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Using Benefit-Cost Criteria for Settling Federalism Disputes: An Application to Food Safety Regulation

Julie A. Caswell and Jaana K. Kleinschmit v. L.

Federalism disputes arising from state regulations, particularly those pursuing health, safety, and environmental goals, are common in 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 dimensions important to evaluating incidence and present benefit-cost spillover criteria for judging federalism disputes. When applied to a Massachusetts regulation of Alar residues in heat-processed apple products, the criteria reach different conclusions on its appropriateness, highlighting key considerations in evaluating state regulation in a federal system.

Key words: benefit-cost criteria, federalism, food safety.

Federalism disputes over the legitimate spheres of state and federal regulatory powers are an everyday occurrence in the United States. State laws have the potential of burdening interstate commerce or conflicting with or impinging on federal law and may be challenged in court or by new federal laws limiting their scope and use. Disputes arising from state regulation, whose purpose is to protect health, welfare, or the environment, are especially difficult to resolve. They pose thorny issues of whether laws are motivated by legitimate or rent-seeking concerns and of how to measure the levels and incidence of benefits and costs.

Our purpose is to contribute to the analysis and management of state-federal regulatory relationships by systematically presenting and evaluating benefit-cost criteria for judging federalism disputes. The criteria are designed to be useful in court cases challenging state laws; to congressional discussion of the merits of preempting particular state laws and regulations; and to the parallel case of country-country con-

flicts over regulations under international trade agreements. We present an application of the criteria to food safety with a case study of state regulation in the late 1980s of Alar® residues in processed apple products.[1]

Legal Approaches to Federalism Disputes

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. The large body of case law and legal literature in this area focuses on standards for judging whether state laws pose undue burdens on interstate commerce or are preempted by the explicit language or implicit intent of federal laws.

There are two major avenues of challenge to state and local laws under the U.S. constitution. First, the commerce clause is relied on in court challenges of state laws in areas where Congress has not acted. The federal courts' general

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[1] Alar is a registered trademark of Uniroyal Inc., which was its sole producer.

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, p. 614)."[2]

Over the years, the courts have developed tests to balance federal and state interests in commerce clause cases. One influential test was laid out in 1970 in *Pike* v. *Bruce Church, Inc.*, 397 U.S. 137, 142: "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." Legitimate local public interests most prominently involve the protection of the safety, health, and welfare of state citizens. The federal courts have traditionally given fairly wide latitude to the states in this area, even where some burden on interstate commerce occurs, because they have found it difficult to judge the state's against the national interest. The necessary balancing has resulted in recurrent conflict for the courts. As Foote notes, "(t)he 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 (1985, p. 118)."

For example, in *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 U.S. 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 was on Washington state apple growers who argued they had developed a superior grading system, which allowed greater marketability of their products (Farber). The Supreme Court balanced the protectionist effect against the purported consumer

benefits, finding the pattern of the statute's benefits and costs unacceptable and invalidating the state law. An important 1994 decision of the Supreme Court invalidating Oregon's higher disposal fees for out-state waste is a continuation of the court's balancing of in- and out-state interests in commerce clause cases.

The second major avenue for challenging state law is the supremacy clause of the U.S. Constitution, which is employed for challenges 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 or limit it. Frequently, however, Congress is not explicit, leaving the courts to judge whether it implicitly intended to preempt or limit such activity. In other cases, federal legislation explicitly includes a role for state regulatory activities and the challenge focuses on whether the state has overstepped its specified role.

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 economic effects is inherent to judging these federalism disputes as well. For example, the degree to which a state law frustrates a federal purpose depends in part on the scope and incidence of its impacts. The main arena for resolving these type of federalism disputes is Congress, which can continually adjust the relationship between federal and state law through its decisions whether to include preemptive or limiting language in new legislation.

The legal treatment of federalism disputes suggests several economic considerations important to their settlement. These center, although not in a precise manner, on the level of benefits and costs arising from a state regulation and, very importantly, on their in- and out-state incidence. The relative level of in-state benefits and costs will help to determine whether the state has a legitimate interest in the regulation. Beyond that, in a normative sense and from the federal point of view, a state regulation's validity is primarily tested based on its spillover effect on other states, in other words, on the burden it imposes on interstate commerce and state sovereignty. Historically,

[2] This 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).

the courts and Congress have found evaluating the benefits, costs, and their incidence for state laws that protect health, welfare, and the environment especially difficult.

Economic Approaches to Federalism Disputes

Outside the federalism context, the overall normative welfare economics test of a government regulation is whether its benefits exceed its costs. In the federalism context, the in- and out-state incidence of the regulation's effects takes precedence in evaluating state regulations; economic models of federalism disputes have followed suit. For example, Rose-Ackerman develops a model of the tastes and preferences of inhabitants of various states in order to measure regulatory spillover effects between states. Political action in the federal system allows citizens to support laws that enable their state to "export costs but support laws that reduce the costs imposed on them (Rose-Ackerman, p. 152)." 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 draws similar conclusions from his analysis of differences in state laws governing product-related quality and performance. He 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, resulting 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. The long-run outcome is similar state laws that are not necessarily optimal and may differ significantly from regulatory preferences that would have been expressed at the federal level, with the federal government and courts having roles to play in controlling this phenomenon.

Foote's (1984) analysis of federalism disputes takes a separate but related tack. 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. Foote analyzes this conflict by classifying state regulations into five stages based on

where their impact is felt (product standards, production standards, process of exchange, conditions of sale and point-of-sale services, and conditions of use) and argues that each class has a likely pattern of benefits and costs that should dictate whether preemption of state law is appropriate. With qualifications, she concludes that preemption of state law is most frequently justified in the first three stages.

These models offer useful insights into the probable incidence of the benefits and costs of state regulations but do not address the specifics of how incidence should be evaluated and measured. Some guidance is attempted by Pierce in his model of geographical spillovers which focuses on the degree to which state regulation is evenhanded. 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 (p. 647)." Pierce summarizes his spillover criterion as follows:

> 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) (p. 653).

This criterion and the legal/economic approaches discussed above suggest several formal benefit-cost spillover criteria for settling federalism disputes.

Benefit-Cost Spillover Criteria for Assessing State Regulation

A key consideration in legal and economic analyses of federalism disputes 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 conceptualizing and quantifying how much is too much.

We develop spillover criteria that focus 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 ($j = 1, ..., n$) 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 as follows:

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

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 expressed 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.

From the above discussion, we can identify five dimensions (table 1) of the incidence of in- and out-state benefits and costs that should be important in the normative evaluation of state regulations (all measures are stated in dollar terms). First is the absolute size of out-state benefits and costs, SB_2 and SC_2, compared to a value D specified by the courts or policy makers. A state regulation with spillovers that are large in dollar terms, regardless of the balance between benefits and costs, may be unacceptable because those experiencing the spillovers were not represented in the state political process that produced the regulation. The second dimension is the relative size of out-state benefits and costs, which 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 (e.g., 1). For example, a state regulation may be unacceptable if spillover benefits exceed spillover costs. Third is the out-state share of total benefits and costs compared to a specified value F. A state regulation may be unacceptable if a large percentage of its benefits and costs are experienced out-state by parties who did not participate in the in-state political process. The fourth dimension is the absolute size of in- versus out-state benefits and costs (SB_1 versus SB_2 and SC_1 versus SC_2). A state regulation may be unacceptable if out-state benefits or costs are larger than those in-state. Finally, the fifth dimension is the relative size of in- versus out-state benefit-cost ratios. A state regulation may be unacceptable if the in-state benefit-cost ratio is significantly higher than the out-state ratio.

In practice, evaluations of state regulations meld these five dimensions with some subset often taking prominence based on the circumstances of a particular law. However, considering them separately is important to a clear evaluation of state regulations. For example, a state law may generate out-state benefits greater than costs (dimension 2) and have a small share of total benefits and costs out-state (dimension 3), suggesting it is acceptable in normative terms, but have out-state benefits and costs that are very large in absolute terms (dimension 1), suggesting it is not acceptable. A clear delineation allows these characteristics to be balanced against each other.

Alternative Criteria

Benefit-cost spillover criteria for evaluating state regulations should directly address one or more of the above dimensions. Note again that the overall benefit-cost ratio for the state regulation, while important from a total welfare viewpoint, is not central to the development of criteria to judge federalism disputes. This is the case because these criteria focus on the spillover dimensions, not on the overall desirability of the regulation. The normative rationale for this focus is that state regulation should affect only parties within the state who can participate in the political process and not export benefits or costs to other states.

A potential initial criterion for judging federalism disputes is that the state regulation have no spillover of benefits or costs to other states. This criterion can be set aside because, since virtually no state law would meet it, it would

Table 1. Dimensions Important to Spillover Criteria

Dimension	Description	Formulas	
1	Absolute size of out-state benefits and costs	$SB_2 \gtreqless D$	$SC_2 \gtreqless D$
2	Relative size of out-state benefits and costs	$SB_2 \gtreqless SC_2$	$\dfrac{SB_2}{SC_2} \gtreqless E$
3	Out-state share of total benefits and costs	$\dfrac{SB_2}{SB} \gtreqless F$	$\dfrac{SC_2}{SC} \gtreqless F$
4	Absolute size of in- versus out-state benefits and costs	$SB_1 \gtreqless SB_2$	$SC_1 \gtreqless SC_2$
5	Relative size of in- versus out-state benefit-cost ratios	$\dfrac{SB_1}{SC_1} \gtreqless \dfrac{SB_2}{SC_2}$	

invariably suggest state laws be invalidated with all regulation on the federal level. We develop four alternative criteria (table 2) for evaluating state regulation.

Criterion 1: maximum absolute spillover. Criterion 1 would require that the absolute size of the spillovers of benefits and costs from a state regulation be less than a specified value G ($SB_2 \leq G$ and $SC_2 \leq G$). The criterion's advantage is its focus on limiting the absolute size of spillovers (dimension 1) and thus the impact of decisions made in one state on parties in other states. Its disadvantages are that it does not address the other dimensions important to spillover criteria that involve value comparisons (e.g., relative size of out-state benefits and costs, out-state share of total benefits and costs) and defining a value for G may be difficult in practice (e.g., should the value of G be the same for regulations affecting industries of very different sizes).

Criterion 2: no net negative spillover. Criterion 2 would require that a state regulation avoid any net negative spillover of benefits and costs to other states, i.e., that out-state benefits be greater than or equal to out-state costs, $SB_2 \geq SC_2$. Its main advantage is the prevention of negative spillovers, assuring that exported benefits are at least as great as exported costs ($SB_2/SC_2 \geq 1$); it thus addresses dimension 2 for spillover criteria. The criterion has a disadvantage in this regard, however, in that it does not treat net

positive and negative spillovers symmetrically, allowing large positive spillovers of benefits, which are still spillovers, but disallowing state regulations with any negative spillover, no matter how small. It also does not place a constraint on the absolute size of out-state benefits or costs (dimension 1) or include any comparison of in- and out-state benefits and costs (dimensions 3–5).

Criterion 3: no disproportionate spillover. Criterion 3 would require that a state regulation have no disproportionate spillover of benefits and costs to other states. 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 plus or minus a judgment factor H ($SB_1/SB = SC_1/SC \pm H$) and, similarly, for out-state benefits and costs ($SB_2/SB = SC_2/SC \pm H$). It also can be stated in terms of equating in- and out-state benefit-cost ratios to the total benefit-cost ratio plus or minus a judgment factor ($SB_1/SC_1 = SB/SC \pm H$, $SB_2/SC_2 = SB/SC \pm H$) or as setting the in-state benefit-cost ratio equal to the out-state ratio plus or minus a judgment factor ($SB_1/SC_1 = SB_2/SC_2 \pm H$).[3]

Criterion 3's advantage is the avoidance of a disproportionate 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

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[3] In the case of $H = 0$, this criterion requires an equal spillover of benefits and costs.

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

Criterion	Description	Formulas	Dimension Coverage[a]				
			1	2	3	4	5
1	Maximum absolute spillover	$SB_2 \leq G$ $SC_2 \leq G$	Y	N	N	N	N
2	No net negative spillover	$SB_2 \geq SC_2$ $SB_2/SC_2 \geq 1$	N	Y	N	N	N
3	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
4	Maximum spillover share	$SB_2/SB \leq K$ $SC_2/SC \leq K$	N	N	Y	Y	N

[a] Y = yes, N = no.

also possible. As Pierce 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 addresses dimension 2 by requiring the out-state benefit-cost ratio be equal to the total ratio plus an adjustment factor of H, $(SB_2/SC_2 = SB/SC \pm H)$. Dimension 5 is also covered as in- and out-state benefit-cost ratios are equated, again with an adjustment factor of $H (SB_1/SC_1 = SB_2/SC_2 \pm H)$.

Criterion 3 has three disadvantages. One, it imposes no constraints on the relative size of in- and out-state benefits and costs (dimension 4). 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 (dimension 1) or the share of benefits and costs exported (dimension 3). Third, it may be difficult in practice to define H (i.e., how disproportionate should be operationalized).

Criterion 4: maximum spillover share. Criterion 4 would constrain the share of the total benefits or costs of a state regulation that may be exported to a specified value K ($SB_2/SB \leq K$, $SC_2/SC \leq K$); for example, 0.2% or 20%. The criterion's advantage is that it places a proportional limit on the extent of in- versus out-state impacts (dimension 3), limiting the impact of exports to parties in other states. It also addresses dimension 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 0.5, 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. Its disadvantages are it places no limit on the absolute or relative size of exported benefits and costs (dimensions 1 and 2), or on the in-state relative to the out-state benefit-cost ratio (dimension 5). Also, the definition of K may be difficult in practice.

Criteria summary. The four criteria formalize and systematically relate measures of spillovers from state regulations that are of normative importance in settling federalism disputes. As table 2 shows, none of the criteria covers all five dimensions of spillover incidence, making use of a combination of three or more necessary for full coverage. Only criterion 1 addresses dimension 1 providing a sense of the absolute size of spillovers. Both criteria 2 and 3 provide coverage of dimension 2, but impose different constraints on the relative size of out-state benefits and costs. Criterion 2 is more restrictive because it rules out any state regulation with negative net spillover, even when such spillovers are small. Criterion 3 is also the only standard that provides coverage of dimension 5, while criterion 4 is the only one that addresses dimensions 3 and 4.

A combination of criteria 1, 3, and 4 alone gives full dimension coverage but constitutes a fairly rigorous test of the appropriateness of state regulations. For this reason, analysts may prefer to include use of criterion 2 in evalua-

tions of state regulations, 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) residues in heat-processed apple products is an example of the type of situation in which spillover criteria may be usefully applied. 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 their varying 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.

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. 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). No residue level was set for UDMH. In 1984, the EPA announced its intent to conduct a new risk

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

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 cancelation of Alar's registration when the tests were complete (van Ravenswaay and Hoehn). 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). In June 1989, Uniroyal voluntarily halted sales of Alar, and in October Uniroyal requested voluntary cancelation of the food-use registrations of products containing daminozide, effectively removing Alar from the market.

In 1986, 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. It felt that 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), while not setting a standard for fresh apples in order to avoid a direct confrontation with EPA. Under the state standards, as of 1 October 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 nondetectable for baby foods by 1 October 1987, and to non-detectable in all heat-processed apple products by 1 October 1988.

The Massachusetts regulation on Alar residues occurred during a period of great market uncertainty regarding Alar's ultimate fate. Pro-

cessors 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*). In other words, many 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 analyze four separate spillover scenarios representing different reactions to the Massachusetts regulation:

1. Single product strategy: producers, processors, and distributors reacted to the Massachusetts regulation by producing a single Alar-free product to be sold nationwide. This case results in the maximum spillover of benefits and costs to other states.
2. Dual product strategy (no price premium for Alar-free products): producers, processors, and distributors reacted by producing dual products—an Alar-free product for sale in Massachusetts and a regular product to be sold elsewhere, receiving no premium for Alar-free product sold in Massachusetts. This case results in small spillovers of benefits and costs.
3. Dual product strategy (partial price premium for Alar-free products): same as case 2 with partial premium for Alar-free products.
4. Dual product strategy (full price premium for Alar-free products): same as case 2 with full premium for Alar-free products.

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 but also on other factors such as

possible reduction in consumer anxiety and in actions taken to avoid the risk. We use two separate approaches to yield benefit estimates for the single and dual product cases. 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 cases. Analysts state this risk as additional lifetime risk of getting cancer per a population (e.g., a $1*10^{-6}$ risk translates to one more cancer 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 breakdown 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 cancers per million people with lifetime exposure. EPA's 1989 estimate for UDMH in apple products is $1.4*10^{-5}$ or 14 extra cancers in 1 million people.[5] In the benefits estimation we treat the EPA estimates as 100 and 14 extra cancer deaths, which results in some overestimation of benefits.

Several methods are in use for calculating the value of a human statistical life. Fisher, Chestnut, and Violette argue that 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, Chestnut, and Violette's review of these studies suggest a range of estimates for the value-per-statistical-life based on death rates of $1.6 to $8.5 million in 1986 dollars, and that this range is useful for evaluating policies expected to extend lives.

A range of benefits for reducing exposure to

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

residues is estimated based on the Fisher, Chestnut, and Violette value of life and EPA risk estimates. 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 seventy 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).[6] 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:

1. $1,656,000 * 0.2 = $331,200
   (lower value of life * lower risk),
2. $8,797,500 * 0.2 = $1,759,500
   (higher value of life * lower risk),
3. $1,656,000 * 1.4 = $2,318,400
   (lower value of life * higher risk),
4. $8,797,500 * 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 for the single product strategy case are reported in the first panel of table 3, columns 1, 3, 4, and 5. In-state (Massachusetts) benefits (SB_1) range from a low of about $2 million to a high of $72 million. Benefits also accrue to all out-state consumers because they are offered Alar-free products. Out-state benefits (SB_2) range from $78 million to $3 billion. Benefits for the dual product strategy case with no price premium are also reported in the first panel of table 3 (columns 1, 3, 4, and 5). In-state benefits are the same as in the single product case while out-state benefits are zero because out-state consumers are not offered Alar-free products.

Approach 2. In a consumer market study, van Ravenswaay and Hoehn 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. This estimate includes a wide set of benefits including reduction in morbidity and

mortality, anxiety and fear, and expenditures to avert or mitigate the risk. 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 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 seven-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.[7] 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 seven-digit SIC codes in 1982 was $781.1 million.[8] 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.[9] 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, for the single product case this yields calculated in-state (Massachusetts) benefits of $4.7 million and out-state (all other states) benefits of $192 million (first panel of table 3, column 2). For the dual product case with no price premium for Alar-free products, in-state benefits are the same while out-state benefits are zero (first panel of table 3, column 2). These figures fall within the range generated by the first benefits estimation approach.

We employ van Ravenswaay and Hoehn's market-based willingness-to-pay measure to

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[6] Respectively, $100/70 = 1.4$ and $14/70 = 0.2$.

[7] The relevant seven-digit products are as follows: 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).

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

[9] The 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).

Table 3. Estimated Benefits of Massachusetts Regulation for Four Product Strategies (in Millions)

Row	Benefit Measures	Willingness-to-Pay Estimates				
		1[a]	2[b]	3[c]	4[d]	5[e]
Single product strategy						
1	SB_1	$1.9	$4.7	$10.3	$13.6	$72.1
2	SB_2	$78.2	$191.9	$417.0	$549.7	$2,918.9
3	SB	$80.1	$196.6	$427.3	$563.2	$2,991.0
Dual product strategy (no premium)						
4	SB_1	$1.9	$4.7	$10.3	$13.6	$72.1
5	SB_2	$0.0	$0.0	$0.0	$0.0	$0.0
6	SB	$1.9	$4.7	$10.3	$13.6	$72.1

		With Partial Premium	With Full Premium
Dual product strategy			
7a	SB_1 (Consumer)	$2.4	$0.0
7b	SB_1 (Proc./dist.)	$0.7	$1.5
7	SB_1 (Total)	$3.1	$1.5
8a	SB_2 (Consumer)	$0.0	$0.0
8b	SB_2 (Proc./dist.)	$1.6	$3.2
8	SB_2 (Total)	$1.6	$3.2
9	SB	$4.7	$4.7

[a] Fisher et al. based estimate of per capita willingness to pay of $0.33 at lower value of life and lower risk.
[b] Van Ravenswaay and Hoehn based estimate of per capita willingness to pay of $0.81.
[c] Fisher et al. based estimate of per capita willingness to pay of $1.76 at higher value of life and lower risk.
[d] Fisher et al. based estimate of per capita willingness to pay of $2.32 at lower value of like and higher risk.
[e] Fisher et al. based estimate of per capita willingness to pay of $12.32 at higher value of life and higher risk.

generate benefits estimates for the two dual-product strategy scenarios that involve price premiums for Alar-free products. We assume their willingness-to-pay estimate is the maximum total premium processors and distributors would be able to capture from consumers through higher prices for Alar-free products.[10] In our estimates, if a price premium is received, the premium is deducted from the consumer benefit and credited to that of the processors and distributors. The second panel of table 3 shows the distribution of benefits with the assumption that processors and distributors capture 50% (partial premium) and 100% (full premium) of the willingness to pay, respectively. The distribution of benefits to in- and out-state companies is discussed below.

Cost Estimation

The costs of loss of Alar in apple production, processing, and distribution are calculated based 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 farmgate were expected to increase by approximately 6%, and prices for processing apples to

Table 4. Estimated Costs of Massachusetts Regulation for Single- and Dual-Product Strategies (in Millions)

Row	Cost Measures	Single-Product Strategy			Dual-Product Strategy		
		In-State	Out-State	Total	In-State	Out-State	Total
Producer costs							
1		$0.6	$32.3	$32.9	$0.3	$0.5	$0.8
Processor and distributor costs							
2	0.1% Cost increase	$0.0	$0.9	$0.9	$0.0	$0.0	$0.0
3	1.0% Cost increase	$0.1	$9.3	$9.4	$0.1	$0.2	$0.3
4	10.0% Cost increase	$0.7	$93.2	$93.9	$0.7	$1.6	$2.3
All costs							
5	$SC_1 (0.1\%)$[a]	$0.6			$0.3		
6	$SC_1 (1.0\%)$[b]	$0.7			$0.4		
7	$SC_1 (10.0\%)$[c]	$1.3			$1.0		
8	$SC_2 (0.1\%)$		$33.2			$0.5	
9	$SC_2 (1.0\%)$		$41.6			$0.7	
10	$SC_2 (10.0\%)$		$125.5			$2.1	
11	$SC (0.1\%)$			$33.8			$0.8
12	$SC (1.0\%)$			$42.3			$1.1
13	$SC (10.0\%)$			$126.8			$3.1

[a] Estimate for a 0.1% cost increase.
[b] Estimate for a 1.0% cost increase.
[c] Estimate for a 10.0% cost increase.

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 were expected 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 net reduction in farmers' profits of $33 million. The EPA's estimate of total social costs from loss of Alar nationally was roughly $60 million, with an upper bound of $108 million.[11] We rely on the EPA estimate of producer costs and develop estimates of processing and distribution costs.

Costs to producers. The EPA estimated the net reduction in producers' profits from national 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). In the single product case, all producers stop using Alar resulting in total costs to producers of $32.9 million. In-state (Massachusetts) costs from loss of Alar are $0.6 million and out-state costs are $32.3 million (table 4, row 1, columns 1–3).[13]

In the three dual-product cases, net costs occur only for apple production destined for the Massachusetts processed apple products market which represents 2.4% of the national market. The Massachusetts share of national apple production is 1.7%, while its share of apple processing is 0.75%. Our estimation assumes that the maximum amount of in-state production affected by the regulation is the amount that would fully supply in-state processing (i.e., 0.75%). The difference is supplied out-state, with the costs incurred there. This results in in-state producer costs of $0.3 million and out-state costs of $0.5 million (table 4, row 1, columns 4–6).

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 seven-digit product level for individual states. Therefore SIC data on total U.S. processing volume and individual state volume in the relevant five-digit product classes were used to estimate each state's share at the five-digit level. These state shares were applied to total U.S. value of shipments of heat-processed apple products at the seven-digit level to yield seven-digit state shares. Thus the five- and seven-digit state volume shares are assumed to be equal. The 1987 in-state (Massachusetts) processing value of shipments is calculated at $7.0 million, the out-state at $932.4 million, and the total at $939.4 million.[14]

No reliable estimates exist of costs to processors and distributors due to the removal of Alar from the market. EPA expected the actual cost of processing apples to go down with loss of Alar as more product was diverted to this market. However, over the longer term it is unlikely this effect would persist. Processors and distributors might incur higher costs, especially under a dual-product strategy, associated with testing and segregating Alar-free products from other products in the distribution chain. Given the lack of data, we estimate potential costs based on three scenarios: a 0.1%, 1.0%, and 10.0 % increase in costs.[15]

In the single-product case, all processors and distributors experience the cost increases shown in table 4, rows 2–4. They range in-state from a low of $7,000 to a high of $0.7 million and out-state from $0.9 to $93.2 million. For the dual-product cases (table 4, rows 2–4), in-state costs are the same as in the single-product case. Out-state costs apply only to processed apple products destined for the Massachusetts market. We assume that apple products processed in-state stay in Massachusetts while the

difference between in-state processing and consumption is supplied by other states. In this case, out-state costs range from $0 to $1.6 million depending of the level of cost increase. When added to the production costs estimated above, three in-state (SC_1), out-state (SC_2), and total (SC) cost estimates are generated for the single- and dual-product cases (table 4, rows 5–13).

Applying Federalism Criteria to Estimated Benefits and Costs

The federalism criteria are applied to the range of estimated benefits and costs for the single- and dual-product cases to evaluate the federalism dispute arising from Massachusetts' regulation of daminozide residues in heat-processed apple products. The benefit values shown in table 3 were combined with the possible cost increases in table 4 to generate a range of benefit, cost, and benefit-cost ratios to be used in this analysis. Table 5 shows these ratios for the four product cases using the benefit measures based on van Ravenswaay and Hoehn's willingness-to-pay estimates.[16] We discuss, in turn, the results of applying each of the spillover criteria.

Criterion 1: maximum absolute spillover. Criterion 1 judges the appropriateness of a state regulation based on the absolute size of its spillovers compared to a specified value G. In the single-product case, the Massachusetts regulation generates sizable out-state benefits and costs; the estimated absolute spillover benefits, for example, range from $78 to $2, 919 million. If the G-value for benefits were set at $78 million or less, the criterion would suggest invalidation or preemption is in order. Similarly, if the G-value for spillover costs were set at $33 million or less, the criterion would suggest the law should not stand since estimated spillover costs range from $33 to $126 million. If the G-values are set higher than these levels, the regulation would be deemed appropriate in the single product case.

In the three dual-product cases, spillover benefits are much smaller, ranging from zero to $3.2 million, while spillover costs are also much smaller, ranging from $0.5 to $2.1 mil-

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[14] The relevant seven-digit products are listed in footnote 7. 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 seven-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.

[15] The 0.1% increase in costs in practice results in a 0% increase.

[16] The analytical results for the other willingness-to-pay estimates are the same as those reported in table 5 with one exception. Under criterion 2, a combination of the lowest willingness to pay of $0.33 with a 10% cost increase suggests the Massachusetts regulation should be invalidated while all other benefit-cost combinations suggest it should be validated.

Table 5. Benefit and Cost Ratios for Four Product Strategies, van Ravenswaay and Hoehn Estimate of Willingness to Pay

Row	Benefit and Cost Ratios	Single	Product Strategies		
			Dual (No Premium)	Dual (Partial Premium)	Dual (Full Premium)
1	SB_1/SB	0.02	1.00	0.66	0.32
2	SB_2/SB	0.98	0.00	0.34	0.68
3	SC_1/SC (0.1%)[a]	0.02	0.38	0.38	0.38
4	SC_1/SC (0.1%)[b]	0.02	0.36	0.36	0.36
5	SC_1/SC (10.0%)[c]	0.01	0.32	0.32	0.32
6	SC_2/SC (0.1%)	0.98	0.62	0.62	0.62
7	SC_2/SC (1.0%)	0.98	0.64	0.64	0.64
8	SC_2/SC (10.0%)	0.99	0.68	0.68	0.68
9	SB/SC (0.1%)	5.82	5.88	5.88	5.88
10	SB/SC (1.0%)	4.65	4.27	4.27	4.27
11	SB/SC (10.0%)	1.55	1.52	1.52	1.52
12	SB_1/SC_1 (0.1%)	7.83	15.67	10.33	5.00
13	SB_1/SC_1 (1.0%)	6.71	11.75	7.75	3.75
14	SB_1/SC_1 (10.0%)	3.62	4.70	3.10	1.50
15	SB_2/SC_2 (0.1%)	5.78	0.00	3.20	6.40
16	SB_2/SC_2 (1.0%)	4.61	0.00	2.29	4.57
17	SB_2/SC_2 (10.0%)	1.53	0.00	0.76	1.52

[a] Estimate for a 0.1% cost increase.
[b] Estimate for a 1.0% cost increase.
[c] Estimate for a 10.0% cost increase.

lion. Thus, under criterion 1 the Massachusetts regulation would likely be deemed appropriate in these cases.

Criterion 2: no net negative spillover. Criterion 2 judges a state regulation based on whether there is any 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 (table 5, rows 15–17). For the single-product case this is true, suggesting the Massachusetts regulation meets criterion 2, exporting more benefits than costs, and the courts and Congress should not interfere with the state's activity. Application of the criterion yields the same result for the dual-product cases with partial or full premiums for Alar-free products, except for the partial premium case with a 10% cost increase. However, if dual products are offered with no price premium to processors and distributors, under criterion 2 the regulation would be considered inappropriate because the out-state benefit-cost ratio is zero since there are no out-state benefits.

Criterion 3: no disproportionate spillover. Under criterion 3 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 3 involves row comparisons in two groups. The first involves analysis of benefit and cost shares. For the single-product case, comparison of SB_1/SB (table 5, row 1) with SC_1/SC (rows 3–5) indicates that the in-state share of the regulation's total benefits (2%) is close to the in-state share of total costs (1% to 2%). Similarly, comparison of SB_2/SB (99%) to SC_2/SC (98%–99%), shows a close match (rows 2 and 6–8). This set of comparisons suggests that under criterion 3 the Massachusetts regulation likely would be deemed appropriate and not a candidate for invalidation or preemption.

The second group compares benefit-cost ratios using 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 for the single-product case the in-state ratio is greater than the total ratio while the out-state

ratio is slightly smaller than the overall ratio. The fact that out-state ratios closely match overall ratios, suggesting no disproportionate exporting of regulatory costs over benefits, would make it likely that the Massachusetts regulation would be judged appropriate under criterion 3.

In the three dual-product cases the evaluation of the regulation depends on the extent to which Massachusetts consumers pay a premium for access to Alar-free products. If they pay no or a partial premium, criterion 3 would judge the regulation inappropriate because in-state parties experience 66%–100% of the benefits but only 32%–38% of the costs (table 5, rows 1 and 3–5). However, if Massachusetts residents pay a full premium for Alar-free products, they experience 32% of the regulation's benefits and 32% to 38% of its costs. In this case, criterion 3 would judge the regulation appropriate because it does not involve disproportionate export of costs over benefits.

Criterion 4: maximum spillover share. Criterion 4 judges a state regulation based on whether the out-state shares of total benefits and costs are less than or equal to a specified value K. In the single-product case, the out-state share of total benefits is 98% (table 5, row 2) and the out-state share of total costs is 98%–99% (table 5, rows 6–8). Thus under criterion 4, if K is specified at anything less than 97%, then the state regulation likely would be judged inappropriate and a candidate for invalidation or preemption. Criterion 4 would likely reach a similar conclusion in all the dual-product cases because the out-state shares of benefits are zero, 34%, or 68%, while the out-state shares of costs are 62%, 64%, and 68%, respectively (table 5, rows 2 and 6–8). Thus unless K is more than 62%–68% in the dual product cases, criterion 4 would likely suggest invalidation or preemption of the state regulation.

Settling the dispute. For the four product cases presented, the spillover criteria give clear but differing answers to the question of whether the Massachusetts regulation of daminozide in heat-processed apple products is appropriate. Only criterion 4 would consistently judge the regulation inappropriate regardless of whether single- or dual-product strategies were followed or the amount of premiums paid by Massachusetts consumers. It does so because, in all

cases, too large a share of benefits or costs are exported to other states.

The other three criteria yield a mix of judgments. In the single-product case, criterion 1 would judge the Massachusetts regulation inappropriate because the absolute size of the spillovers is large, while it would not do so in the dual-product cases where spillovers are modest. Criterion 2 generally would judge the regulation appropriate in all except the dual-product no premium case because the out-state benefit-cost ratio is greater than one. In the dual-product no-premium case, however, the out-state ratio is less than one. Finally, under criterion 3 the regulation is likely to be seen as appropriate in either the single-product or dual-product full premium cases because out-state benefit-cost ratios match overall ratios, suggesting no disproportionate exporting of costs over benefits. In the dual-product no-premium and partial-premium cases there is disproportionate export and the criterion would judge the regulation inappropriate.

How does one settle the federalism dispute based on these results? In terms of national impact, the Massachusetts regulation is likely to have had a benefit-cost ratio well above one regardless of whether single- or dual-product strategies were adopted. But in settling federalism disputes, the key factor is not the overall ratio but the in- versus out-state incidence of the regulation's benefits and costs. At minimum, under all but the dual-product no-premium scenario the regulation exported more benefits than costs and could be judged to have had a positive impact on states other than Massachusetts. However, exports of benefits over costs still have parties in one state imposing their regulatory choices on those in other states. For this regulation, the exported share of the regulation's impact is large across all product strategies, although in the dual-product cases the absolute dollar value of the exports is modest. Finally, the impact of the regulation is not disproportionate if in-state consumers pay a full premium for Alar-free products or if these products are made available nationwide (the single-product strategy).

The result of our evaluation is a complex picture. If we emphasize the degree to which the impacts of the Massachusetts regulation are out-state (criterion 4), we would conclude that regulation of daminozide residues in heat-processed apple products is a more appropriate subject for federal than state action. If we emphasize the other dimensions of spillover criteria, whether the Massachusetts regulation is

deemed appropriate depends on whether single- or dual-product strategies are adopted and the extent to which Massachusetts consumers pay premiums for Alar-free products.

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 focus on the in- and out-state incidence of the state regulation's benefits and costs. However, incidence is a complex concept resulting in fuzziness in thinking about federalism disputes. The Congress, courts, and state legislatures need to be more aware of specific economic effects in deciding federalism questions. We discuss five dimensions important to evaluating incidence and present practical benefit-cost spillover criteria based on them for judging federalism disputes. When applied to a Massachusetts regulation on Alar residues in heat-processed apple products, the criteria reach different conclusions on its appropriateness depending in part on how the market reacted to the regulation. The application illustrates how use of the spillover criteria can clarify analysis of federalism disputes arising from state regulations.

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