Chapter 7
Involuntary Transfers and Regulation of Property

The Control of Externalities

These notes consider various remedies for controlling externalities. The following model considers both short and long run efficiency in anticipation of the fact that some remedies that are efficient in the short run are not efficient in the long run. To be concrete, consider a railroad whose trains emit sparks that occasionally set fire to crops on farmland adjacent to the tracks. Let

n_T = number of trains run by the railroad;
n_F = number of farms (or total acreage);
x = expenditure on abatement by the railroad per train;
y = expenditure on precaution by each farmer per acre (e.g., moving crops);
$n_T n_F D(x,y)$ = total expected fire damage, where $D_x<0$, $D_y<0$, $D_{xx}>0$, $D_{yy}>0$;
$b_T(n_T)$ = marginal benefit of trains, $b_T'<0$;
$b_F(n_F)$ = marginal benefit of farming, $b_F'<0$.

Social welfare is given by

$$W = \int_0^{n_T} b_T(u)du + \int_0^{n_F} b_F(z)dz - [n_T n_F D(x,y) + n_T x + n_F y] \qquad (7.1)$$

Efficiency conditions. Short run efficiency concerns the choices of care by the two parties, taking as given the number of trains and farmers. The following first order conditions describe the optimal values of x and y, respectively, given n_T and n_F:

$$n_F D_x + 1 = 0 \qquad (7.2)$$

$$n_T D_y + 1 = 0 \qquad (7.3)$$

Thus, parties should invest in precaution to the point where marginal benefits equal marginal costs.

In the long run, the number of trains and farm acreage are variable. The first order conditions defining the efficient n_T and n_F are

$$b_T - [n_F D + x] = 0 \qquad (7.4)$$

$$b_F - [n_T D + y] = 0 \qquad (7.5)$$

Thus, each activity should be increased until the marginal benefit equals the marginal cost. We now consider how well various remedies achieve efficiency in the short and long run.

Pigovian tax-subsidy approach. Under this approach, the government imposes a tax on, or pays a subsidy to, the party "causing" the externality (in this case, the railroad). Consider first the short run. Under a tax on fire damage, the railroad will choose the efficient level of abatement provided that the marginal tax equals marginal damages, or $t'(x)=n_F D_x$; and farmers will choose the efficient level of precaution provided that they do not receive any of the tax revenue. Symmetrically, a subsidy to the railroad will induce efficient precaution by both parties provided that the marginal reduction in the subsidy equals the marginal damages, or $-s'(x)=n_F D_x$.

In the long run, the railroad will only choose the efficient number of trains if it fully internalizes the crop damage. This requires that it pay a tax per train equal to $t=n_F D(x,y)$. (Note that this tax satisfies the above marginal condition.) Clearly, any subsidy paid to the railroad will induce it to run an excessive number of trains. As for farming, efficient entry of farmers requires that they fully internalize their contribution to crop damage. This is satisfied as long as farmers do not expect to receive any compensation for their losses (including lump sum payments).

The property rule-liability rule approach. Coase (1960) argued that the Pigovian approach is not the only way to internalize externalities. An expanded set of remedies is revealed by considering the choice between property rules and liability rules. Under property rules, the parties to an externality reach the efficient outcome through bargaining, provided that transaction costs are low. Suppose, for example, that farmers' right to be free from crop damage is protected by a property rule. Thus, they can block the railroad from running any trains by an injunction. However, the railroad can seek to purchase rights to impose crop damage from farmers. For each train that it runs, the railroad will invest in abatement up to the point where the last dollar spent just equals the marginal damages to farmers, after which it will prefer to compensate farmers for their residual damages. And, given efficient abatement per train, the railroad will run trains up to the point where the marginal amount it has to compensate farmers for running one more train equals the marginal benefit. The result is an efficient number of trains.

Efficient precaution by farmers can also be achieved by contracting. Continuing with the assumption that farmers have the right to be free from damage, this requires that the railroad pay farmers to invest in abatement up to the point where the last dollar spent equals the marginal savings in crop damages. Achieving the efficient amount of farming is more problematic. According to (6.5), long run efficiency requires that farmers enter up to the point where the marginal benefits of the last farm (or acre) equal its marginal contribution to crop damage plus cost of abatement. But since farmers are compensated for these costs under the current assignment of rights, there exists an incentive for too many to enter. In theory, Coasian bargaining can prevent this, but only if the railroad can identify all *potential* entrants into farming and then pay them their marginal benefits of entry to stay out. Clearly this poses a significant informational demand on the railroad.

(A similar problem would face farmers if the railroads initially had the right to run trains without incurring damage liability.) This discussion illustrates the limited usefulness of private contracting in internalizing most externalities, especially regarding long run efficiency.

Now suppose the farmer's right is protected by a liability rule. If liability is strict, the railroad must pay full compensation regardless of its level of abatement. In terms of short run efficiency, strict liability induces efficient abatement by the railroad, but because farmers are fully compensated, they have no incentive to invest in precaution. (The outcome is identical to the above tax scheme if the tax revenue is given to farmers.) In contrast, a negligence rule, which only holds the railroad liable if it failed to invest in efficient abatement, will induce both parties to invest efficiently. The railroad will choose the efficient level of abatement to avoid liability, and farmers will choose efficient precaution to minimize their losses.

Neither liability rule, however, will achieve long run efficiency for both railroads and farming. Under strict liability, too many farmers will enter because they do not consider the impact of their entry on total damages. Although the railroad does face full liability for each train it runs, equal to $n_F D(x,y)$, this amount is too large because of the excessive amount of farming. Thus, too few trains will run (though the number of trains is efficient given the number of farms.) The situation is reversed under negligence. The railroad will invest in optimal abatement, but it will run too many trains because it is not liable for the crop damage. In contrast, farmers will face the full amount of their damages, $n_T D(x,y)$, but too few farmers will enter because the number of trains is too large (though, again, the amount of farming is efficient given the number of trains). In general, liability rules cannot create long run incentives for both parties because of the constraint that what one party pays the other must receive. (The situation is identical to the choice of an activity level by injurers and victims in Chapter 2.)

Zoning, covenants, and common law control. Probably the most common legal response to land market externalities in the United States is zoning, a form of public regulation. The widespread use of zoning, however, does not necessarily make it the most efficient response to externalities. High administrative and enforcement costs often exceed the saved "nuisance costs," thereby making the system inefficient. This would not be a problem, however, if the penalty for violations were payment of an appropriate fine, which would allow landowners to circumvent inefficient regulations. In this sense, zoning regulations are best enforced by a liability rule. The fact that compliance with zoning ordinances is required, however (that is, they are enforced by a property rule), forecloses this route to efficiency.

A private alternative to zoning are land use covenants, or deed restrictions that impose limits on what landowners can do with their property. Such restrictions are usually put in place by developers when they first sub-divide a parcel of land in recognition of the fact that, once divided, individual owners will often undertake activities that impose externalities on one another. By attaching the restriction up front, the developer maximizes the aggregate value of the development (and hence his profit) by internalizing the neighborhood externalities. Further, since the restrictions are attached to the deed rather than to the landowner (that is, they "run with the land"), they avoid the transaction costs that would be necessary if each new resident had to negotiate anew with all existing residents. In this sense, covenants represent an effective private alternative to zoning for small-scale developments. They are not effective, however, in controlling externalities in large-scale urban areas where development occurs in a piecemeal and decentralized fashion.

Trespass and nuisance laws also represent private (common law) alternatives to zoning. Trespass is effective in internalizing small-scale intrusions (for example, boundary disputes between neighbors), while nuisance law is best suited to control localized harms that affect a few individuals. However, nuisance law is inadequate to internalize harms that are dispersed across a large number of landowners because no single owner will have an adequate incentive to incur the cost of bringing suit, even though the aggregate harm may exceed the benefit. For these types of externalities, public regulation is usually the best remedy.

Adverse Possession

The theory of adverse possession described here is based on the presence of offsetting risks to the ownership of land. The first risk arises from the possibility of past claims by previous owners who were deprived of their title through fraud or error. A time limit on such claims limits this risk to current owners. Let $p(t)$ be the risk of such a claim, where t is the duration of the prior owner's property right. We assume that $p'(t)>0$ and $p(0)=0$. The other risk is that the current owner may himself be displaced by a squatter. This possibility can be reduced by periodic monitoring of the property to eject squatters or correct boundary errors. A longer time limit on the owner's property right lowers this cost by reducing the frequency of monitoring. Formally, let $m(t)$ be the cost of monitoring that the owner must expend to retain title with certainty, where $m'(t)<0$ and $m(\infty)=0$.

Now suppose the current owner contemplates investing in the land. Let $V(x)$ be the market value of an investment of x dollars, where $V'>0$, $V''<0$. Given uncertainty, the owner will choose x to maximize the expected value, $(1-p(t))[V(x)-m(t)]-x$, taking t as given. This yields the first order condition

$$(1-p(t))V'(x) - 1 = 0 \qquad (7.6)$$

which defines the optimal investment, $x^*(t)$, as a function of the time limit, where $\partial x^*/\partial t = p'V'/(1-p)V''<0$.

Given this characterization of the landowner's problem, we can derive the optimal duration of property rights as the value of t that maximizes the social value of land net of monitoring costs:

$$V(x^*(t)) - x^*(t) - m(t). \qquad (7.7)$$

Differentiating (7.7) and substituting from (7.6) yields

$$p(t)V'(x)(\partial x^*/\partial t) = m'(t). \quad (7.8)$$

Thus, the optimal time limit balances the detrimental effect of longer *t* on investment incentives (the left-hand side) against the savings in monitoring costs (the right-hand side).

The Mistaken Improver Problem

The analysis to this point has treated the probability of a claim as a function only of the statutory period, but owners can lower the risk of a claim by surveying their property prior to development to detect boundary errors. Suppose that a survey reveals ownership with certainty. If the developer turns out to be the owner, he can proceed with development as if there were no risk of a loss. However, if someone else is revealed to be the owner, the developer can bargain to purchase the land if it is more valuable in the developed state. In this way, the value of the land is maximized. Determining ownership is costly, however, which may make it more profitable for the developer to proceed without a survey. This raises the possibility of mistaken improvement of another's property—the so-called *mistaken improver problem*.

Let *V* be the market value of the improved land, and let *p* be the probability, prior to survey, that the land is owned by someone else who values it in its unimproved state at *R*. Further, suppose that *R* is unobservable to the developer but is known to be distributed by the function *F(R)*. If the developer surveys at cost *s* prior to developing, the expected value of the land is $(1-p)V + pE\max[V,R] - s$, or

$$(1-p)V + p[F(V)V + \int_V^\infty R\,dF(R)] - s \quad (7.9)$$

If, however, the developer proceeds without a survey, the value of the land is fixed at *V*, regardless of who turns out to be the owner. A survey is therefore socially optimal if (7.9) exceeds *V*, or if

$$p\int_V^\infty (R - V)\,dF(R) > s \quad (7.10)$$

The left-hand side of this condition is the expected benefit of avoiding irreversible improvement of land that may be owned by someone else and is more valuable in its unimproved state. As shown in the text, the law of mistaken improvement in most states aligns the developer's private incentive to conduct a survey with this social condition.

The Holdout Problem

The holdout problem is the primary economic justification for allowing the government to force transactions using eminent domain. The exact nature of the social cost associated with holdouts is unclear in the literature. Some authors have described it as a problem of monopoly, while others have characterized it in terms of transaction costs or breakdowns in bargaining. The monopoly argument seems to suggest that projects involving holdouts will be underprovided (due to the overpricing of land), while the bargaining cost approach tends to focus on delay as the primary source of inefficiency. The following model focuses on the sequential nature of bargaining between the buyer and sellers.

For simplicity, suppose that the buyer wishes to assemble two contiguous, but independently owned parcels. (The analysis easily generalizes to *n* parcels.) Let

V = value of the consolidated parcels to the buyer;
R = reservation price of each seller;

where we assume

$$V > 2R \tag{7.11}$$

Thus, the parcels are more valuable if both are acquired by the buyer. Also let

v = value of a single parcel to the buyer

where

$$v < R \tag{7.12}$$

Thus, it is inefficient for the buyer to acquire a single parcel. We suppose that the buyer negotiates sequentially with the two sellers, and that all parties are fully informed. In any transaction, prices are determined by ordinary Nash bargaining.

We examine the nature of the bargaining in reverse sequence of time. Thus, suppose that the buyer has successfully acquired the first parcel for a price of P_1 (to be determined). In negotiating with the second seller, this is therefore a sunk payment. If the buyer acquires the second parcel for a price P_2, his net gain is $V–P_2$, whereas if he fails, he is left with the value of the first parcel alone, v. Thus, his net gain from the purchase would be $V–v–P_2$. As for the seller, her net gain from a sale is $P_2–R$. The resulting price, determined by Nash bargaining, therefore solves

$$\max_{P_2}(V - v - P_2)(P_2 - R)$$

which yields

$$P_2 = \frac{V + R - v}{2} \tag{7.13}$$

Note that this is independent of the price of the first parcel.

Now move back to the first sale. In this case, before he has acquired either parcel (but anticipating the outcome of future bargaining), the buyer's expected net gain from a successful purchase of parcel one is $V–P_1 –P_2$. The seller's gain, as above, is $P_1–R$. Nash bargaining in this case yields

$$P_1 = \frac{V + R - P_2}{2} \qquad (7.14)$$

which does depend on P_2. However, substituting from (7.13) yields

$$P_1 = \frac{V + R + v}{4} \qquad (7.15)$$

Comparing (7.13) and (7.14) immediately shows that

$$P_2 - P_1 = \frac{V + R - 3v}{2} \qquad (7.16)$$

which is positive given (7.11) and (7.12). Thus, the price is higher for the later seller. This turns out to be a general result: prices rise for later sellers, which provides sellers an incentive to sell later, or to "hold out," potentially resulting in significant delay. As noted, this is one type of inefficiency often associated with land assembly.

Another efficiency issue is whether the threat of a holdout prevents the buyer from undertaking the project in the first place. In anticipation of the above sequence of prices, the buyer will initiate the project if $V–P_1–P_2\geq 0$. After substituting from (7.13) and (7.14), this condition becomes

$$V \geq 2R + (R–v). \qquad (7.17)$$

Comparing this to (7.11) shows that too few projects will be initiated.

Takings and Land Use Incentives

One of the primary contributions of the economics literature on takings law has been to argue that paying compensation for takings (or regulations) may lead to inefficient land use incentives. To illustrate, consider a parcel of land worth $V(x)$ if the landowner makes an irreversible investment of x dollars, where $V'>0$, $V''<0$. The land may also be valuable for public use, yielding a benefit of $B(y)$, where y is the fraction of the land taken. Setting y=1 therefore represents a taking of the entire parcel. Alternatively, $y<1$ may be interpreted as the probability of a taking, or as the fraction of the parcel's value that is extinguished by a regulation. In any case, $0\leq y\leq 1$, and $B'>0$, $B''<0$.

If the land is taken or regulated, suppose that compensation of $C(x)$ will be paid in proportion to the fraction taken—that is, $yC(x)$ will be paid for an expected loss of a fraction y of the land—where $C(x)\geq 0$ and $C'\geq 0$. The time sequence is that the landowner chooses x given the anticipated behavior of the government (i.e., its choice of y) and the compensation rule; then, the government chooses y and pays $C(x)$.

The social optimum

The socially optimal choices of x and y maximize $B(y)+(1–y)V(x)–x$. The resulting first order conditions are

$$(1-y)V'(x) - 1 = 0 \tag{7.18}$$

$$B'(y) - V(x) = 0. \tag{7.19}$$

Together, these conditions determine x^* and y^*. Also note for future reference that (7.19) defines the function $y^*(x)$, which is be the government's optimal taking decision for any given x. Differentiating (7.19) yields

$$\frac{\partial y^*}{\partial x} = \frac{V'}{B''} < 0. \tag{7.20}$$

Thus, the amount of land it is optimal for the government to take is decreasing in the landowner's investment because its higher x increases the opportunity cost of a taking.

Actual investment and taking decisions

Now consider the decisions made separately by each party. We consider three different scenarios regarding the government's behavior. In the first, the government's decision is exogenous (that is, y is fixed), while the landowner chooses x to maximize $(1–y)V(x) + pC(x) –x$. The first order condition is

$$(1-y)V'(x) + yC'(x) - 1 = 0. \tag{7.21}$$

Comparing this to condition (7.18) shows that C'=0 is necessary for the landowner to invest efficiently. That is, compensation must be lump sum. It follows that no compensation ($C(x)$=0) is efficient, but any positive lump sum amount will also work. This is the famous "no compensation" result.

We now show that this result does not hold up under different assumptions about the government's behavior. Suppose, for example, that the government chooses y to maximize social welfare. (That is, it is benevolent.) Formally, it chooses $y^*(x)$ for any x. The landowner's objective remains the same as above, but he rationally accounts for the dependence of y on his choice of x. Thus, the first order condition defining x in this case is

$$(1-y)V'(x) + yC'(x) - [V(x) - C(x)](\partial y^*/\partial x) - 1 = 0. \tag{7.22}$$

Compensation must again be lump sum, but zero compensation is no longer consistent with efficiency. This is reflected by the third term in (7.14), which, given (7.12), implies that the landowner will overinvest if $C(x)<V(x)$ and underinvest if $C(x)>V(x)$. Intuitively, if the landowner expects to be undercompensated in the event of a taking, he will increase his investment in order to lower the probability of a taking. Conversely, if he expects to be overcompensated, he will underinvest in order to raise the probability of a taking.

This version of the model embodies two sources of moral hazard for the landowner. The first is the threat of overinvestment if compensation is an increasing function of x (the basis for the no-compensation result above), while the second is the effect of x on the government's taking decision. One compensation rule that resolves both problems and induces both an efficient level of investment and the efficient taking decision is $C=V(x^*)$. That is, compensation is set at the full value of the land evaluated at the efficient level of investment.

In the final scenario, the government is not benevolent but instead acts on behalf of the majority (those who receive the benefits of the taking) while ignoring the costs to the individual property owners, except to the extent that it must pay them compensation. Such a government is said to have "fiscal illusion" in that it only cares about dollar costs. In this case, the government chooses y to maximize $B(y)–yC(x)$, which yields the first order condition

$$B'(y) - C(x) = 0. \qquad (7.23)$$

This defines the function $y^g(x)$ whose characteristics depend on the nature of the compensation rule. The landowner maximizes the same objective function as above, yielding the same first order condition as in (7.14), except that $\partial y^*/\partial x$ is replaced by $\partial y^g/\partial x$. Note that the compensation rule, $C=V(x^*)$, will again yield both the efficient level of landowner investment and the efficient taking decision by the government.

Now consider an alternative compensation rule that also induces efficient behavior by both the landowner and the government:

$$C = \begin{cases} 0, & \text{if } y \leq y^* \\ V(x), & \text{if } y > y^* \end{cases} \qquad (7.24)$$

Note that this rule is conditional on the behavior of the government: specifically, it requires the government to pay full compensation if it takes too much land, but requires no compensation if the government takes no more than the efficient amount.

To prove that (x^*,y^*) is a Nash equilibrium when this rule is in place, suppose that $x=x^*$. Then, the government's optimal response is to choose y^*. First, note that it will never choose $y<y^*$ since $B'>0$, and it will prefer y^* to $y>y^*$ since $B(y^*)>B(y^*)–y^*V(x^*)\geq\max_{y>y^*} B(y)–yV(x^*)$. Now suppose that $y=y^*$. Since in that case $C=0$, the landowner chooses x to maximize $(1–y^*)V(x)–x$, which yields x^*. This establishes the claim.

One advantage of the rule in (7.24) over the unconditional compensation rule $C=V(x^*)$, which also yields an efficient outcome, is that the conditional rule will result in fewer takings claims (and hence lower administrative costs) because landowners only expect to be compensated, and hence will only file a claim, if the government acts inefficiently. Another advantage is that the rule in (7.24) is more descriptive of actual takings law in cases involving government regulations (so-called regulatory takings), which constitute the vast majority of takings claims. For example, it closely resembles the "diminution of value" test and the "nuisance exception," both of which are conditional rules that limit compensation to cases of excessive regulatory action.