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The Effects of Litigation on Economic Regulations

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The Effects of Litigation on Economic Regulations

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To Katherine and to my parents

The Effects of Litigation on Economic Regulations

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This thesis focuses on the effect of litigation on economic regulations. An interesting aspect of U.S. regulatory policy is that agencies such as the Environmental Protection Agency are often forbidden from taking costs into account when issuing a regulation. This thesis presents a theoretical model that shows that such a policy is optimal under certain conditions. The use of discretionary tools such as a cost-benefit analysis opens the agency to greater amounts of litigation. As litigation costs become substantial, it is more likely to be optimal for the legislature to promulgate regulations without knowing their cost, even if it risks imposing regulations whose benefits are outweighed by its costs.

Another remarkable aspect of environmental policy is that the EPA often chooses

not to issue regulations even when it has the discretion to do so. An example of this manifests itself in the implementation of the Clean Air Act. When the law was first passed, Congress granted the EPA discretion to identify and regulate hazardous air pollutants. However, after years of inaction by the EPA, Congress amended the act and specifically identified the toxins for which the agency was to set standards. Again, this phenomenon may be a result of litigation costs. This thesis shows that an agency with discretion will not enforce every regulation over which it has discretion. Instead, it will focus on enforcing the regulations with the greatest net benefits. The number of regulations the agency chooses to enforce heavily depends on the probability it wins any legal challenges.

A final example concerns the Fish and Wildlife Service, the agency in charge of identifying endangered species. Because it is expensive for the FWS to identify and locate endangered species, interested parties often sue the FWS to force it to protect a particular species. This thesis presents a theoretical model that shows that such litigation can convey important information to the agency and help it decide which regulations it should issue. Expected net benefits are greater when the agency uses litigation costs to filter regulations than when it enforces every possible regulation.

Contents

Chapter 1: Introduction

A striking aspect of regulatory policy is that the actions of the government often seem to contradict the recommendation of economists. A prime example is the case of the Environmental Protection Agency (EPA), which is frequently denied the discretion to take costs into account when deciding when to issue a regulation. On February 27, 2001, the United States Supreme Court ruled that the Clean Air Act prohibits the EPA from considering costs in the regulation of criteria air pollutants. This frustrates many economists who insist that efficiency demands that both costs and benefits be considered when deciding whether to promulgate a regulation or not. In fact, a group of prominent economists filed an amicus brief in the case asking the Supreme Court to allow cost considerations.

Another remarkable aspect of environmental policy is that the EPA often chooses not to promulgate rules and regulations even when it has been granted the discretion to do so. An example where this has occurred is the implementation of the 1977 Clean Air Act Amendments. Although Congress did not grant the EPA discretion to consider cost when issuing the standards for criteria air pollutants, it did grant the EPA discretion to identify and develop standards for secondary hazardous air pollutants. However, after a decade of almost complete inaction by the EPA, Congress amended the act in 1990 and specifically identified 189 toxins for which the agency was to set standards. This is remarkable because the EPA had all of the information available to Congress, the authority to regulate as it deemed necessary, and a mandate to protect the environment, and yet it failed to act. If Congress was easily able to identify the toxins, the EPA should have been able to as well.

A final intriguing example concerns the Fish and Wildlife Service (FWS) of the Department of the Interior, the agency in charge of identifying and protecting endangered species. Although the FWS has the discretion to identify, locate and protect endangered species, it often does not commit a substantial portion of its resources to finding endangered species. In fact, the FWS temporarily halted the listing of new endangered species in 2001. Instead, many of its most recent regulations were promulgated only after interested parties sued the FWS to force it to protect a particular species. For example, six California plants, including the purple amole and the Santa Cruz tar plant, were granted protection as a result of a court order in January 2002.

In this dissertation we show that each of these behavior by the government can be explained by considering the effects of litigation on the implementation and enforcement of economic regulations. The effects of litigation are easy to overlook, but can help explain the actions of the government. Although a substantial literature in environmental economics focuses on picking the most efficient instrument to induce a desired policy effect, such models generally fail to consider the role of litigation in regulatory policy. While economists often recognize that litigation introduces waste and decreases the efficiency of government regulations, they seldom consider how litigation costs affect the decisions of the government.

Chapter Two presents a theoretical model that addresses the first point by showing that under certain conditions it is optimal for the legislature not to grant an agency discretion and prevent it from taking costs into account. The reason is that discretionary tools such as a cost-benefit analysis increase the range of potential legal challenges that the agency will face. As litigation costs become substantial, it is more likely to be optimal for the legislature to grant an agency little discretion, even if doing so increases the risk that inefficient regulations (those having larger costs than benefits) will be imposed.

The second phenomenon – that an agency with discretion may fail to act even though it has good information about a problem – may also be a result of litigation costs. Chapter Three shows that an agency with discretion will not issue every regulation possible, but instead will focus on issuing the regulations with the greatest net benefits. Chapter Three concludes that the number of regulations the agency chooses to promulgate heavily depends on the probability that it wins any resulting legal challenges.

Chapter Four addresses the third phenomenon: an agency that fails to act until forced to do so by a court challenge. It presents a theoretical model that allows such litigation to convey important information to the agency. The model shows that the agency can use litigation costs to infer which regulations it should adopt. Chapter Four concludes that expected net benefits are greater when the agency considers the litigation costs incurred by private parties to filter regulations than when it issues every possible regulation.

Chapter 2: Litigation Costs and Legislative Delegation

2.1 Introduction

A remarkable aspect of U.S. environmental policy is that Congress has granted the Environmental Protection Agency (EPA) little or no discretion in many important policy areas. An example of this is the regulation of criteria air pollutants. Congress listed six specific criteria air pollutants in the Clean Air Act and instructed the EPA to set the National Ambient Air Quality Standards for each one without regard to cost.[1] [2]

In July, 2000, a group of prominent economists filed a brief of *amici curiae* with the U.S. Supreme Court, asking it to reverse the decision of the lower courts and allow the EPA to consider costs when making its decisions. They argued that allowing the EPA to use tools such as a cost-benefit analysis helps it make better decisions and results in more efficient regulations. Therefore, this lack of discretion afforded to the EPA suggests that Congress is unconcerned with efficiency, and as a result, we might expect to see inefficient policies. Empirical studies suggest that this is in fact the case: Viscusi (1996) presents a list of of twenty such regulations that fail a cost-benefit test. However,

[1]The six criteria air pollutants are ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, lead and particulate matter.

[2]Although the agency was permitted to conduct cost-benefit analyses, the courts have consistently interpreted the law as preventing the use of such results to determine the appropriate air quality standards. For the purposes of this thesis, we assume the courts correctly interpreted Congressional intent. It is also noteworthy that the Courts' first decision on the matter was in 1980 (*Lead Industry Association vs. EPA*, 499 U.S. 1042), and Congress, aware of the decision, has not subsequently amended the wording of the law.

it can be shown that there are clear reasons why it might be optimal to disallow the use of a cost-benefit analysis. The explanation lies in the structure of the government.

Conventional models generally treat the government as a single entity. Although often convenient and innocuous, this simplification eschews an interesting aspect of governmental structure: that legislation and implementation of laws are carried out by different branches of the government. For example, the EPA must enforce the laws passed by Congress. In the face of uncertainty concerning a regulation's effect, Congress must decide how much discretion to allow agencies regarding when and how the law is applied.

Although the relationship between Congress and the EPA is an example of this dichotomy, similar relationships exist in many other areas of government at both federal and state levels. Therefore, for the remainder of this thesis, we consider generalized models that refer to the two parts of government simply as the "legislature" and the "agency".[3]

A legislature wishing to impose certain regulations must choose whether or not to delegate decision-making authority to an agency. If it does not delegate, then the legislature must fully specify the regulation within the law, and the agency must rigidly enforce it. If the legislature does grant discretion to an agency, that agency can use efficiency tests such as a cost-benefit analysis to separate the good regulations from the

[3]It is important to note that this is not a principal-agent problem. Although we use similar terminology, we assume in this thesis that the legislature and agency share a common objective function. Both wish to maximize social welfare. Thus, the focus of this chapter is on the appropriate part of government from which to regulate.

bad and enforce the regulations where appropriate.[4]

However, there are drawbacks associated with allocating discretion. If a regulation is directly embedded in the law, then it is difficult to challenge. For example, it might face a challenge on the grounds that the law is unconstitutional. But if the legislature allows discretion, then not only do the constitutional challenges remain, but the actual decisions by the agency can also be challenged in court. Because the agency can incur substantial litigation costs following the use of a cost-benefit analysis, and because decisions of the legislature are unchallengable in this manner, laws prohibiting delegation in certain areas may be welfare improving.[5] In other words, the agency avoids litigation costs by having its hands tied by the legislature. Even considering that the agency might enforce some bad regulations, the net benefit to society could be greater with blanket regulation if the avoided litigation costs are sufficiently large.

2.2 The General Model

The optimality of prohibiting delegation in certain circumstances can be proven using a simple model. Suppose that there exists a potential regulation with unknown net benefit $\widetilde{B}$ drawn from a probability distribution $f(B)$. Some draws from this distribution will

[4] Although a legislature may be capable of using efficiency measures itself, they do not always do so. Any number of constraints might cause a situation to develop where the legislature must either regulate itself without using such efficiency measures or delegate to an agency that can. It is these scenarios which this paper considers.

[5] For the purposes of this paper, we assume that the agency has complete information after completing a cost-benefit analysis, so there is no risk that the agency will issue bad regulations. Moreover, litigation will still occur when regulation is optimal. Thus, all litigation concerning the agency's decisions is completely wasteful.

have a positive net benefit, while others will have a negative net benefit. In other words, the regulation has potential to be either 'good' or 'bad'. Ideally, the regulation is only adopted if it is good.

We further assume that the legislature cannot observe, *ex ante*, the true benefit of adopting the regulation, $\widetilde{B}$, although it does know $f(B)$. Let the mean benefit be denoted by $\overline{B}$, and the lower and upper limits of the distribution be denoted by B_L and B_U, respectively. We focus on the case where $B_L < 0$: when $B_L > 0$, the regulation necessarily has a positive net benefit and there is no advantage to delegating.

Now, the legislature must choose whether or not to delegate. If it does not, the agency must strictly enforce the regulation. We will henceforth refer to this type of regulation as the *no delegation* case. If the legislature does delegate, then the agency can use a cost-benefit analysis to learn the regulation's true benefit, $\widetilde{B}$. After the agency discovers the regulation's true benefit, it decides whether or not to proceed with regulation. However, we assume that if the agency proceeds with the regulation after using such an analysis, then it will incur a fixed litigation cost, L. It will not incur any litigation costs if it does not choose to regulate. Because the litigation cost is known by the agency *ex ante*, we further assume that the agency will never proceed with imposing a regulation if its benefit is less than L.

The expected benefit, or value, associated with adopting a regulation without discretion is:

$$V_{ND} = E(B) = \int_{B_L}^{B_U} \widetilde{B} f\left(B\right) dB = \overline{B} \tag{1}$$

This can be expressed as the sum of three integrals:

$$= \int_{B_L}^{0} \tilde{B} f(B)\, dB + \int_{0}^{L} \tilde{B} f(B)\, dB + \int_{L}^{B_U} \tilde{B} f(B)\, dB \tag{2}$$

The first integral is the expected value of bad regulations – those which have a net benefit less than zero. The second integral are those regulations that are good in theory, but bad in practice. Their net benefits are greater than zero, but less than the associated litigation costs. Finally, the third integral are the regulations that are unambiguously good. Net benefits are positive and exceed litigation costs.

The advantage of delegation is that the agency can use a cost-benefit analysis and avoid regulations with a negative net benefit (the first integral). However, the disadvantage is that the agency also will sometimes fail to regulate when it should because the net benefits do not exceed the litigation cost (the second integral). These can be thought of as the opportunity costs of delegating. Because the agency will only adopt a regulation if its benefits exceed L, expected benefits given delegation are:

$$V_D = E(B|\, B > L) - L = \int_{L}^{B_U} \tilde{B} f(B)\, dB - L$$

Thus, delegation improves welfare when $V_D > V_{ND}$. When:

$$\int_{L}^{B_U} \tilde{B} f(B)\, dB - L \;>\; \int_{B_L}^{0} \tilde{B} f(B)\, dB + \int_{0}^{L} \tilde{B} f(B)\, dB + \int_{L}^{B_U} \tilde{B} f(B)\, dB \tag{3}$$

Or, conversely, it can be shown that no delegation is superior to delegation when:

$$L + \int_0^L \tilde{B} f(B)\, dB \; > \; -\int_{B_L}^0 \tilde{B} f(B)\, dB \tag{4}$$

In other words, the legislature will choose not to delegate discretion to the agency when the litigation and opportunity costs associated with discretion exceed the benefit of avoiding the bad regulations.

Thus far, we have shown there are certain times when it is optimal for the legislature to prohibit agency discretion. Whether this is true or not for a particular set of regulations depends on the distribution of net benefits. Therefore, we now examine the model's predictions under several specific distributions.

2.3 Specific Models

2.3.1 Uniform Distribution with fixed litigation costs

Now, suppose that the distribution of net benefits is known to be uniform on the closed interval $[\overline{B} - \Delta, \overline{B} + \Delta]$ with mean benefit $\overline{B}$. We also assume that $\overline{B} - \Delta < 0$, so there exists the potential for the regulation to have a negative expected benefit. The expected benefits associated with the *no delegation* case are:

$$V_{ND} = \int_{B-\Delta}^{B+\Delta} \tilde{B} f(B)\, dB = \overline{B} \tag{5}$$

As stated before, the regulation can turn out to be either good or bad. Because of the existence of litigation costs, the agency will only regulate when it learns that the regulation is good with net benefit greater than L. The expected benefits minus litigation costs from such a good regulation are:

$$V_D = \int_L^{\overline{B}+\Delta} \widetilde{B} f(B)\, dB - L \tag{6}$$

Thus it is optimal for the legislature to delegate when V_D exceeds the expected benefit of legislative regulation, V_{ND}:

$$\int_L^{\overline{B}+\Delta} \widetilde{B} f(B)\, dB - L \; > \; \overline{B} \tag{7}$$

Integrating gives:

$$\frac{(\overline{B}+\Delta)^2}{4\Delta} - \frac{L^2}{4\Delta} - L \; > \; \overline{B}$$

Define θ to be the *ex ante* gains from delegation. θ represents the difference in benefits associated with delegation and legislative regulation before litigation costs are taken into account. Then:

$$\theta = \frac{\left(\overline{B}+\Delta\right)^2}{4\Delta} - \frac{L^2}{4\Delta} - \overline{B}$$

Thus, delegation will occur if and only if $\theta > L$.

Next, we calculate several comparative static results to see how the legislature's decision changes with respect to changes in $\overline{B}$, Δ, and L. First, consider how changes in $\overline{B}$ affect θ:

$$\frac{\partial\theta}{\partial\overline{B}} = \frac{2\overline{B} - 2\Delta}{4\Delta} = \frac{\overline{B} - \Delta}{2\Delta} \tag{8}$$

which must be less than zero, since $\Delta > \overline{B}$.

This implies that the incentive to delegate decreases as the expected benefits increase when holding all else constant. If expected benefits increase as Δ is held constant, then the probability that the regulation is bad decreases. And if there is a lower probability of a regulation having a negative net benefit, then there is less to gain by delegating.

To compute $\frac{\partial\theta}{\partial\Delta}$, rewrite θ as

$$\theta = \frac{\overline{B}^2 - 2\overline{B}\Delta + \Delta^2 - L^2}{4\Delta}$$

Then,

$$\frac{\partial\theta}{\partial\Delta} = \frac{1}{4}\left[\frac{2\Delta - 2\overline{B}}{\Delta} - \frac{\left(\overline{B}^2 - 2\Delta\overline{B} + \Delta^2 - L^2\right)}{\Delta^2}\right]$$

$$\frac{\partial\theta}{\partial\Delta} = \frac{1}{4}\left[\frac{2\Delta^2 - 2\Delta\overline{B}}{\Delta^2} - \frac{\left(\overline{B}^2 - 2\Delta\overline{B} + \Delta^2 - L^2\right)}{\Delta^2}\right]$$

$$\frac{\partial\theta}{\partial\Delta} = \frac{1}{4}\left(\frac{\Delta^2 - \overline{B}^2 - L^2}{\Delta^2}\right)$$

$$\frac{\partial\theta}{\partial\Delta} = \frac{1}{4}\left(1 - \frac{\overline{B}^2}{\Delta^2} - \frac{L^2}{\Delta^2}\right) > 0 \tag{9}$$

as it can be shown that $\frac{B^2+L^2}{\Delta^2} < 1$ in the region where $\theta > 0$.

Hence, the gain from delegation increases as Δ increases. This is because larger values of Δ imply larger gains and losses associated with regulation. In other words, the worst regulations become even worse as Δ increases, so the incentive to delegate increases.

Finally, we calculate $\frac{\partial\theta}{\partial L}$, which equals:

$$-\frac{L}{2\Delta} < 0 \tag{10}$$

This implies that as litigation costs increase, the gain from delegation decreases. The reasoning behind this is that when L increases, so does the threshold for which delegation must cover. The higher the litigation costs, the more benefits delegation must provide to cover the costs as now even a regulation with a positive net benefit may no longer be optimal to impose.

2.3.2 Costs and Benefits are each distributed uniformly

We continue to explore this model by considering a slightly more general case in which we separate net benefits ($\tilde{B}$) into costs (c) and gross benefits (g) and assume that each is distributed uniformly:

$c \sim [0, C]$ and

$g \sim [0, G]$

Then net benefits, $\tilde{B} = g - c$, has mean equal to $\frac{G-C}{2}$ and is distributed over the range $[-C, G]$. If we assume that $G - C > 0$, then expected net benefits are positive, leaving three regions of interest:

I.$-C < \tilde{B} < 0$

II. $0 < \tilde{B} < G - C$

III. $G - C < \tilde{B} < G$

The distribution is broken into three regions for the following reason: Because each of the two uniform distributions do not have the same length, $g - c$ is not uniform over its range. The first region corresponds to when $g = 0$, but c is still varying. The third region corresponds to when $g = G$ and c is still varying. Neither c nor g are fixed in the second, middle region. We don't need to worry about the areas when c is fixed and g is varying because of the assumption that $G - C > 0$. Therefore, those areas are contained within the second region.

For each of these three regions, we calculate the distribution function along the appropriate range.

In Region I, f(B) = $\int_{-C}^{B} \frac{1}{GC} dC$ = $\frac{B+C}{GC}$

In Region II, f(B) = $\int_{-C}^{0} \frac{1}{GC} dC$ = $\frac{C}{GC}$=$\frac{1}{G}$

In Region III, f(B) = $\int_{B-G}^{0} \frac{1}{GC} dC$ = $\frac{G-B}{GC}$

So long as $G \neq C$, then this distribution will have the shape of a trapezoid.[6]

[6]If $g = c$, then the distribution will look like a triangle, with the apex located at the mean.

Next, we can calculate the expected net benefits with and without delegation. There are two cases to consider: Case I, when $L < G - C$, and Case II when $L > G - C$. We need to consider two separate cases because the agency adopts regulations in Region II and Region III when $L < G - C$, but only adopts regulations in Region III when $L > G - C$. We continue to assume that L is fixed.

Case I

When $L < G - C$, the expected benefits associated with the *no delegation* case are:

$$V_{ND} = \int_{-C}^{0} B\frac{B+C}{GC}dB + \int_{0}^{L} B\frac{1}{G}dB + \int_{L}^{G-C} B\frac{1}{G}dB + \int_{G-C}^{G} B\frac{G-B}{GC}dB$$

$$= -\frac{C^3}{6GC} + \frac{L^2}{2G} + \frac{(G-C)^2}{2G} - \frac{L^2}{2G} + \frac{G^3}{2GC} - \frac{(G-C)^2}{2C} - \frac{G^2}{3C} + \frac{(G-C)^3}{3GC}$$

$$= \frac{G-C}{2} = \frac{B}{2}$$

which is the mean of the distribution.

Expected benefits given delegation are:

$$V_D = \int_{L}^{G-C} B\frac{1}{G}dB + \int_{G-C}^{G} B\frac{G-B}{GC}dB - L$$

The legislature will choose to grant discretion to the agency as long as $V_D > V_{ND}$. If:

$$\int_L^{G-C} B\frac{1}{G}dB + \int_{G-C}^{G} B\frac{G-B}{GC}dB - L > \frac{G-C}{2}$$

$$-L > \int_{-C}^{0} B\frac{B+C}{GC}dB + \int_0^L B\frac{1}{G}dB$$

$$-L > -\frac{C^2}{6G} + \frac{L^2}{2G}$$

$$\frac{C^2}{3} > L^2 + 2LG \tag{11}$$

Figure 1 depicts for different combinations of C and G, the L that would make the legislature exactly indifferent between delegation or not. At points above the surface they should not grant discretion, while for those below, discretion is more efficient.

Case II

Next we look at Case II when $G - C < L$. As before, the expected benefits associated with the *no delegation* case are:

$$V_{ND} = \int_{-C}^{0} B\frac{B+C}{GC}dB + \int_0^{G-C} B\frac{1}{G}dB + \int_{G-C}^{L} B\frac{G-B}{GC}dB + \int_L^G B\frac{G-B}{GC}dB$$

$$= \frac{G - C}{2} = \frac{B}{2}$$

Expected benefits given delegation are:

$$V_D = \int_L^G B \frac{G - B}{GC} dB - L$$

As before, the legislature will choose to delegate in Case II if and only if $V_D > V_{ND}$:

$$-L > \int_{-C}^0 B \frac{B + C}{GC} dB + \int_0^{G-C} B \frac{1}{G} dB + \int_{G-C}^L B \frac{G - B}{GC} dB$$

$$-L > \frac{B}{2} - \int_L^G B \frac{G - B}{GC} dB$$

$$L(-2L^2 + 3LG + 6GC) < G^3 - 3CG(G - C) \tag{12}$$

This function cannot be explicitly solved for L in terms of G and C as was done in Case I. However, we can choose an arbitrary value for L (for example, let L = 10), which yields Figure 2. All points with a coordinate on the vertical axis equal to zero indicate indifference between delegating and not. At points above the surface, the legislature should not grant discretion.

Finally, we set arbitrary values for c and g to see at what value of L it becomes optimal for the legislature not to delegate discretion to the agency. Suppose that $G = 5$ and $C = 3$. Also, assume that this problem resembles Case I with L bounded by 0 and 2. Then the cutoff L solves the equation: $L^2 + 10L - 3 = 0$. Because we only care about the positive root, L = .2915, or just about 29% of expected net benefits. For all values of L above .2915, it is optimal not to delegate. Likewise, delegation is optimal for all values of L below. This suggests that litigation costs not need be that substantial for no delegation to be superior to delegation.

2.3.3 Uniform Distribution with proportional litigation costs

We further extend the model by relaxing the assumption that litigation costs are constant. Rather, we now assume that they are proportional to costs. If we assume that firms bear any of the costs of regulation, then they have a greater incentive to fight the more costly regulations. We continue to assume that both costs and benefits are distributed uniformly upon the intervals $[0, C]$ and $[0, G]$ respectively. We now assume that $L = \alpha c$. Given delegation, the agency will impose a given regulation if the net benefit exceeds the litigation cost. If:

$$g - c - L \geq 0$$

Substituting for L:

$$g - c(1 + \alpha) \geq 0 \tag{13}$$

Let $\omega = (g, c)$ where $\Omega = \{w \mid g - c(1+\alpha) \geq 0\}$. In other words, Ω is the set containing all combinations of G, C, and α that make delegation desirable. Then, the legislature will delegate when:

$$\int_{\Omega} [g - c(1+\alpha)]\, f(\omega)\, d\omega > \frac{G - C}{2} \tag{14}$$

We continue to assume that $G - C > 0$, which insures that *no delegation* is a legitimate alternative. However, depending on the value of α, $C(1+\alpha)$ may be either less than or greater than G. So we consider two cases; Case I where $C(1+\alpha) < G$ and Case II where $C(1+\alpha) \geq G$.

Case I

Expected benefits associated with delegating when $C(1+\alpha) < G$ are:

$$V_D = \int_0^{(1+\alpha)C} \int_0^{\frac{g}{1+\alpha}} [g - c(1+\alpha)]\, f(c, g)\, dcdg$$

$$+ \int_{(1+\alpha)C}^{G} \int_0^{C} [g - c(1+\alpha)]\, f(c, g)\, dcdg$$

$$= \frac{1}{CG} \left(\int_0^{(1+\alpha)C} [cg - \frac{c^2(1+\alpha)}{2} \bigg|_0^{\frac{g}{1+\alpha}}]\, dg + \int_{(1+\alpha)C}^{G} [gc - \frac{c^2(1+\alpha)}{2} \bigg|_0^{C}]\, dg \right)$$

$$= \frac{1}{CG} \left(\int_{0}^{(1+\alpha)C} [\frac{g^2}{2(1+\alpha)}] \, dg + \int_{(1+\alpha)C}^{G} [\frac{g^2}{2(1+\alpha)}] \, dg \right)$$

$$V_D = \frac{3G^2 - (1+\alpha)CG - (1+\alpha)^2C^2}{6G} \tag{15}$$

This implies that delegation is superior to no delegation when:

$$\frac{3G^2 - (1+\alpha)CG - (1+\alpha)^2C^2}{6G} > \frac{G-C}{2}$$

Again, let θ be the net gain from delegation. Then,

$$\theta = \frac{(2-\alpha)CG - (1+\alpha)^2C^2}{6G} \tag{16}$$

and delegation is optimal whenever $\theta > 0$. Calculating the derivative of θ with respect to α:

$$\frac{\partial\theta}{\partial\alpha} = -\frac{CG + 2(1+\alpha)^2C^2}{6G} < 0 \tag{17}$$

This implies that for given values of G and C, the gains to delegation decrease as α increases. In other words, the legislature has a greater incentive to impose regulations itself as litigation costs increase. We use a numerical example to help illustrate this. As before, suppose that $G = 5$ and $C = 3$. When $\alpha = 0.5,\ \theta = 0.125$, implying that the legislature should grant discretion to the agency. However, θ falls to -0.113 when α rises to 0.6, implying that no delegation is now optimal.

Case II

Next we turn our attention the the case when $c(1+\alpha) \geq g$. Expected benefits associated with delegation equal:

$$V_D = \int_0^G \int_0^{\frac{g}{1+\alpha}} [g - c(1+\alpha)] \, f(c,g) \, dcdg$$

$$V_D = \frac{1}{CG} \int_0^G \, [gc - \frac{(1+\alpha)c^2}{2}] \bigg|_0^{\frac{g}{1+\alpha}} \, dg$$

$$V_D = \frac{1}{CG} \int_0^G \frac{g^2}{(1+\alpha)} - \frac{g^2}{2(1+\alpha)} dg$$

$$V_D = \frac{1}{CG} [\frac{G^3}{6(1+\alpha)}] \tag{18}$$

Thus, it is optimal for the legislature to delegate when:

$$\frac{G^2}{6C(1+\alpha)} > \frac{G-C}{2} \tag{19}$$

Then,

$$\theta = \frac{G^2}{6C(1+\alpha)} - \frac{G-C}{2}$$

$$\frac{\partial \theta}{\partial \alpha} = -\frac{G^2}{6C(1+\alpha)^2} < 0 \tag{20}$$

implying that, as in Case I, no delegation becomes more desirable as litigation costs increase.

If we let $G = 5$ and $C = 3$ again, while imposing the constraint that $C(1+\alpha) \geq G$ (thus, $\alpha \geq 0.667$), then delegation is never optimal. If we let $G = 4$, $C = 3$ and $\alpha = 0.5$, then $\theta = 0.093$, and delegation is optimal. However,when α rises to 0.8, θ falls to -0.006 implying that the legislature should not grant discretion to the agency. Again, this demonstrates that there exist reasonable scenarios where it is optimal for the legislature to prohibit the agency from using discretionary tools.

2.4 Conclusion

The model developed in this chapter shows that there are certain conditions under which it is optimal for a legislature not to grant an agency discretion. This leads to some interesting results. First, we would now expect there to be instances of government regulation which *ex post* clearly should not have been done. Superfund is a glaring example of such a regulation. Second, because it is the existence of litigation costs that cause the government to tie its own hands, it is litigation itself that is the cause of inefficient governmental regulations. An empirically testable implication of this result is that cost-benefit analyses should be used more often in areas of regulation less likely to face expensive litigation.

Chapter 3: Optimal Agency Behavior in the Presence of Litigation Costs

3.1 Introduction

An interesting phenomenon of regulatory activity is that government agencies do not always issue as many regulations as economists might expect. An example of such an occurrence is the Environmental Protection Agency's regulation of toxic air pollutants. When Congress passed the Clean Air Act Amendments of 1977, it instructed the EPA to identify secondary hazardous air pollutants not already regulated by the Act and set standards for their emissions levels. By the time Congress revisited the act in 1990, the EPA had set standards on only seven pollutants. This was alarming to many, including members of Congress, as it was generally accepted that there were far more toxic air pollutants than just those for which the EPA had issued standards. In fact, in light of the EPA's failure to act, Congress explicitly listed 189 pollutants in the 1990 amendments and required the EPA to issue emission standards for each of them within the next eight years.

In the context of this thesis, Congress reduced the amount of discretion the EPA had over the regulation of toxic air pollutants. This is puzzling because if Congress was able to name an additional 182 pollutants, then the EPA surely must have also known of their existence and harm. This chapter builds a model which offers an explanation for the EPA's lack of action. As in the previous chapter, litigation and discretion play important roles in explaining the government's behavior.

Chapter Two showed that discretion is a double-edged sword. On one hand, a government agency that has been granted discretion is able to make more informed decisions. Armed with this tool, the agency can choose when it is best to issue a regulation. If the agency makes its decisions with the goal of maximizing social net benefits, discretion insures that only the efficient regulations are promulgated.

However, discretion comes at a price. In addition to the costs directly associated with determining when the regulation should and should not be enforced, there are also indirect costs that accompany discretion. In Chapter Two, we introduced litigation costs as such an example. The more decisions the agency has the authority to make, the more decisions there are that might be appealed. One of the difficulties that an agency with discretion faces is paying for these litigation costs. If the agency knows that its decisions will be challenged, the costs associated with those challenges may affect the number of regulations the agency decides to enforce. In fact, an agency will not enforce the optimal number of regulations because of these costs.

Litigation costs can explain why the EPA did not issue regulations for as many toxic air pollutants as Congress apparently expected. We show that any agency whose decisions are subject to litigation will issue fewer regulations that would be efficient in the absence of litigation costs. The EPA, in other words, issued few regulations because it was constrained by its litigation budget.

3.2 The General Model

We now consider how an agency decides which regulations to promulgate in the presence of costly litigation. Suppose that a particular agency has been granted discretion to promulgate regulations in a certain area however it sees fit. Further, assume that there exist a large number of potential regulations N, and it costlessly knows the true net social benefit of each. The agency must decide how many actual regulations, n, it will promulgate. We assume that each regulation will be challenged in court exactly once with probability equal to one. The regulation is only enforced if the agency wins the challenge. Let the probability of the agency winning the challenge of regulation i be π_i and assume that it is purely a function of the amount it spends on litigation, L_i: $\pi_i = f(L_i)$.[7] Finally, the agency has a fixed budget to spend on litigation, C.

We are interested in the case where the agency chooses not to act on every potential regulation. This will occur when N is large and there are non-convexities in $f(L)$ such that $f(0) = 0$, $f'(0) = 0$ and $\lim_{L_i \to \infty} f'(L_i) = 0$. One way to interpret this is that there are fixed costs. It is easy to imagine a situation where the first dollar spent on litigation does nothing to increase the probability the agency wins the suit. Such an example might be the initial fees for simply filing court documents. Or perhaps, an agency cannot add a lawyer to a case without incurring a certain non-trivial discrete cost. The sufficient condition that $\lim_{L_i \to \infty} f'(L_i) = 0$ exists because there becomes a point where

[7] In this chapter, we assume that litigation is not wasteful. Assuming wasteful litigation complicates the algebra, but does not alter the direction of the results.

additional litigation dollars no longer have a marginal benefit. The agency is already spending so much defending the regulation that another dollar cannot possibly help.

Suppose that the agency wants to maximize net benefits (gross benefits less costs, which include administrative costs) subject to its litigation budget. It must choose the number of regulations to issue, n, and the amount to be spent defending each one L_i. We begin with a simple model and assume that all regulations are identical and result in a positive net benefit of B. Under this assumption, the agency will spend the same amount defending each regulation (See Appendix A for a proof). Therefore, $L_i = C/n$. Define $V(n)$ to be the expected net benefit of n regulations:

$$V(n) = n \cdot B \cdot f\,(\frac{C}{n}) \tag{21}$$

The agency chooses n to maximize V. The partial derivatives of V are:

$$\frac{\partial V}{\partial n} = Bf - Bf' \cdot \frac{C}{n} \tag{22}$$

and

$$\frac{\partial^2 V}{\partial n^2} = Bf'' \cdot \frac{C^2}{n^3} \tag{23}$$

At an interior solution, $\frac{\partial V}{\partial n} = 0$. Setting equation 22 equal to zero, we get:

$$Bf - Bf' \cdot \frac{C}{n} = 0$$

or

$$Bf = Bf' \cdot \frac{C}{n} \tag{24}$$

which can be rewritten as:

$$B\frac{f(L)}{L} = B \cdot f'(L)$$

There are two important results that flow from this. First, the agency's optimal expenditure on litigation for a given regulation depends only on the probability function, $f(L)$ and does not depend on the size of the budget, C. The agency is spending the optimal amount defending the regulation when the average return on litigation $B\frac{f(L)}{L}$ equals the marginal return to litigation, $B \cdot f'(L)$. This result is displayed graphically in Figure 3.

The second result, which is implied by the first, is that the optimal number of regulations increases when the agency's budget increases. If the agency's budget increases, it will not spread those additional dollars over existing projects to increase the likelihood of winning those challenges. Rather, it will use the increased funds to defend regulations it previously decided not to defend.

3.3 Specific Functional Form

Next, we consider specific functional forms of the probability and benefit functions. We continue to assume that there are N possible regulations and that the benefits of regulation i, B_i, are linear and specified by $B \cdot i$. We further assume that the net benefit of each regulation is known and that the best regulation has a net benefit of B_1. That is, the net benefit of the best regulation is given by B and net benefits for the other regulations are scaled by their rank. This scaling still insures that each regulation has a positive net benefit. The last regulation promulgated has a net benefit equal to B_{1-n} with $0 < n < 1$. Therefore, n is also the proportion of regulations the agency enforces: if $n = 1$, it enforces every regulation. Likewise, if $n = 0$, then it does not enforce any regulations.

We also specify a functional form for the probability function. Let π_i be given by:

$$\pi_i = \begin{cases} (1 - \frac{\gamma_i}{L_i}) & L_i \geq \gamma_i \\ \pi_i = 0 & L_i < \gamma_i \end{cases}$$

where γ_i can be interpreted as the fixed cost associated with litigation. If the agency spends less than γ_i on litigation, it cannot win the suit. Also notice that a higher value for γ_i implies a lower probability of winning the challenge for any given level of L_i. Then, the agency wishes to maximize:

$$V = \int_{1-n}^{1} B \cdot i \cdot (1 - \frac{\gamma_i}{L_i}) \cdot di \tag{25}$$

subject to the constraint:

$$\int_{1-n}^{1} L_i \cdot di - C = 0 \tag{26}$$

The Hamiltonian function for this problem is:

$$\phi = \int_{1-n}^{1} B \cdot i \cdot (1 - \frac{\gamma_i}{L_i}) \cdot di - \lambda(\int_{1-n}^{1} L_i \cdot di - C) \tag{27}$$

Taking the first order conditions with respect to litigation expenditure on regulation i, L_i, gives:

$$\frac{\partial \phi}{\partial L_i} = \frac{B \cdot i \cdot \gamma}{L_i^2} - \lambda = 0$$

As mentioned above, there are N different regulations with regulation 1 being the best. Thus, we can compare regulation i to the best regulation. Comparing the first order conditions produces the expression:

$$\frac{B \cdot i \cdot \gamma_i}{L_i^2} = \frac{B \cdot \gamma_1}{L_1^2} \tag{28}$$

which holds for all promulgated regulations. In order to interpret equation 28, suppose that $\gamma_i = \gamma_j \; \forall \, i, \, j$. Then,

$$\frac{B \cdot i}{L_i^2} = \frac{B}{L_1^2}$$

which implies that:

$$L_i = L_1 \sqrt{i} \tag{29}$$

Substitute equation 29 into equation 26 to get:

$$\int_{1-n}^{1} L_1 \sqrt{i} \, di = C \tag{30}$$

Integration yields:

$$\frac{2L_1 \cdot i^{(3/2)}}{3} \Big|_{1-n}^{1} = C$$

$$\frac{2}{3}L_1\left(1-(1-n)^{3/2}\right) = C \tag{31}$$

Next, we wish to solve for L_1 in terms of C and n. Rearranging equation 31 we get:

$$L_1 = \frac{3C}{2(1-(1-n)^{3/2})} \tag{32}$$

Substituting equation 32 into equation 29 gives:

$$L_i = i^{1/2}\frac{3C}{2(1-(1-n)^{3/2})} \tag{33}$$

Remember that a lower value of i implies a lower benefit, B. Thus, we expect that agency spends fewer litigation dollars on regulations with lower expected net benefits, which is exactly what equation 33 shows.

Returning our attention to the value function given in equation 25:

$$V = \int_{1-n}^{1} B \cdot i \cdot (1 - \frac{\gamma}{L_i}) \cdot di$$

We substitute equation 33 into equation 25 in order to solve for V in terms of n and the exogenous variables, B and C. Doing so yields:

$$V = \int_{1-n}^{1} B \cdot i \cdot di - \int_{1-n}^{1} \frac{B \cdot \gamma \cdot i^{1/2} 2(1-(1-n)^{3/2})}{3C} di \tag{34}$$

$$V = \frac{B \cdot i^2}{2} \Big|_{1-n}^{1} - \frac{4B \cdot \gamma \cdot i^{3/2} (1-(1-n)^{3/2})}{9C} \Big|_{1-n}^{1}$$

$$\begin{aligned} V = \; & \tfrac{B}{2} - \tfrac{B(1-n)^2}{2} - \tfrac{4B \cdot \gamma \cdot (1-(1-n)^{3/2})}{9C} \\ & + \tfrac{4B \cdot \gamma \cdot (1-n)^{3/2} (1-(1-n)^{3/2})}{9C} \end{aligned} \tag{35}$$

$$V = B \cdot n(1 - \frac{n}{2}) - \frac{4B \cdot \gamma \cdot (1-(1-n)^{3/2})^2}{9C} \tag{36}$$

In order to calculate the optimal number of regulations (n), we take the partial derivative of equation 36 with respect to n:

$$\frac{\partial V}{\partial n} = B(1-n) - \frac{4B \cdot \gamma}{3C} \left((1-n)^{1/2} - (1-n)^2 \right) \tag{37}$$

Because we assume that there is an interior solution, we know that $\partial V / \partial n = 0$. In particular, this allows us to see how the optimal choice of n varies with C, B and γ. Begin by defining $G(n, C, B, \gamma)$ to be the derivative of V with respect to n:

$$G(n, C, B, \gamma) \equiv \frac{\partial V}{\partial n} \tag{38}$$

At an interior solution, $G = 0$. By the implicit function theorem, we know that

$$\frac{dn}{dC} = -\frac{\partial G/\partial C}{\partial G/\partial n} \tag{39}$$

Solving for $\partial G/\partial C$:

$$\partial G/\partial C = \frac{4B \cdot \gamma}{3C^2}(1-n)^{\frac{1}{2}} - \frac{4B \cdot \gamma}{3C^2}(1-n)^2 \tag{40}$$

Collecting terms gives:

$$\partial G/\partial C = \frac{4B \cdot \gamma}{3C^2}[(1-n)^{\frac{1}{2}} - (1-n)^2] \tag{41}$$

This expression is strictly positive because B, γ and C are all positive and since $0 < n < 1$, $[(1-n)^{\frac{1}{2}} - (1-n)^2]$ is also positive. Furthermore, $\partial G/\partial n$ is negative by assumption, because a necessary condition for $\frac{\partial V}{\partial n}$ to be a local maximum is for $\frac{\partial^2 V}{\partial n^2}$ to be negative. Then,

$$\frac{dn}{dC} = -\frac{\partial G/\partial C}{\partial G/\partial n} > 0 \tag{42}$$

In other words, the agency will promulgate more regulations as its litigation budget increases, rather than just increase the amount it spends litigating the current regulations. This is the same result achieved in the general model presented in Section 3.2.

Next, we wish to consider how changes in B affect the optimal number of regulations.

$$\frac{dn}{dB} = -\frac{\partial G/\partial B}{\partial G/\partial n}$$

Calculating $\partial G/\partial B$:

$$\partial G/\partial B = [(1-n) - \frac{4\cdot\gamma}{3C}\{(1-n)^{\frac{1}{2}} - (1-n)^2\}] \tag{43}$$

This can be shows to be zero for the following argument. Equation 37 can be rewritten as:

$$\frac{\partial V}{\partial n} = B\left(1 - n - \frac{4\cdot\gamma}{3C}(1-n)^{1/2} + \frac{4\cdot\gamma}{3C}(1-n)^2\right) = 0$$

If we are at an optimum and $B \neq 0$, then it must be true that:

$$1 - n - \frac{4\cdot\gamma}{3C}(1-n)^{1/2} + \frac{4\cdot\gamma}{3C}(1-n)^2 = 0$$

Therefore, we know that equation 43, and thus $\frac{dn}{dB}$, equals zero. As shown in Section 3.2, the agency's optimal choice of L will depend on the shapes of the probability function and its derivative. A change in the maximum net benefits only affects the value function, not the probability function. This shows that the previous result holds in more general circumstances – a change in net benefits does not affect the number of regulations the agency chooses to defend.

Finally, let us look at how a change in γ affects the optimal number of regulations, n.

$$\frac{dn}{d\gamma} = -\frac{\partial G/\partial\gamma}{\partial G/\partial n}$$

We have already established that $\frac{\partial G}{\partial n}$ is negative. Calculating $\frac{\partial G}{\partial \gamma}$:

$$\frac{\partial G}{\partial \gamma} = \frac{4B}{3C}((1-n)^2 - (1-n)^{\frac{1}{2}})$$

which is negative for the reasons listed before. This implies that

$$\frac{dn}{d\gamma} = -\frac{\partial G/\partial \gamma}{\partial G/\partial n} < 0$$

So, as fixed costs increase, the optimal number of regulations decreases. This is intuitive: remember that the agency's probability of winning the legal challenge is zero if it spends less than γ defending the regulation. Any litigation expenditure less than γ is wasted, so if the agency decides to defend a regulation, it will spend at least γ doing so. Thus, if the fixed costs increases, more litigation dollars must be spent on each regulation before there is positive marginal benefit to litigation.

3.4 Heterogeneous Fixed Costs

In Section 3.3, we assumed that fixed costs, γ, are identical for every regulation. However, it is worthwhile to consider examples where this condition does not hold. As discussed in the previous section, higher values for γ imply higher fixed costs. Furthermore, the probability of winning a challenge for a given expenditure on litigation is lower for a project with a greater value of γ. Letting γ vary allows us to see how an agency might choose between regulations that vary in both net benefits and fixed litigation costs.

Suppose that fixed litigation costs, γ_j, are given by the expression $\gamma_j = \gamma \cdot j$. Also suppose that j ranges from $\widehat{j}$ to 1, where $\widehat{j}$ is the lower bound for j. A lower bound on j is necessary because if $j = 0$, then the agency wins the suit regardless of how little it spends on litigation. Then, the probability function becomes: $\pi(i,j) = (1 - \frac{\gamma \cdot j}{L_{i,j}})$ and the objective function becomes:

$$V = \int_{\widehat{j}}^{1} \int_{n_j}^{1} B \cdot i \cdot \left(1 - \frac{\gamma \cdot j}{L_{i,j}}\right) di \cdot dj \tag{44}$$

Following the same steps we used in Section 3.3, we arrive at the expression:

$$L_{i,j} = \widehat{L} \cdot \sqrt{\frac{i \cdot j}{\widehat{j}}} \tag{45}$$

where $\widehat{L} = L_{1,\widehat{j}}$, and $\widehat{L}$ is the amount the agency spends defending the ideal regulation: a regulation with the greatest possible net benefit ($i = 1$) and lowest possible fixed cost ($j = \widehat{j}$).

Also note that the agency will decide which regulations to defend by considering both fixed costs and net benefits in tandem. For all regulations with a particular value of j, and hence a particular value of γ_j, there exists an n_j such that the agency will enforce those regulations where $i \geq n_j$. Then, as a limit of integration, the choice of i is a function of j, $i = n_j$, and is defined between zero and one. In effect, n_j tells us for the minimum value for i in order for the agency to defend any given regulation with fixed cost γ_j.

Substituting equation 45 into equation 44, the Hamiltonian for the agency's maximization problem becomes:

$$\phi = \int_{\hat{j}}^{1} \int_{n_j}^{1} B \cdot i \cdot \left(1 - \frac{\gamma \cdot j}{\hat{L} \cdot \sqrt{\frac{i \cdot j}{\hat{j}}}} \right) di \cdot dj - \lambda \left(\int_{\hat{j}}^{1} \int_{n_j}^{1} \hat{L} \cdot \sqrt{\frac{i \cdot j}{\hat{j}}} di \cdot dj - C \right) \quad (46)$$

We are interested to see how the agency's optimal choice of n_j is affected by changes in the parameters. We begin by solving for the first order conditions, $\frac{\partial \phi}{\partial \hat{L}}$ and $\frac{\partial \phi}{\partial n_j}$. Rewriting ϕ:

$$\phi = \int_{\hat{j}}^{1} \int_{n_j}^{1} (B \cdot i \cdot di \cdot dj) - \int_{\hat{j}}^{1} \int_{n_j}^{1} \frac{B \cdot i \cdot \gamma \cdot j}{\hat{L} \cdot \sqrt{\frac{i \cdot j}{\hat{j}}}} di \cdot dj$$

$$-\lambda \int_{\hat{j}}^{1} \int_{n_j}^{1} \hat{L} \cdot \sqrt{\frac{i \cdot j}{\hat{j}}} di \cdot dj + \lambda C \quad (47)$$

$$\phi = \int_{\hat{j}}^{1} \int_{n_j}^{1} (B \cdot i \cdot di \cdot dj) - \int_{\hat{j}}^{1} \int_{n_j}^{1} \frac{B \cdot i^{\frac{1}{2}} \cdot \gamma \cdot j^{\frac{1}{2}} \cdot \hat{j}^{\frac{1}{2}}}{\hat{L}} di \cdot dj$$

$$-\lambda \int_{\hat{j}}^{1} \int_{n_j}^{1} \hat{L} \cdot \frac{i^{\frac{1}{2}} \cdot j^{\frac{1}{2}}}{\hat{j}^{\frac{1}{2}}} di \cdot dj + \lambda C \quad (48)$$

Differentiating with respect to $\hat{L}$:

$$\frac{\partial \phi}{\partial \hat{L}} = \frac{B \cdot \gamma \cdot i^{\frac{1}{2}} \cdot j^{\frac{1}{2}} \cdot \hat{j}^{\frac{1}{2}}}{\hat{L}^2} - \lambda \frac{i^{\frac{1}{2}} \cdot j^{\frac{1}{2}}}{\hat{j}^{\frac{1}{2}}} = 0 \quad (49)$$

Solving equation 49 for λ:

$$\lambda = \frac{B \cdot \gamma \cdot \widehat{j}}{\widehat{L}^2} \tag{50}$$

To make things easier to follow, define ϕ_1 to be the first term in equation 48, ϕ_2 to be the second term and ϕ_3 to be the last two terms. With these definitions, $\phi = \phi_1 + \phi_2 + \phi_3$. Then,

$$\phi_1 = \int_{\widehat{j}}^{1} \int_{n_j}^{1} (B \cdot i) \, di \cdot dj \tag{51}$$

Integrating equation 51 over i:

$$\phi_1 = \int_{\widehat{j}}^{1} \frac{B \cdot i^2}{2} \cdot dj \,\Big|_{n_j}^{1}$$

$$\phi_1 = \int_{\widehat{j}}^{1} \frac{B}{2}(1 - n_j^2) \, dj \tag{52}$$

Differentiating with respect to n_j:

$$\frac{\partial \phi_1}{\partial n_j} = -B \cdot n_j \tag{53}$$

Next, consider ϕ_2:

$$\phi_2 = -\int_{\widehat{j}}^{1} \int_{n_j}^{1} \left(\frac{B \cdot \gamma \cdot j^{\frac{1}{2}} \cdot \widehat{j}^{\frac{1}{2}} \cdot i^{\frac{1}{2}}}{\widehat{L}} \right) di \cdot dj$$

$$\phi_2 = -\int_{\widehat{j}}^{1} \left(\frac{2B \cdot \gamma \cdot j^{\frac{1}{2}} \cdot \widehat{j}^{\frac{1}{2}} \cdot i^{\frac{3}{2}}}{3\widehat{L}} \right) dj \,\Big|_{n_j}^{1}$$

$$\phi_2 = -\int_{\widehat{j}}^{1} \frac{2B \cdot \gamma \cdot j^{\frac{1}{2}} \cdot \widehat{j}^{\frac{1}{2}}}{3\widehat{L}} (1 + n_j^{\frac{3}{2}})\, dj \tag{54}$$

Differentiating with respect to n_j:

$$\frac{\partial \phi_2}{\partial n_j} = \frac{B \cdot \gamma \cdot j^{\frac{1}{2}} \cdot \widehat{j}^{\frac{1}{2}} \cdot n_j^{\frac{1}{2}}}{\widehat{L}} \tag{55}$$

Finally, looking at ϕ_3:

$$\phi_3 = -\lambda \int_{\widehat{j}}^{1} \int_{n_j}^{1} \left(\widehat{L} \cdot \frac{i^{\frac{1}{2}} \cdot j^{\frac{1}{2}}}{\widehat{j}^{\frac{1}{2}}} \right) di \cdot dj + \lambda C$$

$$\phi_3 = -\lambda \int_{\widehat{j}}^{1} \left(\frac{2\widehat{L} \cdot i^{\frac{3}{2}} \cdot j^{\frac{1}{2}}}{3\widehat{j}^{\frac{1}{2}}} \right) dj \,\Big|_{n_j}^{1} + \lambda C$$

$$\phi_3 = -\lambda \int_{\widehat{j}}^{1} \left(\frac{2\widehat{L} \cdot j^{\frac{1}{2}}}{3\widehat{j}^{\frac{1}{2}}} \right) \left(1 + n_j^{\frac{3}{2}} \right) dj + \lambda C$$

Differentiating with respect to n_j:

$$\frac{\partial \phi_3}{\partial n_j} = \frac{\lambda \cdot \widehat{L} \cdot n_j^{\frac{1}{2}} \cdot j^{\frac{1}{2}}}{\widehat{j}^{\frac{1}{2}}} \tag{56}$$

Because $\phi = \phi_1 + \phi_2 + \phi_3$, then it follows that

$$\frac{\partial \phi}{\partial n_j} = \frac{\partial \phi_1}{\partial n_j} + \frac{\partial \phi_2}{\partial nj} + \frac{\partial \phi_3}{\partial n_j}$$

Therefore from equations 53, 55, and 56:

$$\frac{\partial \phi}{\partial n_j} = -B \cdot n_j + \frac{B \cdot \gamma \cdot j^{\frac{1}{2}} \cdot \widehat{j}^{\frac{1}{2}} \cdot n_j^{\frac{1}{2}}}{\widehat{L}} + \frac{\lambda \cdot \widehat{L} \cdot n_j^{\frac{1}{2}} \cdot j^{\frac{1}{2}}}{\widehat{j}^{\frac{1}{2}}}$$

Substituting equation 50 into the above equation, we get:

$$\frac{\partial \phi}{\partial n_j} = -B \cdot n_j + \frac{B \cdot \gamma \cdot j^{\frac{1}{2}} \cdot \widehat{j}^{\frac{1}{2}} \cdot n_j^{\frac{1}{2}}}{\widehat{L}} + \frac{B \cdot \gamma \cdot \widehat{j}}{\widehat{L}^2} \cdot \frac{\widehat{L} \cdot n_j^{\frac{1}{2}} \cdot j^{\frac{1}{2}}}{\widehat{j}^{\frac{1}{2}}}$$

Simplifying:

$$\frac{\partial \phi}{\partial n_j} = -B \cdot n_j + \frac{B \cdot \gamma \cdot j^{\frac{1}{2}} \cdot \widehat{j}^{\frac{1}{2}} \cdot n_j^{\frac{1}{2}}}{\widehat{L}} + \frac{B \cdot \gamma \cdot j^{\frac{1}{2}} \cdot \widehat{j}^{\frac{1}{2}} \cdot n_j^{\frac{1}{2}}}{\widehat{L}}$$

$$\frac{\partial \phi}{\partial n_j} = -B \cdot n_j + \frac{2B \cdot \gamma \cdot j^{\frac{1}{2}} \cdot \widehat{j}^{\frac{1}{2}} \cdot n_j^{\frac{1}{2}}}{\widehat{L}}$$

We set the above equation equal to zero and solve for n_j:

$$B \cdot n_j = \frac{2B \cdot \gamma \cdot j^{\frac{1}{2}} \cdot \hat{j}^{\frac{1}{2}} \cdot n_j^{\frac{1}{2}}}{\hat{L}}$$

$$n_j^{\frac{1}{2}} = \frac{2 \cdot \gamma \cdot j^{\frac{1}{2}} \cdot \hat{j}^{\frac{1}{2}}}{\hat{L}}$$

$$n_j = \frac{4 \cdot \gamma^2 \cdot j \cdot \hat{j}}{\hat{L}^2} \tag{57}$$

Equation 57 is an expression that defines the cutoff level of i for all regulations with a fixed cost of j. As discussed above, for any given value of j, the agency will defend the regulation if and only if $i \geq n_j$. The agency's decision is shown graphically in Figure 4. The agency defends all the regulations to the right of the dividing line and does not defend any regulations to the left. The slope of n_j is positive because the parameters γ, j, $\hat{j}$ and $\hat{L}$ are all positive. It can also be seen in equation 57 that n_j is linear in j. Therefore, any increase in j results in a linear increase in n_j, the threshold level of benefits.

Because $\frac{\partial n_j}{\partial j} > 0$, greater fixed litigation costs associated with a given regulation imply that greater net benefits are necessary for the agency to justify defending such a regulation. It also means that under this scenario, the agency will not always enforce the regulations with the greatest net benefit. In fact, it might defend regulations with relatively small net benefits if their associated fixed costs are appropriately small as well.

Next, we can see how a change in the agency's budget will affect the agency's choice of which regulations to enforce. If its budget increases, then it will continue to enforce every regulation that it had been previously enforcing. We further know from previous sections that the degree to which the agency defends a given regulation is purely a function of the probability of winning the case. Because a change in C does not change the probability function, the agency will continue to spend the same amount defending those regulations and use additional funds to defend new regulations. Thus, n_j must shift to the left, as seen in Figure 5.

Figure 6 shows how a change in $\widehat{j}$ affects n_j. An increase in $\widehat{j}$ means that the minimum level of fixed litigation costs increases. In other words, there are some regulations that the agency will no longer defend because they no longer exist. This also implies that the agency will no longer exhaust its litigation budget unless it defends additional regulations or spends more defending the remaining regulations. However, we know from equation 45 that the latter is not true; an increase in $\widehat{j}$ results in a decrease in $L_{i,j}$. Coupled with the fact that $\frac{\partial n_j}{\partial \widehat{j}}$ is positive, we can therefore conclude that an increase in $\widehat{j}$ will result in the agency defending more regulations and that most of the newly defended regulations can be found on the right-hand side of the graph.

A final result that is evident from equation 57 is that $\frac{\partial n_j}{\partial \gamma}$ is positive. Remember that an increase in γ implies that the fixed cost associated with each regulation also increases. Therefore, the minimum benefit that a regulation must have in order to justify regulation also increases.

3.5 Perfect Correlation Between Fixed Costs and Benefits

In Section 3.4, we assumed that fixed litigation costs and net benefits are uniformly and independently distributed. It is interesting to consider other distributions to see if the results from previous sections hold more generally. For arbitrary distributions it will not be possible to carry out the integrations analytically and numerical analysis would have to be used. However, an interesting and special case which can be solved analytically arises when benefits of a regulation B_i, and the fixed component of its litigation costs, γ_j, are perfectly correlated.

In other words, regulations with greater net benefits also have greater fixed litigation costs. One interpretation for this is that the regulations with greater benefits are larger and hence, face greater legal opposition. Thus, fixed costs will be greater for regulations with greater net benefits than for regulations with lower net benefits. We can model this scenario by assuming that $\gamma_j = \gamma_i = \gamma \cdot i$. This implies that the projects with higher values of B also have higher values of γ.

Adopting this assumption produces the expression (from equation 28):

$$\frac{B \cdot \gamma \cdot i^2}{L_i^2} = \frac{B \cdot \gamma}{L_1^2} \tag{58}$$

which simplifies to

$$L_i = i \cdot L_1 \tag{59}$$

Following the same steps as in Section 3.3, the constraint becomes:

$$\int_{1-n}^{1} L_i \, di = C$$

$$\int_{1-n}^{1} i \cdot L_1 \, di = C \tag{60}$$

Integration yields:

$$\frac{L_1 \cdot i^2}{2} \Big|_{1-n}^{1} = C$$

$$\frac{1}{2} L_1 (1 - (1-n)^2) = C \tag{61}$$

We can solve equation 61 for L_1:

$$L_1 = \frac{2C}{2n - n^2} \tag{62}$$

Substituting equation 59 into equation 62 to solve for L_i:

$$L_i = \frac{2C \cdot i}{2n - n^2} \tag{63}$$

Next, we substitute L_i into the value function:

$$V = \int_{1-n}^{1} B \cdot i \cdot (1 - \frac{\gamma_i}{L_i}) \cdot di$$

Simplifying and integrating:

$$V = \int_{1-n}^{1} B \cdot i \cdot di - \int_{1-n}^{1} \frac{B \cdot \gamma \cdot i^2 \cdot (2n - n^2)}{2C \cdot i} di$$

$$V = \int_{1-n}^{1} B \cdot i \cdot di - \int_{1-n}^{1} \frac{B \cdot \gamma \cdot i \cdot (2n - n^2)}{2C} di$$

$$V = \frac{B \cdot i^2}{2} \Big|_{1-n}^{1} - \frac{B \cdot \gamma \cdot (2n - n^2) \cdot i^2}{4C} \Big|_{1-n}^{1}$$

$$V = \frac{B}{2} - \frac{B(1-n)^2}{2} - \frac{B \cdot \gamma \cdot (2n - n^2)}{4C} + \frac{B \cdot \gamma \cdot (2n - n^2) \cdot (1-n)^2}{4C}$$

$$V = Bn - \frac{Bn^2}{2} - \frac{B\gamma n^2}{C} + \frac{B\gamma n^3}{C} - \frac{B\gamma n^4}{4C} \tag{64}$$

Next, we define $G(\ )$ to be a function giving the derivative of V with respect to the number of regulations, n:

$$G \equiv \frac{\partial V}{\partial n} = B - Bn + \frac{B\gamma}{C}(-2n + 3n^2 - n^3) \tag{65}$$

Again, we use the implicit function theorem to find how changes in the exogenous variables B, γ, and C affect the optimal number of regulations, n. Recall equation 39:

$$\frac{dn}{dC} = -\frac{\partial G/\partial C}{\partial G/\partial n}$$

Begin by calculating $\frac{\partial G}{\partial C}$:

$$\frac{\partial G}{\partial C} = \frac{B\gamma n}{C^2}(2 - 3n + 3n^2) \tag{66}$$

which is positive for $0 < n < 1$ and equal to zero for $n = 1$. Likewise,

$$\frac{\partial G}{\partial n} = -B + \frac{B\gamma}{C}(-2 + 6n - 3n^2) \tag{67}$$

which we know to be negative for the same reasons as discussed in the previous sections. Combining equations 66 and 67 shows that $\frac{dn}{dC}$ is positive for $0 < n < 1$ and equal to zero if $n = 1$. In other words, an increase in the agency's litigation budget will result in it promulgating a greater number of regulations. If $n = 1$, then the agency is already issuing every possible regulation, so an increase in its budget cannot result in an increase in the number of regulations that it defends.

On the other hand, the partial derivative of G with respect to B,

$$\frac{\partial G}{\partial B} = 1 - n + \frac{\gamma n}{C}(-2 + 3n - n^2) \tag{68}$$

is equal to zero. This holds for the same reason as was discussed in Section 3.3: the optimal choice of regulation depends solely on the probability function, and not the objective function. Because B does not appear in the probability function, it does not appear in equation 68. This implies that $\frac{dn}{dB}$ is also equal to zero.

Finally, consider

$$\frac{\partial G}{\partial \gamma} = \frac{Bn}{C}(-2 + 3n - n^2) \tag{69}$$

We have already concluded in equation 68 that $\frac{\partial G}{\partial B} = 0$. Because $0 < n < 1$, then $1 - n > 0$. This implies that $\frac{\gamma n}{C}(-2 + 3n - n^2) < 0$. Because γ, n, and C are all positive, then it must be true that $(-2 + 3n - n^2)$ is negative. The same expression can be found in equation 69 and therefore we can conclude that $\frac{\partial G}{\partial \gamma}$ is also negative. When combined with equation 67, this result implies that the agency defends fewer regulations as γ increases, $\frac{dn}{d\gamma} < 0$.

3.6 Conclusion

We find that if an agency must bear the cost of litigation, then it will regulate in fewer instances than if it did not. This certainly appears to explain the EPA's delay in identifying and issuing standards for toxic air pollutants. It was not until Congress revoked some of its discretion (which, as previously discussed in Chapter 2, reduces the amount of litigation that the agency faces), that the EPA listed emission standards for many air toxins.

In addition, the model presented in this chapter produces other interesting results.

For one, the model predicts that the agency's choice concerning how much to spend on a given regulation is independent of net benefits, B. We also show that as the fixed cost of litigation increases, the agency will promulgate fewer regulations. In fact, it can be optimal for an agency to focus its efforts on defending a few regulations rather than spending a little defending every regulation. Finally, the model shows that the agency will promulgate more regulations when its litigation budget increases, not simply just spend more defending the same regulations.

This model also has interesting policy implications. In the context of this thesis, if the legislature grants the agency discretion, then the agency faces the problem discussed in this chapter, and litigation costs will prevent it from promulgating the optimal number of regulations. On the other hand, if the legislature decides to not grant discretion to the agency, then it must regulate on its own with far less information than the agency would be able to. A possible solution would be for the government to increase the agency's litigation budget. However, this would not be as effective as a legislature might hope. The increase in funding will result in the agency issuing more regulations, but the increase may be very small. Considering that the EPA only issued regulations for 7 of 189 air toxins, it seems that the EPA's legal budget was substantially smaller than necessary.

Another solution, which is beyond the scope of this paper, is a loser-pays litigation system, such as the one used in Great Britain. If the agency is more likely to win the challenge than its opposition, then one might suspect that such a system would allow the agency to defend a greater number of regulations. Furthermore, such a system might also decrease the propensity for a regulation to be challenged at all. This seems an attractive idea if litigation is purely wasteful. However, there could be negative consequences if litigation provides benefits of its own, such as increased information. In fact, upcoming in Chapter Four, we consider a model where litigation helps agencies make more informed decisions.

Chapter 4: Litigation Costs as a Source of Additional Information

4.1 Introduction

Chapters Two and Three concentrated on some of the disadvantages of litigation and argued that litigation is not only wasteful spending in its own right, but that it also creates inefficiencies in other areas. Chapter Two showed that the potential for litigation might prompt the legislature to grant less discretion to an executive agency, resulting in a less than optimal solution. Then, Chapter Three examined how the existence of litigation costs constrains an agency's budget, forcing it to enforce fewer that the optimal number of regulations. Clearly, we have painted a dire picture of litigation's effects.

However, litigation has advantages too. Furthermore, plausible scenarios exist where these good results outweigh the bad ones. It is possible that these situations exist even in governmental decision making areas. Prior chapters assumed that the government was blessed with perfect information, or at least, the ability to obtain it. While this assumption is often harmless in that it only affects the magnitude of the results but not their direction, this assumption could be less innocuous in other situations. In fact, one of the positive aspects of litigation is that it can be a source of additional information for the government. For example, we might expect a company or industry to initiate more litigation against regulations that impose higher costs on those firms than those with lower associated costs.

In this paper, we consider the case where the government is unable to collect very much information regarding potential regulations on its own. Without this information, it is nearly impossible to make an efficient choice regarding which regulations to issue. We consider a model where litigation is useful precisely because it is costly. We show that the government can impose rules that allow it to use litigation as a signal of net benefits. Furthermore, we will show that it is possible for expected benefits to be greater under a scenario where litigation costs exist than under a scenario where they do not.

4.2 Background

Consider the U.S. Fish and Wildlife Service, whose task it is to protect endangered species. When the Endangered Species Act was first enacted in 1973, it was meant to protect large and popular animals such as the bald eagle. In recent years, it has often been used to protect less publicly popular species such as beetles or snails. Yet, one of the greatest problems the FWS faces is the extreme difficulty to identify and locate more species to protect. This is not to say that these species do not exist. Rather, there simply is too much land and too much information for it to process. It is easier to find an owl than it is an insect. Furthermore, even when it is able to identify and locate an endangered species, this is an expensive process. Finally, the agency has very little information regarding the cost or benefits of protecting a species. Without enough information, the FWS is unlikely to locate species, and even less likely to protect those with the greatest net benefit.

One of the positive contributions of litigation is that it provides the government with a less expensive means to obtain information. It can accomplish this by serving as a proxy for costs and benefits. Suppose that a government agency such as the FWS found itself unable to obtain sufficient information to make an informed decision regarding whether or not it should issue a given regulation. Further, suppose that the agency would not act on it own without such information, but would issue the regulation when directed by a court. Along those lines, the court would force the agency to act when an independent organization is able to prove that the species is endangered and that the declaration of critical habitat is necessary for its survival.

Such a setup helps the government in the following way. Suppose that a non-governmental organization (NGO) cares deeply about species protection and has more information than the government regarding the location of endangered species. The NGO might have this information because it is a group comprised of concerned members who are likely to have such private information.[8] However, an NGO has a constrained budget just like any other organization does, and will only be able to locate and try to protect a limited number of species. But this inability to protect every possible species does not mean that the NGO is ineffective. Because an NGO has reasonable knowledge of the benefits of protecting a species, is likely to try and protect the species with the greatest benefit first. Thus, litigation might not only help provide the agency with information regarding the location of endangered species, but it will also help the agency prioritize which species should be protected first.

[8]In fact, one might argue that this is the very reason that NGOs do exist. The entire purpose behind an NGO is for a group of individuals with like preferences to share these preferences with the government and influence policy decisions.

4.3 The Free Rider Problem

One complication inherent in the above set-up is the free rider problem. Because the protection of species is a public good, we expect that protection will be provided for an inefficiently low number of species. Consider the following example: suppose that m identical NGOs, each with a willingness to pay function for giving money to protect n species: $WTP(n) = A - Bn$. The marginal cost of finding and protecting a species is constant, C. This is where the free rider problem arises. Even assuming that the different NGOs do not behave strategically (which would result in even less protection), each organization acting rationally and sequentially will still underprovide this public good. To show this, let us first begin by characterizing the efficient solution.

Temporarily assume that the government has perfect information, recognizes the existence of the free rider problem, and provides the public good itself. The government's choice is then to determine the optimal number of species, n. The optimal solution is for the government to set n such that marginal social willingness to pay equals marginal cost:

$$m(A - Bn) = C \tag{70}$$

$$n_{optimal} = \frac{mA - C}{mB} \tag{71}$$

This n is the optimal amount of species protection absent the free rider problem.

Next, we compare this solution to the one reached by private provision of the good. Continue to assume that m different NGOs have identical preferences, and therefore, an identical willingness to pay. Under this scenario, a single firm will provide the public good as long as its marginal benefit of doing so is greater than or equal to its marginal cost.

Suppose that the firm's willingness to pay is $WTP = A - Bn$ and its marginal cost is $MC = C$. Setting $WTP = MC$ yields:

$$A - Bn = C \tag{72}$$

solving for $n_{private}$:

$$n_{private} = \frac{A - C}{B} \tag{73}$$

It is important to note that if a firm supplies this amount of species protection, a second NGO will not provide any further species protection. By the very nature of public goods, species protection is non-rival. The benefits of species protection provided by a given NGO are shared by each of the other NGOs as well. To that extent, the marginal benefit of additional species protection is less than the marginal benefit of the last unit of initial species protection. Thus, the private marginal benefit of additional species protection by a second NGO will be less than its marginal cost, and will not be provided.

Comparing the competitive provision to the amount of protection provided by the government:

$$n_{optimal} = \frac{mA - C}{mB} > \frac{A - C}{B} = n_{private} \tag{74}$$

Because rational private organizations only take their own willingness to pay into account, we have underprovision of a public good.

Also, we know that marginal social benefit of a regulation is $m(A - Bn)$. Substituting $n_{private}$ from equation 73, we get:

$$MSB = m(A - B \cdot (\frac{A - C}{B})) \tag{75}$$

Simplifying:

$$MSB = mC \tag{76}$$

Thus, we know that underprovision occurs and its severity increases with m.

4.4 A Model Without Wasteful Litigation

Although the free rider problem will result in private underprovision of the public good, the government can take advantage of this phenomenon. The existence of the free rider problem lets the agency infer that the social benefit of the litigated regulation is substantially greater than the private cost of litigation. Suppose that it is extremely costly for the agency to determine either the costs or the benefits of a given regulation, as described in the example provided above. Instead suppose that the agency only issues a regulation when forced to via litigation. Furthermore, assume that each and every lawsuit brought forth by an NGO is successful and forces the agency to issue the regulation in that instance. We henceforth refer to this type of regulation as rule-based regulation.

As discussed in the previous section, an NGO will file suit as long as its marginal benefit from regulation is greater than the cost it incurs through the lawsuit. Just as the

NGO does not take social costs into account, it does not internalize the social benefits either. Dependent on the degree of free ridership, social benefits could be much greater than the NGO's private benefit. So, whether or not rule-based regulation is a viable alternative to not issuing any regulations depends on the value of several variables. We begin by defining the following:

$L =$ cost incurred by a private organization to bring forth a suit.

$m =$ the number of NGOs.

$b =$ the social benefit of a given regulation.

$c =$ the social cost of a given regulation.

$f(b, c) =$the joint distribution of b and c.

Furthermore, temporarily assume that litigation costs, L, are not wasteful (We drop this assumption in Section 4.5.) Instead, assume that they act as some form of transfer payment between the NGO and the rest of society. This allows us to simplify the model. Under these assumptions, the NGO will sue the agency if the private benefit exceeds the private cost of litigation, L. However, because of free riders, we know that the social benefit of each litigated regulation is greater than or equal to mL. In other words, the agency will end up enforcing all regulations with a benefit of at least mL. Under these assumptions, the expected net benefit to society of rule-based regulation can be expressed as:

$$V = \int_0^\infty \int_{mL}^\infty (b - c) \cdot f(b, c) \, db \, dc \tag{77}$$

Next, we wish to compare this rule-based solution to the first-best solution. The first-best solution includes the regulations the agency would enforce if it had both perfect information regarding the cost and benefits of any potential regulation and also the discretion to act on such information. Under a first-best scenario, the agency will only enforce a regulation if $b > c$. The expected value under the first-best scenario is:

$$V_1 = \int_0^{\infty} \int_0^{b} (b - c)\, f(b, c)\, dc\, db \tag{78}$$

Even though the limits and order of distribution are different, we can still compare equations 77 and 78. Subtracting V from V_1 yields:

$$V_1 - V = \int_0^{\infty} \int_0^{b} (b - c)\, f(b, c)\, dc\, db - \int_0^{\infty} \int_{mL}^{\infty} (b - c) \cdot f(b, c)\, db\, dc \tag{79}$$

The smaller the value of $V_1 - V$, the closer the rule approximates the first-best solution. Figure 7 helps display the effect of rule-based regulation under different joint distributions of $f(b, c)$. Figure 7 is split into four different regions, where the vertical line represents the minimum inferred net benefit as defined by the rule: Region I contains those regulations that have a negative net benefit and are issued under rule-based regulation but not under the first-best solution. These regulations are also represented by the second term of the right-hand side of equation 79. Region II are those regulations that have a negative net benefit and are not issued under either regulatory scenario. Region III contains the regulations that have a positive net benefit and are issued under the first-best solution but not under the rule-based solution. These regulations are also given in the first term of the right-hand side of equation 79. Finally, Region IV contains the regulations that have a positive net benefit and are issued under both first-best and rule-based regulation. The effective density of each section depends on the joint distribution, $f(b, c)$.

Three distributions are of particular interest. The first is when b and c are negatively correlated. Second, we consider the rule when b and c are positively correlated. Finally, the case when b and c are uncorrelated is considered. We begin with the case of negative correlation.

When b and c are negatively correlated, a high value for b implies that costs are low. It also means that when b has a low value, costs are high. Thus, as demonstrated in Figure 8, most potential regulations are distributed in Regions II and IV. Because of this, the rule works relatively well. As discussed above, the rule insures that the minimum benefit of a regulation is greater than or equal to mL for any given value of L. With negative correlation, this also implies that costs are likely to be low. If costs and benefits are perfectly negatively correlated, and if the agency can optimally set L, then it can do so such that benefits are always greater than costs. If these conditions hold, then rule perfectly replicates the results of the first-best solution.

When benefits and costs are positively correlated, as shown in Figure 9, benefits and costs closely track each other. Regulations that have high benefits also have high costs. Likewise, low cost regulations have small benefits. If the expected benefits of the average regulation equal zero, then compared to a policy of regulating in each possible instance, rule-based regulation filters out regulations that are in Regions II and III. When b and c are positively correlated, Region II has a greater density than Region III. Thus, expected value is greater under rule-based regulation than under a policy of regulating in each possible instance. If expected benefits are less than zero, then the rule is less effective. Conversely, the rule is more effective when expected net benefits are greater than zero.

Ultimately, neither of the two previous joint distributions are very interesting because they do not provide rule-based regulation much of a chance to filter out inefficient regulations. The case of negative correlation is quite unlikely. The case of positive correlation is more likely, but the result depends greatly on the expected value of the regulations. Thus, we turn our attention to the case where costs and benefits are uncorrelated. Not only is this a more realistic scenario, but we will find that the efficacy of rule-based regulation does not depend on whether or not the expected value is positive or negative.

The final joint distribution for consideration is when benefits and costs are uncorrelated. This distribution is most interesting because it is not easily explained by a graph. Instead, we will solve this problem algebraically. If we assume that b and c are uncorrelated, then $f(b, c) = g(b)h(c)$. Then,

$$V = \int_0^\infty \int_{mL}^\infty (b - c) \cdot g(b)h(c)\, dbdc$$

$$V = \int_0^\infty \int_{mL}^\infty b \cdot g(b)h(c) - c \cdot g(b)h(c)\, dbdc$$

$$V = \int_0^\infty h(c) \int_{mL}^\infty b \cdot g(b)\, dbdc - \int_0^\infty c \cdot h(c) \int_{mL}^\infty g(b)\, dbdc \tag{80}$$

Suppose that $L = 0$. Then,

$$V = \int_0^\infty h(c) \int_0^\infty b \cdot g(b)\, dbdc - \int_0^\infty c \cdot h(c) \int_0^\infty g(b)\, dbdc$$

$$= \int_0^\infty \overline{b} \cdot h(c)\, dc - \int_0^\infty c \cdot h(c)\, dc$$

$$V = \overline{b} - \overline{c} \tag{81}$$

This is the expected result: when $L = 0$, the rule does not filter out any projects. Rather, the agency is regulating whenever possible. Thus, we expect net benefits to equal the difference between the means of gross benefits and costs.

Now suppose that $L > 0$. Then,

$$V = \int_0^\infty h(c)(1 - G(mL))(\overline{b}\,|_{mL})\, dc - \int_0^\infty c \cdot h(c)(1 - G(mL))\, dc \tag{82}$$

where $\overline{b}\,|_{mL}$ is the mean value of b given $b \geq mL$. Then,

$$V = (1 - G(mL))(\overline{b}\,|_{mL}) - \overline{c} \cdot (1 - G(mL))$$

$$V = [1 - G(mL)] \cdot [(\bar{b}\,|_{mL}) - \bar{c}] \tag{83}$$

Thus, the expected value of rule-based regulation depends on both the proportion of regulations with benefits exceeding mL (the first term) and the expected benefit of a regulation, given that $b \geq mL$ (the second term).

4.5 Endogenous Litigation Costs

To this point, we have assumed that the amount if costs the NGO to sue the agency, L, is exogenous. Suppose instead that the government (although not necessarily the agency in charge of promulgating the regulation) could set L. In order to analyze this further, we need to consider specific distributions for b and c. For mathematical simplicity, we use the uniform distribution. Specifically, assume that b and c are both distributed uniformly along $[0, B]$ and $[0, C]$ respectively. Then,

$$V = \int_0^C \int_{mL}^B (b - c) \cdot g(b)h(c)\, dbdc$$

Integration yields:

$$V = (1 - \frac{mL}{B})(\frac{mL + B}{2} - \frac{C}{2}) \tag{84}$$

As a check, suppose that $L = 0$, then

$$V = \frac{B - C}{2} = \bar{b} - \bar{c}$$

confirming the result of equation 81.

If we assume that L is endogenous, then we can solve for the optimal choice of L. The government might be able to set L by affecting how expensive it is to successfully challenge the agency. To calculate the value of L that maximizes V for this distribution:

$$\frac{\partial V}{\partial L} = (\frac{m}{2B})(C - bL - B - mL + B) \tag{85}$$

$$\frac{\partial V}{\partial L} = \frac{1}{2B}(C - 2mL)$$

We set this equal to zero to get the optimal value for L:

$$L = \frac{C}{2m} \tag{86}$$

Notice that the optimal choice of L depends on costs and the number of free riders, but does not depend on benefits. We can calculate the partial derivative of L with respect to m to see how the free-rider problem affects the optimal choice of L:

$$\frac{\partial L}{\partial m} = -\frac{C}{2m^2} < 0$$

Thus, the optimal level of L decreases when m increases. In other words, if the government can set how much it costs to bring forth a suit, it will impose lower litigation costs when the free-rider problem is greater. Setting L high when m is high might result in too few regulations being implemented.

Substituting the optimal value of L into equation 84, we arrive at an expression for the expected value of rule-based regulation:

$$V_r = \frac{B}{2} - \frac{C}{2} + \frac{C^2}{8B} \tag{87}$$

This model has two possible cases. The first, which will we call Case I, is when $B > C$. When $B > C$, the highest possible benefit to any given regulation is greater than the highest possible cost associated with any given regulation. This also implies that the mean benefit is greater than the mean cost, or that the expected benefit of the average regulation is positive. Likewise, Case II is when $C \geq B$. Under Case II, the maximum cost exceeds the maximum benefit and the expected value of the average regulation is negative. Let us begin by focusing on Case I.

When $B > C$, the expected value of issuing zero regulations is $V = 0$. Alternatively, the expected value of regulating whenever possible is $V = \overline{b} - \overline{c}$, as described in equation 81. So, we can conclude from equation 87 that V_r is greater than either regulating in all possible situations or none at all. Thus, for Case I, rule-based regulation is always superior to never regulating or always regulating.

Turning our attention to Case II, an important result that follows from equation 87 is that there exist values for B and C such that $V_r > 0$. This implies that the expected value of this rule-based regulation can be greater than the expected value of issuing no regulations at all ($V = 0$) under these circumstances. It also implies that that the expected value of ruled-based regulation can be greater than the expected value of promulgating every possible regulation ($V = \frac{B-C}{2} < 0$). Thus, under these circumstances, and if the government has the ability to set L, rule-based regulation can be a superior alternative to issuing every regulation or issuing no regulations.

In order to compare this to our earlier results, let us consider the first-best solution for the uniform distribution. We continue to assume that both costs (c) and benefits (b) are distributed uniformly and independently along $[0, B]$ and $[0, C]$ respectively.

Define $s = b - c$; the difference between the benefits and the costs of a given regulation. In other words, s is the true net benefit of a regulation absent any litigation costs. An agency that maximizes social net benefits will only issue those regulations with $s \geq 0$. In order to calculate the expected value of the first-best solution, we need to know how s is distributed. Although both b and c are distributed uniformly, the distribution of s is not uniform. The lowest possible value for s equals $-C$ and the greatest possible value for s equals B. As we did in chapter two, we separate $f(s)$ into three different regions. Region 1 contains the potential regulations where s is unambiguously negative. Thus, c can range anywhere from $-C$ to s in this range. In Region 2, s can be either positive or negative, so we integrate over the entire range of c. Finally, s is always positive in Region 3 and c can range from $(s - b)$ to 0 (its lower bound). The distributions for s in those three regions are:

In Region 1, $f(s) = \int_{-C}^{s} \frac{1}{BC} dC = \frac{s+C}{BC}$

In Region 2, $f(s) = \int_{-C}^{0} \frac{1}{BC} dC = \frac{C}{BC} = \frac{1}{B}$

In Region 3, $f(s) = \int_{s-B}^{0} \frac{1}{BC} dC = \frac{B-s}{BC}$

Let us first look at the first-best solution under Case I, when $B > C$. The agency will not issue any regulations in Region 1 because $c > b$ at all points within the region. Thus, the value of regulation under the first-best scenario is:

$$V_1^I = \int_0^{B-C} \frac{s}{B} ds + \int_{B-C}^{B} s \cdot \frac{B-s}{BC} dS \tag{88}$$

$$V_1^I = \frac{1}{B}\int_0^{B-C} s \cdot ds + \int_{B-C}^{B} \frac{Bs}{BC} ds - \int_{B-C}^{B} \frac{s^2}{BC} ds$$

$$V_1^I = \frac{1}{B}\int_0^{B-C} s \cdot ds + \frac{1}{C}\int_{B-C}^{B} s \cdot ds - \frac{1}{BC}\int_{B-C}^{B} s^2 \cdot ds$$

$$V_1^I = \frac{s^2}{2B}\Big|_0^{B-C} + \frac{s^2}{2C}\Big|_{B-C}^{B} - \frac{s^3}{3BC}\Big|_{B-C}^{B}$$

$$V_1^I = \frac{1}{2B}(B-C)^2 + \frac{1}{2C}(B^2 - (B-C)^2) - \frac{1}{3BC}(B^3 - (B-C)^3)$$

$$\begin{aligned} V_1^I = \ & \tfrac{1}{2B}(B-C)^2 + \tfrac{1}{2C}(B^2 - B^2 + 2BC - C^2) \\ & - \tfrac{1}{3BC}(B^3 - (B^3 - 3B^2C + 3BC^2 - C)^3) \end{aligned}$$

$$V_1^I = \tfrac{1}{2B}(B^2 - 2BC + C^2) + \tfrac{1}{2C}(2BC - C^2)$$
$$-\tfrac{1}{3BC}(3B^2C - 3BC^2 + C)^3)$$

$$V_1^I = \frac{1}{2B}(B^2 - 2BC + C^2) + B - \frac{C}{2} - B + C - \frac{C^2}{3B}$$

$$V_1^I = \frac{1}{6B}(3B^2 - 6BC + 3C^2) + \frac{3BC}{6B} - \frac{2C^2}{6B}$$

$$V_1^I = \frac{1}{6B}(3B^2 - 6BC + 3C^2 + 3BC - 2C^2)$$

$$V_1^I = \frac{1}{6B}(3B^2 - 3BC + C^2)$$

Simplifying, the expected value under the first-best solution is:

$$V_1^I = \frac{1}{2}B - \frac{1}{2}C + \frac{1}{6}\frac{C^2}{B} \tag{89}$$

Next we consider Case II, when $C \geq B$. Because $C \geq B$, the only region of $f(s)$ that we are interested in is Region 3. This is because $s < 0$ for all values in region 2 when $C > B$.

$$f(s) = \int_{s-B}^{0} \frac{1}{BC} dC$$

$$f(s) = \frac{B-s}{BC} \tag{90}$$

The expected value of the first-best solution under Case II is

$$V_1^{II} = \int_0^B (\frac{B-s}{BC}) \cdot s\,ds$$

$$= \frac{s^2}{2C}\Big|_0^B + \frac{s^3}{3BC}\Big|_0^B$$

$$= \frac{B^2}{2C} - \frac{B^3}{3BC}$$

$$V_1^{II} = \frac{B^2}{6C} \tag{91}$$

Next, we compare Case I and Case II when $B = C = 1$.

$$V_1^I = \frac{1}{2}B - \frac{1}{2}C + \frac{1}{6}\frac{C^2}{B} = \frac{1}{2} - \frac{1}{2} + \frac{1}{6} = \frac{1}{6}$$

and

$$V_1^{II} = \frac{B^2}{6C} = \frac{1}{6} \tag{92}$$

So, $V_1^I = V_1^{II}$, which is what we would expect. The two distributions of $f(s)$ should converge when $C = 1,\ B = 1$.

4.5.1 Example 1

Next, we use a numerical example to compare how the first-best solution compares to the rule-based solution. Consider first an example where $B > C$, that is, Case I from above. Specifically, assume that $B = 8$ and $C = 6$.

The expected value from the first-best solution is (using equation 89):

$$V_1^I = \frac{B}{2} - \frac{C}{2} + \frac{1}{6}\frac{C^2}{B} \tag{93}$$

$$V_1^I = 4 - 3 + \frac{1}{6} \cdot \frac{36}{8}$$

$$V_1^I = \frac{28}{16} \tag{94}$$

Comparing this to the rule-based solution (from equation 87):

$$V_r^I = \frac{B}{2} - \frac{C}{2} + \frac{C^2}{8B}$$

$$V_r^I = 4 - 3 + \frac{36}{64}$$

$$V_r^I = \frac{25}{16}$$

Define $\Delta_r^I = V_1^I - V_r$ to be the difference between the expected value of the first-best solution and the expected value of rule-based regulation. Then,

$$\Delta_r^I = \left(\frac{B}{2} - \frac{C}{2} + \frac{1}{6}\frac{C^2}{B}\right) - \left(\frac{B}{2} - \frac{C}{2} + \frac{C^2}{8B}\right)$$

$$\Delta_r^I = \frac{C^2}{24B} \tag{95}$$

For this example

$$\Delta_r^I = V_1^I - V_r^I = \frac{3}{16}$$

Now we wish to see how Δ_r changes with changes in B and C.

$$\frac{\partial \Delta_r^I}{\partial B} = -\frac{C^2}{24B^2} < 0$$

This implies that Δ_r decreases when B increases. In other words, increases in B make the first-best solution easier to approximate by using the rule. Likewise,

$$\frac{\partial \Delta_r^I}{\partial C} = \frac{C}{12B} > 0$$

Thus, changes in C affect Δ_r in the opposite way that changes in B do. An increase in C makes the the first-best solution harder to approximate by using the rule. Not surprisingly, rule-based regulation becomes a less attractive option as C increases.

4.5.2 Example 2

Next, we consider an example from Case II when $C > B$. Specifically, we assume that $B = 6$ and $C = 8$ now. Using these values, the expected value of the first-best solution is:

$$V_1^{II} = \frac{B^2}{6C} \tag{96}$$

$$V_1^{II} = \frac{3}{4}$$

Likewise, comparing this to the rule-based solution:

$$V_r^{II} = \frac{B}{2} - \frac{C}{2} + \frac{C^2}{8B}$$

$$V_r^{II} = 3 - 4 + \frac{64}{48}$$

$$V_r^{II} = \frac{1}{3}$$

Finally,

$$\Delta_r^{II} = V_1^{II} - V_r^{II} = \frac{5}{12}$$

Again, the first-best solution produces a greater expected value than does the rule-based solution. Even more so, as the difference between c and b increases, the smaller will be the benefit we expect to capture by using the rule over no regulation at all.

4.6 Wasteful Litigation Costs

Up to this point we have assumed that litigation costs are pure transfers and are not wasteful. However, it is interesting to relax this assumption. It is very intuitive that rule-based regulation can produce positive expected values when litigation is a pure transfer – any sort of filtering process should improve expected benefits if it comes without costs. A more pointed question is whether the additional information that litigation provides under rule-based regulation is worth the additional costs. We answer this question by considering a model where litigation costs can be partially or completely wasteful. To do this, we introduce a new variable, t, where $0 < t < 1$ and is the degree to which litigation is wasteful. For example, if $t = 1$, then the litigation is completely wasteful. Doing so, we can rewrite the expected value of regulation resulting from use of the rule:

$$V_{rw} = \int_0^\infty \int_{mL}^\infty (b - c - tL) \cdot g(b)h(c)dbdc \tag{97}$$

Following the same steps as used previously, we arrive at the following value for rule-based regulation under uniform distributions of b and c:

$$V_{rw} = (1 - \frac{mL}{B})(\frac{mL + B}{2} - \frac{C}{2} - tL)$$

Multiplying through and collecting terms:

$$V_{rw} = \frac{mL + B}{2} - \frac{C}{2} - tL - \frac{m^2L^2}{2B} - \frac{mLB}{2B} + \frac{mLC}{2B} + \frac{mtL^2}{B}$$

$$V_{rw} = \frac{B}{2} - \frac{C}{2} - tL - \frac{m^2L^2}{2B} + \frac{mLC}{2B} + \frac{mtL^2}{B} \tag{98}$$

In order to solve for the optimal value of L, we calculate $\frac{\partial V_{rw}}{\partial L}$:

$$\frac{\partial V_{rw}}{\partial L} = -t - \frac{m^2L}{B} + \frac{mC}{2B} + \frac{2mtL}{B} \tag{99}$$

Setting $\frac{\partial V_{rw}}{\partial L} = 0$, we get:

$$\frac{m^2L}{B} - \frac{2mtL}{B} = \frac{mC}{2B} - t$$

$$2m^2L - 4mtL = mC - 2tB$$

$$L = \frac{2tB - mC}{(4mt - 2m^2)} \tag{100}$$

Notice that unlike in Section 4.5, the optimal choice of L depends on the maximum value for benefits, B.

Again, we wish to compare regulation using the rule to first-best regulation. Begin by defining $\Delta_{rw} = V_1 - V_{rw}$. As in Section 4, consider two cases: Case I where $B > C$, and Case II where $C > B$. Implicit in the definition of the first-best solution is that there are no litigation costs. Then, for Case I, the expected value of the first-best solution is that same as given before in equation 89:

$$V_1^I = \frac{1}{2}B - \frac{1}{2}C + \frac{1}{6}\frac{C^2}{B}$$

Then,:

$$\Delta_{rw}^I = \frac{C^2}{6B} + tL + \frac{m^2L^2}{2B} - \frac{CmL}{2B} - \frac{mtL^2}{B} \tag{101}$$

We can compare this result to the one given in equation 95 for Δ_r^I.

$$\Delta_{rw}^I - \Delta_r^I = \frac{C^2}{6B} + tL + \frac{m^2L^2}{2B} - \frac{CmL}{2B} - \frac{mtL^2}{B} - \frac{C^2}{24B} \tag{102}$$

Moreover,

$$\frac{\partial\left(\Delta_{rw}^I - \Delta_r^I\right)}{\partial t} = L(1 - \frac{mL}{B})$$

The value of this derivative is positive whenever $mL < B$, a condition that will always hold. If $mL > B$, then the rule filters out every potential regulation. Recall that smaller values for Δ imply that the rule more closely approximates the first-best solution. Thus, the positive value for $\Delta_{rw}^I - \Delta_r^I$ means that it is harder for a rule-based solution to replicate the first-best solution under a scenario of wasteful litigation than under a scenario of wasteless litigation. The more wasteful the litigation, the less efficient the rule becomes.

4.6.1 Example 3

We continue to use the numbers from Example 1 when $B > C$ (Case I). In addition to the values: $C = 6$, $B = 8$, assume that $m = 4$ and $t = 1$. Then, from equation 100:

$$L = \frac{1}{2}$$

The first-best solution is one without wasteful litigation, so the solution will be the same as calculated previously in equation 94: $V_1^I = \frac{28}{16}$. We can also calculate the value of V_{rw}^I:

$$V_{rw}^I = \frac{B}{2} - \frac{C}{2} - tL - \frac{m^2L^2}{2B} + \frac{mLC}{2B} + \frac{mtL^2}{B}$$
$$= 4 - 3 - \frac{1}{2} - \frac{2}{8} + \frac{6}{8} + \frac{1}{8}$$
$$V_{rw}^I = \frac{9}{8}$$

Then,

$$\Delta_{rw}^I = V_1^I - V_{rw}^I = \frac{28}{16} - \frac{9}{8} = \frac{5}{8}$$

This result says that for the values used above, the first-best solution is better than the rule-based solution by a value of $\frac{5}{8}$ or by 35% percent of V_1. Combining this with Example 1, we know that $\Delta_{rw}^I - \Delta_r^I = \frac{5}{8} - \frac{3}{16} = \frac{7}{16}$. This confirms (for the chosen values of B, C) that wasteful litigation decreases the efficiency of rule-based regulation as compared to wasteless litigation.

4.6.2 Example 4

In our final example, we consider the case where litigation costs are wasteful and $C \geq B$, as in Example 2. This case is of particular interest because this is the most likely case where rule-based regulation will fail. Recall from equation 96 that the expected value of first-best regulation under a Case II scenario is $V_1^{II} = \frac{B^2}{6C}$. Then,

$$\Delta_{rw}^{II} = V_1^{II} - V_{rw}^{II} = \frac{B^2}{6C} - (\frac{B}{2} - \frac{C}{2} - tL - \frac{m^2L^2}{2B} + \frac{mLC}{2B} + \frac{mtL^2}{B})$$

$$\Delta_{rw}^{II} = \frac{B^2}{6C} - \frac{B}{2} + \frac{C}{2} + tL + \frac{mL}{2B}(mL - C - 2tL) \quad (103)$$

To show that V_{rw} can still be positive under these conditions, suppose that $B = 4$, $C = 5$, $m = 4$ and $t = 1$. Then, $L = \frac{3}{4}$ and $V_1^{II} = \frac{16}{30}$. Under these assumptions, $V_{rw}^{II} = \frac{1}{16}$and $\Delta_{rw}^{II} = \frac{113}{240}$.

As we concluded before when litigation costs were not wasteful, Example 4 demonstrates that scenarios exist where the expected value resulting from the use of rule-based regulation is positive and exceeds the expected value of either regulating whenever possible or not at all. Thus, we show that even when litigation costs are wasteful and when the expected value of the average regulation is negative, rule-based regulation can be a superior alternative to the choices listed earlier and generate a positive expected value.

4.7 Conclusion

In this chapter, we have shown that litigation may help a government agency make a more efficient choice when faced with little information regarding either the costs or benefits of a potential regulation. We have also shown that the existence of free riders allows the government to infer a greater net benefit associated with the regulation than if no free riders. This allows the government to set the threshold litigation costs lower than if the free rider problem did not exist.

We conclude that although a rule-based solution can only approximate the first-best solution, it is often a better alternative than issuing every regulation or issuing no regulations at all. This holds regardless of the fact that the efficiency of rule-based regulation decreases as litigation becomes more wasteful. Finally, because litigation is necessary for a rule-based solution to be used, expected benefits to regulation can be greater under a scenario with litigation than under a scenario without wasteful litigation.

Chapter 5: Conclusion

A vast literature in environmental economics is devoted to the discussion of whether it is more efficient to use a price or quantity instrument to achieve a desired effect. Inherent in these models is the assumption that the government can enact its choice of policy without hindrance from outside parties. However, this assumption is rarely true, and eschews an important aspect of government decision-making. In fact, many government regulations are subject to legal challenges and are not enforced unless the regulation survives the challenge. The likelihood that a regulation will be challenged depends on the amount of discretion granted to the agency in charge of enforcing it.

How a regulation is written into law affects how much discretion an agency is granted. The legislation can be broadly written and give the agency substantial discretion regarding how the regulation is to be enforced. Such discretion enables the agency to use analytical tools to determine exactly how and when the regulation should be enforced, increasing efficiency. In contrast to the actions of the legislature, the decisions of an agency are more easily challenged and result in greater amounts of litigation.

Alternatively, the legislation can be strictly written and give the agency little opportunity to enforce the regulation as it sees fit. If the legislature does not grant the agency much discretion, it is difficult for parties to challenge the regulation. But without the ability to decide which regulations should be promulgated, the agency will issue regulations whose costs exceed their benefits.

This thesis has shown that litigation can substantially affect a government's decision regarding when and how to regulate. One such way is that litigation affects the amount of discretion a legislature is willing to grant an agency. As discussed above, discretion allows an agency to make more informed and efficient decisions regarding which regulations to issue, but it also increases the scope of potential legal challenges, thereby raising the litigation costs the agency is likely to face. As litigation costs become more substantial, it becomes less advantageous for the legislature to grant discretion, regardless of any efficiency gain associated with discretion. Whether or not discretion is worth this additional price depends on the distribution of costs and benefits among potential regulations. This means we should expect the agency to have greater discretion over regulations with smaller costs. The smaller are costs, the lower the incentive for private firms to litigate.

Litigation also affects the behavior of an agency that has been granted discretion. We find that although discretion allows an agency to identify the most efficient regulations, the resulting increase in litigation reduces the number of regulations that it will adopt. The model presented in this thesis assumes that the probability the agency successfully enforces a regulation depends on the amount it spends on litigation defending its decisions. Non-convexities in the probability function, such as fixed litigation costs and diminishing returns to litigation, mean that the agency will devote substantial resources to any regulation it chooses to defend. The agency will never spend a small amount defending a given regulation, preventing it from defending the optimal number of regulations.

However, litigation can sometimes help an agency make better decisions. When an agency is unable to obtain all of the information it needs to regulate efficiently, litigation costs can act as a proxy for that information. When an interested party such as an NGO sues the agency for failing to act, the agency can infer that social benefits are at least as large as the litigation costs borne by the party. Furthermore, free riders increase the agency's estimate of net benefits. If the agency knows that there are free riders, then it can infer that social benefits are substantially greater than the private costs incurred by the NGO.

Thus, there are important choices at different levels of the government. The legislature, knowing that discretion can yield more efficient regulation, might decide that it is worth the increased costs. Discretion, and thus litigation, is most useful when the government has little information regarding the costs and benefits of potential regulations, and when mistakes are most costly. Once an agency has been granted discretion, it has to decide how to use it. As is modeled in Chapter Three, it can use its litigation budget to defend the regulations with the greatest net benefits. Alternatively, it might infer the benefits of potential regulations from the litigation costs incurred by private parties and use that information to decide which regulations should be promulgated as discussed in Chapter Four.

There are several directions for further research, both empirical and analytical. One possibility would be to test the model in Chapter Two empirically. It would be possible to look at the historical record of different government agencies to compare the amount of discretion each agency was granted with the amount of litigation the agency faced. We would expect to see that regulations with greater discretion resulted in greater amounts of litigation.

The model in Chapter Two could also be extended by incorporating the litigation and probability constraints that are introduced in Chapter Three. The existing model assumes that the agency can afford to defend every regulation it promulgates and that it will do so successfully. Relaxing these assumptions would make granting the agency discretion even less attractive for the legislature.

Another possibility for future research is to introduce strategic behavior on behalf of the agents. In the current model, we assume that the probability that the agency successfully defends the regulation is a function of its litigation expenditures alone. However, the regulated industry also has a vested interest in winning the challenge. An interesting extension would be for the probability that the agency wins the challenge to also reflect other variables such as the amount that other parties spend on litigation and the merits of the case.

One way to examine the impact of introducing strategic behavior is by considering how a loser-pays system affects the models in Chapters Three and Four. Introducing a loser-pays system will force us to consider how the industry would react and spend on litigation. Considering strategic behavior on the part of the agents would result in a game-theoretic model. Therefore, we will need to find the equilibrium. An important result of Chapter Three is that the amount that the agency spends on litigation is entirely dependent on the probability function. Because industries are likely to spend more challenging regulations with higher costs, we expect to see that the agency will focus on defending regulations with lower costs rather than regulations with higher benefits.

We could also examine how a loser-pays system affects the model built in Chapter

Four. In that model, the government is always the loser of the challenge. In fact, the agency does not really want to win the challenge. But if the agency loses every challenge, then NGOs will not incur any litigation costs and there is no credible threat to deter NGOs from suing when benefits are low. The agency needs to successfully defend itself against a sufficient number of challenges such that the expected litigation cost to the NGO is sufficient to filter out the good regulations from the bad.

The results of this thesis show that it is not surprising that Congress has often granted little discretion to agencies such as the EPA. Although it seems inefficient that the EPA promulgates regulations without considering their costs, net social benefits would be less if it did. In fact, this thesis shows that the legislature should not allow agencies such as the EPA to use cost-benefit analyses more often. Not only does such discretion result in greater amounts of wasteful litigation, but it also prevents the agency from promulgating regulations that clearly increase social net benefits.

This thesis also shows why Congress is unwilling to grant immunity from legal challenges when it grants discretion to an agency. Under the right circumstances, litigation can provide the agency with more information than it could obtain than if there were no litigation at all.

Figures

Figure 1

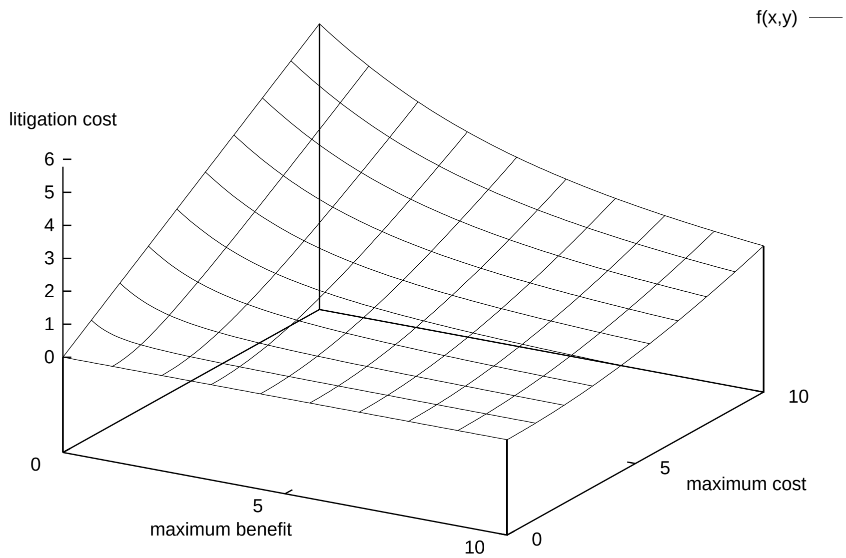

Figure 2

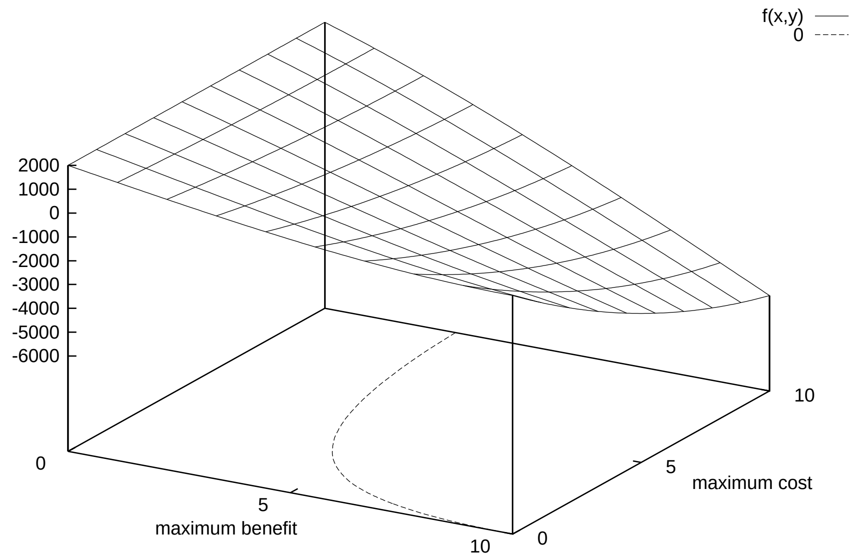
f(x,y)
0
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
0
5
maximum benefit
10
0
5
maximum cost
10

Figure 3

$\pi = f(L)$

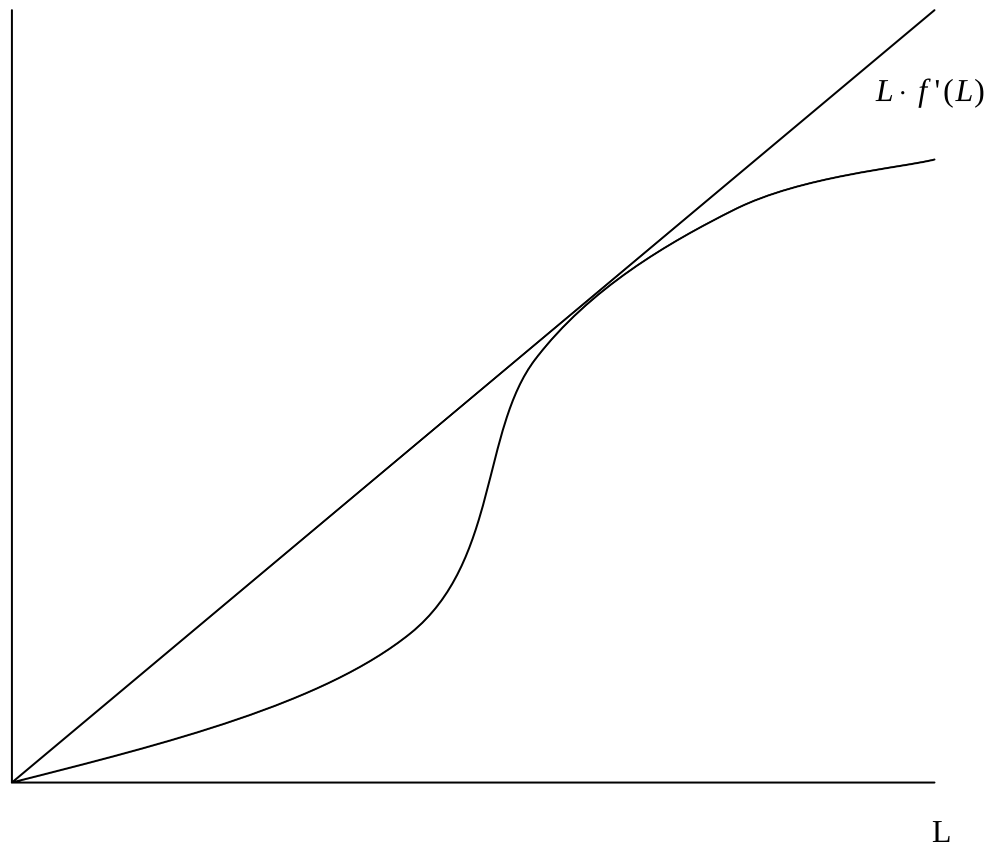

Figure 4

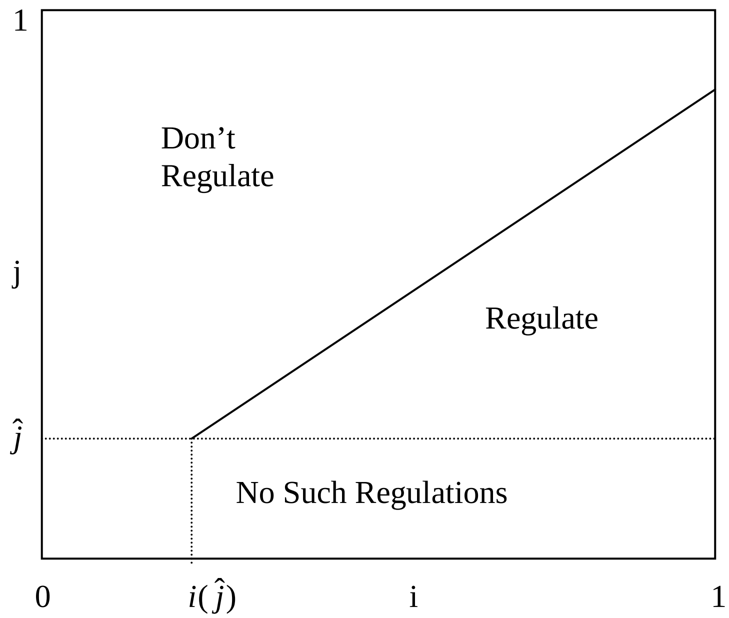

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Figure 5

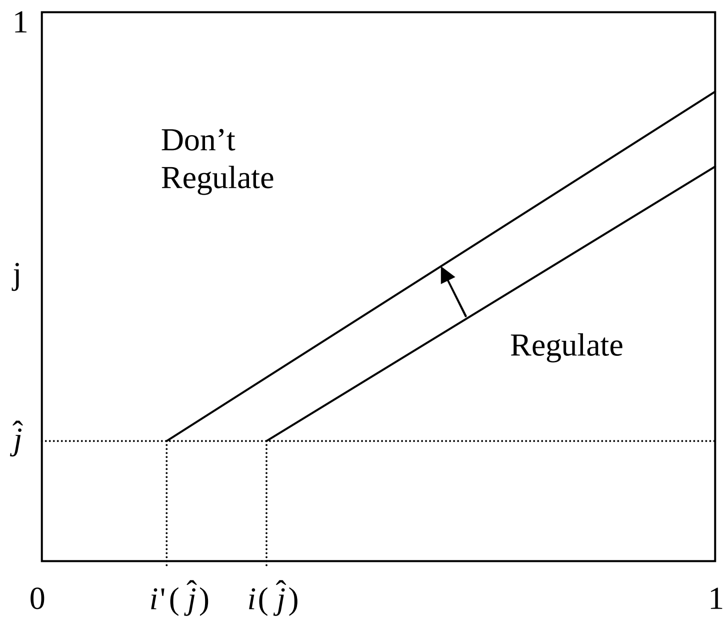


Figure 6

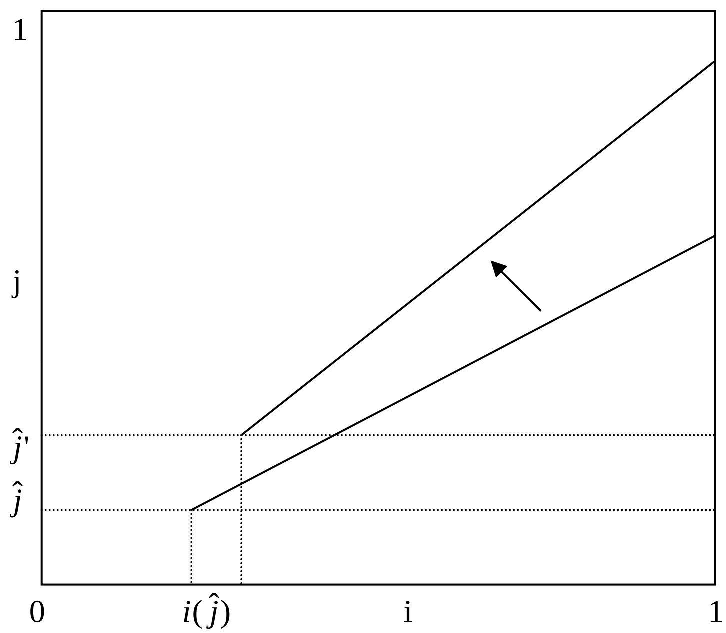


Figure 7

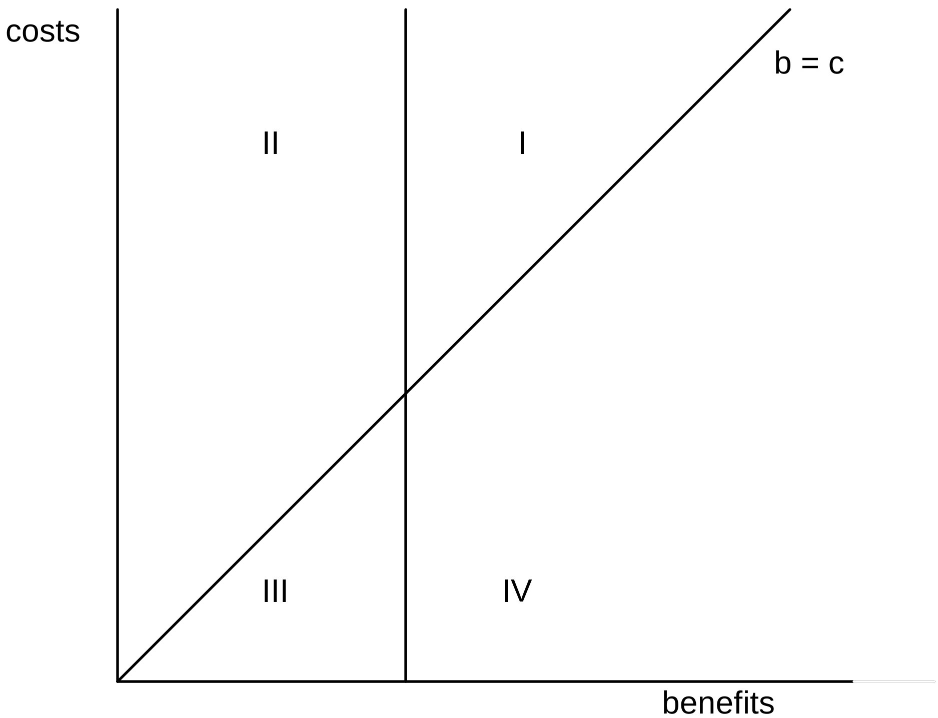


Figure 8

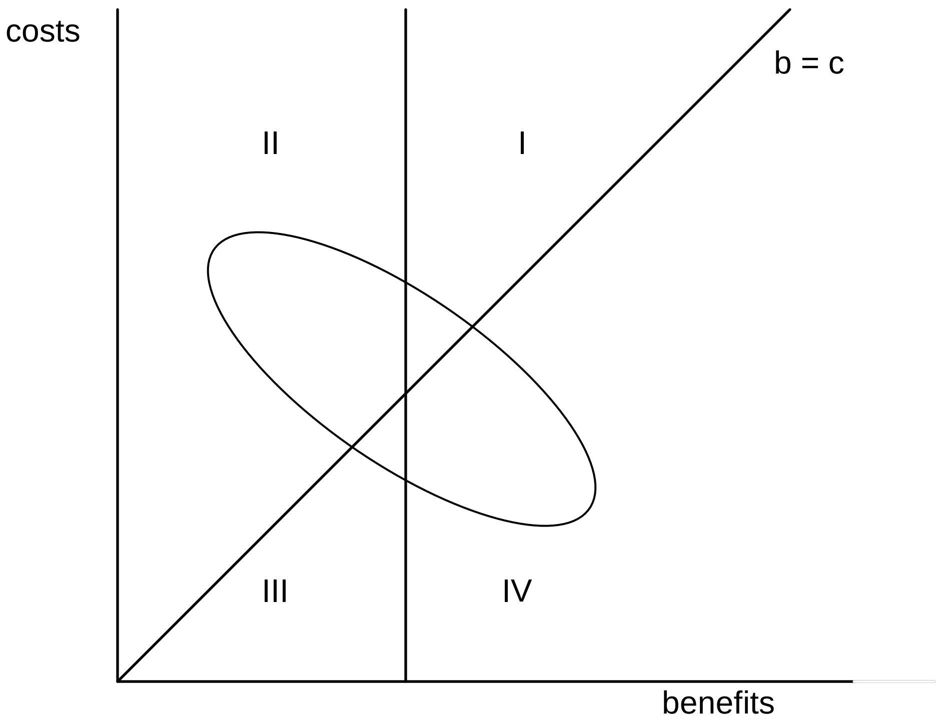
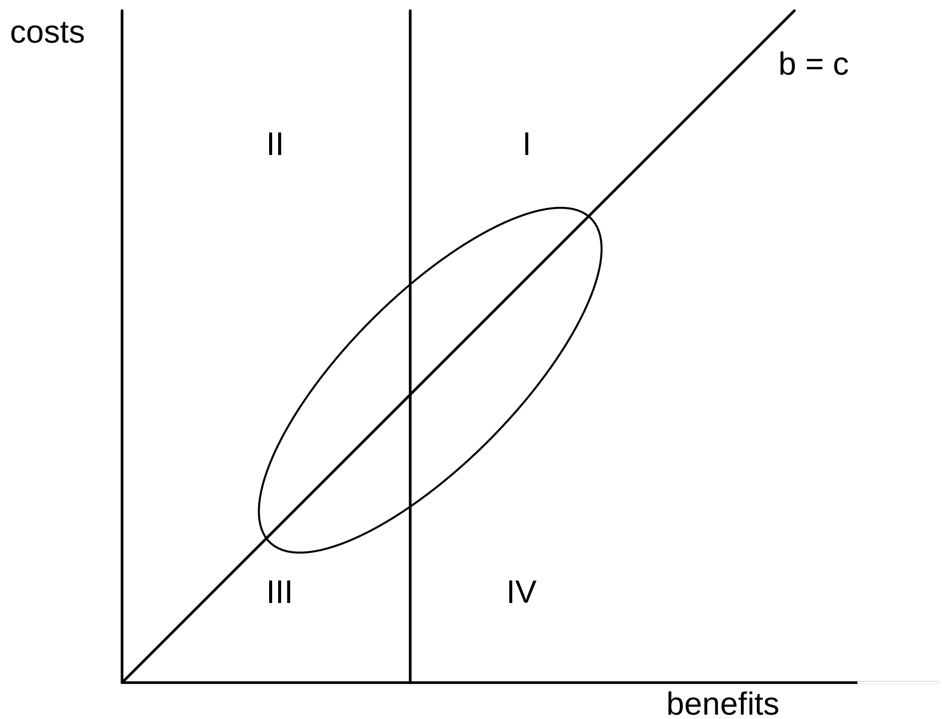


Figure 9



Appendix A

Suppose that there exist N identical regulations with identical costs. Then, the agency seeks to maximize the Hamiltonian:

$$V = \sum_{i=1}^{N} B_i \cdot f(L_i) + \lambda \left(C - \sum_{i=1}^{N} L_i \right)$$

The partial derivatives are

$$\frac{\partial V}{\partial L_i} = B \cdot f'(L_i) - \lambda = 0 \tag{104}$$

$$\frac{\partial V}{\partial L_j} = B \cdot f'(L_j) - \lambda = 0 \tag{105}$$

Setting equations 104 and 105 equal to each other, we get:

$$B \cdot f'(L_i) = B \cdot f'(L_j)$$

$$f'(L_i) = f'(L_j) \tag{106}$$

If we assume that $f(L_i) = f(L_j)\ \forall i, j$, then $L_i = L_j$. For example, suppose that:

$$f(L_i) = 1 - \frac{\gamma}{L_i} \tag{107}$$

and

$$f(L_j) = 1 - \frac{\gamma}{L_j} \tag{108}$$

Then the first order conditions are:

$$f'(L_i) = -\frac{\gamma}{L_i^2} \tag{109}$$

and

$$f'(L_j) = -\frac{\gamma}{L_j^2} \tag{110}$$

So, equation 106 becomes:

$$-\frac{\gamma}{L_i^2} = -\frac{\gamma}{L_j^2} \tag{111}$$

or

$$L_i = L_j \tag{112}$$

Thus, if all regulations have identical probability functions, benefits and marginal costs, then the result will be that agency will spend the same amount defending each regulation.

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