. Expressing risk in this way may tend to bias economic outcomes towards negative outcomes. Consensus regarding the way risk is expressed in the evaluation of SPS regulations is needed.

Knowledge about $p(\Phi)$ in equation (1) is rarely perfect. Economists have coped with this limitation by applying sensitivity analysis to their estimations. Although a valuable and useful tool *per se*, sensitivity analysis does not internalize the uncertainty surrounding the pest risk estimates. Such a limitation is particularly relevant to SA and other multi-step SPS regulations which are designed to reduce not only the risk of a pest invasion, but also uncertainties surrounding the risk management policy.

Recently, researchers have started to turn their attention to bioeconomic models as an attempt to improve the integration of biological risk and uncertainty into economic models (Finnoff et al., 2005). Although the use of bioeconomic models is praised as a tool for achieving a comprehensive estimation of the feedback effects between human activity and natural resources (Holden et al., 2005), only Finnoff et al. (2005) have attempted this approach to the invasive species problem and a fully evaluation of this tool is needed.

Geographic and time dimensions

Both geographic and time dimensions are rarely simultaneously incorporated into the economic evaluation of SPS regulations. The underlying assumption of most economic analyses is that infestations, when realized, occur instantly and spread everywhere. Recently, Peterson et al. (2004) attempted to circumvent these limitations by modeling a two-step invasion process in which the infestation is investigated in two different regions, under two different regulatory and market conditions. Although innovative in its joint inclusion of time and geography, Peterson et al.'s approach is still crude in its treatment of these variables.

Working with SPS cattle regulations, Forsythe and others (OIE, 2000) proposed to further circumvent these limitations by modeling the evolution of a pest infestation as a Markov process that could take the annual evolution of both the probability of pest infestation and pest recovery into account. Although promising, this approach has not been applied to the plant side of the field. An important limitation for this approach is that the information needed to build the Markov models is often unavailable: regulatory focus on pest infestation has precluded APHIS to provide probabilities of pest recovery in most of pest risk assessments.

Even if the elements for the Markov model (or any suitable other) were available for an economic evaluation of SPS regulations that takes both time and space into account, two important issues need to be considered: the time frame for the analysis and the discount rates to be applied. Decision about these variables is never trivial. Section 2.3.2.1 of ISPM-11 does indeed call attention to the need to consider dispersion and time, but does not specify how. The outcome of economic evaluations of SPS regulations will potentially vary dramatically with the time frame on which the analysis is based and the discount rate applied. Depending on the expected relative sequence of expenditures and benefits, the time frame chosen for an evaluation can have a strong influence on the outcome of the cost/benefit analysis. For instance, for cases where the negative consequences of a pest infestation are realized only a few years after the invasion (e.g., recovery efforts could neutralize the earlier negative consequences only a few years after the invasion to allow the benefits of trade to materialize), a short time frame of analysis would likely render negative outcomes. The opposite may occur if extended time frames were applied to a situation like this. Alternatively, there are some species where the risk of infestation increases as time goes by. For cases like these, a short time frame of analysis would yield outcomes more favorable than those in which a longer time frame is considered. An extreme situation would occur when the pest risk is low but very extreme and catastrophic in its consequences once realized. In this case an extended timeframe would always render negative consequences.

What constitutes an appropriate time frame? Although it is not the goal of this paper to develop such a standard but to identify and emphasize its relevance to consistent policy development, we argue that the impact of such a time frame can not be ignored in the economic evaluation of SPS regulations. Inconsistencies across evaluations render bias. Therefore, consistency should be achieved within the analysis (i.e., both costs and benefits should be estimated across the same time frame) and between analyses.

Time frame decisions are intrinsically linked to decisions about discount rate. To be comparable, costs and benefits occurring at different times must be expressed in terms of dollars of a particular time. The OMB (1992) suggests: "*The standard criterion for deciding whether a government program can be justified on economic principles is net present value -- the discounted monetized value of expected net benefits (i.e., benefits minus costs)*." Choice of discount rate can be crucial to the final outcome of the economic evaluation, particularly in situations where the expected impact of the policy is expected to occur long time after enacted (Revesz, 1999). For instance, when the negative consequences of a pest infestation are realized long after the infestation occurs, an unrealistically high discount rate (i.e., unrealistically assumes people does not value the future as much as the present) would likely have a bias towards trade.

What constitutes an appropriate discount rate? The answer to this question is not straightforward for social discount rates are not reflected by any market rate (Newell and Pizer 2004). Defining an appropriate discount rate could become particularly controversial for SPS regulations with an impact which may last over many generations. For SPS regulations like these, an intergenerational discount rate may be considered. However, choosing such a rate is never straightforward either, since it involves assuming the preferences of future generations is known. Revesz and Stavinz (2004) systematized current approaches to intergenerational discounting in two conceptual categories: one which seeks to maximize the utilities of present and future generations based on a social welfare function (e.g., Lind, 1995); and another based on the assumption that existing individuals take decisions after they internalize the welfare of future generations (e.g., Shefrin and Thaler 1988; Cropper et al, 1994; Rothenberg 1993; Schelling 1995).

In 1992, the OMB provided some guidance by suggesting Federal Agencies to apply a real discount rate of 7% as a base line in their cost-benefit analyses (OMB, 1992). The OMB also suggested to use a larger discount rate to be applied in sensitivity analyses for policies whose "regulatory *proposal whose main cost is to reduce business investment*" In 2003, the OMB modified this directive to allow the use of a 3 percent (or lower) real discount rate for intergenerational analyses (OMB, 2003). The 3% discount rate is more in agreement to which most economists believe discount rates for environmental evaluations such as SPS regulations should be (Revesz and Stavins, 2004). A 3 % discount rate has also been suggested for economic analyses in the public health arena (Miller et al., 2000).

Although it is overall accepted that the same discount rate should be applied to both benefits and costs (e.g., Revesz and Stavinz, 2004), there is evidence suggesting that individuals tend to apply a range of discount rates for cases differing in the magnitude of their expected impacts, for gains than for losses, and with the time span under consideration (e.g., Cropper et al., 1994; Cropper and Laibson 1999). Although some approaches to incorporate these changes into evaluation models have been attempted in the past (e.g., Ainslie 1991; Weitzman 1994, 1998), they have been criticized for implying inconsistent decisions over time (Revesz and Stavins, 2004).

Missing information

Economic analyses should include all relevant costs and benefits. Incomplete information often makes such an ideal difficult to achieve. Lack of proper scientific knowledge regarding the behavior of an invasive species in a new location, on its interaction with the new plant, animal, and human environment is present in most SPS evaluations. A recent review of 23 economic evaluations of pest invasions indicated a generalized failure by economists to address these shortcomings (Born et al., 2005). Evans et al. (2002) invoked the "precautionary principle" and argued for a ban on trade for cases like these; however, for some cases, such a criterion may be unnecessarily stringent.[12]

Under which conditions can economic evaluators consider a source of risk with incomplete information non-relevant and ignore it? ISPM-11 does not provide guidance on this critical issue. The literature indicates several approaches are available. A "value of added information" approach estimates the advantages of acquiring the missing information (when such acquisition is technically feasible). As it was mentioned above, because APHIS is mandated to prevent the entry of invasive species, the agency does not routinely estimates biological consequences associated with eventual establishment of the invasive species. Therefore, although possible to obtain, probabilities of pest recovery required for some of the suggested methodologies (e.g., the use of Markov models) are rarely available to evaluators (or regulators). The "value of added information" approach is thus an important tool for regulators and evaluators to decide about obtaining missing (but possible to obtain) pieces of information.

On the other hand, when fully acquiring missing information is not feasible, a series of risk-abatement measures (multi-step SPS regulations) can be applied to reduce the uncertainties associated with missing information to a tolerable minimum. Many multi-step SPS regulations are indeed designed to abate regulatory uncertainty. However, application of multi-step SPS regulations poses additional challenges to economists and evaluators. First, the marginal contribution of each step to the overall pest-risk management also needs to be evaluated. In other words, economists should investigate not only the welfare impact of these policies as a whole, but also the marginal welfare impact associated with each individual step. Second, for evaluators and decision-makers to determine the optimum number of steps necessary to reach a minimum level of uncertainty, they will need to define the level that is acceptable. Unfortunately, consensus about these issues has not been reached and does not seem probable in the near future. Without a clear understanding of uncertainty reduction, nor the availability of an analytical standard for a minimum acceptable level of uncertainty, the consistent design of optimal multi-step SPS regulations will be difficult to achieve. Furthermore, like the WTO mandate for consistency in acceptable levels of pest risk, it would be desirable for regulatory agencies to display consistency regarding the targeted levels of uncertainty that systems approach and other multi-step SPS regulations aim to reach. Such double consistency would act as an additional constraint on the enactment of sub-optimal policies.

Discussion

The last decade has witnessed impressive progress in the way economic analyses have been accepted and applied to the evaluation of SPS regulations. Economic models of increasing complexity and accuracy have been proposed and applied to this end. Despite these encouraging efforts, there are still many technical difficulties that need to be addressed.

As this paper reviewed, technical difficulties economists face are complex and difficult to solve. Problems are further exacerbated by incomplete information. Lack of consistent biological information hampers economic model building efforts and increases the complexity of the problems to be solved. Economists and policymakers react to this complexity in different ways, with little or no consistency, creating analytical chaos. Efforts to bring order to this chaos had yielded the elaboration of some international standards although they are very vague and highly incomplete. This paper documents and systematizes the variety and complexity of those problems. We believe this is the first and needed step to break this vicious analytical circle. Although the complexity of the policy issues precludes the immediate development of comprehensive standards, identification and systematization of analytic issues allows us to suggest possible and feasible ways to proceed.

We identify three areas we believe may have a more immediate impact on the quality of economic analyses related to trade in food products. The first area we identified as of large potential for immediate analytical progress is in the analysis of increasingly popular multi-step SPS regulations such as SA. This type of regulations is particularly difficult to analyze since they tend to be designed to reduce not only risk, but also uncertainty. As we have already mentioned, the inclusion of uncertainty into economic models of SPS regulations presents technical problems of non-immediate solution. However, the economic evaluation of multi-step SPS regulations can be improved by estimating not only the overall impact of the norm, but also the marginal impact of each step. By also looking at the marginal value of each individual step, economists may help design better, closer to optimal multi-step SPS regulations.

The second area we identified is related to the treatment of missing biological information. We identify two types of biological information that is not currently available: non-retrievable and retrievable. An example of what we call non-retrievable biological information constitutes the complex pest-environment interactions that entomologist, environmentalists, etc., cannot estimate with the level of accuracy economist would need for their models. Retrievable information on the other hand, is biological information subject to collection but not collected by legal or bureaucratic constraints. An example of retrievable biological information constitutes the collection of data reflecting the evolution of a pest invasion. Post-invasion measures such as probability of pest recovery are not the focus of APHIS and therefore are rarely available to economists and evaluators. By applying a value of missing information approach, economists may work with biologists and officials into developing a list of retrievable information that could be routinely produced and used to improve the quality of SPS evaluations..

Third, analytical progress could be rapidly attained by increasing the consistency of economic analyses. Economists seem to have reached implicit consensus about the need to adopt a societal point of view in evaluating SPS regulations. There are many other measures in which inconsistency is prevalent. Defining an appropriate time frame and discount rate is of crucial importance to economic analyses, yet is still often overlooked. Although different interest groups would argue for measures more appropriate to reflect their points of view, however, consensus on these measures (or at least on an approach to defining them) would be achievable and its impact on the quality of economic evaluations substantial.

The three areas we have discussed above appear to be feasible to develop and therefore, have the largest potential to achieve immediate analytical progress. A large array of analytical problems would still remain untapped. One set of problems which are extremely difficult to tackle is mainly biological: it involves the existence of non-retrievable biological information. This type of limitation poses an enormous challenge to both biologists and economists who want to make decisions based on relevant, but missing, information. It is not clear which is the optimal mechanism for economists to respond to this challenge. A second group of problems which are difficult to solve are mainly economic in nature. They include the valuation of non-market goods. Decisions made on how to estimate the value of environment or human life have proven controversial in the past. Efforts in the public health arena to reach consensus on the way to estimate the value of human life have yielded a working compromise which avoids the monetization of quality of life (i.e., the value of human life is based on the value of expected lifetime production). Such a compromise could be adopted for the evaluation of SPS regulations with an expected impact on public health. Similarly, consensus on the methodology to be adopted for estimating the value of the environment may also be very difficult to reach.

Reaching consensus regarding the economic evaluation of SPS regulations might be further compromised by existing differences in the technical capabilities of trading partners. The complexity and analytical requirements of some SPS regulations are often beyond the means of developing countries (Wiig and Kolstad, 1992). Hopes for more transparent and consistent evaluations of SPS regulations across nations may require developed countries to provide technical assistance to developing countries (Wiig and Kolstad, 2005). However, for such assistance to become useful, it is necessary for developed countries to dramatically improve their still inconsistent, unsatisfactory analytical approaches.

Endnotes

[1] The Plant Protection Act of 2000 (7 U.S.C. § 7758) gives the U.S. Secretary of Agriculture authority to restrict importation from pest-infested localities

[2] Please see W. Ron DeHaven's (APHIS Administrator) welcome at http://www.aphis.usda.gov/lpa/about/welcome.html

[3] U.S. Executive Order (EO) 12866 [58 Fed. Reg. 51,735 (October 4, 1993)] asks each federal agency to determine whether a regulatory action is "significant" and therefore subject to review by the Office of Management and Budget (OMB). Among other requirements, the EO defines "significant regulatory action" as one that is likely to result in a rule that may have an annual effect on the economy of $100 million or more.

[4] APHIS works under authorities from 11 different statutes dating back as far as the Plant Quarantine Act of 1912.

[5] In this paper we define uncertainty as a lack of knowledge concerning the probability distribution of future events (pest infestation, pest recovery, etc.).

[6] The U.S. Plant Protection Act delineates a systems approach as "a defined set of phytosanitary procedures, at least two of which have an independent effect in mitigating pest risk associated with the movement of commodities" (USDA APHIS). Although other policy regimes may have multiple steps, a systems approach is defined specifically to include two or more requirements that independently reduce risk.

[7] Article 6 of the SPS Agreement (WTO) states that a country is required to allow imports from subnational regions abroad that are free or nearly free of pests or disease.

[8] FAO (2001) has identified the following six types of impacts an invasive species may cause: (1) production; (2) price and market effects; (3) trade; (4) food security and nutrition; (5) human health and the environment; and (6) financial costs impacts. For

simplicity and clarity, in this paper we collapsed these risks to the three mentioned in the text.

[9] U.S. statutes such as 7 CFR 319 and 7 CFR 360 focus on pest exclusion strategies. The Plant Protection Act (H.R.1504 and S.910) and Executive Order 13112 (1999) also focus on preventing the introduction of invasive species, but do emphasize the need for pest risk assessment in decision-making.

[10] The items discussed in this section do not follow the same order as they appear in the FAO document. The order has been re-arranged to facilitate the discussion presented here.

[11] ISPM-11 suggests the application of "use" and "non-use" methods for estimating environmental values. Use values are based on some element of the environment being consumed with price recorded. Non-use values include option value (value for a late use), existence value (value associated with the environment's existence), and bequest value (value associated to make it available for future generations). The sum of all these benefits (Use Value + Option Value + Bequest Value + Existence Value) equals Total Economic Value (TEV). The difference between TEV estimated before and after the SPS regulation would provide a measure of the impact of the SPS regulation on environment.

[12] As it reads in Evans et al. (2002): "*The precautionary principle dictates that when the consequences of a rare event are large, the safest path should be taken and the risky activity should not be permitted at all as SPS measures are determined based on the view that practically no risk is acceptabl*e."

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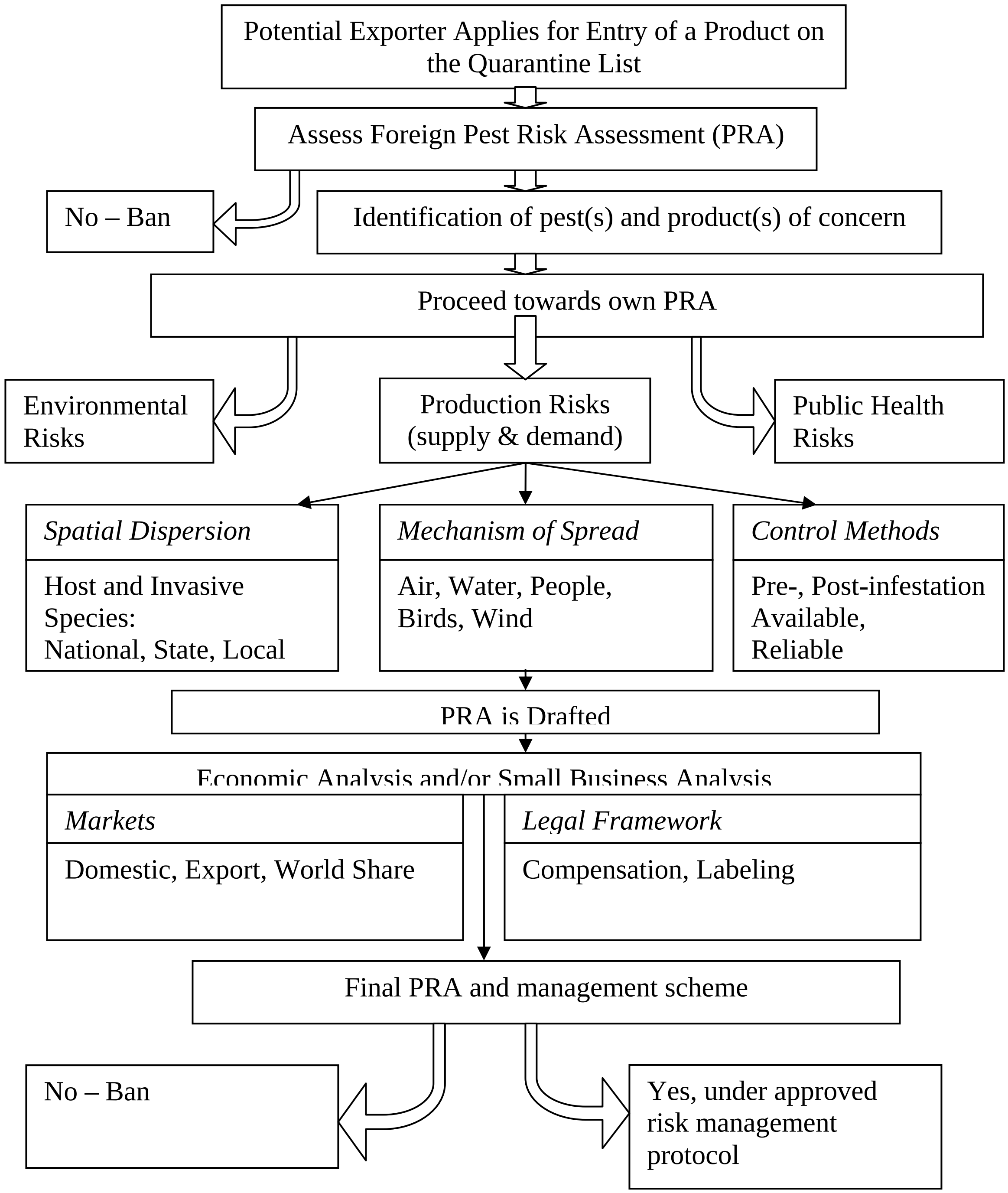

Figure 1. Schematic For Consideration Of An Invasive Species Policy Change