Rent-Seeking in Noxious Weed Regulations: Evidence from US States

He Min
Munisamy Gopinath*
Steven T. Buccola
Department of Agricultural and Resource Economics

Peter B. McEvoy
Department of Botany and Plant Pathology

Oregon State University

(E-mail: m.gopinath@oregonstate.edu, Ph: 541-737-1402, Fax: 541-737-2563)

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Abstract: Many non-native insect, disease, and weed pests of food, fiber, and nursery crops pose threats to the U.S. environment, agricultural production, and exports. In this study we focus on regulations controlling the spread of noxious weeds, especially the regulatory differences among US states and investigate the determinants of such regulations. With a simple game-theoretic framework, we derive cross-state regulatory congruence as a function of ecological and agronomic characteristics and stakeholder lobbying through political contributions. Empirical results suggest ecological and agronomic dissimilarities drive large cross-state differences in noxious weed regulation across states. However, evidence of stakeholder interests in shaping these regulations is found to be statistically significant. In particular, the seed industry appears to favor more uniform regulations among US states.

Key Words: Invasive Species, Political Economy, Weed Regulation

JEL Classification: Q5, H7

Min is a Graduate Student, Gopinath an Associate Professor and Buccola a Professor in the Department of Agricultural and Resource Economics, and McEvoy is a Professor in the Department of Botany and Plant Pathology, Oregon State University, Corvallis, Oregon.

*Corresponding author (E-mail: m.gopinath@oregonstate.edu, Ph: 541-737-1402, Fax: 541-737-2563).

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Rent-Seeking in Noxious Weed Regulations: Evidence from US States

Many non-native insect, disease, and weed pests of food, fiber, and nursery crops pose threats to the U.S. environment, agricultural production, and exports. Prominent examples are citrus canker and the Mediterranean fruit fly and, more recently, soybean rust (Animal and Plant Health Inspection Service, APHIS, and Economic Research Service, ERS, US Department of Agriculture, USDA). Among such threats, weed intrusions, commonly referred to as noxious weeds, have significant environmental and economic impacts (Pimentel et al., 2000). Unwanted weeds can be transmitted, knowingly or unknowingly, from one country or state to another through both natural and human channels.

Noxious weeds are considered to be invasive species (IS), that is, "*nonnative, alien, or exotic to the ecosystem under consideration, and when introduced, cause, or are likely to cause, economic or environmental harm or harm to human health*," (ERS, USDA, 2003). The Plant Protection Act (PPA) prohibits or regulates the spread of such invasive species by authorizing the Secretary of Agriculture to publish a federal list of noxious weeds (NXW) and to prohibit or restrict their international and interstate commerce. Simultaneously, provisions of the Federal Seed Act (FSA) prohibit or restrict noxious weed seed (NXWS) movements within and at the borders of the United States. More importantly, the PPA and FSA allow each state's Department of Agriculture to maintain additional controls on noxious weeds deemed necessary to the state's ecological, agricultural and environmental interests. Hence, the definition of noxious weeds varies by state, and most states maintain two sets of noxious weed regulations. Based on FSA, the state-level NXWS list regulates interstate trade in seeds using a prohibited (zero tolerance) and/or restricted (defined tolerance) list. The state-level NXW list is often based on the authority granted by the PPA but, individual states also have noxious weed laws. The NXW list, which regulates interstate in nursery products, often has two sub-lists: an *A*-list (zero tolerance) and a *B*-list for weeds posing a potential danger but whose importation is not necessarily prohibited.

Unlike the federal NXW and NXWS lists, there exists large cross-state differences in the size and composition of these lists. For instance, figure 1a shows the number of weed species in state NXWS lists (excluding Alaska and Hawaii), where Colorado and New York have, respectively, the most and least number of weeds. Figure 1b identifies how many of the weed species in California's NXWS list are also listed in other 47 contiguous states. Not surprisingly, a state's number of common weeds with that of California decline as we move from west to east.

In this study we identify and investigate the sources of cross-state differences in NXW and NXWS lists. Specifically, we characterize the basis for state weed regulations by identifying stakeholders, and their costs and benefits.[1] Then, we ask why NXWS and NXW lists diverge from one state to another. To answer this question, we develop a political and ecological economy model of IS regulation. In our inter-disciplinary approach, we model the supply and demand for IS protection and the resulting equilibrium, which determines the size and composition of NXWS and NXW lists. Three economic interest groups are considered for each state: consumers, seed producers and nursery growers, and commodity producers. For consumers, increasing IS protection increases the price of the associated agricultural product by reducing its external supply; but it may also protect the ecosystem and to that extent provide positive marginal utility. Seed producers or nursery growers gain from higher prices for their products and the increased agronomic-protection embodied in the IS protection. Like consumers, commodity producers face a tradeoff between increased input prices (e.g., seed price) but gain from reduced weed intrusions into their state. We derive the social planner's problem as

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[1] For a sample of studies on risk assessment and management of weeds, and broader invasive species, see Eiswerth and Van Kooten (2002), Settle and Shogren (2002), National research Council (2002), Lehtonen (2001), Panetta et al. (2001), Rejmanek (2001, 1999) and Stocker (2001).

the weighted sum of these three interest-groups' welfare, where the respective weights are functions of lobbying efforts of individual groups. We then model the choice of IS protection as a strategic game between a base state and any other state. The regulatory congruence between these two states' IS protection provides the basis for our empirical analysis.

Regulatory congruence represented by an overlap or similarity function, derived from our inter-disciplinary approach, is estimated using data on ecosystem and agronomic characteristics and on the rent-seeking efforts of the stakeholders or interest-groups. For this purpose, data are compiled on (i) NXW and NXWS lists of the 48 contiguous states, (ii) states' ecological characteristics from Bailey's *Ecoregions of the United States*, (iii) states' agronomic characteristics from USDA, and (iv) stakeholder lobbying (e.g., dollar value of contributions by seed producers) from the Institute on Money in State Politics.

The next section presents our approach to the demand and supply of noxious weed regulation. Data and the econometric procedure for estimating cross-state regulatory congruence are then described. Discussion of results is followed by a summary and conclusions.

Research Methods

Central to our research is a political and ecological economy model of IS regulation. Political economy models have become mainstream tools in the analysis of public policies (e.g., Stigler 1971; Peltzman 1976; Becker 1983; Grossman and Helpman 1994; Goldberg and Maggi 1999; Copeland and Taylor, 2004). In our application of such approaches, we model a prohibited weed species list as the consequence of the interplay of the supply and demand for IS protection.[2] Demand arises from two sources. First, scientifically based concerns exist about the health of

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[2] Many of these regulations are considered to be nontariff barriers in agriculture. For measurement of non-tariff barriers and their effects, see Beghin and Bureau (2001), Orden and Roberts (1997), and Hillman (1978).

the local ecosystem if foreign species are introduced. Second, economic interest groups view IS regulations as a way to increase private rents. The supply of IS regulation is provided by policy makers empowered to erect barriers against products containing invasive species.

<u>Consumers' Interest in IS Regulation</u>: Given the political boundaries of IS regulation, we begin with a social planner's objective function the state level. Consider first a state government's policy choices, developed in response to consumer, environmental, and producer interest groups (stakeholder) in a state. Let the state's representative consumer demand a combination of agricultural commodities (food products) and environmental amenities. The indirect utility function of the consumer can be characterized as, $V\,[p(L),\ Y,\ L\,,\mathbf{I}]$, where p is the unit price of the agricultural good(s) or seed(s) impacted by IS regulation; L is the size or stringency of the state noxious weed list; Y is the representative consumer's income; and $\mathbf{I}$ is a vector describing the state's ecosystem. Consumer price p is positively related to the stringency of regulation represented by the weed list's size, L. In other words, if IS regulation becomes stringent, the production cost of agricultural goods impacted by the regulation rises and therefore, agricultural or food price also increases. Regulatory stringency, L, is also a direct argument in the indirect utility function because consumers have ecosystem preferences independent of their food consumption interests. An example of consumers' ecosystem preference is the aversion towards weeds that are fire hazards (e.g., cheat grass) or cause allergies (e.g., ragweed).

The total effect of increasing L on the representative consumer in a state is found by differentiating V with respect to L:

$$(1)\qquad \frac{dV}{dL}=\frac{\partial V}{\partial p}\frac{\partial p}{\partial L}+\frac{\partial V}{\partial L}.$$

We refer to the first right-hand-side term in equation (1) as the *market-price* effect. Economic theory suggests that $\partial V/\partial p$ is negative. However, $\partial p/\partial L$ is positive because stringent weed regulations restricts commodity producers' seed choices, which increases agricultural production cost and thus consumer prices. To the extent that the increase in L protects the environment, the second right-hand-side term in equation (1), the *ecosystem-preference* effect, is positive. The sign of the derivative in equation (1) is either positive or negative depending on the relative strengths of these two effects.

Seed and Commodity Producers' Interest in IS Regulation: Given a set of agronomic conditions, $\boldsymbol{A}$, producers' decision-making in the state planner's model may be represented by two profit functions, one each for seed producers and commodity producers.[3] Seed producers' maximum profit function is given by $\pi_s\,[p_s(L)\,,\mathbf{W}_s\,,L\,,\mathbf{A}]$, where L is defined as in the consumer problem, and p_s and $\mathbf{W}_s$ are, respectively, seed price and the vector of input prices in seed production. As in the standard profit function, profit opportunities are conditioned by output and input prices. In addition, they are directly influenced by weed list L insofar as the list provides seed producers with biological protection from invasive weeds. Holding $\boldsymbol{A}$ and $\boldsymbol{W}_s$ constant, the profit impact of altering the list L is:

$$(2) \qquad \frac{d\pi_s}{dL} = \frac{\partial\pi_s}{\partial p_s}\frac{\partial p_s}{\partial L} + \frac{\partial\pi_s}{\partial L}$$

Note that $\partial p_s / \partial L$ is positive since the stringency of weed regulations provides greater market protection to local seed producers. Since $\partial \pi_s / \partial p_s$ is also positive, the first right-hand term in equation (2), namely the *price-enhancement effect*, is positive.[4] The second right-hand term or the *agronomic-protection effect*, also is positive because the larger the weed list, the greater the agronomic protection (lower weed abatement costs) to local producers. The expected sign of

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[3] In this section we replace the term "seed producers and nursery growers" by "seed producers" for convenience.

[4] However, seed producer profits can be a *negative* function of the size of lists in jurisdictions to which local producers would export. That is, noxious weed regulation can be perceived as export barriers, if a states' seed producers incur additional costs to obtain certification and/or labeling privileges.

equation (2) is, unlike (1), therefore is positive.

The commodity producers' profit function is given by $\pi_m[p_m, p_s(L), \mathbf{W}_m, L, \mathbf{A}]$, where L and $\boldsymbol{A}$ are as defined in the seed producers' problem, p_m is the aggregate price of final commodities, and $\boldsymbol{W}_m$ is a vector of non-seed input prices. Because seeds are inputs to commodity production, $p_s(L)$ enters π_m as an extra input price. Moreover, commodity producers' profits are directly impacted by L if it provides agronomic protection from invasive weeds. Given $\boldsymbol{A}$ and $\boldsymbol{W}_m$, the profit impact on commodity producers of altering weed list L is:

$$(3) \qquad \frac{d\pi_m}{dL} = \frac{\partial \pi_m}{\partial p_s}\frac{\partial p_s}{\partial L} + \frac{\partial \pi_m}{\partial L}.$$

As before $\partial p_s / \partial L$ is positive but $\partial \pi_m / \partial p_s$ is negative because seeds are inputs rather than outputs in commodity production. Therefore, the first right-hand term in equation (3), which is similar to the *market-price effect* on consumers, is negative. The second right-hand term or the *agronomic-protection effect*, remains positive since weed protection also applies to commodity producers. The sign of equation (3) thus depends on the relative strength of these two effects.

<u>The Social Planner's Problem</u>: Let ω_c, ω_s, and ω_m refer respectively to weights the state government places on consumer, seed producer, and commodity producer welfare. Such weights are assumed to depend on stakeholder or interest-group lobbying. The state government's or social planner's objective function can then be written as (Copeland and Taylor, 2004):

$$(4) \qquad G(L) = \max_{L_n} \left\{ \begin{aligned} &\omega_c\, V[p(L), Y, L, \mathbf{I}) + \omega_s\, \pi_s[p_s(L), \mathbf{W}_s, L, \mathbf{A}] \\ &\qquad + \omega_m\, \pi_m[p_m, p_s(L), \mathbf{W}_m, L, \mathbf{A}] \end{aligned} \right\}.$$

An alternative representation of the social planner's problem is:

$$(5) \qquad G(L_n) = \max_{L_n}\{B(L_n; \mathbf{I}, \mathbf{A}, \omega_c\ \omega_s, \omega_m, Z) - C(L_n; \mathbf{I}, \mathbf{A}, \omega_c\ \omega_s, \omega_m, Z)\},$$

Where $Z = \{Y, W_s, W_m\}$. Here, *B* represents a state's benefits from IS regulation including the eco-system preference effect on consumers, price-enhancement on seed producers and agronomic-protection effects on seed and commodity producers. The cost, *C*, represents the price-enhancement effects on consumers and commodity producers.[5]

The representation in (5) of the state's policy problem helps underscore its strategic nature. State *i*'s choice of *L* generally depends on state *j*'s choice because the extent of any similarity in the two states' lists, and thus in the legal constraints facing respective producers, affects the competitive framework in both states. For instance, if the *i*-th state's choice, L^i, is perfectly matched by the *j*-th state, L^j, it alters the benefits and costs of IS regulation to the *i*-th state. In such a strategic environment, the *i*-th state's problem can be recast as one of choosing the degree of congruence or overlap between its IS regulation and that of the *j*-th state. Reflecting as it does the observed cross-state quantitative similarities, congruence-based accounting has the additional virtue of measuring compositional content of regulations. Let

- L_{ij} be the percentage overlap between *i*-th and *j*-th state's noxious weed list (number of common species in the two lists divided by the number of species in the *i*-th state);
- $\mathbf{I}_{ij}$ be the vector representing ecosystem dissimilarities between states *i* and *j*;
- $\boldsymbol{A}_{ij}$ be the vector representing agronomic dissimilarities between states *i* and *j*;

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[5] Note that the first-order condition for maximizing equation (4),

$$\omega_c\left(\frac{\partial V}{\partial p}\frac{\partial p}{\partial L}+\frac{\partial V}{\partial L}\right) + \omega_s\left(\frac{\partial \pi_s}{\partial p_s}\frac{\partial p_s}{\partial L} + \frac{\partial \pi_s}{\partial L}\right) + \omega_m\left(\frac{\partial \pi_m}{\partial p_s}\frac{\partial p_s}{\partial L} + \frac{\partial \pi_m}{\partial L}\right) = 0$$ can be rearranged as:

$$\frac{dB}{dL} = \omega_c\left(\frac{\partial V}{\partial L}\right) + \omega_s\left(\frac{\partial \pi_s}{\partial p_s}\frac{\partial p_s}{\partial L} + \frac{\partial \pi_s}{\partial L}\right) + \omega_m\left(\frac{\partial \pi_m}{\partial L}\right), \text{ and } \frac{dC}{dL} = \omega_c\left(\frac{\partial V}{\partial P}\frac{\partial P}{\partial L}\right) + \omega_m\left(\frac{\partial \pi_m}{\partial p_s}\frac{\partial p_s}{\partial L}\right),$$

which suggests that the solution to the maximization problem in (5) is the same as that in (4).

- ω_{ij}^k, $k = c, s, m$, be the vector of differences in lobbying efforts between *i*-th and *j*-th states, distinguished by consumer (c), seed-producer (s), and commodity-producer (m) interest groups.

Objective functions of the *i*-th and *j*-th state problems then become:[6]

$$
(6) \qquad \begin{aligned}
G^i(L_{ij}) &= \max_{L_{ij}} \left\{ B(L_{ij}; L_{ji}^*, \mathbf{I}_{ij}, \mathbf{A}_{ij}, \omega_{ij}^c, \omega_{ij}^s, \omega_{ij}^m) - C(L_{ij}; L_{ji}^*, \mathbf{I}_{ij}, \mathbf{A}_{ij}, \omega_{ij}^c, \omega_{ij}^s, \omega_{ij}^m) \right\} \\
G^j(L_{ji}) &= \max_{L_{ji}} \left\{ B(L_{ji}; L_{ij}^*, \mathbf{I}_{ji}, \mathbf{A}_{ji}, \omega_{ij}^c, \omega_{ij}^s, \omega_{ij}^m) - C(L_{ji}; L_{ij}^*, \mathbf{I}_{ji}, \mathbf{A}_{ji}, \omega_{ij}^c, \omega_{ij}^s, \omega_{ij}^m) \right\}
\end{aligned}.
$$

The reaction functions for states *i* and *j* would then be:

$$
(7) \qquad L_{ij} = R^i(L_{ji}); \; L_{ji} = R^j(L_{ij}),
$$

resulting in a Nash-type solution as follows:

$$
(8) \qquad L_{ij}^* = L_{ij}^* (\mathbf{I}_{ij}, \mathbf{A}_{ij}, \omega_{ij}^c, \omega_{ij}^s, \omega_{ij}^m), \; \forall i, j .
$$

Equation (8) suggests that the similarity between any two states' weed import regulations should be a function of dissimilarities between (a) their ecosystem and agricultural characteristics, each of which demand biological protection, and (b) their relative lobbying or welfare-weight ratios, ω_{ij}^k, which influence producers' ability to use weed regulations as rent-seeking, import protection. We expect the influence of $\mathbf{I}_{ij}$ and $\mathbf{A}_{ij}$ on overlap L_{ij} to be negative because when ecosystems and cropping patterns differ, weeds regarded as biologically and economically damaging should differ also. That is, larger ecological and agronomic dissimilarities between states should lead to lower regulatory congruence.

Note that the degree of overlap, L_{ij}, is negatively related to the stringency of the i-th state's regulation (L^i). Because the sign of equation (1) depends on the relative sizes of the

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[6] We suppress income and factor price differences by assuming integrated factor markets among US states.

market-consumption and ecosystem-preference effects, a rising consumer-welfare weight ω_{ij}^{c} might have either a positive or negative effect on a state's NXW or NXWS regulatory congruence with others. For instance, a negative (estimated) coefficient on ω_{ij}^{c} in equation (8) would identify that consumers' lobby works to lower overlap, i.e., increase regulatory stringence, and their eco-system gains outweigh market-price effects. Similarly, commodity producer interests depend upon the relative strength of producer preferences for lower seed prices versus lower weed-abatement costs. Since seed producers benefit from price increases and agronomic protection, we anticipate a negative effect on overlap from their lobbying efforts. However, if seed producers perceive increased regulations as export barriers, then they likely lobby for greater regulatory congruence. Thus, the impact of welfare weights $(\omega_{ij}^{c}, \omega_{ij}^{s}, \omega_{ij}^{m})$ on regulatory congruence in equation (8) cannot be predicted *a priori*.

Data Description

To estimate equation (8) we utilize publicly available data. The following describes our database, which includes measures of relevant regulatory congruence and ecological, agronomic, and lobbying dissimilarities across states.

Weed Regulatory Congruence (L_{ij}): Recall that each state has two sets of noxious weed regulations: NXWS and NXW lists based respectively on FSA and PPA. We first compiled all 50 states' NXWS lists for the years 1997 and 2002. However, we excluded Alaska and Hawaii because of significant differences in the list size and ecological make-up (tropical versus tundra). Each unique species from the 48 NXWS lists is compiled into a global list, which initially contained about 1300 weed species. There were duplications and other typographical errors in state NXWS lists, which were eliminated in the compilation of the global list. While some states use more recent scientific names for weed species, many continued to use old names. For example, *Centaurea repens* in Oregon's list and *Acroptilon repens* in California's list refer to the same weed (Russian knapweed). Regulatory congruence is likely underestimated with such inconsistencies in the global list. To overcome this problem, synonyms of each species in the global list are obtained from the National Plant Database (http://plants.usda.gov/), and for each species, the most recent scientific name is used.

The global list is coded using state and species indicators, which are used to identify regulatory overlap. For instance, if a species in the global list appeared on two states' lists, then the overlap between the two states is equal to 1. Such a species comparison is hindered when some states list only a genus name with all its species as a noxious weed, e.g., *Allium spp.*, which we referred to as the *spp* problem. Fortunately, the number of weeds listed this way is relatively small (e.g., 31 in 2002), but a handful of genera had over 50 species each. Adding all species in a genus would significantly inflate the NXWS list. For instance, the number of weeds in the Alabama NXWS list with genus and species name is 23 and if the 5 weeds with only a genus name (*Allium spp.*, *Cuscuta spp., Crotalaria spp., Rumex spp.,* and *Xanthium spp.*) were fully enumerated, then its NXWS list would contain 240 species. Arkansas, which also has 23 weeds with genus and species name and the same 5 weeds with only a genus name, would then have a total of 240 species as well. Among the weeds with specific genus and species names, Alabama and Arkansas have 15 weeds in common. If all species in the 5 genera (*spp* problems) are included, the overlap between the two states jumps to 232, about a 1500% increase over the overlap when weeds with genus and species names alone are considered. To resolve this inflationary problem, we compare a species with a species and a genus with a genus. In the above Alabama-Arkansas example, the overlap is then equal to 15 + 5, the latter addition representing a genus comparison. Most of the *spp* problems were fixed with our taxonomic resolution, but in a few cases a state (A) has listed some species within a genus, while the comparator state (B) has only the genus name. In this case, the number of overlap is set equal to the number of explicit species in the concerned genus in state A.

Each state's NXWS list has two components: prohibited and restricted lists. Most states imposes zero tolerance on the prohibited noxious weed species, while restricted species have defined tolerance (e.g., number per 100 seeds). Therefore we developed three 48x48 overlap matrices, one each for prohibited, restricted and the combined (NXWS) lists:

$$\begin{pmatrix} AL \cap AL & AL \cap AR \ldots & AL \cap WY \\ \vdots & \ddots & \vdots \\ WY \cap AL & WY \cap AR \cdots & WY \cap WY \end{pmatrix}_{48\times 48}$$

where AL, AR and WY denote Alabama, Arkansas and Wyoming, respectively. The overlap matrix is symmetric, where each row corresponds to a state's number of common weed species with all states (including itself). For example, the first row corresponds to the overlap of Alabama's list with itself and all other 47 state lists. Note that the diagonal elements of the overlap matrix are the number of noxious weeds listed in that state. Since the number of the noxious weeds listed by each state is different, we calculated percent overlap by dividing the overlap of noxious weeds in each row by the size of the corresponding state's list. For instance, the first row of the 48x48 overlap matrix is divided by the number of noxious weeds listed in AL. The diagonal elements of the matrix are equal to 1, while off-diagonal elements vary between 0 and 1 depending on the degree of overlap.

The case of NXW lists is uneven relative to that of the NXWS lists. Some states do not have a NW list as of 2004 (e.g., Mississippi, New Jersey), while others have NW lists that list the same weeds in the NXWS list (e.g., Louisiana, Massachusetts). In other cases, the NW list is neither established under statutory authority nor enforced by agriculture departments (e.g., Georgia). In this study, only those NXW lists established and enforced under the Plant Protection Act of 2000 are considered as regulations. Therefore, we have 24 and 36 NXW lists in 1997 and 2002, respectively. A 48x48 matrix of NXW-regulation overlap similar to that of NXWS lists is constructed with empty cells for comparison between states lacking NXW lists.

Indexes of Ecosystem Dissimilarities ($\boldsymbol{I_{ij}}$): In order to attribute differences in NXW/NXWS list to ecosystems characteristics, we first quantify the latter (Rejmanek, 2001). An ecoregion is "a relatively large unit of land or water containing a geographically distinct assemblage of species, natural communities, and environmental conditions" (World Wildlife Fund, 1999). Several methods to classify ecoregions have been developed, each with a set of criteria chosen for specific objectives. For instance, Bailey's (1995) ecoregions delineate continental United States into a hierarchical system with four levels: domains, divisions, provinces and sections (Bailey, 1983; 1995). Leemans' (1992) Holdridge Life Zone system uses biotemperature, mean annual precipitation and potential evapotranspiration ratio to define provinces, while Omernick's (1987) ecoregions are based on land use, land surface form, potential natural vegetation, and soil types.

Bailey's (1995) classification is most widely used (e.g., the US Forest Service) since it includes many of the characteristics in the alternative classifications noted above. We follow Bailey's (1995) classification of the *Ecoregions of the United States* to derive measures of ecological dissimilarities across states. Specifically, we use the data underlying the classification such as land surface form, climate (temperature and precipitation), soil, and surface water characteristics to measure ecosystem differences across US states. The data are taken from the National Resources Inventory of the Natural Resource and Conservation Service, USDA. All data at the county level are aggregated to obtain state-level indices using counties' share of state land as weights. Thus, the following seven variables are used to represent a state's ecosystem:

- Average temperature (mean January temperature)
- Average precipitation (days of measurable precipitation per year)
- The variance of temperature and the variance of precipitation measured using county-level data on temperature and precipitation in each state.
- Land index computed using principal component analysis with data on acres of cropland, pasture, rangeland, forest, small and large urban area, and miscellaneous acres. The Land index of the *i*th state is given by:

  $$Land\ Index_i = \sum (\alpha_r \frac{(X_r - \overline{X})}{\sum_{r=1}^{R} (X_r - \overline{X})^2})$$

  where X_r ($r = 1, ..., R$) denotes land acres in each of the categories defined above and $\forall_r$ is the weight for the *r*-th category.
- A soil and water index created in a way similar to that of the land index. The categories of soil include sandy, silty, clay, loamy, organic and others, while those for water include water body (less than 2, 2-40, more than 40 acres) subdivided into lakes, reservoirs, bay/gulf and estuary, and perennial stream based on width (< 66, 66-660 and > 660 feet).

The land, soil and water index are created also using share rather than the size of each category, which we refer to as land share, water share and soil share indexes. For each ecosystem variable, we construct a 48x48 dissimilarity matrix as before:

$$\begin{pmatrix} (AL - AL)/AL & \dots & (AL - WY)/AL \\ \vdots & \ddots & \vdots \\ (WY - AL)/WY & \cdots & (WY - WY/WY) \end{pmatrix}_{48\times48}$$

Each row corresponds to the percentage difference of an ecosystem variable of a state with itself and the other 47 states. For example, the weighted average precipitation of AL, AR and Arizona

(AZ) are 138.27, 124.50 and 30.30 days (of measurable precipitation), respectively. The percent difference of precipitation between AL with AL, AL with AR, and AL with AZ are respectively 0.00, -0.10, and -0.78, which form the first three elements of the first row of the dissimilarity matrix. The above indices shows that the precipitation in AL is more similar to that of AR than AZ. The main diagonal elements of dissimilarity matrix are zero, while the off-diagonal elements can take values between negative and positive infinity.

Indexes of Agronomic Dissimilarities ($\boldsymbol{A}_{ij}$): We include two variables to represent a state's agronomic characteristics. The irrigated land share of total (state) cropland and the field crop land share of total (state) crop land. Field crops included corn, wheat, barley, soybeans, other grains and cotton. These data are obtained from the 2002 and 1997 *Census of Agriculture*, National Agricultural Statistics Service (NASS), US Department of Agriculture. Again, a 48x48 matrix of dissimilarity indexes is constructed for each variable.

Indexes of Lobbying Dissimilarities ($\omega_{ij}^{c}, \omega_{ij}^{s}, \omega_{ij}^{m}$): To represent stakeholders' interest in NXW/NXWS regulation, we obtained data on campaign contributions in state politics (Institute on Money in State Politics, www.followthemoney.org). Specifically, we obtained the number and dollar amount of contributions made by industry and interest groups. From these data we identify political contributions of agricultural producers within which we also have data on seed producers' contributions. Data on nursery industry's lobby contributions had several missing values, which when replaced by zero lead to infinite dissimilarity indexes. As noted in the theory section, seed producers and nursery growers have similar interests, and therefore, we combined contributions of seed producers and nursery growers into a single lobby variable. To represent the consumer interest group, we use contributions from consumer and environment-based groups under the ideology-oriented contributions to state politics. Thus, we created 2 political-economy variables (dollar and number of contributions) for the 3 stakeholders: seed industry (includes nursery growers), commodity producer groups (agriculture less seed producers and nursery growers), and consumer- and environment-interest (ideology) groups. Additionally, we constructed dollar and number of contribution shares with respect to state totals for each industry. As before, we constructed a 48x48 dissimilarity-index matrix for each lobby variable. Note that the lobbying dissimilarity index, $\omega_{ij}^{c} = \left(\omega_i - \omega_j\right) / \omega_i$, continues to be an increasing function of the base state's lobby contribution.

The descriptive statistics on regulation overlap and all three categories of explanatory variables are presented in table 1. In general, the NXWS lists show about 30 to 40 percent overlap between 1997 and 2002, while overlap in NXW lists is only about 30 percent. However, the variance of overlap has increased for the two sublists of NXWS regulation and the NXW list. Lobbying indexes show a general increase between 1997 and 2002, while agronomic variables changed little during the same period. Ecological variables are observed for 1997 only.

Econometric Procedure and Specification Tests

Given the panel nature (state *i* and *j*) of our data set, regulatory congruence in equation (8) is estimated using three econometric procedures: ordinary least squares (OLS), fixed-effects (FE) and random-effects (RE) estimators. For the OLS estimator, equation (8) is rewritten as:

(9) $$L_{ij} = \alpha_0 + \beta' X_{ij} + \varepsilon_{ij}$$

where $i, j = 1,...,48$, α_0 is the intercept, X_{ij} is a vector of explanatory variables and β is the associated parameter vector of interest and ε_{ij} is the random, disturbance term. The FE estimation replaces α_0 with state-specific intercepts α_i, $i = 1,...,48$, as follows:

(10) $$L_{ij} = \alpha_i + \beta' X_{ij} + \varepsilon_{ij} .$$

Finally, the random effects specification is similar to equation (9), but the disturbance term includes an unobserved, random and state-specific effect μ_i:

(11) $$L_{ij} = \alpha_0 + \beta' X_{ij} + \mu_i + \varepsilon_{ij} .$$

The dependent variable L_{ij} is defined as the percentage overlap between *i*-th and *j*-th states' noxious weed (NXWS or NXW) regulations. The overlap data vector is of dimension 2304x1 (48x48 state-pair overlaps), which is constructed by transposing each row of overlap matrix and stacking them into a column vector. Since diagonal elements of the percent overlap matrix are equal to one, we delete *i*-th state's overlap with its own list and consider observations when $i \neq j$. Thus, we have 2256 (48x47) observations on L_{ij} for NXWS lists. Since NXW lists apply to fewer states, there are only 870 and 1190 observations of state-pair overlaps in 1997 and 2002 NXW lists, respectively. We compute L_{ij} for four lists: NXWS, NXWS prohibited, NXWS restricted, and NXW lists. In the following, we refer to the overlap regression for each of the above four lists as List 1 through 4, respectively.

Consistent with the previous section, the explanatory variables, X_{ij}, fall into three groups: (i) ecosystem dissimilarities between *i*-th and *j*-th state ($\boldsymbol{I}_{ij}$) in terms of average temperature and precipitation, variance of temperature and precipitation, soil and land types, and water sources (7 variables), (ii) agronomic dissimilarities between *i*-th and *j*-th state ($\boldsymbol{A}_{ij}$) captured by field crops' and irrigated area share of total crop land (2 variables), and (iii) lobbying dissimilarities between *i*-th and *j*-th states (ω_{ij}) represented by contributions of seed producers, commodity producers and the consumer groups (3 variables). Thus, the 1x12 vector of explanatory variables is given by $X'_{ij} = [I^1_{ij}, ..., I^7_{ij}, A^1_{ij}, A^2_{ij}, \omega^c_{ij}, \omega^s_{ij}, \omega^m_{ij}]$.

The dependent variable, percent overlap, takes positive values, but the construction of dissimilarity indexes of explanatory variables allowed for differences among states take on values between negative and positive infinity. A negative (positive) value of the dissimilarity index suggests that the base state's indicator is relatively higher (lower) than that of the comparator state. Consider the case of temperature differences, where a negative dissimilarity index implies that the base state's average temperature is higher than that in the comparator state. Therefore, positive dissimilarities can be hypothesized to have different effects on overlaps than the negative indexes. There is some scientific evidence supporting such differences in effects for ecological variables. For instance, Brown, Stevens, and Kaufman (1996) indicate that an introduced species' relationship with others may differ depending on whether the new environment is warmer or colder relative to its native environment. To further illustrate, consider figure 2, where overlap is plotted on the Y-axis and the dissimilarity is represented by the positive and negative quadrants of the X-axis. Larger dissimilarity leads to lower overlap on either quadrants. Therefore, we set up slope and intercept dummies to allow the coefficient on any explanatory variable change between negative and positive realizations of the dissimilarity index. We follow up with a test of the restriction that the coefficient is the same regardless of the sign of the dissimilarity index. In the case of lobbying dissimilarities, the positive and negative dissimilarity indexes simply reflect relative strength of an interest-group between any two states.

The general model is then:

$$L_{ij} = D^{+}\alpha_0 + D^{-}\delta_0 + \beta'(D^{+}X_{ij}) + \gamma'(D^{-}X_{ij}) + \varepsilon_{ij} \tag{12}$$

where $D^{+} = [D_1^{+}, D_2^{+}, ..., D_{12}^{+}]$ is a set of dummy variables which take value 1 when $X_{ij} > 0$, e.g., $D_1^{+} = 1 \;\; if \;\; X_{ij}^{1} > 0; \;\; else \;\; = 0$. Similarly, when $X_{ij} \leq 0$, dummy variables in

$D^- = [D_1^-, D_2^-, ..., D_{12}^-]$ take value 1. Therefore, $\partial L_{ij} / \partial X_{ij} = \beta$ when X_{ij} is positive and $\partial L_{ij} / \partial X_{ij} = \gamma$ otherwise.

For the 4 lists noted earlier, we estimated equation (12) using OLS, FE and RE procedures for each of the two years: 1997 and 2002. A number of specification tests and error-structure analyses are conducted to choose the final specification which best fitted the data. Due to space constraints, we do not report results of specification tests. [7] The first is the Lagrange Multiplier test, which strongly rejected all four OLS specifications in favor of either FE or RE regressions. Next, we rejected the restriction that the coefficient on the dissimilarity index is the same regardless of its sign i.e., positive or negative dissimilarity, using a F test in most specifications. To be consistent in reporting, we only report results from specifications with asymmetric coefficients. The Hausman test was then employed to choose between FE and RE estimators. In most cases, the FE effects specification is preferred over the random effects, where the latter often assumes that the unobserved, random and state-specific effect is independent of explanatory variables.[8] In two cases, we failed to reject the null hypothesis of Hausman test, i.e., the RE specification. However, the coefficients of RE and FE models are qualitatively similar with some quantitative differences. Again, to be consistent in reporting, we only present results from only FE models. Our error-structure analysis using a LM test indicated the presence of groupwise (state-specific) heteroskedasticity. So, we utilize the feasible generalized least squares estimator with fixed effects to estimate equation (12) for the 4 lists.

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[7] A J-test and Cox test indicated that the share-based indexes (soil, land and water) better fit our model compared to size-based indexes (Greene, 1997). Similarly, dollar shares of political contributions are preferred over volume-based measures (e.g., number or share in total number of contributions).

[8] If the difference between the variance-covariance matrix of FE and RE model is not positive definite, the chi-squared statistic of the Hausman test can take negative values. We obtained few negative values, where Greene (1997) suggests setting the Hausman statistic to zero.

Discussion of Results

Table 2 and 3 report the estimated slope parameters of List 1 through 4 for 1997 and 2002, respectively. The intercept dummies in equation (12), i.e., (α_0, δ_0), are not presented due to space limitations. Results in table 2 and 3 relate the four representations of regulatory congruence to dissimilarities in ecosystem, agronomy, and lobby strength across states. So, coefficients are interpreted as effects of dissimilarities between a base state and a comparator state on regulatory congruence between the two states. Since fewer states have NXW lists with varying degree of control, the following discussion weighs more on results from NXWS list.

Ecological Dissimilarities and Regulatory Congruence: In table 2, we first present the results on ecological variables, each of which had two coefficients corresponding to the sign or strength of dissimilarity between the base and comparator states. Consistent with the hypothesis in figure 2, we obtained significant negative slope coefficients for most temperature and precipitation indexes when the strength of dissimilarity is biased toward the comparator state. Similarly, when the dissimilarity index favored the base state, most coefficients on temperature and precipitation indexes have the expected positive sign with statistical significance. There are a few exceptions, mostly in List 4. With regard to the 2002 results in table 3, we find that the effects of ecological variables, proxied by temperature and precipitation dissimilarities, are similar to those in table 2 (1997). For each of the two years, of the 32 coefficients representing temperature and precipitation dissimilarities, only 4 have the unexpected sign with statistical significance. In general, the above results suggest that the relationship between ecological characteristics and noxious weed regulatory differences is best illustrated by figure 2. That is, divergence in ecological characteristics, represented by average and variance of temperature and precipitation, is an important determinant of NXWS and NXW regulatory congruence across states.

Other ecosystem differences represented by land, soil and water share (dissimilairty) indexes do not significantly affect regulatory congruence as illustrated in figure 2. Of the 24 coefficients on land, soil and water share indexes, only 4 have the expected sign with statistical significance (table 2). In 2002 (table 3), only the coefficients on water share index are significant in List 2. These results prompted additional tests on the relevance of land, water and soil indexes for regulatory congruence. Restricting their coefficients to zero or only a subset to zero (e.g., land and water share) did not alter the results on other included variables. Since some of these restrictions are rejected and the efficiency losses are minimal, we retain all 3 variables in List 1 through 4. We suspect that the information embodied in land and water indexes is likely captured in agronomic and precipitation indexes, respectively.

Agronomic Dissimilarities and Regulatory Congruence: With regard to agronomic dissimilarities biased in the direction of the base state (negative quadrant), the coefficients on field crop indexes have the expected sign with statistical significance in List 1, 2, and 3 (table 2). When dissimilarities are positive, again the field crop and irrigated land share indexes mostly have a significantly negative coefficient (List 1, 3, and 4). However, those on the irrigated land share index are mixed when dissimilarities are biased toward the base state. Overall, only one of the twenty coefficients on agronomic dissimilarities has the unexpected sign with statistical significance. The results for 2002 are similar to those in table 2 (1997). As in the case of ecological dissimilarities, the most common results suggest that the relationship between agronomic characteristics and regulatory congruence is best illustrated by figure 2.

Table 4 presents a summary of the direction of the effects of ecological and agronomic dissimilarities on NXWS and NXW regulatory congruence. A blank space in table 4 indicates lack of statistical significance. As noted earlier, we mostly obtained positive coefficients when the strength of dissimilarity favored the base state and vice versa. Since fewer states have NXW lists with varying regulatory control, the emphasis in the above and the following sections is on results from NXWS list.

Interest Groups' Effects on Weed Regulation: Recall that the lobbying dissimilarity index measures the political strength of an interest group, e.g., seed producer, relative to its counterpart in the comparator state. For 1997, the effect of consumer lobbying in List 3 shows a pattern similar to that observed for most agronomic and ecological indexes. That is, when the base state's consumer lobby is stronger than its counterpart in the comparator state, the two states have lower regulatory overlap. Likewise, when the comparator state has a relatively stronger consumer-lobby, the two states have larger regulatory differences. A similar effect is also observed in the case of List 1. However, coefficients on consumer lobby index in other lists are not significant with the exception of List 4, where a significant coefficient has the opposite sign of that in List 3. For 2002, List 1 and 4 have the expected negative coefficient when dissimilarity is biased towards the comparator state. Relating to equation (1), results from table 2 and 3 show a net negative effect of relative consumer lobby on regulatory congruence, which implies that their eco-system preference gains dominate the market-consumption effect.

Dissimilarities in seed industry's lobbying activities did not significantly affect noxious weed regulations in 1997 (table 2). However, its lobbying effect becomes significant in List 2 and 4 for 2002 when the strength of the dissimilarity is biased toward the base state. That is, the greater is the relative strength of the base state's seed lobby, the larger the regulatory congruence between the two states. Recall from equation (2) that seed producers benefit from price-enhancement and agronomic-protection effects. However, we noted following equation (8) that seed producers could perceive weed regulations as export barriers, in which case they likely lobby for regulatory congruence across states. Our seed lobby strength results from table 3 (List 2 and 4) suggest this latter scenario, i.e., base state's relatively strong seed lobby favors regulatory congruence. Evidence of such activity can be found in the *Recommended Uniform State Seed Law* by the Association of American Seed Control Officials, which outlines common procedures for labeling, complaint, and dispute settlement in seed certification and trade across states. The American Seed Trade Association and the American Nursery and Landscape Association also promote development of domestic seed and nursery-product markets and address regulatory issues across states. So, it is likely that states with significant seed or nursery production (e.g., Oregon, California) lobby for regulatory congruence across states.

Most coefficients on commodity producers' lobby index are not significant in table 2 (1997) with List 4 being an exception. However, results for 2002 show a pattern similar to that illustrated in figure 2 for List 1 and 3 (table 3). The other significant coefficients, one each in List 2 and 4, have signs opposite of those shown in figure 2. Relating equation (3) to the results from List 1 and 3, it appears that commodity producers' gains from agronomic protection more than offset the price-enhancement effect.

Statistical significance confirms stakeholders' input, but does not provide information on their relative importance. To infer on the latter, we use a variance decomposition approach from Fields (2003). The variance of the dependent variable, regulatory congruence, is first decomposed into that explained by the explanatory variables and the residual. In our case, the explanatory variables including the fixed effects explained about 60 percent of the variance of regulatory overlap in all four lists for 1997 and 2002. Of this 60 percent, the share of all 3 lobby variables ranged from -6 to 9 percent in 2002, while the range for 1997 is 2 to 10 percent. The rest is accounted by ecological and agronomic dissimilarities and state-specific effects.

Figure 3 outlines common results obtained for the relative lobby strength of stakeholders from table 2 and 3. In the case of seed producers, base state's lobby strength relative to the comparator state leads to regulatory congruence. The net negative effect of consumer lobby on regulatory congruence suggests that its market-consumption effect is more than offset by gains from protection to the local eco-system. For commodity producers, the net negative effect of lobbying on regulatory congruence implies that the price-enhancement effect of regulation is dominated by agronomic-protection gains.

Summary and Conclusions

In this study, we identify large differences in two sets of noxious weed regulations, the Noxious Weed Seed (NXWS) and the Noxious Weed (NXW) list, among US states. We then investigate the determinants of such regulations, which can impact interstate trade in plant and plant products, including interest-groups' activities. An inter-disciplinary approach, with ecological and political considerations, is taken to model the supply and demand for noxious weed regulation. We consider three stakeholders for each state: consumers, seed producers and nursery growers, and commodity producers. Given the social welfare function, a weighted sum of net benefits to each interest group, the regulatory choice is derived from a strategic game between a base state and any other comparator state. The resulting regulatory congruence or similarity between any two states provides the basis for our empirical analysis.

Regulatory congruence in NXWS and NXW lists across contiguous US states is estimated using data on ecosystem and agronomic characteristics, and on the rent-seeking activities. Results from our empirical analysis suggest that ecological dissimilarities, embodied in temperature and precipitation patterns, give raise to variations and hence, limited regulatory congruence across US states. Likewise, agronomic dissimilarities, represented by the share of irrigated land and field crops in a state's arable land, bring about regulatory differences across states. Together, ecological and agronomic characteristics account for two-thirds of the explained variation in the size and composition of NXWS and NXW lists of US states.

Stakeholders' interest in noxious weed regulations is modeled using their political contributions. Consumers' lobby impact on regulations reveals their interest in ecosystem protection over the market-price effects embodied in such regulations. However, commodity producers' lobby impacts show a preference for the agronomic protection provided by these regulations over market-price impacts. Our results identify an upward-sloping relationship between regulatory congruence and seed producers' lobby. That is, a stronger seed lobby leads to greater regulatory congruence. This result can arise if seed producers' perceive noxious weed regulations as export barriers. Evidence of such perception can be found in the activities of the Association of American Seed Control Officials, American Nursery and Landscape Association and others, who recommend conformity of weed laws across states.

Nevertheless, the limited weed regulatory congruence across states should be a concern to policymakers working toward a more integrated seed and horticultural product markets among US states. Lobbies of states with significant seed production or national seed organizations appear to support such integration, while some interest groups within the state (e.g., commodity producers) are likely concerned about agronomic consequences. The challenge is to work toward a more uniform definition of noxious weed regulations and greater overlap across states without compromising concerns of commodity producers. The next question to address is whether or not the limited regulatory overlap affects interstate trade flows in plant and plant products.

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Table 1. Descriptive Statistics on Regulatory Differences and Explanatory Variables (2256 Observations)

Dependent Variables		Unit	Mean	Std.Dev.	Minimum	Maximum
NWS list regulatory overlap						
	2002	NA	0.428	0.182	0.083	0.963
	1997	NA	0.411	0.186	0.057	1.000
NWS-prohibited list regulatory overlap						
	2002	NA	0.401	0.269	0.000	1.000
	1997	NA	0.320	0.202	0.000	1.000
NWS-restricted regulatory list overlap						
	2002	NA	0.411	0.269	0.000	1.000
	1997	NA	0.319	0.197	0.000	1.000
NW list regulatory overlap[a]						
	2002	NA	0.302	0.295	0.000	1.000
	1997	NA	0.310	0.268	0.000	1.000
Independent Variables						
Lobby Variables						
Seed producers						
	2002	$	108618	189283	550	1040040
	1997	$	92233	169980	250	1010680
Consumers						
	2002	$	364199	551105	2500	2564890
	1997	$	253955	624000	5000	4206990
Commodity producers						
	2002	$	775331	1272660	15865	6476520
	1997	$	556395	933924	4550	5179920
Agronomic Variables						
Irrigated land share						
	2002	Acre/Acre	0.177	0.221	0.002	0.794
	1997	Acre/Acre	0.178	0.238	0.002	0.901
Field land share						
	2002	Acre/Acre	0.686	0.171	0.296	1.030
	1997	Acre/Acre	0.685	0.172	0.310	1.089
Ecological Variables[b]						
Average Temperature		January temperature	52.498	7.684	40.161	70.902
Average Precipitation		Days of precipitation	88.450	33.930	21.713	142.551
Variance of Temperature		NA	5.419	6.196	0.000	37.893
Variance of precipitation		NA	266.549	895.464	0.000	4849.02
Land Share Index[c]		Index	0	1.00	-1.785	1.8340
Water Share Index[c]		Index	0	1.00	-1.210	3.981
Soil Share Index[c]		Index	0	1.00	-1.447	2.592

[a] Number of observations is 1190 and 870 respectively for 2002 and 1997

[b] NORSIS, US Forest Service data.

[c] Based on principal component analysis.

Table 2. Estimates of Cross-State Weed Regulatory Congruence, 1997

Slope Coefficients [a]	Sign of Dissimilarity	List 1 NWS	List 2 NWS Prohibited	List 3 NWS Restricted	List 4 NW
I1. Average Temperature	Negative	4.9813	84.4727**	-21.3807**	6.1407
		(3.2738)	(4.4132)	(3.4548)	(7.1744)
	Positive	-97.3581**	-42.5648**	-79.4742**	-44.4595**
		(4.7132)	(7.0742)	(5.0572)	(9.1408)
I2. Average Precipitation	Negative	10.5249**	7.3781**	5.1682**	13.8153**
		(0.6986)	(0.8859)	(0.7147)	(1.3309)
	Positive	-22.7889**	-19.4822**	-32.4031**	6.8839
		(1.9501)	(2.7352)	(2.1169)	(3.9889)
I3. Variance of Temperature	Negative	0.0018	-0.0054	0.0074	-2.6872**
		(0.0037)	(0.0038)	(0.0040)	(0.5272)
	Positive	-6.9931**	-4.6264*	-6.1663**	-11.0265**
		(1.5677)	(2.2303)	(1.6542)	(2.6504)
I4. Variance of Precipitation	Negative	0.0001*	-0.0000	0.0001**	-0.0250*
		(0.0000)	(0.0000)	(0.0000)	(0.0114)
	Positive	-6.64113**	-16.6602**	-5.91907**	-8.7547**
		(1.51491)	(2.17302)	(1.59267)	(2.89615)
I5. Land Share Index	Negative	0.0377	0.0294	0.0122	0.0368
		(0.0245)	(0.0358)	(0.0229)	(0.0189)
	Positive	-0.0057	0.0581	-0.0163	-0.0665*
		(0.0293)	(0.0430)	(0.0274)	(0.0334)
I6. Water Share Index	Negative	0.2186	0.3907*	0.1230	0.3155
		(0.1413)	(0.1844)	(0.1629)	(0.4434)
	Positive	-0.2210	-0.6354**	-0.1177	-0.3793
		(0.1140)	(0.1531)	(0.1319)	(0.3691)
I7. Soil Share Index	Negative	0.0203	-0.2286	0.1888	-0.7390
		(0.1952)	(0.2656)	(0.2135)	(0.4173)
	Positive	-0.0570	0.4465	-0.3991*	0.1713
		(0.1679)	(0.2289)	(0.1816)	(0.3871)
A1. Field Crop Land Share	Negative	3.8381**	7.9762**	4.8898**	2.9998
		(1.4170)	(1.9874)	(1.4321)	(1.9787)
	Positive	-13.3076**	1.0805	-15.4310**	-18.7375**
		(2.6138)	(3.7531)	(2.8232)	(4.3266)
A2. Irrigated Land Share	Negative	0.0151	-0.0455**	0.0631**	0.0287
		(0.0122)	(0.0176)	(0.0131)	(0.0183)
	Positive	-6.8743**	-3.6522	-3.6564*	-5.2978*
		(1.4686)	(2.0594)	(1.5625)	(2.5443)
ω_c: Lobby of Consumer	Negative	0.0230	0.0107	0.3081**	-0.3546**
		(0.0697)	(0.0913)	(0.0834)	(0.1143)
	Positive	-5.6111**	-2.9029	-4.0133*	0.6874
		(1.6113)	(2.2071)	(1.6983)	(2.7670)
ω_s: Lobby of Seed Industry	Negative	-0.0387	0.0162	-0.0436	0.0465
		(0.0259)	(0.0306)	(0.0294)	(0.0588)
	Positive	-0.0484	2.1991	1.5123	-3.69253
		(1.4357)	(2.0100)	(1.5100)	(2.4161)
ω_m: Lobby of Commodity Producer	Negative	0.0708	-0.1074	0.2051*	-0.5762**
		(0.0764)	(0.0902)	(0.0828)	(0.1407)
	Positive	0.3841	0.3476	-0.6256	1.9280*
		(0.5914)	(0.7400)	(0.6747)	(0.9482)

** and * denote significance at the 1% and 5% level, respectively; number in parenthesis is standard error.

[a] I1 through I7 indicate ecological dissimilarity indexes, A1 and A2 are agronomic dissimilarity indexes, and ω_k, k=c,s,m, denote lobbying dissimilarity indexes.

Table 3. Estimates of Cross-State Weed Regulatory Congruence, 2002

Slope Coefficients [a]	Sign of Dissimilarity	List 1 NWS	List 2 NWS-Prohibited	List 3 NWS-Restricted	List 4 NW
I1. Average Temperature	Negative	6.0192*	77.9172**	-22.3952**	27.6193**
		(3.0452)	(4.3315)	(3.3327)	(5.5819)
	Positive	-97.3348**	-39.7359**	-86.9851**	-29.2558**
		(4.5406)	(7.2631)	(4.9156)	(8.3285)
I2. Average Precipitation	Negative	10.7105**	6.9771**	5.4450**	12.7726**
		(0.6691)	(0.8961)	(0.6867)	(1.0705)
	Positive	-17.9395**	-18.6396**	-28.2771**	2.0383
		(1.8217)	(2.6990)	(2.0377)	(3.1967)
I3. Variance of Temperature	Negative	0.0024	-0.0064*	0.0081*	-0.0162**
		(0.0035)	(0.0037)	(0.0041)	(0.0060)
	Positive	-6.5445**	-6.7927**	-6.3753**	-9.3485**
		(1.5217)	(2.2661)	(1.6075)	(2.4415)
I4. Variance of Precipitation	Negative	0.0000	-0.0000	0.0001*	-0.0001
		(0.0000)	(0.0000)	(0.0000)	(0.0000)
	Positive	-5.6056**	-18.1827**	-4.0619*	-7.5137**
		(1.4838)	(2.2530)	(1.5871)	(2.5831)
I5. Land Share Index	Negative	0.0280	0.0421	0.0071	-0.1023
		(0.0234)	(0.0393)	(0.0218)	(0.0682)
	Positive	0.0213	0.0377	0.0058	0.0230
		(0.0281)	(0.0473)	(0.0263)	(0.0946)
I6. Water Share Index	Negative	0.2331	0.4933**	0.1009	0.0644
		(0.1419)	(0.1867)	(0.1687)	(0.4540)
	Positive	-0.1704	-0.6096*	-0.0178	0.0195
		(0.1149)	(0.1544)	(0.1375)	(0.3803)
I7. Soil Share Index	Negative	-0.0481	-0.2558	0.0787	-0.5541
		(0.1862)	(0.2809)	(0.2197)	(0.3862)
	Positive	-0.0186	0.4315	-0.3601	0.1504
		(0.1613)	(0.24151)	(0.1876)	(0.3390)
A1. Field Crop Land Share	Negative	4.6134**	8.9766**	4.3584**	5.9742**
		(1.3560)	(1.9970)	(1.3247)	(1.7632)
	Positive	-11.9382**	1.2836	-15.6365**	1.6604
		(2.5060)	(3.7752)	(2.7747)	(3.9808)
A2. Irrigated Land Share	Negative	0.0254**	-0.0297	0.0577**	0.0135
		(0.0098)	(0.0163)	(0.0117)	(0.0154)
	Positive	-5.2458**	-3.3891	-1.2897	-4.6188*
		(1.3962)	(2.0586)	(1.5069)	(2.3250)
ω_c: Lobby of Consumer	Negative	-0.0626	0.0272	-0.0468	0.2804
		(0.0324)	(0.0499)	(0.0362)	(0.1814)
	Positive	-3.1981*	0.4738	-0.4750	-7.5734**
		(1.5602)	(2.2480)	(1.7143)	(2.5308)
ω_s: Lobby of Seed Industry	Negative	-0.0235	-0.0631**	0.0241	-0.0576**
		(0.0158)	(0.0218)	(0.0178)	(0.0190)
	Positive	-1.7488	-1.6051	1.8992	3.1139
		(1.4492)	(2.1602)	(1.5447)	(2.3757)
ω_m: Lobby of Commodity Producer	Negative	0.4684**	0.2360	0.6222**	-0.7174**
		(0.1139)	(0.1649)	(0.1260)	(0.2241)
	Positive	-3.7354*	7.8416**	-3.4817*	-2.8600
		(1.5426)	(2.3017)	(1.6396)	(2.5521)

** and * denote significance at the 1% and 5% level, respectively; number in parenthesis is standard error.

[a] I1 through I7 indicate ecological dissimilarity indexes, A1 and A2 are agronomic dissimilarity indexes, and ω_k, k=c,s,m, denote lobbying dissimilarity indexes.

Table 4. Signs of Ecological- and Agronomic-Dissimilarity Effects on Weed Regulatory Congruence

	List 1 NWS		List 2 NWS-Prohibited		List 3 NWS-Restricted		List 4 NW	
Dissimilarity	Negative 1997	Positive 1997	Negative 1997	Positive 1997	Negative 1997	Positive 1997	Negative 1997	Positive 1997
Average Temperature	+	-	+	-	-	-		-
Average Precipitation	+	-	+	-	+	-	+	
Variance of Temperature		-		-		-	-	-
Variance of precipitation	+	-		-	+	-	-	-
Land Share Index								-
Water Share Index		-	+	-				-
Soil Share Index				+		-		
Irrigated Land Share		-	-		+	-		-
Filed Crop Land Share	+	-	+		+	-	+	-
	2002	2002	2002	2002	2002	2002	2002	2002
Average Temperature	+	-	+	-	-	-	+	-
Average Precipitation	+	-	+	-	+	-	+	
Variance of Temperature		-	-	-	+	-	-	-
Variance of precipitation		-		-	+	-		-
Land Share Index								
Water Share Index			+	-				
Soil Share Index								
Irrigated Land Share	+	-			+			-
Filed Crop Land Share	+	-	+		+	-	+	

Figure 1a: Size Differences in State Noxious Weed Regulation, 2002

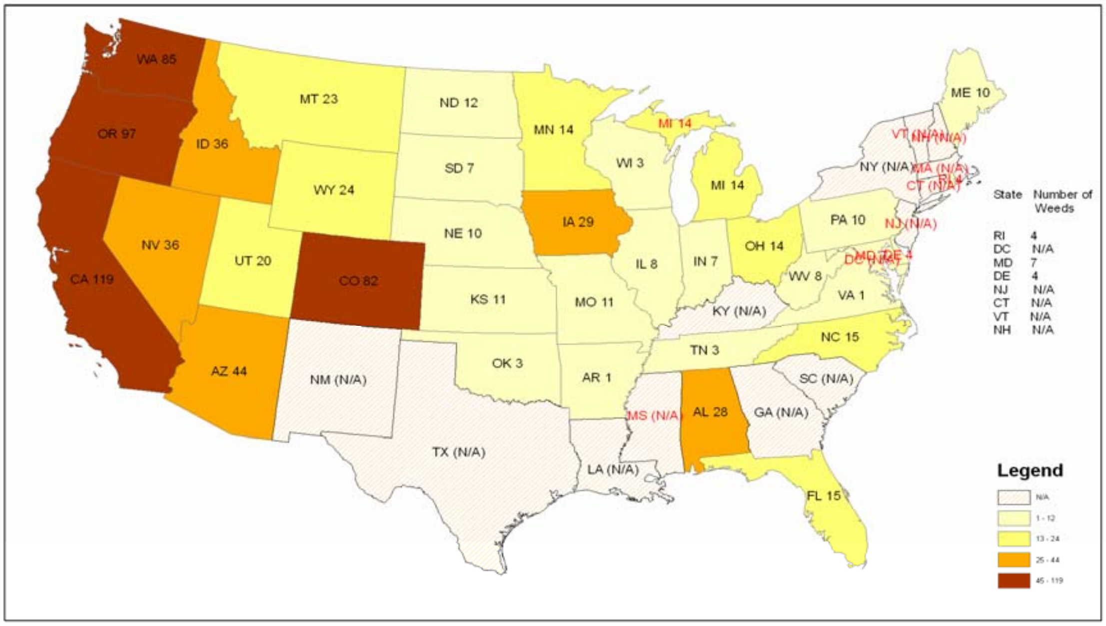

Figure 1b: Compositional Differences in State Noxious Weed Regulation, 2002

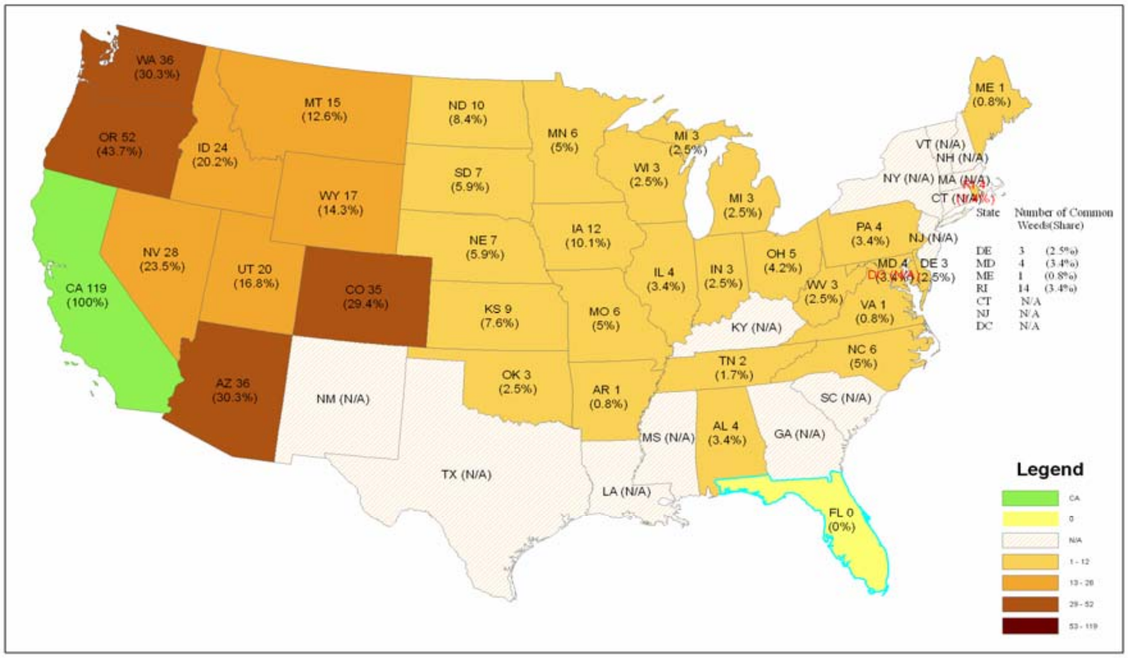

Figure 2. Illustration of Dissimilarity Effects on Weed Regulatory Congruence

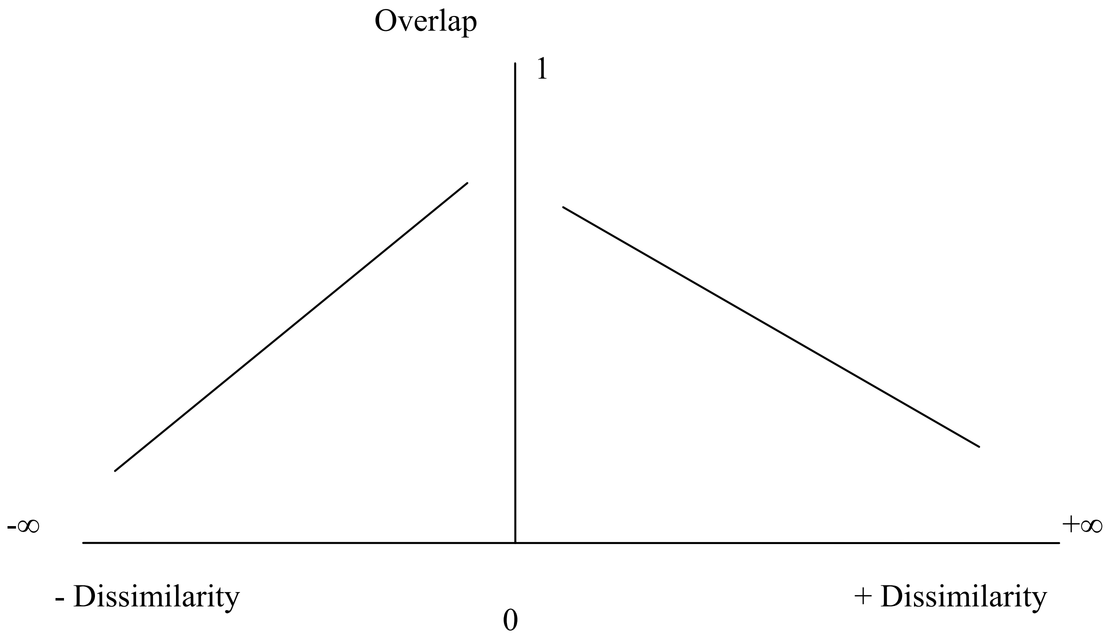

Figure 3. Lobbying Dissimilarities and Weed Regulatory Congruence