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ENDOGENOUS PROPERTY RIGHTS: THE "COASE ASSUMPTION" AND SMOKING REGULATION

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1. Introduction

There are two alternative approaches to internalizing externalities. The Pigouvian approach advocates government intervention, in the form of taxes, subsidies, and regulation. The Coasian approach suggests direct government intervention is unnecessary if the affected parties bargain over the property rights associated with the externality. The assumption that individuals bargain over the property rights associated with an externality will be coined the "Coase assumption." Baumol and Oates (1988) and Kaneko and Wooders (1990) have stressed that bargaining over externalities and the optimality of the resulting outcomes will occur only within small groups. The Coasian approach can work if the agents who contribute to the externality are limited in number and are easily identifiable, and if the number of those affected by the externality is limited. If an externality is widespread, many agents are adversely affected and many agents may be contributing to the externality. The Coasian approach is then no longer feasible because the costs of coordination become prohibitive and because if the externality is diffuse, the widespread externality is taken as given by agents, who view the effects of their own actions as negligible. In this case, direct government intervention may be necessary.

The Coasian approach provides a solution for small-numbers local externalities and the Pigouvian approach addresses widespread externalities. If negotiation in response to an externality improves resource allocation, a Pigouvian solution in addition may be too much of a good thing; this assumes, however, that the negotiation includes all affected parties. If an externality has both local and widespread dimensions, and small groups bargain over the property rights associated with the local externality, the effects of the activities of a small group of agents on the total externality are negligible and government regulation may still be required to alleviate the problems caused by the externality. In this paper, we discuss some effects of government regulation when an activity generates both local and widespread externalities. In particular, we discuss an example of smoking in restaurants.

In a restaurant individuals are affected by smoking at their own table and also by the level of smoke in the entire restaurant. In a large restaurant, it is reasonable to suppose that individuals only negotiate about the local smoke externality that is generated at their own table, but do not negotiate with all the restaurant patrons over the widespread externality. Following the Coasian approach, we assume that the final allocation of property rights over the local environment, the smoke at a table, is determined so as to maximize total welfare of the diners at the table, taking as given the widespread externality. The negotiation at each table, taking the widespread externality as given, determines the local externality; the decisions made at all tables determine the widespread externality.

Assume that initially no restaurants provide no-smoking sections. The government, then, can choose to introduce mandatory no-smoking sections in restaurants. The introduction of no-smoking sections has two effects - the direct effect on the level of the widespread externality and the indirect effect on the level of the widespread externality by the effect on the bargaining over the local externality. By making a number of simplifying assumptions, the effect of government regulation is analyzed. If the government intervention does not cause the property rights that result from bargaining to change, then the effect of the intervention is only the direct effect. If the intervention causes the property rights to change, then the change in property rights can reinforce the direct effect of government intervention or the changed property rights can be the sole effect that provides a welfare improvement.

Our conclusion is that if agents negotiate in terms of the local externality when an activity generates both local and widespread externalities, government intervention should be analyzed both in terms of the direct effects of the intervention and in terms of the indirect effects on property rights.

2. The Model

A transferable utility model where group members know everyone's utility functions allows for bargaining with sidepayments. The following table describes the preferences of smokers and non-smokers at a table. A group (those individuals who will be seated at the same table) would rather be together than separated, but smokers would prefer to smoke and non-smokers would prefer that no one smoked at the table. Suppose there are n individuals in a group, where n_1 are smokers and $n_2=(n-n_1)$ are non-smokers. Smokers get utility (γ) from smoking, each non-smoker is adversely affected by the number of group members smoking (δn_1), and both smokers and non-smokers are adversely affected by the widespread externality. Let u_{ij} denote the utility of an individual for a meal where i=1 if the individual is a smoker, i=2 if the individual is a non-smoker, j=1 if one or more members of the group smoke, and j=2 if no one smokes at the table. The disutility of the widespread externality associated with meal j for an individual of type i is $\varepsilon_i w_j$, where w_j is a measure of the widespread externality associated with meal j, ε_i lies in (0,1), and w_j lies in [0,1]. We assume that nonsmokers are at least as adversely affected by the widespread externality as smokers are ($\varepsilon_1 \leq \varepsilon_2$) and that the widespread externality of a meal with smoking is greater than or equal to the widespread externality of a meal without smoking ($w_1 \geq w_2$).[1] A composite commodity money, m, allows for sidepayments and the utility of a restaurant meal to an individual (net of costs) is 1. We assume that given the level of smoke in the restaurant, and ignoring the contribution of the individuals at a table to the widespread externality, each group will make a (conditionally) Pareto-optimal choice for the members of the group.

	Meal with Smoking	Meal without Smoking
Smoker	$u_{11} = m+1+\gamma-\varepsilon_1 w_1$	$u_{12} = m+1-\varepsilon_1 w_2$
Nonsmoker	$u_{21} = m+1-\delta n_1-\varepsilon_2 w_1$	$u_{22} = m+1-\varepsilon_2 w_2$

When groups are homogeneous, there is no conflict of interest. "Smokers only" groups will always choose a meal with smoking and "non-smokers only" groups choose meals without smoking. For heterogeneous groups, the "Coase assumption" is applied as follows: Groups comprised of both smokers and non-smokers engage in some bargaining process which maximizes group utilities, given the level of the widespread externality. Suppose that non-smokers initially hold the property rights to the air at the table. The gain to each smoker in the group for a meal with smoking is $(u_{11}-u_{12})$; the loss to each non-smoker is $(u_{22}-u_{21})$. If $(n-n_2)(u_{11}-u_{12}) \geq n_2(u_{22}-u_{21})$, then the smokers in the group can compensate the non-smokers, the smokers of the group own the air at the table, and a meal with smoking is chosen. For any heterogeneous group, the choice of meal will be independent of who initially holds the rights to the air. The negotiated outcome is Pareto-efficient conditional on the choices of all other small groups and is independent of the initial property rights assignment.

The decisions of all the heterogeneous groups determines a property rights parameter, λ. When there is heterogeneity, the resolution of the conflict of interest will result in the feature that for some proportion λ of groups, the preferences of smokers dominate. A typical smoker's preferred choice as a member of a heterogeneous group, visiting restaurants a number of times, will occur 100λ percent of the time, so the smoker implicitly owns 100λ% of the air. This is the rationale for viewing λ as representing the smokers' property rights after bargaining.

The proportion of smokers in the population is π and groups of n are chosen at random from the population; that is, group formation is independent of member types. The proportion of groups that are heterogeneous and choose meals with smoking is $\lambda[1-\pi^n-(1-\pi)^n]$; the proportion of groups that are heterogeneous and choose meals without smoking is $(1-\lambda)[1-\pi^n-(1-\pi)^n]$.

3. The Property Rights Parameter for No Segregation

First we will consider the case where there is no segregation, denoted by N. Assume that groups are seated at random in the restaurant so that the widespread externality is the same for a meal with smoking as it is for a meal without smoking: $w_1^N=w_2^N$. The widespread externality is determined by the proportion of patrons smoking and a returns-to-scale parameter. The proportion of patrons smoking is comprised of the proportion of patrons who are in "smokers only" groups and are smokers, and of the proportion of patrons who are smokers, are in heterogeneous groups, and choose meals with smoking. The proportion of smokers in all heterogeneous groups is $(\pi-\pi^n)/[1-\pi^n-(1-\pi)^n]$. The proportion of smokers in heterogeneous groups that choose meals with smoking is p_λ. For λ not equal to zero:

$$p_\lambda = \frac{\sum_{n_2=1}^{v} \binom{n}{n_2}(1-\pi)^{n_2}\pi^{n-n_2}\frac{(n-n_2)}{n}}{\lambda[1-\pi^n-(1-\pi)^n]}$$, where $v \geq 1$ is the critical number of non-smokers

The returns-to-scale parameter, β, allows for the possibility that the smoke generated by a small proportion of smokers smoking is easily dissipated, but that the smoke generated by a larger proportion imposes an increasing average cost. The widespread externality for no segregation is given by $w_j^N = \{\pi^n + \lambda[1-\pi^n-(1-\pi)^n]p_\lambda\}^\beta$. (The case of constant returns to scale is given by $\beta=1$; increasing returns to scale by $\beta>1$.)

In the no segregation case, the group members bargain only over the local externality. Each individual takes the widespread externality as given and the widespread externality is independent of the type of meal chosen. Suppose non-smokers initially hold the property rights to the air. The utility gain to a smoker of a meal with smoking is γ; the loss to a non-smoker is δn_1. If smokers want to smoke, they need to pay the non-smokers. A group will choose a meal with smoking if the smokers in the group can compensate the non-smokers:

$$n_1\gamma \geq \delta n_1 n_2 \qquad \Rightarrow \qquad n_2 \leq \gamma/\delta$$

The critical number of non-smokers at a table is n_2^*. This determines if a meal with smoking or a meal without smoking maximizes group utility for a given group. If the number of non-smokers in the group is less than or equal to n_2^*, then the group will choose a restaurant meal with smoking; if $n_2 > n_2^*$, then the group will choose a restaurant meal without smoking. This critical number is determined by γ/δ. For $\gamma/\delta \geq n-1$, let $n_2^* = n-1$; for $\gamma/\delta < 1$, let $n_2^* = 0$. For $1 \leq \gamma/\delta < n-1$, let n_2^* be the integer such that $n_2^* \leq \gamma/\delta < n_2^* + 1$. With no segregation, γ/δ determines the critical number of non-smokers at a table, and this determines

λ^N, the property rights parameter which measures smokers' rights in all heterogeneous groups after bargaining.

Suppose γ/δ lies in [0,1). Then $n_2^*=0$ and any mixed group with at least one non-smoker will choose a meal without smoking. All mixed groups will have at least one non-smoker and so will choose meals without smoking. Therefore, smokers' preferences in this case never dominate in a mixed group and $\lambda^N=0$. Suppose instead that γ/δ lies in $[n-1,\infty)$. Then $n_2^*=n-1$ and any mixed group with at least n non-smokers will choose a meal without smoking. No mixed groups have more than n-1 non-smokers and so all mixed groups will choose meals with smoking. Therefore, smokers' preferences in this case always dominate in a mixed group and $\lambda^N=1$.

Given n_2^*, λ^N, the property rights parameter for no segregation, can be determined:

$$\lambda^N = 1 \qquad \text{for } n_2^* = n - 1$$

$$\lambda^N = \frac{\sum_{n_2=1}^{n_2^*} \binom{n}{n_2} (1-\pi)^{n_2} \pi^{n-n_2}}{1-\pi^n-(1-\pi)^n} \qquad \text{for } 0 < n_2^* < n-1$$

$$\lambda^N = 0 \qquad \text{for } n_2^* = 0$$

The parameter, λ^N, takes on n possible values and is increasing in the value of γ/δ. The higher the utility of smoking for the smoker or the lower the disutility of the local externality for the non-smoker, the higher the critical number of non-smokers in a group. The higher the critical number of non-smokers in a group, the more often smokers' preferences dominate in a heterogeneous group, the higher the proportion of groups that choose meals with smoking, and the greater the widespread externality.

4. The Property Rights Parameter for Segregation with Flexible Technology

If the government introduces mandatory no-smoking sections, then the widespread externality is no longer the same for a meal with smoking as it is for one without. Assume that restaurants[2] have a flexible technology that allows for a moving boundary between smoking and no-smoking sections. This means that there are no physical or queuing costs associated with segregation. The widespread externality is determined by the proportion of smokers sitting in the smoking section, the returns-to-scale parameter, and the effectiveness of the barrier, which is measured by $\alpha \in (0,1]$. The more effective the barrier between the two sections (that is, the higher the value of α), the greater is the reduction in the widespread externality for groups in the no-smoking section and the more internalized is the widespread externality for groups in the smoking section. The widespread externality for the smoking section, denoted by w_1^S, is affected by both the proportion of smokers to customers in the smoking section and the proportion of smokers in the smoking section to customers in the restaurant, whereas the widespread externality for the no-smoking section, w_2^S, is only affected by the proportion of smokers in the smoking section to customers in the restaurant:

$$w_1^S = \left[\alpha \frac{\pi^n + \lambda[1-\pi^n-(1-\pi)^n]p_\lambda}{\pi^n+\lambda[1-\pi^n-(1-\pi)^n]} + (1-\alpha)\{\pi^n+\lambda[1-\pi^n-(1-\pi)^n]p_\lambda\}\right]^\beta$$

$$w_2^S = [(1-\alpha)\{\pi^n+\lambda[1-\pi^n-(1-\pi)^n]p_\lambda\}]^\beta$$

With segregation, each individual takes the widespread externality as given, but the widespread externality is different for a meal with smoking than for a meal without. The difference in utility for the two types of meals now includes both the difference due to the local externality and the difference due to the widespread externality. Let the change in utility associated with the widespread externality be denoted by $b_i(\lambda)=\varepsilon_i(w_1^S-w_2^S)$. The gain to a smoker of a meal with smoking is $\gamma-b_1(\lambda)$; the loss to the non-smoker is $\delta n_1+b_2(\lambda)$. Under segregation, the gain to a smoker of a meal with smoking is less (if the smoker is adversely affected by the widespread externality) and the loss to a non-smoker is greater than under no segregation. The proportion of heterogeneous groups choosing meals with smoking under segregation is less than or equal to that under no segregation. With segregation, a mixed group will choose a meal with smoking if the smokers in the group can compensate the non-smokers:

$$n_1[\gamma-b_1(\lambda)] \geq n_2[\delta n_1+b_2(\lambda)] \qquad \Rightarrow \qquad n_2 \leq \gamma/\delta - b_1(\lambda)/\delta - b_2(\lambda)n_2/[\delta(n-n_2)]$$

Calculating the critical number of non-smokers at a table is more difficult under segregation than it was for the no segregation case. For $\gamma/\delta \geq n-1 + b_1(1)/\delta + b_2(1)(n-1)/\delta$, let $\hat{n}_2 = n-1$. Otherwise, define the change in utility associated with the widespread externality in terms of the critical value:

$$b_i^*(\nu)=\varepsilon_i\left\{\pi\sum_{n_2=0}^{\nu}\binom{n-1}{n_2}(1-\pi)^{n_2}\pi^{n-1-n_2}\right\}^{\beta}\left\{\left[\frac{\alpha}{\sum_{n_2=0}^{\nu}\binom{n}{n_2}(1-\pi)^{n_2}\pi^{n-n_2}}+(1-\alpha)\right]^{\beta}-(1-\alpha)^{\beta}\right\}$$

Let $\hat{n}_2 = 0$ for $\gamma/\delta < 1 + b_2^*(1)/[\delta(n-1)] + b_1^*(1)/\delta$. For $0<\hat{n}_2<n-1$, let $\hat{n}_2$ be the integer such that $\hat{n}_2 + \hat{n}_2 b_2^*(\hat{n}_2)/[\delta(n-\hat{n}_2)] + b_1^*(\hat{n}_2)/\delta \leq \gamma/\delta < \hat{n}_2 + 1 + (\hat{n}_2+1)b_2^*(\hat{n}_2+1)/[\delta(n-\hat{n}_2-1)] + b_1^*(\hat{n}_2+1)/\delta$.

Given $\hat{n}_2$, λ^S, the property rights parameter for segregation, can be determined:

$\lambda^S = 1 \quad$ for $\hat{n}_2 = n - 1$

$$\lambda^S = \frac{\sum_{n_2=1}^{\hat{n}_2} \binom{n}{n_2} (1-\pi)^{n_2} \pi^{n-n_2}}{1-\pi^n-(1-\pi)^n} \qquad \text{for } 0 < \hat{n}_2 < n-1$$

$$\lambda^S = 0 \qquad \text{for } \hat{n}_2 = 0$$

The fact that the widespread externality differs for a meal with smoking from a meal without smoking in the segregation case can result in a change in the endogenous property rights allocation. The critical number of non-smokers under segregation can be equal to or less than the critical number of non-smokers under no segregation. If the critical number of non-smokers is less in the segregation case, then the widespread externality for customers in the no-smoking section is reduced both because of the barrier and because of the change in the endogenous property rights allocation.

5. Restaurants

One way to internalize the widespread externality is to segregate those groups choosing meals with smoking. Restaurateurs could provide segregation, but in this paper, they fail to do so. The "no segregation" state is considered to be a Nash equilibrium. We will assume that each restaurateur, given that all other restaurateurs do not segregate, has no incentive to segregate.

The proportion of groups that choose restaurant i if restaurants either all segregate or all do not segregate is ρ^i. Assume that λ and the prices charged by any given restaurant are independent of whether segregation is offered or not. Assume also that the price of the meal chosen is independent of whether segregation is offered or not and is independent of whether the group chooses a meal with or without smoking. Then, if restaurant i segregates when all other restaurants do not, the proportion of groups choosing a meal with smoke that choose restaurant i, ρ_1^i, drops and the proportion of groups choosing a meal without smoke that choose restaurant i, ρ_2^i, increases: $\rho_1^i < \rho^i < \rho_2^i$. If restaurant i's market share does not increase by segregating, then restaurant i has no incentive to segregate. For the "no segregation" state to be a Nash equilibrium, the following condition must hold for all restaurants:

$$\rho_1^i\{\pi^n+\lambda[1-\pi^n-(1-\pi)^n]\}+\rho_2^i\{(1-\pi)^n+(1-\lambda)[1-\pi^n-(1-\pi)^n]\}\leq\rho^i$$

Restaurant i has no incentive to segregate if:

$$\lambda\geq\frac{\rho_2^i-\rho^i-(\rho_2^i-\rho_1^i)\pi^n}{[1-\pi^n-(1-\pi)^n](\rho_2^i-\rho_1^i)}$$

The higher the value of λ, the more likely that no restaurant will choose to offer segregation. In other words, the more significant the market share represented by groups choosing meals with smoke, the fewer the number of restaurants that will segregate.

6. The Effect of Government Regulation

The government has the possibility of introducing mandatory no-smoking sections. We will assume that before legislation smokers in heterogeneous groups own the air after bargaining. (This assumption gives us a base point, $\lambda^N=1$, and also provides justification for the "no segregation" Nash equilibrium assumption.) The government will impose segregation legislation only if it is welfare-improving, where the welfare measure is average utility:

$$W^t(\lambda) = \{\pi^n+\lambda[1-\pi^n-(1-\pi)^n]p_\lambda\}u^t_{11} + (1-\lambda)[1-\pi^n-(1-\pi)^n]q_\lambda u^t_{12}$$

$$+ \lambda[1-\pi^n-(1-\pi)^n](1-p_\lambda)\bar{u}^t_{21} + \{(1-\pi)^n+(1-\lambda)[1-\pi^n-(1-\pi)^n](1-q_\lambda)\}u^t_{22}$$

where $t = \begin{cases} \text{N for no segregation} \\ \text{S for segregation} \end{cases}$

p_λ is the proportion of smokers in heterogeneous groups that choose meals with smoking,

q_λ is the proportion of smokers in heterogeneous groups that choose meals without smoking, and

$\bar{u}^t_{21} = m + 1 - \delta p_\lambda n - \varepsilon_2 w^t_1.$

Substituting in the utility functions, the welfare measures for no segregation and segregation can be determined:

$$W^N(\lambda) = m + 1 + \pi^n\gamma - w^N[\varepsilon_2-\pi(\varepsilon_2-\varepsilon_1)] + \lambda[1-\pi^n-(1-\pi)^n]\{p_\lambda\gamma-(1-p_\lambda)\delta p_\lambda n\}$$

$$W^S(\lambda) = m + 1 + \pi^n[\gamma-(w^S_1-w^S_2)\varepsilon_1] - w^S_2[\varepsilon_2-\pi(\varepsilon_2-\varepsilon_1)]$$

$$+ \lambda[1-\pi^n-(1-\pi)^n]\{p_\lambda\gamma-(1-p_\lambda)\delta p_\lambda n-(w^S_1-w^S_2)[\varepsilon_2-p_\lambda(\varepsilon_2-\varepsilon_1)]\}$$

There are two effects of segregation on the widespread externality - one, the Pigou effect, is the direct effect of internalizing the externality for those groups choosing meals with smoking, and the other, the Coase effect, is the indirect effect of changing the property rights parameter. If the critical number of non-smokers remains unchanged when there is segregation, then the property rights parameter is unchanged and segregation only has a direct effect on the widespread externality. If $\lambda=1$, independently of whether there is segregation or not, then segregation is welfare-improving ($W^S(1)>W^N(1)$) only if:

$$\frac{[1-(1-\alpha)^{\beta}]}{\left[\frac{\alpha}{1-(1-\pi)^{n}}+(1-\alpha)\right]^{\beta}-(1-\alpha)^{\beta}} > 1-\frac{(1-\pi)^{n}}{1-\pi\left(1-\frac{\varepsilon_1}{\varepsilon_2}\right)} \qquad \text{(P.1)}$$

This condition, the Pigou condition, identifies when the Pigou effect is welfare-improving. Two propositions follow immediately from this condition:

Proposition 1: If $\lambda^N=\lambda^S=1$, $\beta=1$, and $\varepsilon_1<\varepsilon_2$, then segregation is welfare-improving.

Proposition 2: If $\lambda^N=\lambda^S=1$, $\beta=1$, and $\varepsilon_1=\varepsilon_2$, then segregation is not welfare-improving.

If smokers' preferences always dominate irrespective of whether there is segregation or not and there are constant returns to scale in the widespread smoke externality technology, segregation strictly dominates no segregation if smokers are less adversely affected by the widespread externality than are non-smokers. If, on the other hand, smokers and non-smokers are equally adversely affected by the widespread externality, then segregation only has a distributional impact, but it has no impact in terms of average utility. If the widespread externality technology is characterized by constant returns to scale, segregation weakly dominates no segregation independent of the parameter values.

The case of increasing returns to scale is not as clear-cut as the constant returns to scale case. The effect of internalizing the externality not only has a distributional impact of shifting some of the burden of the widespread externality from all restaurant patrons to those patrons choosing meals with smoke, but internalization also imposes an additional cost because of the increasing average cost structure of the widespread externality. In this case, segregation no longer weakly dominates no segregation. The potential welfare improvement is very sensitive to the degree of the returns to scale, the permeability of the barrier, and the adverse effect of the widespread externality on smokers relative to non-smokers. Consider the extreme case where the barrier introduced by segregation is perfectly impermeable ($\alpha=1$). If smokers are as adversely affected as non-smokers are by the widespread externality ($\varepsilon_1=\varepsilon_2$), then no segregation dominates segregation if there are increasing returns to scale. If smokers are less adversely affected than non-smokers are, then segregation may or may not dominate no segreation if there are increasinsg returns to scale. In general:

Proposition 3: If $\lambda^N=\lambda^S=1$, $\beta>1$, and $\varepsilon_1/\varepsilon_2$ is "small", then segregation is welfare-improving.

For segregation to dominate no segregation given $\lambda=1$, the values of α, β, π, and n determine how small $\varepsilon_1/\varepsilon_2$ must be for condition (P.1) to hold. If smokers are not adversely affected by the widespread externality and $\lambda^N=\lambda^S=1$, then segregation is welfare-improving. If smokers are adversely affected by the widespread externality, $\lambda^N=\lambda^S=1$, and $\beta>1$, then segregation may not be welfare-improving. The three propositions presented assume that all heterogeneous groups choose meals with smoking and that segregation only has the direct effect of internalizing the widespread externality. In these cases, Propositions 1 and 3 provide justification for government intervention in the standard Pigouvian framework.

Assume now that under no segregation, all heterogeneous groups will choose meals with smoke ($\lambda^N=1$), but that segregation has the indirect effect of changing the property rights parameter ($\lambda^S<1$). In this case, the critical number of non-smokers in a group under no segregation is n-1 and so it must be the case that $\gamma/\delta\geq n-1$. The segregation property rights parameter, λ^S, is strictly less than 1 for:

$$\varepsilon_1+(n-1)\varepsilon_2>[1+\frac{\gamma}{\delta}-n]\frac{\delta}{\pi^\beta}\left\{\frac{1}{\left[\frac{\alpha}{1-(1-\pi)^n}+(1-\alpha)\right]^\beta-(1-\alpha)^\beta}\right\} \tag{C.1}$$

This condition, the first Coase condition, identifies if a Coase effect exists. The condition depends on the absolute magnitude of ε_1 and ε_2, rather than on the relative magnitude. If smokers and non-smokers are not "significantly" affected by the widespread externality in absolute terms, then $\lambda^S=1$ and we need only consider the Pigou condition (P.1) to determine if segregation is welfare-improving. If $\lambda^S<1$, then the welfare improvement provided by the direct effect can be reinforced by the indirect effect. The Coase assumption may provide further justification for government intervention when a widespread externality exists ($W^S(\lambda^S)>W^S(1)$):

$$\lambda[1-\pi^n-(1-\pi)^n]\{p_\lambda\gamma-(1-p_\lambda)\delta p_\lambda n-(w_1^S-w_2^S)[\varepsilon_2-p_\lambda(\varepsilon_2-\varepsilon_1)]\} - \pi^n(w_1^S-w_2^S)\varepsilon_1 - w_2^S[\varepsilon_2-\pi(\varepsilon_2-\varepsilon_1)] >$$

$$(\pi-\pi^n)\left[\gamma-\frac{[1-\pi-(1-\pi)^n]\delta n}{1-\pi^n-(1-\pi)^n}\right]-\pi^\beta\left[\frac{\alpha}{1-(1-\pi)^n}+(1-\alpha)\right]^\beta\{[1-\pi-(1-\pi)^n]\varepsilon_2+\pi\varepsilon_1\}$$

$$-\pi^\beta(1-\alpha)^\beta(1-\pi)^n\varepsilon_2 \tag{C.2}$$

Proposition 4: If $\lambda^N=1$, and if conditions (P.1), (C.1), and (C.2) are satisfied, then the indirect effect of within-group bargaining reinforces the direct effect of government intervention.

We can also consider the indirect effect on its own. If smokers and non-smokers are "significantly" affected by the widespread externality in absolute terms, then $\lambda^S<1$ and segregation is welfare-improving ($W^S(\lambda^S)>W^N(1)$) only if:

$$\lambda[1-\pi^n-(1-\pi)^n]\{p_\lambda\gamma-(1-p_\lambda)\delta p_\lambda n-(w_1^S-w_2^S)[\varepsilon_2-p_\lambda(\varepsilon_2-\varepsilon_1)]\} - \pi^n(w_1^S-w_2^S)\varepsilon_1 - w_2^S[\varepsilon_2-\pi(\varepsilon_2-\varepsilon_1)] >$$

$$(\pi-\pi^n)\left[\gamma-\frac{[1-\pi-(1-\pi)^n]\delta n}{1-\pi^n-(1-\pi)^n}\right]-\pi^\beta[\varepsilon_2-\pi(\varepsilon_2-\varepsilon_1)] \qquad \text{(C.3)}$$

For $\lambda<1$, this condition identifies when segregation is welfare-improving given a Coase effect. A surprising result is that even if the direct effect of government intervention does not provide a welfare improvement, the indirect effect of the changed property rights allocation may improve welfare:

Proposition 5: If $\lambda^N=1$, then there exist sets of parameter values for α, β, γ, δ, ε_1, ε_2, π, and n such that conditions (C.1) and (C.3) are satisfied and condition (P.1) is not satisfied.

For the sets of parameters described in Proposition 5, we know that for an unchanged property rights parameter, segregation is not welfare-improving because the costs imposed by segregation on the patrons who choose meals with smoking are equal to or greater than the benefit for the patrons in the no-smoking section. Segregation, however, changes the property rights parameter, which results both in fewer patrons bearing the heavier costs of the smoking section and in a reduced widespread externality. These two results of the changed property rights parameter cause segregation to be welfare-improving.

We will look at a set of parameter values in which the direct effect of regulation is not welfare-improving, but the indirect effect results in increased welfare. The case is one in which $\varepsilon_1/\varepsilon_2$ is not "small enough" to satisfy Proposition 3. The set of parameter values is $\alpha=.5$, $\beta=1.5$, $\gamma=.4$, $\delta=.125$, $\varepsilon_1=.25$, $\varepsilon_2=.33333$, $\pi=.3$, and n=4. In this case, with no segregation, smokers own the air and average welfare net of m is $W^N(1)=.980$. If there were no impact on the property rights allocation, then segregation would not be welfare-improving:

$W^S(1)=.979$. However, the Coase assumption does result in a change in property rights, $\lambda^S=.453$, and the indirect effect of the changed property rights results in government intervention being welfare-improving: $W^S(.453)=1.007$.

Propositions 1 and 3 provide standard Pigou results - the direct effect of internalizing the externality is welfare-improving; Proposition 4 provides an anticipated Coase result - regulation is welfare-improving because the widespread externality is internalized to some degree and because within-group bargaining reduces the amount of externality-producing activity. Proposition 5 provides a surprising Coase result. In this case, the welfare improvement attributable to regulation arises not because of the direct effect of internalizing the widespread externality, but solely because of the indirect effect of changing the property rights parameter. In this case, within-group bargaining is necessary for government regulation to be welfare-improving.

7. Conclusion

Under no segregation, given the proportion of smokers in the population (π) and group size (n), the utility parameters that measure a smoker's utility of smoking (γ) and a non-smoker's disutility of smoke generated by each smoker in the group (δ) determine the amount of the local externality, and the resulting amount of the widespread externality. The existence of the widespread externality results in the failure of bargaining over the local externality to provide a Pareto optimal result. When an externality is both local and widespread, bargaining over the local externality does not rule out that government intervention is justifiable. This is clear. The widespread externality is not necessarily effectively internalized by bargaining over the local externality. If an externality is both local and widespread and agents bargain over the local externality, government intervention should be evaluated not only in terms of its direct effect of internalizing the widespread externality, but also in terms of its potential indirect effect of changing the outcome of the bargaining over the local externality.

In the case of a strictly local externality, the Coase assumption provides an alternative to government intervention. In this example where there is also a widespread externality, the Coase assumption, limited to the bargaining of small groups, may not only provide a gain to the welfare improvement arising from the direct effect of government intervention, but the Coase assumption can provide justification for government regulation. If externalities are both local and widespread, the Coasian and Pigouvian approaches are not necessarily mutually exclusive, but rather can be complementary in internalizing externalities.

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1. To ensure that non-smokers prefer a restaurant meal with smoking to no restaurant meal at all, δ is restricted to lie in $(0, (1-\varepsilon_2)/(n-1))$, and to ensure that smokers prefer a meal with smoking to one without, γ lies in $(\varepsilon_1, 1)$.

2. Restaurants are assumed to be large, having a seating capacity of at least $2/(1-\pi)^n$. This allows for at least two groups choosing meals without smoking, even if all heterogeneous groups choose meals with smoking.