July 2009

Optimal Compensation for Regulatory Takings

Paul Pecorino*
Department of Economics, Finance and Legal Studies
Box 870224
University of Alabama
Tuscaloosa, AL 35487
E-Mail: ppecorin@cba.ua.edu

Abstract

One argument for forcing governments to pay compensation for regulatory takings is that they will tend to over regulate if compensation is not paid. In this paper, a model is developed in which there are two groups in society, one of which bears all of the costs of regulation. Regulation provides (potentially unequal) benefits to both groups. In the absence of compensation, a biased government will not choose the efficient level of regulation. If taxes are non-distorting, a compensation rule can be designed to achieve the first best outcome. The optimal rule always involves a positive degree of compensation regardless of the direction of the government bias. If the government is biased in favor of the regulated group, then compensation will increase the level of the regulation. When taxes are distortionary, the first best outcome cannot be achieved, and the optimal level of compensation may be 0.

JEL classification: K2, H4, D72

Keywords: Takings, Regulation, Compensation

*I would like to thank participants at the 2009 Public Choice Society Meeting and the 2009 American Law and Economics Association Meeting for providing helpful comments on this paper.

1. Introduction

When a governmental regulation imposes costs on a subset of society, should compensation be paid, and if so, how much? This question has been the subject of a long line of Supreme Court cases, including Lucas v. South Carolina, a 1992 case where the court ruled that compensation should be paid when a regulation deprives an individual of essentially all uses of his property.[1] Epstein (1985) makes a broad case that compensation should be paid for regulations that impose costs greater than any off-setting benefits received by the affected parties. Epstein (2007: 744) argues that governments will tend to over regulate if compensation is not paid. This constitutes an important efficiency argument for compensation which is distinct from issues of justice or fairness. In this paper, I investigate the efficiency effects of requiring a government to pay compensation for regulatory takings.

I develop a model in which there are two groups in society, one of which bears all of the costs of regulation. Regulation provides a public good which potentially benefits both groups, and in addition members of both groups are taxpayers. The government sets the level of the regulation, while its welfare function potentially exhibits a bias against one of the two groups. In the absence of compensation, a biased government will not choose the efficient level of regulation. If taxes are non-distorting, a compensation rule can be designed to achieve the efficient outcome. The optimal rule involves a positive degree of compensation regardless of the direction of the government's bias. When the government is biased in favor of the regulated group, a positive degree of compensation will increase the level of regulation. When taxes are distortionary, the first best outcome cannot be achieved, and the optimal level of compensation may be 0.

[1] Epstein (1985) provides a book length treatment of the takings issue, while Miceli and Segerson (1996) is a book length treatment of regulatory takings in particular. These books along with Claeys (2003) and Brennan and Boyd (2006) provide an extensive discussion of court rulings on the takings issue.

The optimal level of compensation depends upon the preferences for the public good exhibited by the two groups. Net compensation (compensation net of tax payments) is 100% only if the regulated group receives no benefit from the regulations. In all other cases, the net compensation received is less than 100%. Gross compensation, however, may exceed 100%. If all the benefits of regulation are captured by the regulated group, then no compensation is paid under the optimal rule.

When taxes are nondistortionary, the optimal level of compensation is independent of the degree of government bias. When taxes are distortionary, the optimal degree of compensation will depend on the degree of government bias, and in particular, the optimal degree of compensation will be zero if the government bias is small. When the degree of bias is small, the government will choose a level of regulation which is close to optimal, even in the absence of compensation. In addition, since compensation is not paid, the distortionary effects of taxation can be avoided. However, if the degree of bias is sufficiently large, the optimal level of compensation becomes positive.

2. Previous Literature

The literature on regulatory takings is intertwined with the literature on compensation for the physical taking of property. Epstein (1985) argues forcefully that regulatory takings should be treated on a par with physical takings of property and that compensation should be paid for regulatory takings unless the regulation provides substantial in-kind benefits to the regulated parties.[2] One argument made in favor of compensation is that the government will tend to over regulate in the absence of compensation. In particular, it has been argued that the government

[2] By contrast, Sax (1964, 1971, 1993) takes a more limited view of the circumstances under which compensation should be paid.

will put insufficient weight on the losses suffered by the regulated group if it is not forced to pay compensation to this group. This is described as the government suffering from "fiscal illusion". Blume, Rubinfeld and Shapiro (1984), Miceli and Segerson (1994) and others have considered models in which the government has fiscal illusion.[3]

The behavior of the government has been one area of concern in the takings literature, but there has also been a major focus on the investment behavior of the individuals whose property may be subject to a government taking. If full compensation is paid, these individuals may have the incentive to overinvest on their property, knowing that the investment amount will be fully refunded if the government takes the land. Thus, Blume, Rubinfeld and Shapiro (1984) conclude that zero compensation is optimal if the government's decision to take the land is independent of its current use. If the government suffers from fiscal illusion, a lump sum compensation is optimal, because this will not distort the investment incentives of the landowners.

Miceli and Segerson (1994) develop optimal compensation rules which are analogous to optimal liability rules in tort law. Under their ex ante rule, the regulated party is compensated if she engaged in the efficient level of investment on her property and suffered a loss due to a taking. Under the ex post rule, the government pays compensation only if its regulation is inefficient.

Fischel and Shapiro (1989) consider the compensation rule that would be chosen behind a veil of ignorance in anticipation of future government behavior. If the future government will behave in a majoritarian manner, partial compensation is found to be optimal. This compensation balances the majoritarian government's tendency to seize too much land against the landowners' incentive to invest too much on land which might be seized. Hermalin (1995) also assumes a

[3] An additional role for government compensation may be that of insurance. If individuals are risk averse, then compensation can provide a form of insurance against losses incurred due to government regulatory policy. See Blume and Rubinfeld (1984).

majoritarian government. He derives an efficient compensation rule, which requires that compensation be equal to the social gains from the taking.[4]

My paper focuses on three aspects of the takings issue. First, there is a potentially biased government which, in the absence of compensation, will not generally choose the optimal level of regulation. Second, both the regulated and the unregulated groups potentially benefit from the public good generated by the regulation, but the preferences for the public good may differ across these two groups. The optimal level of compensation varies with differences in the preference intensity for the public good across these two groups. Third, I allow for distortionary taxation. In focusing on these three issues, I ignore others. Most notably, I do not consider investment decisions on the part of the regulated group. Thus, the possible overinvestment problem which has been identified in the literature is not present in my model. Secondly, I do not consider issues of fairness or justice, but rather focus solely on the efficiency of compensation.

The approach in my paper bears a resemblance to that of Brennan and Boyd (2006). As in their paper, I model a potentially biased government whose welfare is a function of the underlying utilities of the different groups in society. In Brennan and Boyd, landowners, environmentalists (the beneficiaries of regulation) and tax payers constitute disjoint groups. By contrast, in my model, both the regulated and unregulated pay taxes and both may derive (potentially unequal) benefits from the regulation.[5] My model includes distortionary taxation, as does Brennan and Boyd, but they consider compensation schemes such that zero compensation is

[4] In addition to the papers discussed above, other papers in the takings literature include Innes (1997, 2000), Tideman and Plassmann (2005), Niemann and Shapiro (2008), and Miceli (2008).

[5] Brennan and Boyd often resort to special cases in their analysis. In particular, a fair bit of the analysis addresses cases in which the government puts no weight on the well being of one of the three groups.

actually paid in equilibrium.[6] I assume that positive compensation will be paid and therefore distortionary taxation plays a different role in my model compared with theirs.

3. The Model

There are two groups of individuals in society, with N_1 individuals in group 1 and N_2 individuals in group 2. In section 3.1, I will discuss the utility functions of individuals in these two groups. Individuals in group 1 bear all of the costs of regulation, while both groups potentially benefit from regulation. There are two levels of government, where the level 2 government sets the level of a regulation R and the level 1 government sets the percentage of losses k that the level 2 government needs to pay group 1 as a result of imposing R. In section 3.2, I will analyze the level 2 government's problem in choosing R, taking the percentage of compensation k as given. In section 3.3, I will analyze the level 1 government's choice of k.

There are a variety of possible interpretations of the two levels of government presented in the model. The level 1 government could be a federal government imposing compensation rules on the level 2 government which could be interpreted as a state or local government. Alternatively, the level 1 government could represent a constitutional convention attempting to bind future (possibly federal) governments. Lastly, the level 1 government could be the court system in a common law system attempting to impose efficient legal rules on the level 2 government. As we will see, one problem with the constitutional interpretation is that it would be

[6] In their model, optimal rules are set up to create incentives at the margin, but then the level of compensation is adjusted so that no compensation is actually paid in equilibrium. This implies out of equilibrium behaviors for which negative compensation is paid. Something similar could be accomplished in my model if the compensation function had a negative intercept, while being an increasing function of the degree of regulation. If the intercept is sufficiently negative, the government will never pay positive compensation, but the marginal incentives would be in place, because increases in regulation would reduce how much it takes from the regulated group. This is both highly unrealistic and very much at odds with the spirit of Epstein (1985).

very difficult to specify a simple rule which would be optimal for the range of parameter values which we might expect to observe.

Regardless of the interpretation, it should be understood that the determination of the optimal value of compensation is a normative exercise. While I allow that the level 2 government may be biased, I assume the level 1 government is unbiased, because my purpose is not to make positive predictions about the actual level of compensation that will be set, but rather to engage in the normative exercise of determining the optimal level of compensation. There is no presumption that the real world counterpart to the level 1 government actually would act to maximize social welfare.

3.1. Individual Utility Functions

Individuals in group 1 bear all the cost of the regulation R, where the cost of regulation is reflected by decreases in the wealth of group 1. Thus we have $W_1(R)$, where W_1 is the wealth of a member of group 1 and $R \geq 0$ is the level of the regulation.[7] I assume that and $W_1' < 0$ and $W_1'' < 0$, where the prime superscripts denote the first and second derivatives respectively. Thus, as the level of the regulation increases, wealth decreases at an increasing rate. Wealth for members of group 2, W_2 is not affected by R. Regulation provides a pure public good, but members of the two groups may place different weights on this public good. This benefit is denoted $B_1N_1P(R)$ for group 1 and $B_2N_1P(R)$ for group 2, where $P'(R) > 0$ and $P''(R) < 0$. The terms $B_1 > 0$ and $B_2 > 0$ reflect the intensity of preference for the public good in the two groups. Notice that for both groups, the term $P(R)$ is multiplied by N_1. This reflects the idea that the benefit of the public good is larger when the regulated group is larger. This assumption is <u>not</u>

[7] The parameter W reflects the level of wealth prior to the levying of taxes and the payment of transfers. Below, individual wealth will be adjusted to account for these factors.

critical. The results of the paper would continue to hold under the alternative assumption that the benefit to an individual in group *i* is $B_iP(R)$.

In the absence of compensation for regulation, utility for the two groups is

$$U_1 = W_1(R) + B_1N_1P(R), \text{ and} \tag{1a}$$

$$U_2 = W_2 + B_2N_1P(R). \tag{1b}$$

The loss to group 1 from a regulation *R* is $W_1(0) – W_1(R)$, where $W_1(0)$ is the level of wealth in the absence of regulation . Let the individual level of compensation be $k(W_1(0) – W_1(R))$, where $k \geq 0$. Thus, in choosing *k* we are choosing the percentage of the loss which is compensated. We can have $k > 1$, but for reasons discussed below, negative values of *k* are ruled out.

Compensation needs to be financed via taxation. Let the net tax per person in group 1 be T_1 and the net tax person in group 2 be T_2. I assume that taxes are distortionary so that when 1 unit of resources is raised via taxation on net, the taxed party loses $1+\delta$ units of resources.[8] Thus allowing for compensation and taxation, the utilities of the members of group 1 and 2 become

$$U_1 = W_1(R) + k(W_1(0) – W_1(R)) – T_1(1+\delta) + B_1N_1P(R), \text{ and} \tag{2a}$$

$$U_2 = W_2 – T_2(1+\delta) + B_2N_1P(R). \tag{2b}$$

Note that individuals are passive in this model. They simply take the level of *R* as given by the level 2 government and experience the utility as indicated by (2).

Group 1 members are taxpayers. As taxpayers, they will foot part of the bill for compensation that they themselves will receive. Of course, if group 1 is very small, then this will

[8] In addition to the effect of taxation on deadweight losses, the parameter δ may also reflect administrative costs. Distortionary taxes are considered by Innes (2000) and Brennan and Boyd (2006). Miceli (2008) considers a property tax and analyzes how it may induce property owners to undertake the optimal level of investment on their property, when there is some probability that their property will be taken via eminent domain.

constitute a negligible portion of the compensation. If group 1 is large, then a significant portion of the compensation they receive will be paid via taxes they pay. Because members of group 1 are taxpayers, it is worth distinguishing net compensation from gross compensation:

$$\text{Net Compensation} = k(W_1(0) - W_1(R)) - T_1(1+\delta), \qquad (3)$$

where $k(W_1(0) - W_1(R))$ is gross compensation.

The mathematics of this model makes sense as long as $k \geq 0$. If $k < 0$ there is a negative compensation payment, and the model implies that a payment is extracted in a nondistortionary way from group 1, the regulated group. This payment is then used to reduce distortionary taxes. As a result, each dollar of negative compensation raises available resources by $1 + \delta$ units. This is clearly unrealistic. Thus, if an optimal solution appears to calls for $k < 0$, this will be considered a corner solution where $k = 0$.

3.2. Level 2 Government

The level 2 government chooses R to maximize

$$G_2 = N_1U_1(R) + \theta N_2U_2(R), \qquad (4)$$

where $\theta \geq 0$, and U_1 and U_2 are given by (2). The level 2 government takes k (determined by the level 1 government) as given. If $\theta = 1$, the level 2 government is unbiased, while $\theta > 1$ implies a bias towards group 2 and $\theta < 1$ implies a bias towards group 1. While it is not explicitly modeled, the bias term in equation (4) could result from a game in which groups 1 and 2 lobby the level 2 government.[9]

[9] See, for example, Baldwin (1987) and Grossman and Helpman (1994).

The second level government must pay $k(W_1(0) - W_1(R))$ to group 1 members, where k is mandated by the level 1 government. In order to pay this compensation it must levy taxes which satisfy

$$N_1T_1 + N_2T_2 = N_1k(W_1(0) - W_1(R)). \tag{5}$$

I assume that the level 2 government cannot directly redistribute income between the two groups, except via the compensation payments which are mandated by the level 1 government. Instead, any bias exhibited by the level 2 government must be exhibited through the choice of R. Allowing the government to have additional instruments through which it can redistribute welfare across the two groups would raise some interesting issues, but would distract from the main purpose of this paper.[10] As part of the assumption that redistribution is not possible (outside the choice of R), I will assume that $T_1 = T_2$. From (5) we have

$$T_1 = T_2 = \frac{N_1 k}{N_1 + N_2}\left(W_1(0) - W_1(R)\right). \tag{6}$$

Substituting (2) and (6) into (4), the first and second order conditions to the level 2 government's maximization problem may be expressed as follows: [11]

$$-W_1' = \frac{\left(N_1B_1 + \theta N_2B_2\right)\left(N_1 + N_2\right)}{\left(N_1 + N_2\right) + k(\theta - 1)N_2 + k\delta\left(N_1 + \theta N_2\right)}P'(R), \tag{7}$$

$$\left(N_1B_1 + \theta N_2B_2\right)\left(N_1 + N_2\right)P''(R) + \left(N_1 + N_2\right) + k(\theta - 1)N_2 + k\delta\left(N_1 + \theta N_2\right)W_1'' < 0. \tag{8}$$

[10] One interpretation of the level 2 government is that it is a local government. Local government's tend to have a limited ability to redistribute income. In a separate research paper, I am currently conducting an analysis of optimal compensation for regulatory takings when the level 2 government can use the tax system to redistribute income between the two groups. When such redistribution is possible, the level 2 government may be able to undo the effects of a mandated compensation payment.

[11] Denote the coefficient on $P'(R)$ on the right-hand side of (7) as A. There will be an interior equilibrium with a positive level of regulation if $AP'(0) > -W_1'(0)$. I will assume that this condition holds in what follows. The conditions on the W and P functions guarantee that the interior equilibrium is unique.

One key comparative static is the effect of changes in the required rate of compensation *k* on the level of the regulation *R*. From equation (7), we can compute d*R/dk*:

$$\frac{dR}{dk} = \frac{W_1'((1-\theta)N_2 - \delta(N_1 + \theta N_2))}{(N_1B_1 + \theta N_2B_2)(N_1 + N_2)P''(R) + (N_1 + N_2) + k(\theta - 1)N_2 + k\delta(N_1 + \theta N_2)W_1''} \quad (9)$$

By the second order condition, the denominator of (9) is negative, while W_1' is also negative. Thus,

$$\text{Sign } dR/dk = \text{Sign } [(1-\theta)N_2 - \delta(N_1 + \theta N_2)] \quad (10)$$

Result 1 follows immediately from (10):

Result 1: (i) $dR/dk < 0$ if and only if $(1-\theta)N_2 - \delta(N_1 + \theta N_2) < 0$.

(ii) A bias towards group 2 ($\theta>1$) is sufficient for $dR/dk < 0$.

(iii) If the tax distortion is 0 ($\delta = 0$), $dR/dk > 0$ whenever there is a bias towards group 1 ($\theta < 1$).

Interestingly, when there is a sufficient bias towards group 1 (the regulated group), raising the percentage of compensation can raise the level of the regulation.[12] The reason is that when *k* increases, more of the benefit of the regulation is being transferred from the disfavored group (group 2) towards the favored group (group 1). When taxes are nondistortionary there is no presumption on the sign of *dR/dk*, because there is no presumption on whether θ is greater than or less to 1. However, when $\delta > 0$, there is some presumption that $dR/dk < 0$. When taxes

[12] Brennan and Boyd (2006: 196) also have a result along these lines. Also see Polasky, Doremus and Rettig (1997) who argue that paying compensation to landowners will enhance endangered species protection by removing some perverse incentives landowners face regarding the conservation value of their land.

are distortionary, the second level of government tends to reduce R when k increases so as to avoid having to levy distortionary taxes with which to finance the compensation. However, if θ is sufficiently below 1, we may still observe $dR/dk > 0$.

Note that if $\delta > 0$ and N_1 is large relative to N_2, that the expression in (10) will tend to become negative. Compensation is not very effective in this case, because it is largely financed by group 1, the group receiving the transfer. Thus, the government imposes a cost of 1+δ units of resources on group 1 in order to transfer 1 unit of resources back to group 1. This makes a high level of regulation unattractive.

3.3. Level 1 Government

In modeling the level 2 government, I allowed for a possible bias on the part of the government, however, it will be assumed that the level one government attempts to maximize social welfare. Thus, the following analysis should be considered normative in nature.

The level 1 government chooses k to maximize social welfare, but in so doing recognizes the tax distortions associated with paying compensation for regulatory takings. Thus, the objective function for the level 1 government is

$$G_1 = N_1U_1 + N_2U_2 = N_1(W_1(R) + B_1N_1P(R)) + N_2(W_2 + B_2N_1P(R)) - \delta kN_1[W_1(0) - W_1(R)], \quad (11)$$

where U_1 and U_2 are defined by equation (2) and taxes are given by equation (6). The level 1 government maximizes (11) with respect to its choice of k, subject to the first-order condition of the level 2 government in equation (7). We may express dG_1/dk as follows:

$$dG_1 / dk = N_1([W_1'(R)(1+\delta k) + (N_1B_1 + N_2B_2)P'(R)][dR/dk] - \delta N_1[W_1(0) - W_1(R)]). \quad (12)$$

The first order condition for an interior maximum requires that $dG_1/dk = 0$, but we are not guaranteed that there will be an interior maximum.

Before considering the general case, it is worth examining the special case where taxes are nondistortionary ($\delta = 0$). When $\delta = 0$, there is a unique interior optimum where

$$-W_1'(R) = (N_1 B_1 + N_2 B_2) P'(R)\,. \tag{13}$$

If we multiply both sides by N_1, then (13) equates the marginal cost of regulation to the marginal benefit in an expression which is standard in public goods models. The level of R which is derived from (13) is the first best level of regulation R^F. From equation (7), we can derive the relationship between the actual and optimal levels of regulation in the absence of compensation ($k = 0$). In particular, when $k = 0$, $R > R^F$ when $\theta > 1$, $R = R^F$ when $\theta = 1$, and $R < R^F$, when $\theta < 1$. Thus, absent compensation, there is no presumption as to whether the regulation will be above or below (or right at) its optimal value.

The problem for the level 1 government is to find a value of k such that the first order condition for the level 2 government in equation (7) matches the condition in (13). Keeping in mind that $\delta = 0$, equations (7) and (13) will match if

$$k = \frac{B_2(N_1 + N_2)}{(B_1 N_1 + B_2 N_2)} \tag{14}$$

The value of k in (14) allows the level 1 government to achieve its first best outcome. This is summarized as follows:

Result 2: When taxes are nondistortionary ($\delta = 0$), the rate of gross compensation $k = B_2(N_1 + N_2)/(B_1 N_1 + B_2 N_2)$ achieves the first best outcome, R^F.

There are several things to notice about the optimal value of k in (14). First, while there is a nonnegativity constraint placed on k, this is not binding in equation (14); the optimal value of k is always greater than or equal to 0. Second, the optimal value of k is independent of the degree of bias exhibited by the level two government. Third, k is greater than 1 if $B_2 > B_1$ and less than 1 if $B_2 < B_1$. Moreover, k is monotonically increasing in the ratio B_2/B_1; the more that the public good benefits group 2 relative to group 1, the greater the compensation to group 1 from bearing the burden of the regulation. The maximum value of k occurs when B_1 equals 0. Note that in this case, k is the inverse of group 2's population share. If group 1 is negligible, then gross compensation is 100%. However, if group 2 is 50% of the total population, the optimal level of gross compensation is 200%.

Using the definition of net compensation in (3), while noting that $\delta = 0$, we find that

$$\text{Net Compensation} = \left(\frac{B_2 N_2}{B_1 N_1 + B_2 N_2}\right)\left(W_1(0) - W_1(R)\right). \tag{15}$$

Thus, under the optimal compensation scheme, group 2 pays group 1 a fraction of the cost imposed on group 1, where this fraction ($= B_2N_2/(B_1N_1+B_2N_2)$) reflects the percentage of the benefits of the regulation captured by group 2. Conversely, group 1 bears a proportion of the costs equal to their percentage of the benefit from the regulation ($=B_1N_1/(B_1N_1+B_2N_2)$) The optimal value of net compensation ranges between 0 and 100%. If all the benefits of the regulation are captured by group 2 ($B_1 = 0$), net compensation is 100%, while if all the benefits of regulation are captured by group 1 ($B_2 = 0$), net compensation equals 0.[13]

[13] This is entirely consistent with Epstein's (1985) analysis. He argues that compensation need not be paid if the regulation provides substantial in-kind benefits to the regulated parties and more generally that benefits received by the regulated party reduce (but may not eliminate) the need for compensation. In particular, see his chapter 14.

This analysis is summarized as Result 3:

Result 3: When taxes are nondistortionary ($\delta = 0$):

(i) The optimal level of compensation is independent of the degree of bias on the part of the level 2 government.

(ii) The optimal level of gross compensation is greater than 100% of the loss suffered by group 1 members if $B_2 > B_1$ and less than 100% if $B_2 < B_1$.

(iii) The optimal percentage of gross compensation is monotonically increasing in the ratio B_2/B_1.

(iv) The optimal level of net compensation is between 0% and 100% of the loss and is given by $B_2N_2/(B_1N_1 + B_2N_2)$.

The optimal level of compensation determines a price paid by each group in order to obtain the regulation. This price reflects the proportion of the benefit received by the group. Once this price is set correctly, we obtain the optimal level of the regulation, regardless of the degree of bias of the level 2 government. The fact that the optimal level of compensation is independent of the degree of bias θ lowers the informational burden of the level 1 government in setting an optimal value of k. By contrast, the fact that the optimal value of compensation varies with the preference parameters B_1 and B_2 indicates that simple rules would be difficult to specify ex ante as we would expect these parameters to vary based on the type of regulation. Thus, compensation would have to be evaluated on a case-by-case basis. If $B_1 = B_2$ seems like a reasonable benchmark, it is worth noting that the gross compensation percentage is 100% ($k = 1$) in this case.

It might be useful to discuss some examples and how they would (roughly speaking) correspond to different relative values of B_1 and B_2.[14] Consider a group of landowners who cannot develop their land due to the presence of an endangered species. It is possible that these landowners care relatively little about protecting the species in question. In this case, 100% net compensation would be appropriate. [15] On the other hand, a regulation which ensures better water quality might better be described by $B_1 = B_2$, since benefits should be fairly widely (and evenly) spread in this instance. As a result, 100% gross compensation would be appropriate. Finally, consider an historic district designation. While the associated regulations impose costs on individual landowners, the collective effect of these regulations may be to raise property values in the historic district. If most of the benefits are captured by the affected properties owners (B_1 large relative to B_2), little or no compensation would be justified.[16]

Thus far, we have analyzed the model when $\delta = 0$. Now consider the more general case in which $\delta > 0$. If we substitute equation (7) into (12), we can rewrite it as follows:

$$\frac{dG_1}{dk} = \frac{dR}{dk} N_1 N_2 (\theta - 1) W_1' \frac{\left[B_2(N_1 + N_2) + \delta k N_1 (B_2 - B_1) - k(N_1 B_1 + N_2 B_2)\right]}{(N_1 + N_2)(N_1 B_1 + \theta N_2 B_2)} - \delta N_1 \left[W_1(0) - W_1(R)\right] \tag{16}$$

If the level 2 government is unbiased ($\theta = 1$), dG_1/dk is always negative implying a corner solution of $k = 0$. When $\theta = 1$, the level 2 government chooses R^F, even in the absence of

[14] Miceli and Segerson (1996: 173-209) discuss a number of specific examples of regulatory takings and how their approach to the issue would be reflected in each case.
[15] The fact that B_1 and B_2 are not directly observable is obviously of practical importance. When benefits are completely intangible, for example the valuation of the preservation of a particular species, this problem may be particularly acute.
[16] This example draws on Miceli and Segerson's (1996: 182) discussion of historic districts.

compensation. Having positive levels of compensation will result in losses due to the tax distortion and the fact that the level 2 government will reduce R below R^F. This leads to Result 4:

> Result 4: If taxes are distortionary ($\delta > 0$) and the level 2 government is unbiased ($\theta = 1$), the optimal level of compensation is 0. This achieves the first best outcome, R^F.

The expression in (16) is fairly complicated, so to gain some further insight, it will be useful to consider the special case where $B_1 = B_2$. Recall that when $\delta = 0$, this case is associated with an optimal value of $k = 1$. Equation (16) may now be expressed as

$$dG_1 / dk = (dR / dk) N_1 N_2 (\theta - 1) W_1 '(1-k) / (N_1 + \theta N_2) - \delta N_1 [W_1(0) - W_1(R)] \quad (17)$$

From equation (10), $dR/dk < 0$ when $\theta > 1$, but also when $(N_2 - \delta N_1)/(1+\delta)N_2 < \theta < 1$. In this latter range, dR/dk and $\theta - 1$ have the same sign, and the derivative in (17) is always negative. Thus, in the range $(N_2 - \delta N_1)/(1+\delta)N_2 < \theta < 1$, we are at a corner solution with the optimal value of $k = 0$. For the analysis below it is worth noting that a necessary condition for an interior solution for k is that dR/dk and $\theta - 1$ have opposite signs. This will be true when $\theta > 1$, and when $\theta < (N_2 - \delta N_1)/(1+\delta)N_2$.

Setting dG_1/dk to 0 and solving for k yields the following:

$$k = 1 - \frac{\delta (N_1 + \theta N_2)}{(dR / dk)(\theta - 1) N_2 W_1 '(R)} \left[W_1(0) - W_1(R) \right] \quad (18)$$

To achieve the first best outcome, R must be chosen such that (13) holds, without incurring any losses due to the tax distortion. If $\delta > 0$ and $\theta \neq 1$, this first best outcome cannot be obtained. When $\theta \neq 1$, increases in k above 0 can help move R toward the level obtained from (13), but this also induces tax distortions. The level one government will have to trade-off these two distortions, and in general, R will deviate from the value obtained from (13). When $\delta > 0$ and $\theta \neq 1$, denote the level of R under the optimal value of k as R^S, where S stands for second best.

It can be shown (the proof is in the appendix) that if $\theta > 1$ and $\delta > 0$, under the optimal value of k, $R^S > R^F$, with the opposite result holding for $\theta < 1$. This is summarized as Result 5:

> Result 5: When $B_1 = B_2$, $\theta \neq 1$, and $\delta > 0$, the optimal value of k does not achieve the first best level of the regulation R as determined by equation (13). If $\theta > 1$, $R^S > R^F$ and if $\theta < 1$, $R^S < R^F$.

The intuition behind Result 5 is straightforward. When $\theta > 1$, the level 2 government regulates too much in the absence of compensation. The level 1 government only partially corrects this distortion, trading off higher values of k against a greater tax distortion. When $\theta < 1$, R is set too low in the absence of compensation. As discussed above, when $(N_2-\delta N_1)/(1+\delta)N_2 < \theta < 1$, $k = 0$, and the under regulation is uncorrected. If $\theta < (N_2-\delta N_1)/(1+\delta)N_2$, increases in k will raise the level of regulation, but again the level 1 government will set k too low to fully correct this distortion, because of the losses arising from taxation.

In further interpreting (18), some caution is warranted, because the right-hand side contains several endogenous variables. Nevertheless, (18) gives several fairly intuitive insights into the optimal value of k. If $\delta = 0$, $k = 1$ which corresponds to the case we analyzed earlier, when $B_1 = B_2$. Note that $\delta > 0$ implies that k is reduced below 1, so that gross compensation is always below 100%. (Recall that previously, when $B_1 = B_2$ that gross compensation was 100%.) A large value of δ will tend to be associated with either a small value of k or $k = 0$. If N_1 is large relative to N_2, k will also tend to be small or 0. The reason is that when group 1 is large, its compensation is largely financed by taxes upon itself.[17] Since these taxes are distortionary, compensation becomes pointless in this case. Thus, when taxes are distortionary, the case for compensating a group for a regulatory taking is stronger when that group is small relative to the entire population. We will also tend to have small or zero values of k when θ is near 1, because government bias is small, and it is optimal to minimize or avoid entirely losses due to the tax distortion.[18] This is summarized as follows:

Result 6: The optimal value of k tends to be small or zero when

(i) group 1 is large relative to group 2,

(ii) the tax distortion δ is large, and

(iii) government bias is small (θ is near 1).

One conclusion which might be tempting to draw from equation (18) is that k will be small or zero whenever the loss per person in group 1, $[W_1(0) - W_1(R)]$ is large. However, this is not a valid inference from (18). The loss $[W_1(0) - W_1(R)]$ will be large when R is large, and a large value of R will lead to a large absolute value of $W_1'(R)$. This will potentially offset the effect of a large value of $[W_1(0) - W_1(R)]$, so no general conclusion can be drawn about the size of the loss and the percentage of gross compensation k.

[17] See Epstein's (1985: 206) discussion of this issue. He is not considering distortionary taxes per se in this discussion, but he does note that when the regulated group becomes large, it largely pays compensation to itself (via taxation), and this undermines the rationale for paying compensation.

[18] Recall that we have previously established a corner solution of $k = 0$ when $(N_2-\delta N_1)/(1+\delta)N_2 < \theta < 1$, but the statement in the text also applies for value of θ greater than, but close to 1.

4. Conclusion

One basic intuition from the regulatory takings literature is that when compensation is not paid, the responsible governmental unit will regulate too much. This presumes that the government in question is biased against the group bearing the costs of the regulation. When taxes are nondistortionary, I show that the first best outcome is generally associated with a positive level of compensation. Both the gross and net level of the optimal compensation depend upon how the benefits of the regulation are distributed, but the optimal level of compensation is independent of the government's preference parameter. Thus, positive compensation is optimal, even when the lower level government sets too low a level of regulation in the absence of compensation. This means that positive compensation is optimal, even if the government is biased in favor of the regulated group. In this situation, a positive level of compensation will raise the level of regulation up towards its optimal level.

The results above are quite favorable to the idea that a positive level of compensation should be paid to a group suffering from a regulatory taking, though the optimal level of compensation depends upon the particulars of the regulation at hand and can vary quite substantially. Once it is acknowledged that taxes are distortionary, the implications are much less clear. Depending on parameter values, it is possible that the optimal level of compensation is 0. Compensation will tend to be low or zero when the tax distortion is large, when the group to be compensated is large relative to society as a whole, and when the government bias is small. Thus, in contrast to the situation where taxes are nondistortionary, the optimal level of compensation now depends upon the preferences of the regulating government. The results under distortionary taxation lend support to Miceli and Segerson's (1994) ex post rule under which compensation is not paid by the government when the regulation is efficient.[19] In my model, the regulation will only be in the neighborhood of the efficient level if the government is nearly unbiased. Combined with losses due to tax distortions, this case would be consistent with 0 compensation being paid. However, the model implies that compensation should be paid if the government (in the absence of compensation) would set the level of regulation either far above or far below the optimal level. The model is also consistent with the idea that compensation may be optimal when (as in case of Lucas v. South Carolina), the group affected by the regulation is small.

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[19] Also see Innes (2000).

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Appendix

Result 5 states that when $B_1 = B_2$ and $\delta > 0$, under the optimal value of k, $R^S > R^F$ when $\theta > 1$ and $R^S < R^F$ when $\theta < 1$. Given the curvature properties of the $W(R)$ and $P(R)$ functions, R^S will exceed R^F if and only if the coefficient on $P(R)$ on the right-hand side of equation (7) exceeds the coefficient on $P(R)$ on the right-hand side of equation (13). This will be true if

$$k < \frac{(\theta - 1)N_2}{(\theta - 1)N_2 + \delta(N_1 + \theta N_2)} \qquad \text{(A.1)}$$

As established in the main body of the paper, the condition $(N_2\text{-}\delta N_1)/(1+\delta)N_2 < \theta < 1$ is sufficient to ensure a corner solution in which $k= 0$. This condition on θ guarantees that the right-hand side of (A.1) is negative, and with $k = 0$, the condition in (A.1) is violated. Thus, when $(N_2\text{-}\delta N_1)/(1+\delta)N_2 < \theta < 1$, $R^S < R^F$. This is consistent with Result 5, but we still need to consider the cases $\theta > 1$ and $\theta < (N_2\text{-}\delta N_1)/(1+\delta)N_2$.

When $\theta > 1$, $dR/dk < 0$. A value of $k = 1$ would allow us to obtain R^F, but from equation (18) we have $k < 1$. Taken together, this implies that $R^S > R^F$. This leaves the case $\theta < (N_2\text{-}\delta N_1)/(1+\delta)N_2$. In this region, $dR/dk > 0$ and we once again need $k = 1$ to achieve R^F. Since $k < 1$, this implies $R^S < R^F$. This establishes that under the optimal value of k (with $\delta > 0$ and $B_1 = B_2$) that $R^S > R^F$ when $\theta > 1$, and $R^S < R^F$ when $\theta < 1$.