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with an Application to Food Safety Regulation**

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**ECONOMIC CRITERIA FOR SETTling FEDERALISM DISPUTES
WITH AN APPLICATION TO FOOD SAFETY REGULATION**

Abstract

Federalism disputes arising from state regulations, particularly those pursuing health, safety, and environmental goals, are a common feature of the U.S. political system. Discussion of bases for settling such disputes often focuses on the in- and out-state incidence of benefits and costs but incidence is a complex concept that has not been systematically analyzed. We discuss five factors important to evaluating incidence and present spillover criteria for judging disputes based on them. When applied to a Massachusetts regulation of daminozide residues in heat-processed apple products, the criteria reach different conclusions on its appropriateness, although the main criteria suggest it should be invalidated by the courts or preempted by federal law. The application illustrates how the spillover criteria can clarify analysis of federalism disputes.

ECONOMIC CRITERIA FOR SETTLING FEDERALISM DISPUTES WITH AN APPLICATION TO FOOD SAFETY REGULATION

INTRODUCTION

Periods of deregulation or lack of action by the federal government, such as the 1980s, encourage the states to pass laws that have the potential of burdening interstate commerce or conflicting with or impinging on federal law. This situation and many others give rise to federalism disputes where the validity of particular state laws and regulations is challenged in the courts or in the writing of new federal laws that seek to preempt or limit state action. In the courts, an extensive body of case law has developed around federalism disputes but the standards for judging them retain a fuzziness, or indeterminateness, especially where a state law's purpose is protection of health, welfare, or the environment and federal law is not explicitly preemptive. Economic analyses of federal-state regulatory disputes emphasize judging state laws based on the size and incidence (in- versus out-state) of externalities, benefits, and costs associated with the regulated activity and the regulation itself. A fuzziness intrudes here as well, as there is no consensus on the appropriate formulas for operationalizing incidence.

Our purpose is to contribute to the analysis of federal-state regulatory relationships by systematically presenting economic criteria for judging federalism disputes. The criteria are based on measures of the incidence of in- versus out-state benefits and costs, and may be characterized as spillover criteria. They have at least two major applications for formalizing the analysis of federalism disputes: as an input to court cases and to Congressional discussion of the merits of preempting state regulation. We begin with background on legal and economic analyses of federalism disputes; present the economic criteria; and then apply them to food safety regulation, in particular to the case of state regulation of Alar residues in heat-processed apple products.

LEGAL AND ECONOMIC ANALYSES OF FEDERALISM DISPUTES

A large body of case law and legal literature addresses federalism disputes. State laws can be invalidated under either the commerce or supremacy clauses of the U.S. Constitution. The legal discussion focuses on standards for judging whether state laws pose undue burdens on interstate commerce and thus should be invalidated, or federal law preempts state regulations based on its explicit language or implicit intent. Here we discuss examples of case law related to food products. The economic literature on federalism disputes is more limited and focuses on the development of economic criteria for judging whether invalidation or preemption is appropriate in specific cases.

The U.S. political system contains an inherent tension between federal power and states' rights. It requires continuous balancing of the federal government's interest in maintaining an unhindered national market and in regulating interstate commerce, with the states' interest in legislating to meet the needs of their separate constituencies. All recognize that state regulation may have advantages over federal regulation. As smaller units, states may meet the needs of consumers more closely, be more flexible in making necessary changes, experiment more successfully with solutions to problems, and be more efficient in administering and enforcing regulatory programs. However, state regulation may also have disadvantages including costs associated with fragmenting the national market and the possibility it may be rent seeking in nature, erecting barriers to trade in order to benefit in-state interests. For food products, state regulation may be undesirable if states' ability to develop appropriate standards and enforcement strategies is limited or if different sets of standards confuse consumers about products' healthfulness and safety.

Invalidation of State Regulation Under the Commerce Clause

The commerce clause is relied on in court challenges of state and local laws in areas where Congress has not acted. The federal courts' protection of interstate commerce is based on three beliefs: "national economic welfare is maximized by free trade among the states; states frequently

perceive their best interests to lie in erection of barriers to free trade in some commodities or by some means; and Congress' agenda is too crowded to rely on it as the sole source of limitations on state barriers to interstate commerce (Pierce, 1985: p. 614)."¹ According to a thorough analysis by Pierce (1985), commerce clause cases can be divided into three major categories: those involving state regulation that places burdens on the free flow of interstate commerce; those where the state has erected barriers to protect its own economic interests; and those involving state regulations that favor health, safety and environmental goals but may thus burden interstate commerce. Our focus is on the latter type of cases. Many recent federalism disputes heard in the courts involve these cases because the states have an increased interest in these areas and any state action is likely to have some effect on interstate commerce.

Over the years, the courts have developed tests to balance federal and state interests in such cases. One influential statement of this test was announced in *Pike v. Bruce Church, Inc.*, 397 U.S. 137, 142 (1970): "Where the statute regulates evenhandedly to effectuate a legitimate local public interest, and effects on interstate commerce are only incidental, it will be upheld unless the burden imposed on such commerce is clearly excessive in relation to the putative local benefits." The necessary balancing has resulted in recurrent conflict for the courts. As Foote notes, "The Supreme Court has developed a relatively indeterminate balancing test, upholding state regulation that affects interstate commerce if the regulation is rationally related to a legitimate state interest and if the state interest in regulation outweighs the burden imposed on commerce (Foote, 1985: p. 118)." The indeterminateness of the balancing test fundamentally stems from the second part of the formula--the balancing of the legitimate state interest against the burden imposed on commerce. How is this tradeoff to be measured?

¹This area of law is commonly referred to as dormant commerce clause jurisprudence since "the language of the Constitution does not explicitly refer to state interference with interstate commerce. It was only by interpreting the document's silence that courts could ascertain the states' role in regulating commerce (Foote, 1985: pp. 117-18)."

Two cases involving food products highlight the difficulties. In the first, *American Can Co. v. Oregon Liquor Control Commission*, 15 Or. App. 618, 517 P:2d 691 (1973), an Oregon statute requiring soft drinks to be sold in reusable containers was challenged. The statute was based on the state's environmental interests, such as reduced environmental harm due to reduced litter. The Oregon law burdened interstate trade by introducing the need for different distribution systems throughout the country. The state appellate court found, however, that the imposed burden was not substantial enough to invalidate the statute (Pierce, 1985). The court also validated the law because it was reluctant to compare incomparables, in this case the national economic interest in a uniform market versus state environmental concerns.

In the second case, *Hunt v. Washington Apple Advertising Commission*, 432 U.S. 333 (1977), the state of North Carolina had prohibited the use on labels of any grading system for apples other than the one provided by the United States Department of Agriculture. North Carolina argued that the presence of multiple grading systems could cause confusion and harm to consumers. The main negative impact of the law appeared to be on Washington state apple growers who argued they had developed a superior grading system, which allowed greater marketability of their products (Farber, 1986). North Carolina's statute favored apple growers in states with no grading system of their own, including North Carolina growers, at the expense of states with advanced grading systems (Smith, 1986). The Supreme Court balanced the protectionist effect against the purported consumer benefits, finding that the pattern of the statute's burdens and benefits was sufficient to indicate discrimination and invalidate the state law.

Balancing federal and state interests is difficult, with many factors entering into courts' decisions. The task is made more difficult by a lack of clarity in operationalizing measures of a law's in-versus out-state effects. Is the absolute size of the in- and out-state benefits and costs the key issue? Or is it the ratio of in- and out-state benefits and costs? To date, these issues are not decided or systematically analyzed.

Invalidation of State Regulation Under the Supremacy Clause

The supremacy clause of the U.S. Constitution is employed to challenge state actions in areas where Congress has acted. In such cases, the state often argues it is supplementing federal regulation in order to increase protection of its citizens. Congress has the power to block any form of state regulation and the courts will find such a result where Congress has made explicit its intent to preempt. Frequently, however, Congress has not been explicit leaving the courts to judge whether it implicitly intended to preempt. These later cases fall into three categories: where there is a direct conflict between state and federal law; where state law frustrates the purpose of a federal scheme or poses an obstacle to accomplishment of Congressional goals; and where Congress intended to occupy a field, leaving no room for state action.

On their face, preemption cases do not involve the same type of balancing of interests required in commerce clause cases. The courts engage in analysis of conflict between laws (e.g., is it possible to comply simultaneously with the federal and state law); whether state law obstructs Congressional goals; and of Congressional intent. However, the balancing of in- versus out-state effects is inherent to the judging of any federalism dispute. For example, the degree to which a state law frustrates a federal purpose depends in part on the scope and incidence of its impacts. In any case, as Pierce concludes in his review of federalism disputes, preemption of state regulation by federal law is not frequently exercised by the courts, and vague Congressional language gives "states considerable latitude to impose regulatory requirements in areas involving extensive federal regulation even when the state regulation conflicts with the goals of federal regulation (Pierce, 1985: p. 631)." Thus the main arena for resolving these federalism disputes is in Congress, which can continually adjust the relationship between federal and state law through its decisions whether to include preemptive language in new legislation. In making these adjustments, it must perform the same balancing of federal and state interests found in commerce clause cases. What guidance can economic criteria lend to these decisions?

Economic Analyses of Federalism Disputes

Formal analyses of federalism disputes employing an explicit economic approach are relatively small in number, including Rose-Ackerman (1981), Rice (1985), Foote (1984), and Pierce (1985). Rose-Ackerman (1981) develops a model of the tastes and preferences of inhabitants of various states in order to measure regulatory spillover effects between states. Political action allows citizens to support laws that enable their state to "export costs but support laws that reduce the costs imposed on them (Rose-Ackerman, 1981: p. 152)." Such participation is only possible in a federal system that leaves room for non-unitary regulations. The status quo will differ in different states, which will impact individuals' views of national legislation and reveals the relative bargaining power of the people. Rose-Ackerman's analysis suggests that federalism matters in a political system where capital can move but inhabitants are relatively inflexible toward moving. She suggests that state laws may spread to other states for economic reasons rather than due to their usefulness. In particular, state laws may be used to avoid economic costs at the expense of others, and national laws (preemption) may be enacted in order to control the size of spillovers and the costs of inconsistent laws.

Rice (1985) draws similar conclusions from his analysis of differences in state laws governing product-related quality and performance claims. He employs the model to examine the economic reasons for a state law to spread to other states. Rice argues that states have a high degree of freedom to enact laws of their choice and that the costs of protective laws are not fully internalized within the enacting jurisdictions as long as less protective states exist. Since most consumers do not fully relocate to match their regulatory preferences with those of the state they reside in, and "exit" is not totally effective in any case since less protective states pay part of the cost of the more protective states, differing state laws result in income redistribution. Legislatures of less protective states will be inclined toward passing more protective laws in order to avoid negative spillovers into their states and to encourage positive spill-ins from the remaining less protective jurisdictions. This results in an increasing number of states exporting costs to a decreasing number of lagging jurisdictions, magnify-

ing the overcharge in less protective jurisdictions. The long-run outcome is resemblance among state laws. Rice argues this equilibrium is not necessarily optimal and may differ significantly from regulatory preferences that would have been mirrored in a federal system. The federal government and the courts have roles to play in controlling this phenomenon.

Foote's analysis of federalism disputes takes a separate but related tack (Foote, 1984). She notes that the degree of conflict between state and federal regulation of health and safety has increased since the 1960s as the federal government increased its regulatory activity in this area. To analyze this conflict, Foote classifies state regulations into five stages based on where their impact is felt and argues that each class has a likely pattern of benefits and costs that should dictate whether preemption of state law is appropriate. The first stage, product standards, involves the federal interest in safety and health and in unhindered interstate trade through uniform national standards. The federal interest in a uniform market usually exceeds the states' interest in improved health and safety standards for products, with preemption of state laws being the frequent consequence. The second stage, production, involves the national interest in health and environmental standards and site specific workplace and community issues. Foote argues that economies of scale in decision making and interstate competition call for federal regulation of production but state laws do not necessarily undermine federal regulation, especially when their effects are completely in-state. The third stage, the process of exchange, requires product information. Preemption of state law is justified in cases where producers cannot realize economies of scale without preemption, e.g. where information is to appear on the product package, but not for other information that may be provided separately. State regulation of the fourth stage, conditions of sale and point-of-sale services, usually has only in-state impacts and preemption is not justified. The same is true for stage five, conditions of use, as long as the regulations do not undermine federal safety requirements.

The Rose-Ackerman, Rice, and Foote models present useful insights into the probable incidence of the benefits and costs of state regulations. However, the next step, measurement of

incidence, is not undertaken and remains undefined. Pierce attempts this measurement with his model of geographical spillovers (1985: pp. 646-654). In evaluating a state regulation the model focuses on the degree to which it is evenhanded or the law's relative impact on in- and out-state interests. The theory is that "the state's political process will produce a reasonable balance of regulatory benefits and burdens from a national perspective if, but only if, there is at least a rough equivalence between the proportion of total benefits that accrue to in-state interests and the proportion of total burdens that are imposed on in-state interests (Pierce, 1985: p. 647)." Pierce summarizes his spillover criteria as:

States should be allowed to make regulatory decisions with no geographic spillover (or with negative spillover equal in percentage to positive spillover), but they should not be allowed to make regulatory decisions with either positive or negative geographic spillover (or, more accurately, with disproportionate positive or negative spillover) (Pierce, 1985: p. 653).

Pierce's model is a base for the criteria for settling federalism disputes presented here.

Legal and economic analyses of federalism disputes include a range of considerations. Key among them is the degree to which the impacts of state regulation spill over to other states. Too much spillover is almost uniformly deemed to be legitimate grounds for blocking state regulation, either through invalidation under the commerce clause or preemption under federal law. The difficulty arises in quantifying how much is too much, which the literature does not systematically address.

SPILOVER CRITERIA FOR ASSESSING STATE REGULATION

We develop spillover criteria, inspired by Pierce's work, for assessing the incidence of the benefits and costs of a state regulation. The model focuses on the short run where a state regulation has gone into effect but no new regulatory response has been made by other states or the federal government. (Analysis of longer term impacts involves adding terms reflecting further regulatory

adjustments.) The short-run benefits of a state regulation can be expressed as:

$$SB = \sum_{i=1}^2 \sum_{j=1}^n sb_{ij},$$

where sb_{ij} are the benefits accruing to a particular interest group j ($j=1, \dots, n$) and the i subscript indicates whether the group is in-state ($i=1$) or out-state ($i=2$). The total short-run in-state benefits are:

$$SB_1 = \sum_{j=1}^n sb_{1j}.$$

Total short-run out-state spillover benefits are:

$$SB_2 = \sum_{j=1}^n sb_{2j}.$$

Short-run total costs can be expressed as:

$$SC = \sum_{i=1}^2 \sum_{j=1}^n sc_{ij},$$

with short-run in-state costs expressed as SC_1 and out-state spillover costs as SC_2 . This model is flexible in analyzing the benefits and costs arising from state regulation since net benefits (benefits minus costs) can be determined for interest groups, states, or nationwide.

Factors Important to Spillover Criteria

The incidence of in- and out-state benefits and costs may be judged on several dimensions, each of which has validity and should not be confused with the others. We describe these dimensions as factors and assess the federalism criteria based on their ability to reflect these factors. All measures are stated in dollar terms. The five factors (see Table 1) are:

Factor 1: Absolute Size of Out-State Benefits and Costs. The first important factor is the absolute size of out-state spillovers, SB_2 and SC_2 . Absolute size is compared to a specified value D .

Table 1. Factors Important to Spillover Criteria

Factor	Description	Formulas
1	Absolute Size of Out-State Benefits and Costs	$SB_2 \begin{matrix} > \\ = \\ < \end{matrix} D \quad SC_2 \begin{matrix} > \\ = \\ < \end{matrix} D$
2	Relative Size of Out-State Benefits and Costs	$SB_2 \begin{matrix} > \\ = \\ < \end{matrix} SC_2 \quad \frac{SB_2}{SC_2} \begin{matrix} > \\ = \\ < \end{matrix} E$
3	Out-State Share of Total Benefits and Costs	$\frac{SB_2}{SB} \begin{matrix} > \\ = \\ < \end{matrix} F \quad \frac{SC_2}{SC} \begin{matrix} > \\ = \\ < \end{matrix} F$
4	Absolute Size of In- Versus Out-State Benefits and Costs	$SB_1 \begin{matrix} > \\ = \\ < \end{matrix} SB_2 \quad SC_1 \begin{matrix} > \\ = \\ < \end{matrix} SC_2$
5	Relative Size of In- Versus Out-State Benefit/Cost Ratios	$\frac{SB_1}{SC_1} \begin{matrix} > \\ = \\ < \end{matrix} \frac{SB_2}{SC_2}$

Factor 2: Relative Size of Out-State Benefits and Costs. The second factor compares the absolute size of spillover benefits and costs. It may be expressed based on the size of SB_2 compared to SC_2 or as an out-state benefit/cost-ratio that exceeds, equals, or is less than a specified value E.

Factor 3: Out-State Share of Total Benefits and Costs. The third factor is the shares of a regulation's total benefits and costs that spill over to other states. These shares are compared to a specified value F.

Factor 4: Absolute Size of In- Versus Out-State Benefits and Costs. The fourth factor compares the absolute size of in- and out-state benefits (SB_1 versus SB_2) and in- and out-state costs (SC_1 versus SC_2).

Factor 5: Relative Size of In- Versus Out-State Benefit/Cost Ratios. The final factor measures the relative size of the in-state benefit/cost ratio compared to the out-state ratio.

Alternative Criteria

Several alternative criteria are suggested by the literature on federalism disputes and others are developed here. To be useful, each criterion should address one or more of the above factors. The criteria are stated in mathematical form; described in terms of their meaning and relevance to a state regulation; and assessed on their factor coverage.² The seven criteria (see Table 2) are:

Criterion 1: No Spillover. Criterion 1 judges the appropriateness of a state regulation based on whether there are any out-state spillover effects and is thus a zero spillover criterion. It may be alternatively described as: $SB_2 = SC_2 = 0$ or $SB_1 = SB$ and $SC_1 = SC$. The major advantage of this criterion is the avoidance of any out-state effects from a state regulation. Its main disadvantage is its absolute rigidity. Hardly any regulation would meet this criterion implying that all regulation would be at the federal level.

The criterion provides coverage of the first three factors. Factor 1 is addressed since out-state benefits and costs are measured in absolute values and restricted to equal zero. Factor 2 also is covered because both out-state benefits and costs are constrained to equal zero. Factor 3 is addressed because the criterion constrains the out-state share of benefits and costs to be zero. Factor 4 is not addressed since the criterion does not constrain the absolute size of in- versus out-state benefits and costs. Factor 5 is not covered because the criterion does not address in- versus out-state benefit/cost ratios. The in-state ratio could be greater than, equal to, or less than the out-state ratio, which in effect is undefined since out-state effects are constrained to zero.

Criterion 2: Maximum Absolute Spillover. Criterion 2 requires that the absolute size of the spillovers be less than a specified value G ($SB_2 \leq G$ and $SC_2 \leq G$). The criterion's advantage is in

²The criteria are economic in being based on the comparison of benefits and costs. They are the product of regulatory practice in the United States. As such, they do not bear any close resemblance to formal, normative economic welfare criteria such as pareto optimality. For example, Criteria 3 and 4 (see below), require that out-state benefits be greater than out-state costs. While this suggests that out-staters as a group are made better off by the regulation, it does not address changes in individual welfare. Furthermore, the criteria do not focus on the overall (in- and out-state) benefit and cost profile of a state regulation.

Table 2. Spillover Criteria for the Benefits and Costs of a State Regulation

Criterion	Description	Formulas	Factor Coverage ^a				
			1	2	3	4	5
1	No Spillover	$SB_2 = SC_2 = 0$ $SB_1 = SB$ $SC_1 = SC$	Y	Y	Y	N	N
2	Maximum Absolute Spillover	$SB_2 \leq G$ $SC_2 \leq G$	Y	N	N	N	N
3	Net Positive Spillover	$SB_2 > SC_2$	N	Y	N	N	N
4	No Net Negative Spillover	$SB_2 \geq SC_2$	N	Y	N	N	N
5	Equal Spillover	$SB_1/SB = SC_1/SC$ $SB_2/SB = SC_2/SC$ $SB_1/SC_1 = SB/SC$ $SB_2/SC_2 = SB/SC$ $SB_1/SC_1 = SB_2/SC_2$	N	Y	N	N	Y
6	No Disproportionate Spillover	$SB_1/SB = SC_1/SC \pm H$ $SB_2/SB = SC_2/SC \pm H$ $SB_1/SC_1 = SB/SC \pm H$ $SB_2/SC_2 = SB/SC \pm H$ $SB_1/SC_1 = SB_2/SC_2 \pm H$	N	Y	N	N	Y
7	Maximum Spillover Share	$SB_2/SB \leq K$ $SC_2/SC \leq K$	N	N	Y	Y	N

^aY = yes, N = no.

limiting the absolute size of spillovers. Its disadvantages are it does not give any sense of the relative size of in- versus out-state benefits and costs, and defining the G value may be difficult in practice. Only Factor 1 is captured by Criterion 2 in its constraint on the absolute size of the spillovers. The other factors, which are value comparisons, are not captured.

Criterion 3: Net Positive Spillover. Criterion 3 requires that a state regulation have a net positive spillover, e.g., that out-state benefits be greater than out-state costs, $SB_2 > SC_2$. Its main

advantage is the prevention of negative or zero net spillovers. Its drawbacks are it does not place a constraint on the absolute size of out-state benefits or costs and does not treat positive and negative spillovers symmetrically. It allows for large positive spillovers of benefits, which are still spillovers, but would disallow state regulations with any negative spillover, no matter how small.

Of the five factors, only the second is covered by Criterion 3, with out-state benefits restricted to exceed out-state costs, $SB_2 > SC_2$. Using the second formula for Factor 2, this criterion restricts the out-state benefit/cost ratio to be greater than one, so that the specified value of E is 1. Factors 1 and 3 are not covered by Criterion 3 since it is not concerned with the absolute size of the spillovers or the share of out-state to total benefits and costs. Nor are factors 4 and 5 covered since there is no comparison of in- and out-state benefits and costs.

Criterion 4: No Net Negative Spillover. Criterion 4 is a non-negativity criterion requiring avoidance of a net negative spillover. It relaxes Criterion 3 by allowing zero net benefits and includes Criterion 1 as a special case where $SB_2 = SC_2 = 0$. Its advantage is the avoidance of net negative spillovers. Its disadvantages and factor coverage mirror those of Criterion 3.

Criterion 5: Equal Spillover. Criterion 5 requires equal spillover of the benefits and costs of a state regulation and is based on Pierce's work (1985). There are several alternative ways to state this criterion. It equates the ratio of in-state benefits to total benefits to the ratio of in-state costs to total costs ($SB_1/SB = SC_1/SC$) and, similarly, for out-state benefits and costs ($SB_2/SB = SC_2/SC$). It can also be stated in terms of equating in- and out-state benefit/cost ratios to the total benefit/cost ratio ($SB_1/SC_1 = SB/SC$, $SB_2/SC_2 = SB/SC$) or as setting the in-state benefit/cost ratio equal to the out-state ratio ($SB_1/SC_1 = SB_2/SC_2$).

An advantage of Criterion 5 is the avoidance of an unequal export of benefits and costs to other states, which presumably occurs most often in cases where the exported costs outweigh the benefits, although the reverse scenario is also possible. As Pierce (1985) notes, this affords out-state interests the same protection against passage of unreasonable laws as is enjoyed by in-state parties,

since both will experience the same benefit/cost ratio. The criterion also has the advantage of symmetrical treatment of spillover benefits and costs. It has three disadvantages. One, it imposes no constraints on the relative size of in- and out-state benefits and costs. Hypothetically, all of the benefits and costs could be exported and still meet this criterion. Second, the criterion places no constraints on the absolute size of the spillovers. Finally, Criterion 5 is extremely rigid since it would be very rare that a state law would have exactly equal spillover.

Criterion 5 captures two of the five factors. Factor 2 is addressed as it requires that the out-state benefit/cost ratio equal the total ratio ($SB_2/SC_2 = SB/SC$, so that $E = SB/SC$). Factor 5 is addressed as Criterion 5 restricts the in-state benefit/cost ratio to equal the out-state ratio. The criterion does not address the absolute size of spillovers (Factor 1), the share of benefits and costs exported (Factor 3), or the relative size of in- versus out-state benefits and costs (Factor 4).

Criterion 6: No Disproportionate Spillover. Criterion 6 relaxes Criterion 5 by requiring that there be no disproportionate spillover. This is accomplished by adding an adjustment factor, H , to the formulas yielding the alternative expressions: $SB_1/SB = SC_1/SC \pm H$; $SB_2/SB = SC_2/SC \pm H$; $SB_1/SC_1 = SB/SC \pm H$; $SB_2/SC_2 = SB/SC \pm H$; and $SB_1/SC_1 = SB_2/SC_2 \pm H$. The major advantage of Criterion 6 is that disproportionate spillovers are avoided, yielding a more flexible and useful standard than is provided by Criterion 5. Its disadvantages mirror those of Criterion 5 except for its rigidity, with the addition that with Criterion 6 it may be difficult in practice to define H .

Factors 2 and 5 are captured by Criterion 6. Factor 2 is addressed as the criterion requires the out-state benefit/cost ratio be equal to the total ratio plus an adjustment factor of H , ($SB_2/SC_2 = SB/SC \pm H$). Factor 5 is also covered as in- and out-state benefit/cost ratios are equated, again with an adjustment factor of H ($SB_1/SC_1 = SB_2/SC_2 \pm H$). As was the case with Criterion 5, the other three factors are not addressed.

Criterion 7: Maximum Spillover Share. Criterion 7 constrains the share of the total benefits or costs of a state regulation that may be exported to a specified value K ($SB_2/SB \leq K$, $SC_2/SC \leq$

K), which in most applications would presumably be set below .5 and perhaps quite far below it. The criterion's advantage is in placing a proportional limit on the extent of in- versus out-state impacts. Its disadvantages are it places no limit on the absolute or relative size of exported benefits and costs, or on the ratio of exported benefits to costs. Also, the definition of K may be difficult in practice.

Criterion 7 provides coverage of Factor 3 by constraining the out-state share of benefits and costs. It also addresses Factor 4 by constraining the absolute size of in- versus out-state benefits and costs, with the relationship depending on the definition of K. For example, if K is defined to be less than .5, in-state will be restricted to be greater than out-state benefits ($SB_1 > SB_2$) and in-state to be greater than out-state costs. None of the remaining three factors are addressed by Criterion 7.

Criteria Summary. The seven criteria formalize and systematically relate dimensions of spillovers from state regulations that may be important in settling federalism disputes. Each criterion's usefulness should be judged on its coverage of the five factors important to spillover criteria. The ideal result might be a single criterion that supplies complete factor coverage. As Table 2 shows, none of the criteria fulfills this condition making use of a combination of two or more necessary for full factor coverage. Only Criteria 1 and 2 address Factor 1 providing a sense of the absolute size of spillovers. Criterion 1 might appear to be more useful than Criterion 2 because it covers more factors but is not because its rigidity regarding spillovers means it would invariably rule out state regulation. Thus a combination of Criterion 2 with one or more other criteria is most promising.

Both Criteria 3 and 4 provide coverage of Factor 2 but their usefulness is limited by their ruling out of any state regulation with negative net spillover, even when such spillovers are small. Criteria 5 and 6 each provide coverage of Factors 2 and 5, with Criterion 5 being of limited usefulness due to its requirement of exactly equal spillovers. Criterion 7 is the only one other than Criterion 1 that addresses Factor 3 and is preferable to it because of its flexibility. It is also the only criterion that addresses Factor 4. Thus a combination of Criteria 2, 6, and 7 is most useful in analyzing federalism disputes, since it gives full factor coverage with a minimum set of easily understood

criteria. However, it should be noted that this combination constitutes a fairly rigorous test of the appropriateness of a state regulation. Some analysts may prefer to use Criterion 4, since it allows the most latitude for state regulation. For application, the criteria require the actual measurement or estimation of all in- and out-state benefits and costs in monetary terms.

APPLYING THE SPILLOVER CRITERIA: THE CASE OF ALAR RESIDUES

The federalism dispute arising from state regulation of daminozide (Alar[™])³ residues in heat-processed apple products is explored here in an application of the spillover criteria. Such state regulations are often seen as a burden on interstate commerce by producers, processors, and retailers who seek court invalidation or preemption by federal law. The states, and groups within states, often view such regulation as a necessary tool to address varying consumer needs. Congress has legislated on pesticide residues but not explicitly preempted all state action. In the mid-1980s, the state of Massachusetts introduced stricter daminozide residue standards for heat-processed apple products than those of the U.S. Environmental Protection Agency.⁴ In such cases, the courts and Congress must determine how to settle the federalism dispute. Spillover criteria are useful in analyzing just such situations.

Case Background

Alar is a growth regulator that was primarily used by apple growers to prevent early drop of apples so that fruit stayed hanging on the tree to ripen to a crisp, red, fresh looking product (U.S. EPA, 1984). In economic terms, Alar also helped to reduce picking costs because fewer pickers could harvest for a longer period of time, and shelf life of the product was enhanced. Because Alar is absorbed by the plant and its fruit, it cannot be washed off before consumption or during processing.

³Alar is a registered trademark of the Uniroyal Inc., which was its sole producer.

⁴New York and Maine also sought to set their own standards. For purposes of this application, we ignore their activities.

Heat processing decomposes Alar into another, more toxic component UDMH (unsymmetrical dimethylhydrazine) (U.S. EPA, 1987a).

Daminozide was originally registered in 1963 for use on apples, with the residue tolerance level set at 30 parts per million (ppm) (U.S. EPA, 1985; van Ravenswaay and Hoehn, 1991). No residue level was set for UDMH. In 1984, the EPA announced its intent to conduct a new risk assessment of daminozide and UDMH, including review of animal studies done in the 1970s. As a result, EPA classified daminozide, as well as UDMH, as probable human carcinogens (U.S. EPA, 1985). It also recommended to its Scientific Advisory Panel that Alar be banned. However, the panel found the evidence that daminozide is carcinogenic to be inadequate and EPA withdrew from its intent to ban (U.S. EPA, 1986). Instead, it established a lower residue tolerance level of 20 ppm and ordered Uniroyal to conduct new tests on the degree of toxicity (U.S. EPA, 1986; 1987b).

In February 1989, EPA announced that preliminary results from the new Uniroyal studies indicated the cancer risk posed by Alar was unacceptable (U.S. EPA, 1989a) and EPA was likely to seek cancellation of Alar's registration when the tests were complete (van Ravenswaay and Hoehn, 1991). Spring 1989 saw intense media scrutiny of Alar, with special attention to residues in children's food. In fact, the broad discussion of the Alar controversy in the printed press and on popular TV shows such as *60 Minutes* throughout the late 1980s led to an enormous increase in consumer concern about eating apples and apple products (van Ravenswaay and Hoehn, 1991). In June 1989 Uniroyal voluntarily halted sales of Alar and in October requested voluntary cancellation of the food-use registrations of products containing daminozide, effectively removing Alar from the market.

The Massachusetts Department of Public Health was not satisfied with EPA's actions regarding Alar and its reduction of residue tolerance levels for apples from 30 to 20 ppm in 1986. It felt this reduction would not provide sufficient incentives to further reduce residue levels or have the effect of lowering dietary exposure, especially for infants and children (U.S. EPA, 1987b). In 1986, the state of Massachusetts instituted its own residue tolerances for daminozide in heat-processed apple

products (Massachusetts Department of Public Health, 1986), while not setting a standard for fresh apples in order to avoid a direct confrontation with EPA (Caswell, 1988). Under the state standards, as of October 1, 1986, the residue tolerance was set at 5 ppm for heat-processed apple products and 1 ppm for baby foods. The residues were to decrease to 1 ppm in heat-processed products and to non-detectable for baby foods by October 1, 1987 and to non-detectable in all heat-processed apple products by October 1, 1988.

The Massachusetts regulation on Alar residues occurred during a period of great market uncertainty regarding Alar's ultimate fate. Processors and retailers found themselves in a difficult situation, with many believing the national standard would likely change to that of Massachusetts in the near future. The general climate of uncertainty, along with the Massachusetts action, led much of private industry to declare voluntary boycotts on Alar-treated apples and apple products (*Consumer Reports*, 1989). In other words, they voluntarily applied the Massachusetts standard outside Massachusetts, pursuing a single, national, Alar-free product strategy. This led to protection of the health of consumers outside the state and possible higher costs and prices for Alar-free food products. In our estimates, we initially assume that the Massachusetts action was the deciding factor in a national switch from Alar use to no use and that this impact occurred immediately in 1987. This results in some overestimation of benefits and costs, a point we return to in interpreting the sensitivity of the results. Benefits and costs are calculated on a yearly basis with results presented for 1987. Analysis of the size and incidence of the estimated benefits and costs of the Massachusetts regulation, developed in the next sections, contributes to settling this federalism dispute by quantifying the claims of the various involved parties.

Benefits Estimation: Placing a Monetary Value on Changes in Health

The major benefit expected from reducing Alar residues in heat-processed apple products is an improvement in human health, either decreased morbidity or mortality. Benefits measurement requires placing a monetary value on the health improvement. We use two separate approaches to

yield five benefit estimates. The benefits are calculated per person and then estimated by state based on state population figures for 1987 by the U.S. Department of Commerce, Bureau of Census Population Division. All calculations are reported in 1987 dollars.

Approach 1. The main measure used for improvement due to reduction in exposure to pesticide residue risk is a reduction in excess cancer deaths. Analysts state this risk as additional lifetime risk of cancer death per a population (e.g., a 1×10^{-6} risk translates to one more cancer death per million people over a lifetime exposure). During the 1980s, EPA, some states, and private groups issued risk assessments for Alar and UDMH. Since our focus is heat-processed apple products, we rely on the EPA's two published estimates during this period for the general population for risk associated with the break down product of daminozide, UDMH, in apple products. EPA's 1985 risk estimate for UDMH in apple products was 1×10^{-4} or an estimated 100 extra cancer deaths per million people with lifetime exposure. EPA's 1989 estimate for UDMH in apple products is 1.4×10^{-5} or 14 extra cancer deaths in 1 million people.⁵

Several methods are in use for calculating the value of a human statistical life. Fisher, Chestnut, and Violette (1989) argue the most credible measure of the value of reducing risk is the amount people are willing to pay for the risk reduction. They discuss three major categories of willingness to pay estimation studies: wage-risk studies, contingent valuation studies, and consumer market studies. Fisher et al.'s review of these studies suggest a range of estimates for the value-per-statistical-life of \$1.6 to \$8.5 million in 1986 dollars and that this range is useful for evaluating policies expected to extend lives.

⁵Other risk estimates generally fall within this range, although risk estimates for all food products and specific population groups, especially children under 1 year of age, are higher (U.S. EPA, 1985; 1989a; 1989b). The state of Massachusetts' published risk estimate was 120 extra cancer deaths per 1 million people for a 5 ppm residue level in apple products, and 24 deaths for a 1 ppm tolerance level (Massachusetts Department of Public Health, 1986). The Natural Resources Defense Council's estimate published in 1989 was 41 cancer deaths per 1 million people (Sewell and Whyatt, 1989).

A range of benefits for reducing exposure to residues is estimated based on the Fisher et al. value of life and EPA risk estimates.⁶ The low value of life is \$1.6 million and the high value is \$8.5 million, or \$1,656,000 and \$8,797,500 in 1987 dollars. The risk estimates for UDMH in apple products are the 1985 estimate of 1×10^{-4} and the 1989 estimate of 1.4×10^{-5} , or 100×10^{-6} and 14×10^{-6} , respectively. These estimates are for a lifetime, which is assumed to be 70 years. Therefore the annual risk levels for the above estimates are 1.4×10^{-6} and 0.2×10^{-6} (i.e., 1.4 or 0.2 cancer deaths per million people per year).⁷ A range of dollar benefits per million people per year for avoidance of this risk is calculated by multiplying the two value of life estimates by the two risk estimates:

- A) $\$1,656,000 \times 0.2 = \$331,200$ (lower value of life * lower risk),
- B) $\$8,797,500 \times 0.2 = \$1,759,500$ (higher value of life * lower risk) ,
- C) $\$1,656,000 \times 1.4 = \$2,318,400$ (lower value of life * higher risk),
- D) $\$8,797,500 \times 1.4 = \$12,316,500$ (higher value of life * higher risk).

These translate to an annual per capita willingness to pay of \$0.33, \$1.76, \$2.32, and \$12.32. The benefits based on this estimation are reported in columns 1, 3, 4, and 5 of rows 1-3, Table 3. In-state (Massachusetts) benefits range from a low of about \$2 million to a high of \$72 million, while out-state (all other states) benefits range from \$78 million to \$3 billion.

Approach 2. In a consumer market study, van Ravenswaay and Hoehn (1991) measured changes in consumer behavior after the public became aware that Alar was a suspected carcinogen. They estimated consumers' implied willingness to pay for Alar-free apples and cancer risk reductions. Annual per capita willingness to pay to avoid Alar in processed apple products can be calculated based on these results without using value of life or EPA risk estimates. Van Ravenswaay and Hoehn

⁶Caution is required in extending the Fisher et al. value of life estimates to the case of Alar because the characteristics of the risks analyzed differ. Fisher et al. considered risks that are somewhat voluntary and familiar (job-related risks, smoking, seat belt use), while the risk from premature death due to Alar exposure is involuntary and unfamiliar to consumers. The risk perception literature suggests that individuals may see and value different types of risks differently.

⁷Respectively, $100/70 = 1.4$ and $14/70 = 0.2$.

Table 3. Summary of Estimated Benefits and Costs of Massachusetts Regulation (In Dollars)

Row	Column Benefit & Cost Measures	1	2	3	4	5
		\$0.33 ^a	\$0.81 ^b	\$1.76 ^c	\$2.32 ^d	\$12.32 ^e
1	SB ₁	1,932,150	4,742,550	10,304,800	13,583,600	72,133,600
2	SB ₂	78,184,260	191,906,150	416,982,720	549,659,040	2,918,879,040
3	SB	80,116,410	196,649,270	427,287,520	563,242,640	2,991,012,640
4	SC ₁ (0.1%) ^f	562,846	562,846	562,846	562,846	562,846
5	SC ₁ (1.0%) ^g	626,233	626,233	626,233	626,233	626,233
6	SC ₁ (10.0%) ^h	1,260,103	1,260,103	1,260,103	1,260,103	1,260,103
7	SC ₂ (0.1%)	33,276,554	33,276,554	33,276,554	33,276,554	33,276,554
8	SC ₂ (1.0%)	41,667,767	41,667,767	41,667,767	41,667,767	41,667,767
9	SC ₂ (10.0%)	125,579,897	125,579,897	125,579,897	125,579,897	125,579,897
10	SC (0.1%)	33,839,400	33,839,400	33,839,400	33,839,400	33,839,400
11	SC (1.0%)	42,294,000	42,294,000	42,294,000	42,294,000	42,294,000
12	SC (10.0%)	126,840,000	126,840,000	126,840,000	126,840,000	126,840,000

^aFisher et al. based estimate of willingness-to-pay at lower value of life and lower risk.

^bvan Ravenswaay and Hoehn based estimate of willingness to pay.

^cFisher et al. based estimate of willingness to pay at higher value of life and lower risk.

^dFisher et al. based estimate of willingness to pay at lower value of like and higher risk.

^eFisher et al. based estimate of willingness to pay at higher value of life and higher risk.

^fEstimate for a 0.1% cost increase.

^gEstimate for a 1.0% cost increase.

^hEstimate for a 10.0% cost increase.

(1991) estimated that in 1987 consumers were willing to pay \$1.31, or 17.4% of apple expenditures, per capita to avoid Alar in apples. To estimate willingness to pay for Alar-free heat-processed apple products, we apply this percentage to expenditures on these products. Dollar value of shipments data for the relevant 7-digit Standard Industrial Classification products for the year 1982 are used as a proxy for processed apple expenditures per capita since no data are available on them.⁸ The 1982 figures are used to exclude the effects of sales losses that may have occurred in these products after 1984 due to publicity about risks associated with Alar. The U.S. total value of shipments for processed apple products in the relevant 7-digit SIC codes in 1982 was \$781.1 million.⁹ The U.S. population for the same year was 231,995,000 (U.S. Department of Census, Bureau of the Census Population Division), resulting in a per capita expenditure on processed apple products of \$3.37 for 1982, or \$4.64 in 1987 dollars.¹⁰ Applying van Ravenswaay and Hoehn's willingness to pay estimate of 17.4% of expenditures, we calculate a per capita willingness to pay of \$0.81 per year to avoid Alar in processed apple products. Based on 1987 state populations, this yields calculated in-state (Massachusetts) benefits of \$4.7 million and out-state (all other states) benefits of \$192 million (column 2 of rows 1-3, Table 3). These figures fall within the range generated by the first benefits estimation approach.

Cost Estimation

The costs of loss of Alar in apple production, processing, and distribution are calculated based

⁸The relevant 7-digit products are: SIC 2032111 canned baby foods, fruits; SIC 2032171 canned baby food, juices; SIC 2033112 canned fruits, apples; SIC 2033113 canned fruits, applesauce; SIC 2033161 canned fruit, pie mixes, apple; SIC 2033A11 canned fruit juices and nectars, single strength: apple juice; SIC 2034321 dried and dehydrated fruits: apples; and SIC 2037155 frozen fruits: apples and applesauce (U.S. Department of Commerce, 1982 Census of Manufactures).

⁹The SIC data did not list a value of shipments for SIC 2032111, canned baby foods, fruits for 1982 because of disclosure problems. This SIC is not included in the calculations.

¹⁰The consumer price index for apples for all urban consumers was applied. The value for July 1982 = 331.8 and July 1987 = 457.0, for a ratio of $457/331.8 = 1.377$ (U.S. Department of Labor, 1982; 1987).

on EPA and our estimates. The two major benefits of Alar use in apple production are increased storage life and preharvest fruit drop prevention (U.S. EPA, 1985). Other listed benefits are quality improvement effects such as increased red color, delayed watercore, or bruise reduction. EPA evaluated such quality improvements due to Alar use with an apple model that measured four benefit categories: increase in storage life; increase in total supply of fresh apples; reduction in pruning costs; and early bearing of young trees (U.S. EPA, 1985). Without Alar, a decline was expected in the supply of fresh apples, with a simultaneous increase in the supply of processed apples since fresh apples of lower quality would be sold for processing. Prices for fresh apples at the farm gate were expected to increase by approximately 6%, and prices for processing apples to decrease by 10% (U.S. EPA, 1985). Retail prices for fresh apples were expected to increase by \$1.00 to \$1.90 per bushel, and the price of processed apple products to decline but not enough to offset the increase for fresh apples (U.S. EPA, 1985). These price and quantity effects result in an estimated reduction in consumer expenditures of \$170 million and an overall reduction in farmers' profits of \$33 million. The EPA's estimate of total social costs from loss of Alar was roughly \$60 million, with an upper bound of \$108 million.

We rely on the EPA estimate of producer costs and develop estimates of processing and distribution costs.¹¹ We initially assume that producers, processors, and distributors reacted to the Massachusetts regulation by pursuing a single-product strategy, in effect switching to an Alar-free product to be sold nationwide. We also assume that all apple production was affected, since producers wish to maintain the option of selling in the processed as well as fresh apple markets. This overstates the impact to the extent that producers continued to use Alar and that decisions to discontinue Alar use were based on factors additional to the Massachusetts regulation. Estimated costs are for 1987.

¹¹The total cost range (SC) of our estimates, \$33 to \$126 million, encompasses EPA's overall range of \$60 to \$108 million. Higher estimates of producer losses have been published (e.g., O'Rourke, 1990) but they are for sales losses associated with an Alar "scare" not for an orderly end of Alar use as is assumed in the EPA estimates.

Costs to Producers: The EPA estimated costs to producers from loss of Alar at \$32.9 million. We allocate this cost to the states based on their 1986 shares of total production as reported in the U.S. Department of Agriculture's *Fruit: Situation and Outlook Yearbook* (1987).¹² Overall production rather than data on specific varieties of apples is used based on EPA's finding that Alar was applied to almost all varieties for its broad sphere of action (U.S. EPA, 1985). Based on total costs to producers of \$32.9 million, in-state (Massachusetts) costs from loss of Alar are \$555,803 and out-state costs are \$32,344,197.¹³

Costs to Processors and Distributors: Cost estimates for processors and distributors from loss of Alar are based on 1987 Census of Manufactures data. Census data do not generally list information on apple processing at the 7-digit product level for individual states. Therefore SIC data on total U.S. processing volume and individual state volume in the relevant 5-digit product classes were used to estimate each state's share at the 5-digit level. These state shares were applied to total U.S. value of shipments of heat-processed apple products at the 7-digit level to yield 7-digit state shares. Thus the 5- and 7-digit state volume shares are assumed to be equal. The 1987 in-state (Massachusetts) processing value of shipments is calculated at \$7.043 million, the out-state at \$932.357 million, and the total at \$939.4 million.¹⁴ No reliable estimates exist of probable higher costs to processors and distributors due to the removal of Alar from the market. EPA expected the actual cost of processing

¹²State-by-state shares were not available for 1987.

¹³Note this procedure overestimates producer costs from loss of Alar in growing apples for processing because the EPA estimates are for loss of Alar in all apple production.

¹⁴The relevant 7-digit products are listed in footnote 6. The SIC data did not list a value of shipments for SIC 2032111, canned baby foods, fruits for 1987 because of disclosure problems. This SIC is not included in the calculations. For SIC 2032171 canned baby foods, juices the data provide an estimate of \$115.5 million for 1982, with data withheld for 1987 due to disclosure problems. Inflating this value to 1987 yields a value of shipments of \$159.5 million, which is an overestimation for apple juice. The value of shipments figures are at wholesale prices. The 1982 figures suggest that, after inflation, the value of shipments in these seven 7-digit SICs in 1987 would have been \$1,076.46 million. Actual figures show the 1987 value of shipments to be \$939.4 million. The difference presumably reflects lost sales due to publicity about Alar.

apples to go down with loss of Alar as more product was diverted to this market. Again using a single-product strategy, we estimate these costs based on three scenarios: a 0.1%, 1.0%, and 10.0% increase in costs. Estimated increased in- and out-state costs are shown in Table 4. They range in-state from a low of \$7,000 to a high of \$704,000 and out-state from \$932,000 to \$93,000,000. When added to the production costs estimated in the previous section, 3 in-state (rows 4-6, Table 3) and out-state (rows 7-9, Table 3) cost estimates are generated. The federalism criteria can be applied to the estimated benefits and costs to analyze the federalism dispute arising from Massachusetts' regulation of daminozide residues in heat-processed apple products.

Table 4. Increased Processing and Distribution Costs (in Dollars)

Costs	0.1% Cost Increase	1.0% Cost Increase	10.0% Cost Increase
In-State	7,043	70,430	704,300
Out-State	932,357	9,323,570	93,235,700
Total	939,400	9,394,000	93,940,000

Results of Applying Federalism Criteria to Estimated Benefits and Costs

A range of estimated benefits and costs of the Massachusetts daminozide residue standard given an industry-wide single-product strategy are shown in Table 3. Here each of the willingness to pay values is combined with the possible cost increases to generate a further range of benefit, cost, and benefit/cost ratios to be used in applying the federalism criteria. These ratios are shown in Table 5. We discuss each of the spillover criteria in turn.

Criterion 1: No Spillover. Criterion 1 requires that all effects of the state regulation be in-state, judging the validity of the stricter Massachusetts residue standard on whether the out-state effects are zero. The benefit and cost calculations indicate that Criterion 1 does not hold for this state regulation (see rows 2, 7, 8 and 9, Table 3). For example, a willingness to pay of \$1.76 and a 1%

Table 5. Summary of Estimated Benefit and Cost Ratios

Row	Benefit & Cost Measures	\$0.33 ^a	\$0.81 ^b	\$1.76 ^a	\$2.32 ^a	\$12.32 ^a
1	SB ₁ /SB	0.024	0.024	0.024	0.024	0.024
2	SB ₂ /SB	0.976	0.976	0.976	0.976	0.976
3	SC ₁ /SC (0.1%) ^c	0.017	0.017	0.017	0.017	0.017
4	SC ₁ /SC (0.1%) ^d	0.015	0.015	0.015	0.015	0.015
5	SC ₁ /SC (10.0%) ^e	0.010	0.010	0.010	0.010	0.010
6	SC ₂ /SC (0.1%)	0.983	0.983	0.983	0.983	0.983
7	SC ₂ /SC (1.0%)	0.985	0.985	0.985	0.985	0.985
8	SC ₂ /SC (10.0%)	0.990	0.990	0.990	0.990	0.990
9	SB/SC (0.1%)	2.368	5.811	12.627	16.645	88.388
10	SB/SC (1.0%)	1.894	4.650	10.103	13.317	70.720
11	SB/SC (10.0%)	0.632	1.550	3.369	4.441	23.581
12	SB ₁ /SC ₁ (0.1%)	3.433	8.426	18.308	24.134	128.159
13	SB ₁ /SC ₁ (1.0%)	3.085	7.573	16.455	21.691	115.187
14	SB ₁ /SC ₁ (10.0%)	1.533	3.764	8.178	10.780	57.244
15	SB ₂ /SC ₂ (0.1%)	2.350	5.767	12.531	16.518	87.716
16	SB ₂ /SC ₂ (1.0%)	1.876	4.606	10.007	13.191	70.051
17	SB ₂ /SC ₂ (10.0%)	0.623	1.528	3.320	4.377	23.243

^aFisher et al. based estimates of willingness to pay.

^bVan Ravenswaay and Hoehn based estimate of willingness to pay.

^cEstimate for a 0.1% cost increase.

^dEstimate for a 1.0% cost increase.

^eEstimate for a 10.0% cost increase.

cost increase result in SB_2 of \$417 million and SC_2 of \$42 million. Under this criterion, the Massachusetts action should be invalidated by the courts or preempted by federal law.

Criterion 2: Maximum Absolute Size. Criterion 2 limits the absolute size of the spillovers to a specified value G . For the Massachusetts regulation, if the G value for spillover benefits were set at \$78 million or less, the criterion would suggest invalidation or preemption is in order since SB_2 is greater than this value for all willingness to pay scenarios (row 2, Table 3). Similarly, if the G value for spillover costs were set at \$33 million or less the criterion would suggest the law should not stand. Depending on the willingness to pay and cost scenarios used, the regulation generated sizable out-state benefits and costs making it unlikely it would be judged appropriate under Criterion 2.

Criterion 3: Net Positive Spillover. This criterion requires out-state benefits to be greater than out-state costs, $SB_2 > SC_2$. Another way of stating Criterion 3 is that the out-state benefit/cost ratio (SB_2/SC_2) should be greater than one. This is the case except for the combination of a willingness to pay of \$0.33 and a cost increase of 10% (rows 15-17, Table 5), where SB_2/SC_2 is only 0.623. Therefore almost all scenarios of the Massachusetts regulation meet criterion 3, suggesting that the courts and Congress should not interfere with the state's activity.

Criterion 4: No Net Negative Spillover. Criterion 4 requires no net negative spillover. It can be stated as the requirement that the out-state benefit/cost ratio (SB_2/SC_2) be greater than or equal to one. As found under Criterion 3, this condition holds for every scenario except the lowest willingness to pay of \$0.33 and a 10% cost increase. Like Criterion 3, Criterion 4 suggests the state regulatory activity should not be blocked.

Criterion 5: Equal Spillover. Criterion 5 argues that state regulation is valid only where there is equal spillover of benefits and costs. As expected, given the strict equality requirement, none of the five formulas (see Table 2) for Criterion 5 hold for the Massachusetts regulation (compare row 1 with rows 3-5; row 2 with rows 6-8; rows 12-14 with rows 9-11; rows 15-17 with rows 9-11; and rows 12-14 with rows 15-16, Table 5). This is the case for all levels of willingness to pay and cost

increases. Thus Criterion 5 is not met by the Massachusetts regulation of daminozide residues, suggesting under this criterion that invalidation or preemption is appropriate.

Criterion 6: No Disproportionate Spillover. Under Criterion 6 a state regulation is deemed appropriate if there is no disproportionate spillover, with the acceptable disproportionality defined by the policy maker through specification of H values. Criterion 6 involves the same row comparisons as Criterion 5, with the adjustment of addition (or subtraction) of an H value. The comparisons are in two groups. The first involves analysis of benefit and cost shares. Comparison of SB_1/SB (row 1, Table 5) with SC_1/SC (rows 3-5) indicates that the in-state share of the regulation's total benefits (2.4%) is reasonably close to the in-state share of total costs (1.0-1.7%), implying an H value of .007 to .014 (0.7-1.4%). Similarly, comparison of SB_2/SB (97.6%) to SC_2/SC (98.3%-99.0%), shows a reasonably close match again implying an H value of .007 to .014 (0.7-1.4%). This set of comparisons suggests that under Criterion 6, the Massachusetts regulation would likely be deemed appropriate and not a candidate for invalidation or preemption.

The second group compares benefit/cost ratios with three different formulas. Comparisons of in- and out-state benefit/cost ratios to the total ratio (rows 12-14 to rows 9-11 and rows 15-17 to rows 9-11, respectively) shows that the in-state ratio is greater than the total ratio by 45 to 142%, while the out-state ratio is slightly smaller (by about 1%) than the overall ratio (out-state and total ratios match closely because out-state impacts are such a dominant share of all effects). In-state benefit/cost ratios are 46 to 146% greater than out-state ratios (rows 12-14 versus rows 15-17), a gap that may well be considered large depending on the policy maker's viewpoint.

The two groups of comparisons show that although in- and out-state shares of benefits and costs are closely comparable, in- and out-state benefit/cost ratios are not closely matched. The fact that in-state ratios are considerably more favorable than those out-state would likely mean that the Massachusetts regulation would be judged inappropriate under Criterion 6.

Criterion 7: Maximum Spillover Share. Criterion 7 requires the out-state shares of total benefits and costs to be less than a specified value K. For the Massachusetts regulation, the out-state

share of total benefits is 97.6% (row 2, Table 5), while the out-state share of total costs is 98-99% (rows 6-8, Table 5). Thus under Criterion 7 if K is specified at anything less than 97% the state regulation would be judged inappropriate and be subject to invalidation or preemption.

Settling the Dispute. Assuming a single-product scenario and for a wide range of benefit and cost estimations, the seven criteria give clear answers to the question whether the Massachusetts regulation of daminozide residues in heat-processed apple products is appropriate, although the answers vary with the criteria. Criteria 1, 2, 5, 6, and 7 suggest that, for this particular state action, court invalidation or preemption by federal law is appropriate. The main cause of this conclusion is that under a single-product scenario a very large share of the regulation's impacts occurs out-state. A secondary cause is that the in-state benefit/cost ratio exceeds the out-state ratio because costs are disproportionately felt out-state. Earlier we concluded that a combination of Criteria 2, 6, and 7 yields the most useful basis for judging the appropriateness of a state regulation, given a spillover basis of judgement. Under this criteria set, the Massachusetts regulation would be deemed inappropriate and recommended for invalidation under court review or preemption by federal law.

Under Criterion 3 and the more generally stated Criterion 4, the Massachusetts regulation would be deemed appropriate since it results in a net positive spillover under nearly all benefit and cost scenarios. Use of Criterion 4 to judge state regulations may be desirable if the goal is to give states maximum latitude in experimenting with regulations. However, Criterion 4 does not provide a symmetrical test since it allows large positive spillovers but disallows negative spillovers of any size.

The above analysis assumes that, in response to the Massachusetts regulation of daminozide residues in heat-processed apple products, producers and processors adopted a strategy of producing a single, Alar-free product for national sale. This overestimates the impact of the regulation to the extent they instead adopted a dual-product strategy, producing one product for Massachusetts and another for the rest of the country. However, assuming a dual-product strategy does not alter our conclusions unless the segregation of in- and out-state product is complete and all the costs of the dual

system are borne by in-state consumers. If spillover adoption occurs, even on the order of only 10% of out-state product meeting Massachusetts standards, Criteria 2, 6, and 7 still suggest the state law should be invalidated or preempted, while Criterion 4 suggests it is appropriate. Thus even though this particular regulation has an overall benefit/cost ratio that is generally well above 1, we conclude under our "best" set of economic criteria that regulation of daminozide residues in heat-processed apple products is not an appropriate subject for state action.

CONCLUSIONS

Federalism disputes arising from state regulation, particularly regulations pursuing health, safety, and environmental goals, are a common feature of the U.S. political system. Legal and economic discussions of bases for settling such disputes often focus on the in- and out-state incidence of the state regulation's benefits and costs. However, incidence is a complex concept, which the literature to date has not systematically analyzed, resulting in a fuzziness in thinking about federalism disputes. We discuss five factors important to evaluating incidence and present spillover criteria based on these factors for judging federalism disputes. No single criterion captures the important factors suggesting use of a small set of criteria that addresses the absolute size of spillovers, the proportionality between spillover benefits and costs, and the share of spillover to total benefits and costs. We note that this criteria set constitutes a fairly stringent standard for judging state regulations.

Applying the criteria to a Massachusetts regulation of daminozide residues in heat-processed apple products shows that the criteria reach different conclusions on the appropriateness of the state regulation. Given our benefit and cost estimates, the main economic criteria set suggests the Massachusetts regulation should be invalidated by the courts or preempted by federal law based on its spillovers of benefits and costs. However, other criteria suggest the law is appropriate because net spillovers were positive. The application illustrates how use of the spillover criteria can clarify analysis of federalism disputes arising from state regulations.

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REGIONAL RESEARCH PROJECT NE-165
Private Strategies, Public Policy and Food Marketing Performance
Working Papers

1. Rogers, Richard T. and Julie Caswell. 1987. "Strategic Management and the Internal Organization of Food Marketing Firms." University of Massachusetts, Amherst, MA.
2. Roberts, Tanya. 1987. "Salmonellosis Control: Estimated Economic Benefits." ERS/USDA, Washington, DC.
3. Lee, David R. 1987. "Labor Market Dynamics in the U.S. Food Sector." Cornell University, Ithaca, NY.
4. McLaughlin, Edward W. and Vithala R. Rao. 1987. "An Exploratory Modeling of the Decision Process of New Product Selection by Supermarket Buyers." Cornell University, Ithaca, NY.
5. Smith, M. E., E. O. van Ravenswaay and S. R. Thompson. 1987. "Sales Loss Determination in Food Contamination Incidents: An Application to Milk Bans in Hawaii." Michigan State University, East Lansing, MI.
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PRIVATE STRATEGIES, PUBLIC POLICIES & FOOD SYSTEM PERFORMANCE

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