# Efficient Relocation of Spectrum Incumbents*

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*Abstract*

Changes in technologies and in consumer demands have made prior radio spectrum allocations far from efficient. To address this problem the FCC has recently reallocated spectrum for more flexible use in bands that are partially occupied by incumbent license holders. Often, it is necessary for the new license holder to relocate incumbents to make efficient use of the spectrum. Regulations structuring the negotiation between incumbent and new entrant can promote efficiency. In particular, giving the new entrant the right to move the incumbent with compensation can reduce negotiation costs and promote efficiency when there is private information about spectrum values but good public information about the cost of relocating the incumbent. We examine the experience of broadband PCS entrants in relocating microwave incumbents. We conclude with some remarks on how these ideas might be applied to digital television spectrum.

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# Efficient Relocation of Spectrum Incumbents

Peter Cramton, Evan Kwerel, and John Williams

*There is no single issue more important to the competitive rollout of services than microwave relocation.*

— Tom Wheeler, President, CTIA, *Wireless Business and Technology*, March 1996, p. 26.

## 1  Introduction

Since 1934, the Federal Communications Commission (FCC) has allocated radio spectrum through the award of narrowly-defined licenses. Changes in technologies and consumer demands have made these prior allocations far from efficient. In response, the FCC has reallocated spectrum for more flexible use in bands that are partially occupied by incumbent license holders. The recent personal communication services (PCS) allocation is an example. Licenses are assigned by competitive auction to promote an assignment to the firm that can make the best use of the spectrum.[1] However, often the new entrant must relocate the incumbent before it can provide an efficient service. The question we address in this article is: should the FCC attempt to structure the relocation negotiations? And, if so, how?

In a world without transaction costs, the answer is simple. All that is needed are clear property rights.[2] Then the parties, left to their own devices, will negotiate efficiently. Whenever the value of relocation exceeds the cost, the parties will agree on terms for relocation. No further regulation by the FCC is needed. Two factors, however, complicate the analysis. First, transaction costs are not zero. Different property rights involve different transaction costs.[3] Second, the assignment of property rights has large distributional consequences, which affect the FCC's ability to reallocate spectrum to flexible use.

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[1] On the advantages of treating spectrum as private property see Ronald H. Coase, The Federal Communications Commission, 2 *J. Law & Econ.* 1 (1959), and Arthur S. De Vany, et al., A Property System for Market Allocation of the Electromagnetic Spectrum: A Legal-Economic-Engineering Study, 21 *Stanford Law Rev.* 1499 (1969).

[2] Ronald H. Coase, The Problem of Social Cost, 3 *J. Law & Econ.* 1 (1960).

[3] Harold Demsetz, When Does the Rule of Liability Matter? 1 *J. Legal Studies* 13 (1972); Guido Calabresi & A. Douglas Melamed, Property Rules, Liability Rules, and Inalienability: One View of the Cathedral, 85 *Harvard Law Rev.* 1089 (1972).

In analyzing the efficiency of alternative rules, the FCC must consider how the rules influence both the reallocation and relocation decisions. For example, in PCS, without providing incumbents with a share of the gain from reallocation, the incumbents would have blocked the reallocation of spectrum from fixed microwave to emerging technologies. In general, the FCC may be able to increase the supply of spectrum for reallocation to flexible use by guaranteeing the incumbents a share of the potential gains.

Two alternative property rights are natural in this setting. Incumbents argue for a *right to stay*. Under this rule, an incumbent is free to use the spectrum according to the terms of the existing license. Relocation can only occur if the incumbent agrees. Entrants argue for a *right to move*. With this rule, the entrant can unilaterally move the incumbent. Two versions of this rule arise depending on whether the entrant must pay for the relocation (right to move with or without compensation). Compromise rules are also possible, such as giving the incumbent a right to stay for a limited period of time after which the entrant has the right to move the incumbent. Indeed, this is the rule that the FCC adopted for PCS. We evaluate the effects of these rules on bargaining outcomes and transaction costs.[4]

Transaction costs are likely to be highest when the incumbent has a right to stay. This rule puts incumbents in a position to bargain for a large and uncertain pie, which depends on the parties' private information. Presumably, the entrant has better information about the value of relocation and the incumbent has better information about the cost. This asymmetry of information creates incentives for both parties to engage in costly strategic bargaining. In this setting, there is no guarantee that an efficient agreement will be reached, and if it is it may involve costly delay. In addition, since the entrant may need to move numerous incumbents to use the spectrum efficiently, there is a potential holdout problem. An incumbent's bargaining position may improve if it is the last to settle with the entrant. Each incumbent may hold out for a better deal. Finally, an incumbent may be operating across several new licenses, auctioned at separate times. Early entrants will not take into account the value to subsequent entrants of relocating an incumbent. The later entrants are able to free-ride on the early entrants, frustrating efficient relocation.

Transaction costs may be substantially reduced under a right to move. With this rule, negotiation may be unnecessary. The status quo of clearing the spectrum may be efficient. In any event, the rule focuses negotiations primarily on the cost of relocation rather than on the value to the entrant of clearing the spectrum. Information about the relocation cost may be revealed by requiring that the incumbent let

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[4] We limit our analysis to these simple rules. More complex rules that depend on additional information revealed by the parties may perform better. See Peter Cramton, Robert Gibbons & Paul Klemperer, Dissolving a Partnership Efficiently, 55 *Econometrica* 615 (1987), and Ian Ayres & Eric Talley, Solomonic Bargaining: Dividing A Legal Entitlement To Facilitate Coasean Trade, 104 *Yale Law J.* 1027 (1995).

independent third parties estimate the cost of relocating. Then if the entrant pays the cost of relocating, the entrant is in a position to make an efficient decision to clear the spectrum. This rule effectively shifts bargaining power to the entrant, reducing the need for and scope of negotiations.

Unfortunately, the right-to-move rule, even with compensation, may not be politically feasible. Incumbents likely would lobby to block a reallocation that does not make them better off. In the case of PCS, the FCC modified the right-to-move rule by introducing an initial period where the incumbent has a right to stay. This gives the incumbents a limited ability to get a premium above relocation costs. This premium was a way to make the PCS reallocation acceptable to incumbents and yet limit the inefficiency in bargaining. Furthermore, the rule encourages voluntary settlements. This tends to keep the FCC out of resolving disputes in individual cases, further reducing transaction costs.

The early experience with this rule suggests that it is largely successful in encouraging settlements. Most parties are able to agree fairly quickly. Nonetheless, there is evidence that some incumbents are taking advantage of the long period with a right-to-stay and demanding large premiums over actual costs. A shorter right-to-stay period would reduce these demands and promote faster, more efficient settlements. However, such a change might weaken the FCC's ability to negotiate future reallocations with incumbents.

We begin by analyzing the efficiency of alternative property right rules in a setting when negotiation is not possible. Then we analyze the bargaining problem between an incumbent and an entrant under the various rules. We then discuss the recent experience with the FCC's microwave relocation rules for PCS. We conclude by applying these ideas to reallocations of broadcasting spectrum.

## 2   Efficiency of various rules without negotiation

A corollary of the Coase Theorem is that when bargaining is difficult, property rights can play an important role in limiting inefficiencies. We begin by making the extreme assumption that bargaining is impossible. Hence, the parties can only do what can be accomplished by unilateral action. In this case, the best rule is one that minimizes the need to negotiate.

Three outcomes are possible: relocating the incumbent, terminating the incumbent, and accommodating the incumbent. Let

$c$ be the cost of relocating the incumbent,

$v_i$ be the value to the incumbent of the existing service, and

$v_e$ be the value to the entrant of removing the incumbent.

The outcome is efficient if it involves the least cost or smallest value loss. Specifically, efficiency requires

(1) the incumbent relocates if $c < v_i$ and $c < v_e$,

(2) the incumbent terminates service if $v_i < c$ and $v_i < v_e$, and

(3) the entrant accommodates the incumbent if $v_e < c$ and $v_e < v_i$.

Relocation makes sense only if the cost of relocating the incumbent is less than both the entrant's value from clear spectrum and the incumbent's value of the service (case 1). Otherwise, the incumbent's service should be terminated (case 2) or accommodated (case 3), depending on whether the entrant's value from clearing exceeds the incumbent's value from continuing operations.

Bargaining is made difficult because both the entrant and the incumbent have private information. In particular, the entrant's value $v_e$ of clear spectrum is known only by the entrant, and the incumbent's value $v_i$ of its service is only known by the incumbent. These values are subjective and cannot be verified by a third party. In contrast, the cost $c$ of relocating is an objective cost, which can be estimated accurately by a third party.[5] We assume that the cost $c$ is estimated by an independent third party and known to both entrant and incumbent.

Consider the following property right rules:

1. *Right to stay*. The incumbent has the right to continue its existing service according to the terms of its license.

2. *Right to move without compensation*. The entrant has the right to clear the incumbent and is not required to compensate the incumbent for the loss of its existing service.

3. *Right to move with compensation*. The entrant has the right to clear the incumbent but must pay the incumbent the cost of relocating.

Table 1 shows the six possible orderings of the variables $c$, $v_i$, and $v_e$. For each ordering, the efficient outcome is given as well as the outcome under each of the three rules, assuming that negotiation is not possible. The last row gives the probability of an efficient outcome under the three rules, assuming that each ordering is equally likely.

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[5] To a first approximation, this is a straightforward engineering exercise.

Table 1. Outcome under each rule without negotiation

| Case | Efficient Outcome | Right to stay | Right to move without compensation | Right to move with compensation |
|---|---|---|---|---|
| 1. $c < v_i < v_e$ | Relocate | *Accommodate* | Relocate | Relocate |
| 2. $c < v_e < v_i$ | Relocate | *Accommodate* | Relocate | Relocate |
| 3. $v_i < c < v_e$ | Terminate | *Accommodate* | Terminate | Terminate |
| 4. $v_i < v_e < c$ | Terminate | *Accommodate* | Terminate | *Accommodate* |
| 5. $v_e < c < v_i$ | Accommodate | Accommodate | *Relocate* | Accommodate |
| 6. $v_e < v_i < c$ | Accommodate | Accommodate | *Terminate* | Accommodate |
| Pr(Efficient) | 1 | 1/3 | 2/3 | 5/6 |

Note: Pr(Efficient) assumes each case is equally likely. Inefficient outcomes are in *italics*.

Under the right to stay, the incumbent always continues service. Hence, it is only efficient when accommodation is best (one-third of the time). Under the right to move without compensation, the entrant always demands that the spectrum be cleared. The incumbent then decides to relocate or terminate, depending on whether $c < v_i$. This yields the efficient outcome in two-thirds of the cases.[6] Under the right to move with compensation, the entrant clears the spectrum if $c < v_e$, in which case the incumbent decides to relocate or terminate, depending on whether $c < v_i$. This results in the efficient outcome in five of the six cases. The only time negotiation is needed is when the entrant accommodates, even though the incumbent has a lower value. Moreover, the size of the inefficiency is bounded by the cost of relocation.

Unless the regulator has strong priors about the likely efficiency of relocation, termination, and accommodation, the best rule is a right to move with compensation. Under this rule, both the entrant and the incumbent compare the cost of relocation with their private values. The right to stay is the worst rule, since the outcome without negotiation is independent of the cost and values.

In general, the best rule depends on the regulator's priors over the six cases. If it is likely that accommodation is efficient, then the right to move with compensation may perform best. If it is likely that accommodation is inefficient, then the right to move without compensation may perform best. Notice that the right to stay is dominated by the right to move with compensation. Hence, the right to move with compensation should be preferred to the right to stay no matter what the probabilities of the six cases.

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[6] The efficiency analysis assumes that the relocation cost $c$ fully reflects the social cost of spectrum used in relocating incumbent microwave licenses. This is not the case, since microwave licensees do not pay for the spectrum in the relocation bands. These bands are managed by the FCC, which tries to accommodate without charge all microwave users relocating from the PCS bands.

An important assumption in the preference for the right to move with compensation is that the cost $c$ of relocating is publicly known. If instead only the incumbent knows the cost of relocating, then the right to move with compensation may be problematic. Accommodation will tend to occur too frequently, since the incumbent will overstate the cost of relocating.

A critical feature of our problem is the option to relocate. Without the relocation option, there would be only two outcomes, accommodate or terminate, and only two rules, "right to stay" and "right to move." There would be no reason to expect that one is better than the other without knowing the facts about the likely spectrum values under each outcome. The possibility of relocating the incumbent changes the analysis in two ways. First, the cost of relocating $c$ is observable. This makes the "right to move with compensation" a feasible cost-benefit rule, since the amount of compensation can be determined without negotiation. Second, the incumbent can always exercise the relocation option unilaterally. This ability of the incumbent to mitigate damages is the source of the efficiency advantage of the right-to-move rules over the right-to-stay rule. Without the ability of the incumbent to exercise the relocation option, the "right to move without compensation" column in Table 1 would show "terminate" in all cases and the probability of efficiency would be the same as under the right-to-stay rule (efficient only in cases 3 and 4). The "right to move without compensation" puts the costs on the party who is best able to mitigate damages. The right to move with compensation also benefits from the ability of the incumbent to mitigate. The entrant determines whether it wishes to clear the spectrum based on whether the benefits exceed the relocation costs, but the incumbent chooses whether to terminate or relocate if the entrant decides to clear.

## 3   Negotiation difficulties under each rule

We now relax the assumption that bargaining is impossible. Instead, we make the realistic assumption that bargaining occurs between the entrant and the incumbent, but that negotiations may be difficult because of the parties' private information. For each rule, we begin by assuming full-information, so that the parties know whether negotiation is needed to move to the Pareto frontier. Consistent with the Coase Theorem, negotiations are costless in this case. We further assume that the parties split equally the welfare gain that results from negotiation. This is the Nash bargaining solution with two risk-neutral bargainers. This outcome can also be justified as the unique equilibrium outcome of a noncooperative bargaining game. Specifically, if the parties alternate offers, have equal discount rates,

and can make offers quickly, then the Nash bargaining solution is the unique subgame-perfect equilibrium of the noncooperative bargaining game.[7]

The full-information analysis is the building block for the realistic case where bargaining is costly due to the parties' private information over valuations. For each setting, we assess how costly bargaining is likely to be by modeling the bargaining as a noncooperative game with incomplete information. Specifically, we assume that the bargaining is characterized by the signaling equilibrium, in which the bargainers reveal their private information through their willingness to postpone agreement.[8] Eventually, the parties settle but only after a period of costly delay. When private information is revealed, the settlement is the same as the Nash bargaining solution, postponed sufficiently to make the information revelation credible. The bargaining inefficiency grows with the size of the pie under negotiation and amount of uncertainty over private information variables. Inefficiencies are greatest when both bargainers have private information about values.

### 3.1  Negotiations under a right-to-stay rule

Suppose the incumbent has the right to stay. It can, however, agree to clear the spectrum if suitable terms can be negotiated with the entrant. The settlement depends on the three cases:

1.  $v_i > c$ and $v_e > c$. The incumbent relocates for a total bargaining gain of $v_e - c$. Each gains $\frac{1}{2}(v_e - c)$. This is the net gain over the status quo to each party. To secure the value $v_e$, the entrant pays the cost $c$ plus a premium $\frac{1}{2}(v_e - c)$ to relocate the incumbent.

2.  $v_i \leq c$ and $v_i < v_e$. The incumbent terminates service for a total bargaining gain of $v_e - v_i$. Each gains $\frac{1}{2}(v_e - v_i)$. To get the incumbent to terminate, the entrant pays the incumbent its loss $v_i$ plus a premium $\frac{1}{2}(v_e - v_i)$.

3.  $v_e \leq c$ and $v_e \leq v_i$. The entrant accommodates the incumbent for a total bargaining gain of 0. The status quo is efficient in this case, so no bargaining is needed.

An important feature of this bargain is that the outcome depends on $v_e$, $v_i$, and $c$. In all but case 3, the incumbent is able to extract a premium from negotiations. The size of the premium increases with the entrant's value of clearing the spectrum and decreases with the cost of relocation (case 1) or the

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[7] Ariel Rubinstein, Perfect Equilibrium in a Bargaining Model, 50 *Econometrica* 97 (1982).

[8] The parties have independent private values and discount delayed gains from trade. The bargaining involves alternating offers until a settlement is reached. Peter Cramton, Strategic Delay in Bargaining with Two-Sided Uncertainty, 59 *Review Econ. Studies* 205 (1992).

incumbent's value of the service (case 2). Inefficiency is avoided, but only because of the unrealistic assumption that all variables are commonly known.

To make the model more realistic, assume the entrant has private information about the value $v_e$ and the incumbent has private information about the value $v_i$. In this case, the entrant has an incentive to understate its value and the incumbent has an incentive to overstate its value. This misrepresentation often prevents an efficient agreement. For example, assuming the parties know they are in case 2, if $v_e$ and $v_i$ are each uniformly distributed on the same interval and the parties adopt the signaling equilibrium, then 44 percent of the potential gains from trade are lost as a result of costly delay.[9] This is an extreme example in that it treats the case of greatest uncertainty. However, so long as there is some uncertainty about the existence of gains from trade, the bargaining will involve some costly delay.[10]

A natural way to reduce the bargaining costs is to require that the incumbent let an independent third party estimate the cost $c$ of relocating. Under the assumption that $c < v_i$, then the bargaining has just one-sided uncertainty. The entrant's value of relocation is private information, but the cost of relocation is commonly known. The revelation of the cost $c$ can greatly reduce bargaining costs. In the signaling equilibrium, when the entrant's value is uniformly distributed between $c$ and some upper bound, then 19 percent of the gains from trade are lost to delay.[11] Whenever the incumbent is able to negotiate a premium above $c$, bargaining will be inefficient, because of the delay needed to extract the premium.

The bargaining problem is further complicated when, as is commonly the case in PCS, the entrant has numerous incumbents to relocate. To highlight the problem, suppose that the entrant must clear all the incumbents before service can be provided. Further suppose that the other incumbents have settled with the entrant. Then in case 1, the last incumbent will be able to extract a premium equal to $\frac{1}{2}(v_e - c)$, where $v_e$ is the value from moving all incumbents and $c$ is the cost of moving the last one. Clearly, the entrant would be unable to pay all incumbents such a large premium; hence, there is an incentive for each incumbent to hold out to be the last to settle. If the entrant is unable to negotiate with all of the incumbents as one, then timely settlement is discouraged. In PCS, the entrant's problem is not so severe. The entrant may be able to work around the incumbent. However, to the extent that relocating one incumbent increases the value of relocating another, settlement may be difficult.

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[9] Ibid.

[10] Roger B. Myerson & Mark A. Satterthwaite, Efficient Mechanisms for Bilateral Trading, 28 *J. Econ. Theory* 265 (1983).

[11] Peter Cramton, Dynamic Bargaining with Transaction Costs, 37 *Management Science* 1221 (1991). In contrast, the loss could be as high as 44 percent if the relocation cost is privately known by the incumbent.

A final problem frustrating efficient settlement in PCS is that a single incumbent may operate across multiple licenses, which are auctioned at different times. For example, a microwave incumbent may operate across the A and C bands. Since the C band was auctioned over 1 year after the A band, an A-band winner eager to get to market will not take into account the C-band gain from relocation. Efficiency requires that the C-band winner share in the cost of relocation. However, until the C-band winner is determined, this is impossible without regulation. Even if the winners are known, there is still a free-rider problem. Each entrant has an incentive to let the other entrants negotiate the relocation.

The main difficulty with the right-to-stay rule is that it gives the incumbent too much bargaining power. Relocation or termination under this rule requires a successful negotiation between entrant and incumbent. But bargaining costs are likely to be high because of the large pie under negotiation and the private information about valuations

## 3.2  Negotiations under a right-to-move-with-compensation rule

Negotiating under a right-to-move rule may facilitate efficiency by limiting the frequency and scope of negotiations. First consider the bargaining with full information. The right-to-move rule, by shifting the threat point of the bargaining, that is, the outcome if bargaining fails, alters the pie that the parties are bargaining over. The threat point under the right-to-move rule is complicated, because there are two possibilities. The entrant can accommodate or relocate the incumbent. The bargaining outcome depends on whether relocation is a credible threat when termination is efficient. We assume that it is not, since relocation is irreversible and costly. If during negotiations the entrant accommodates the incumbent, then the appropriate threat point is accommodation. Relocation in this case is like an outside option. It affects the outcome by bounding the premium that the incumbent can extract.[12] The parties split equally the gain from settlement in each of the three cases, subject to the constraint that the incumbent cannot extract a premium larger than $c$.

1.  $v_i > c$ and $v_e > c$. The incumbent relocates for a total bargaining gain of 0. The status quo is efficient in this case, so no bargaining is needed.

2.  $v_i \leq c$ and $v_i < v_e$. The incumbent terminates service for a total bargaining gain of $v_e - v_i$. The incumbent gets a premium of $\min\{c, \frac{1}{2}(v_e - v_i)\}$.[13]

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[12] Ken Binmore, Ariel Rubinstein & Asher Wolinsky, The Nash Bargaining Solution in Economic Modelling, 17 *Rand J. Econ.* 176 (1986).

[13] If relocation was a credible threat, then the incumbent's premium would be reduced to $\frac{1}{2}(\min\{c, v_e\} - v_i)$.

3. $v_e \leq c$ and $v_e \leq v_i$. The entrant accommodates the incumbent for a total bargaining gain of 0. The status quo is efficient in this case, so no bargaining is needed.

With full information, negotiation is unnecessary in two of the three cases. If either relocation or accommodation is efficient, then the entrant can assure the efficient outcome by unilateral action. Only if termination is efficient is there something to negotiate.

Now suppose that the parameters are private information (the entrant knows $v_e$ and the incumbent knows $c$ and $v_i$). Then again bargaining may be difficult as before. However, if $c$ is revealed by independent third-party estimates, then the situation is much improved. Specifically, the entrant can often achieve the efficient outcome by adopting the following simple rule. If $v_e > c$, then the entrant gives the incumbent $c$ to clear the spectrum (relocate or terminate). If $v_e < c$, then the entrant accommodates the incumbent. This unilateral action is efficient unless $v_i < v_e < c$, since then the entrant accommodates when the incumbent should terminate. Hence, even with private information about valuations, negotiations are often not needed. Bargaining when valuations are low can reduce this inefficiency. But if negotiations fail, the size of the inefficiency is bounded by the cost of relocation.

### 3.3 Negotiations under a right-to-move-without-compensation rule

Since the entrant can force a move without compensation, the incumbent's only alternative to immediate relocation is to terminate operations until settlement. Thus, temporary termination is the threat during bargaining, and relocation is the outside option for the incumbent. As before, the outside option of relocation limits the premium the entrant can extract for not forcing termination. Outcomes in the three cases are as follows:

1. $v_i > c$ and $v_e > c$. The incumbent relocates for a total bargaining gain of 0. The status quo is efficient in this case, so no bargaining is needed.

2. $v_i \leq c$ and $v_i < v_e$. The incumbent terminates service for a total bargaining gain of 0. No bargaining is needed.

3. $v_e \leq c$ and $v_e \leq v_i$. The entrant accommodates the incumbent for a total bargaining gain of $\min\{c, v_i\} - v_e$. The entrant gets a premium of $\min\{c - v_e, \frac{1}{2}(v_i - v_e)\}$ for letting the incumbent stay.[14]

Again, no bargaining is needed in two of the three cases. Only when accommodation is best, do the parties have something to negotiate.

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[14] If relocation was a credible threat, then the entrant's premium would be reduced to $\frac{1}{2}(\min\{c, v_i\} - v_e)$.

With private information, the entrant can achieve efficiency in two of the three cases simply by insisting that the incumbent relocate or terminate. Since the incumbent knows $v_i$ and $c$, it will efficiently relocate in case 1 and terminate in case 2. Bargaining is required in case 3. The entrant will have to communicate information about $v_e$, if the gains from efficient accommodation are to be realized. However, since the entrant's total payment increases in $v_e$, it has an incentive to overstate $v_e$, preventing efficient accommodation.

When the entrant does not pay the cost of relocation, there is too little accommodation. Termination and relocation decisions are likely made independently of $v_e$, which is inefficient. In contrast, when the entrant pays the cost of relocation, then the only inefficiency is accommodation when termination is best ($v_i < v_e < c$). Hence, the right to move with compensation is likely to be more efficient than the right to move without compensation (so long as the cost of relocation can be measured). Moreover, incumbents are made worse-off without compensation, so they would probably be able to block such a rule.

## 4 Negotiations under a delayed right-to-move rule

Despite the lower bargaining costs, incumbents will not like the right-to-move rule. The lower bargaining costs stem directly from taking away the incumbent's ability to negotiate a substantial premium for clearing the spectrum. Hence, since incumbents are likely to have political power in the rule-making, it may be impossible politically to adopt a right-to-move rule. Moreover, some delay of the right to move is warranted, because it will take time before the entrant is ready to begin providing service. With an immediate right to move, the entrant would be able to negotiate a premium for letting the incumbent stay during this period, even though the incumbent's service is imposing no costs on the entrant. A natural compromise is to give the incumbents the right to stay for a limited period, after which the entrants have the right to move. This was exactly what the FCC did in the case of broadband PCS. The microwave incumbents have the right to stay for a period and then the entrant has the right to move with compensation.

What is the consequence of a delayed right-to-move rule? Again, it is instructive to first consider the case of full information and alternating offers. The bargain from a sequence of threats is just the weighted average of the full-information bargain for each threat where the weights are given by the fraction of time spent in each threat, assuming that a settlement is never reached.[15] Hence, the settlement is simply a weighted average of the settlement under the right-to-stay rule and the settlement under the right-to-move rule. Even though settlement occurs before the transition to the right-to-move rule, the delayed right to

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[15] Peter Cramton & Joseph Tracy, Wage Bargaining with Time-Varying Threats, 12 *J. Labor Econ.* 594 (1994).

move has an important impact on the bargaining outcome. The incumbent knows that with each day of delay, the entrant's bargaining position improves as its right to move grows near. Let $\gamma$ be the (discounted) fraction of time spent under the right-to-stay rule. Then the bargaining outcome is as follows in each of the three cases:

1. $v_i > c$ and $v_e > c$. The incumbent relocates for a total bargaining gain of $\gamma(v_e - c)$. The bargaining gain under the right to stay $(v_e - c)$ is reduced by the factor $\gamma$, since there is no gain to bargaining under the right to move. To secure the value $v_e$, the entrant pays the cost $c$ plus a premium $\gamma(v_e - c)/2$ to relocate the incumbent.

2. $v_i \leq c$ and $v_i < v_e$. The incumbent terminates service for a total bargaining gain of $v_e - v_i$ if $\frac{1}{2}(v_i - v_e) < c$, or $\gamma(v_e - v_i) + (1-\gamma)c$ otherwise. In the first case, $\frac{1}{2}(v_i - v_e) < c$, the bound $c$ on the bargaining gain under the right to move is not binding, so the bargaining gain is $v_e - v_i$ under both threats. However, when $\frac{1}{2}(v_i - v_e) > c$, then the bargaining gain under the right to move is $c$.

3. $v_e \leq c$ and $v_e \leq v_i$. The entrant accommodates the incumbent for a total bargaining gain of 0. The status quo is efficient in this case.

The incumbent is now able to extract a relocation premium, but the size of the premium is limited by the length of the right-to-stay phase. In PCS, clearing the spectrum has no value until the network is up, which probably takes about 1 year. Hence, with a 3-year right-to-stay period and a 10-year horizon, an estimate of $\gamma$ would be about 20 percent = $(3 - 1)/10$. The pie being bargained over in case 1 is only about one-fifth its size under a right-to-stay rule.

Now assume that there is private information about $v_e$, but that $c$ is commonly known and it is known that we are in case 1. This is the case of one-sided uncertainty with a time-varying threat studied by Peter Cramton and Joseph Tracy. The bargaining cost in this case is roughly proportional to the size of the inefficiency from impasse.[16] In particular, if the possible inefficiency is cut by a factor of five, then the bargaining costs are cut by a factor of five. Hence, limiting the duration of the right-to-stay rule does effectively limit bargaining costs.

Switching to a right-to-move rule, even after several years, has a dramatic effect on the bargaining outcome. The ability of the incumbent to extract a large premium is greatly reduced, since with each day of disagreement the incumbent's bargaining position worsens. This makes the incumbent eager to settle, and bargaining costs are reduced.

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[16] Ibid.

# 5 Relocation of Microwave Incumbents in PCS

The foregoing theory is helpful in understanding FCC relocation rules and the actual experience of PCS entrants relocating microwave incumbents. The FCC has relied on all three relocation rules, typically providing an initial period with the right to stay and then a period with either the right to move without compensation or the right to move with compensation. The choice of rules, especially the length of the right to stay period, has been determined by the relative political power of incumbents and new entrants as well as efficiency considerations. The FCC had to consider two, sometimes conflicting, efficiency margins when adopting the rules governing relocation of microwave incumbents in spectrum that was ultimately reallocated for PCS. The first was the reallocation of spectrum from microwave services to more flexible use. The second, given that the initial reallocation had been made, was the relocation of incumbent microwave systems. By increasing the length of the right to stay period the commission increased the likelihood of being able to make an efficiency enhancing reallocation, while reducing the efficiency of the relocation of incumbents after the reallocation had be adopted. In contrast, replacing a right-to-move-without-compensation rule with a right-to-move-with-compensation rule seems to have increased efficiency on both margins.

## 5.1 Background

In September 1992,[17] the FCC reallocated 220 MHz of spectrum in the 1850–2200 MHz band for future communications services that employ emerging technologies. A year later,[18] the FCC allocated 120 MHz of this spectrum (1850–1910 MHz and 1930–1990 MHz) for broadband PCS. While PCS was defined flexibly to include a wide range of mobile and fixed services, it became clear that the likely use would be to provide services competitive with the two existing cellular systems. Given the rapid growth of cellular, the expected benefits to consumers and the economy were large.

The rules for PCS provided for the exhaustive licensing of the spectrum throughout the United States using competitive bidding procedures. To do this, the spectrum was divided into six spectrum "blocks"— three with 30 MHz (blocks A, B, and C) and three with 10 MHz (blocks D, E, and F). For blocks A and B, the United States was divided into 51 service areas patterned after the Rand McNally Metropolitan Trading Areas (MTAs). For blocks C, D, E, and F, 493 areas were used, based on Rand McNally's smaller Basic Trading Area (BTAs). Each spectrum block and service area constituted a separate license. The licenses were arranged in three groupings by block and auctioned in three separate events using

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[17] *First Report and Order and Third Notice of Proposed Rule Making Re: Redevelopment of Spectrum to Encourage Innovation in the Use of New Technologies*, 7 FCC 6886 (1992).

[18] *Second Report and Order Re: Amendment of the commission's rules to Establish New Personal Communications Services*, 8 FCC 7700 (1993).

simultaneous, multiple round bidding. The auction for the 99 licenses on blocks A and B was completed in March 1995,[19] followed by the 493 block C licenses in May 1996, and the 1,479 block D, E, and F licenses in January 1997.[20]

Before its reallocation to PCS, the 1850–1990 MHz band was allocated for private fixed point-to-point service for businesses and non-federal governmental entities to be used for their own internal communications. A point-to-point system typically consists of multiple radio "links" of 30 miles or so in length connected together in tandem to relay communications over longer distances. Each radio link consists of a transmitter and receiver with directional antennas facing each other at the opposite ends of a communications path. A two-way link has a transmitter and receiver at both ends to carry communications in both directions. Point-to-point licenses are site-specific—authorizing operation at particular locations rather than throughout an area as in PCS—and are subject to a variety of technical rules designed to limit spectrum use to just the amount "needed." Licensees in bands allocated to point-to-point service are protected from interference by a coordination process prescribed by the FCC. Spectrum is assigned free, and the rights to unassigned spectrum in an area are retained by the FCC for future assignment.

In sharp contrast to the site-licensing approach used for point-to-point systems, PCS licenses cover wide areas and are designed to permit maximum flexibility of use subject only to restrictions on the amount of power into adjoining spectrum blocks and areas. The PCS license is, in effect, an "overlay" license on spectrum that is partially occupied by point-to-point systems. The FCC decided to protect the incumbent systems by limiting the amount of interference power a PCS licensee may introduce into a point-to-point receiver operating inside the PCS licensee's spectrum block. The power limit protecting incumbent receivers and the potential for interference from incumbent transmitters serve to constrain the frequencies and locations available for PCS facilities. In some areas with high concentrations of incumbents, the interference constraints could prevent a PCS licensee from offering a competitive service.

Historically, when spectrum was reallocated from one use to another, incumbent licensees were given the right to stay, that is, "grandfathered," for a relatively long period (typically 10 or more years) to allow amortization of their equipment investment. After the grandfather period the new entrants would have the right to move an incumbent without compensation if the incumbent was causing interference,

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[19] Three licenses were awarded under the FCC's Pioneer's Preference program.

[20] *The FCC Report to Congress on Spectrum Auctions*, Federal Communications Commission, Wireless Telecommunications Bureau, September 30, 1997, p. 10.

that is, incumbents would normally be reduced to "secondary" status.[21] Long grandfather periods reduced the costs to incumbents, and since the new uses anticipated in such reallocations were expected to develop slowly, a long delay in spectrum availability was considered of little consequence. However, in the PCS case the cost of a long delay in clearing spectrum could be high given the large value of additional competition and capacity in the rapidly expanding cellular market. But merely shortening the grandfather period would increase the cost to incumbents, who might then oppose and delay the relocation by political or legal means. The need for a politically acceptable means to reduce the delay in band clearing led the FCC to introduce the idea of allowing new entrants to compensate incumbents for early relocation. This has the added efficiency of subjecting individual relocations to a cost-benefit test so that incumbents would be moved only when the value of the cleared spectrum was at least equal to the relocation cost.

## 5.2   FCC Rule Making

Four features of the evolution of FCC relocation policy are worth noting: the persistent difference in treatment of public safety and non-public safety incumbents, the reduction of the time period incumbents were granted the right to stay, the introduction of additional measures to reduce bargaining costs, and the issuing of cost-sharing rules to address the free rider problem when moving microwave incumbents benefits multiple PCS licensees.

In January 1992,[22] 9 months before the reallocation decision, the commission proposed to give non-public safety incumbents the right to stay for a fixed transition period, after which they would become secondary. The Commission suggested that the transition period be 10 or 15 years to allow amortization of existing equipment, but proposed to allow new entrants to negotiate financial arrangements with incumbents to move them before the end of the transition period. Public safety incumbents (defined here as state and local government licensees) were to be given the right to stay indefinitely and were also permitted to negotiate with new entrants to move.

Most microwave interests opposed the commission's proposal to make non-public safety incumbents secondary after a transition period. A trade group representing microwave users, the Utilities Telecommunications Council (UTC), suggested as a compromise that incumbents be given the right to stay for 10 years, after which new entrants would have the right to move incumbents provided the new

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[21] A secondary licensee is responsible for remedying any interference it causes to, or receives from, primary users. 47 CFR 2.104(d)(4) Secondary users are also expected to cease operation immediately and remain off the air until the cause of the interference to a primary user is eliminated.

[22] *Notice of Proposed Rule Making Re: Redevelopment of Spectrum to Encourage Innovation in the Use of New Technologies*, 7 FCC 1542 (1992).

entrants paid for all relocation costs.[23] Under pressure from such groups, the United States Senate passed an amendment to the FCC's appropriations bill[24] that would have given microwave incumbents the right to stay for at least 8 years and would have barred the commission from ever making incumbents secondary. In explaining why he introduced the bill, Senator Ernest Hollings, chair of the Senate Commerce Committee, which has jurisdiction over FCC legislation, said, "I generally do not offer legislation concerning spectrum allocation matters at the FCC. I believe that these are matters that are often very technical in nature and should not be subject to the political process. In this case, however, the FCC has itself shown a lack of respect for the process involved in making frequency allocation decisions. The FCC has shown a blatant disregard for the legitimate concerns of the utilities who currently use this spectrum."[25] Ultimately, the amendment was dropped from the final appropriations bill[26] when the commission decided to act more favorably toward incumbents.[27]

The intense political pressure from incumbents proved effective. In its September 1992 reallocation order,[28] the commission proposed to give non-public safety incumbents the right to stay during a transition ("voluntary negotiation") period, after which a right-to-move-with-compensation rule would apply. The Commission tentatively concluded that the transition period should be between 3 and 10 years and sought comment.[29] In contrast to the commission's January proposal, new entrants would never have the right to move incumbents without compensation. During the transition period any relocation would be voluntary. After the transition period new entrants would have the right to move non-public safety incumbents provided they pay all relocation expenses, build new microwave facilities at the relocation

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[23] *First Report and Order*, *supra* note 17, at para. 22.

[24] 138 *Cong. Rec.* S10346 (July 27, 1992).

[25] "Hollings' Amended Appropriations Measure to Accommodate 2 GHz Microwave Operations Headed for House-Senate Conference; Computer Industry Leads PCS Proponents' Opposition," *Telecommunications Reports*, August 3, 1992, pp. 1-2.

[26] *First Report and Order*, *supra* note 17, at footnote 32.

[27] The Commission's September 17, 1992 decision "essentially addresses concerns raised by Sen. Earnest F. Hollings (D., S.C.). Mr. Hollings had included bill language, to protect the primary status of microwave users, in appropriations legislation." *Telecommunications Reports*, August 3, 1992, pp. 1-2.

[28] *First Report and Order*, *supra* note 17.

[29] The Commission proposed that the transition start upon the effective date of the *Report and Order* establishing rules for rechannelization of the higher frequency microwave bands where incumbents were expected to relocate. If a license for unoccupied spectrum were not assigned to a new entrant until after the end of the transition period, the incumbent would lose the possibility of negotiating for more than its cost of moving. To provide incumbents a minimum amount of time for voluntary negotiations, and hence the possibility of sharing some of the gains of a reallocation, the commission also proposed to give incumbents the right to stay for a minimum of one year from the date the new entrant is issued a license.

frequencies, and demonstrate that new facilities are comparable. The Commission referred to such a move with compensation as "involuntary relocation."

The Commission also decided, as originally proposed, to give public safety licensees the right to stay indefinitely.[30] This exemption from involuntary relocation ensured public safety incumbents greater expected gains from bargaining with new entrants than non-public safety incumbents. The politically powerful public safety lobby and the commission's concern about disrupting facilities used to protect human life may explain the more favorable treatment of public safety facilities.[31]

If this favorable treatment of public safety was efficiency enhancing, it was the efficiency of the reallocation of spectrum from microwave services to more flexible use and not the efficiency of relocation of incumbents once the reallocation had been made. Without the support of the public safety lobby there would be no reallocation from microwave services to more flexible use, but according to our analysis, giving public safety licensees the right to stay indefinitely is likely to reduce the efficiency of relocation. Indeed, when applied to public safety licensees, the right to stay rule was likely to reduce efficiency even more than suggested in the foregoing sections. Public safety incumbents, which were defined to include all state and local governments, may be particularly bad at achieving efficient relocation outcomes for two reasons. First, as public or nonprofit entities they are often constrained legally or organizationally to receive compensation in kind in the form of upgraded facilities instead of in cash. Limitations on the ability to accept cash compensation can result in public safety incumbents' choosing to relocate when termination is the efficient outcome or building more expensive facilities when less expensive facilities plus cash would be better. Second, principal/agent problems may be especially severe for nonprofit and governmental organizations. Incumbent licensees may not always make efficient relocation/termination decisions because those decisions are often made by individuals within the organization with a personal or bureaucratic interest in maintaining a large microwave system. Incumbents will typically have someone in their microwave systems department deal with the issue of relocation. A person whose job it is to manage a microwave system will be likely to find many reasons why the organization continues to need a microwave system—reliability, diversity—even if the overall organization might be better served by using wireline facilities or eliminating the function altogether. If this is more likely to be a problem for public institutions, then on efficiency grounds we would not want

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[30] The FCC defined public safety incumbents as operations licensed to the public safety and special emergency radio services, including state and local governments, police, fire, and medical emergency communications. *First Report and Order*, *supra* note 17, at para. 26.

[31] In its January 1992 *Notice of Proposed Rule Making*, the commission stated, "We recognize that state and local government agencies would face special economic and operational considerations in relocating their 2 GHz fixed microwave operations to higher frequencies or alternative media. We are particularly sensitive to the need to avoid any disruption of police, fire and other public safety communications." *Notice*, *supra* note 22, at para. 25.

to give public safety incumbents greater rights to stay than other entities. Indeed, we might want to give them less, because they may be too likely to stay when they should terminate or relocate.

The Commission gradually shifted spectrum rights from incumbents to new entrants. This was likely to increase the efficiency of the relocation process and increase expected auction revenues. Such a shift in rights was possible because incumbents lost bargaining power relative to PCS licensees in the commission's rule-making process. Once the reallocation had been made it was much harder for incumbents to reverse it than to block it initially, and the reallocation created a more well-defined group of potential winners from such a shift. In July 1993,[32] the commission adopted a minimum 3-year transition period for non-public safety incumbents. This was the shortest time in the range it proposed in September 1992.[33] The transition period began with a 2-year "voluntary negotiation period," during which incumbents had the right to stay and were not required to negotiate. After the two-year period, a new entrant could initiate a 1-year "mandatory negotiation period" during which both parties would be required to bargain in good faith. After the mandatory negotiation period, a new entrant could apply for involuntary relocation of an incumbent fixed microwave facility.

In February 1997,[34] the commission shortened the voluntary negotiation period for non-public safety microwave incumbents in the PCS C, D,E, and F blocks by 1 year, establishing a 1-year voluntary negotiation period followed by a 1-year mandatory period. The voluntary negotiation period for the PCS A and B blocks remained two years, ending on April 5, 1997.

The spectrum rights of public safety incumbents were scaled back as well. In July 1993,[35] the commission narrowed the group that was granted the right to stay indefinitely. Only facilities on which the majority of use is for police, fire, or emergency medical services involving safety of life or property were to be exempt from the involuntary relocation process. In March 1994,[36] the commission decided to end this exemption. The Commission established a 4-year voluntary negotiation period followed by a 1-

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[32] *Third Report and Order and Memorandum Opinion and Order Re: Redevelopment of Spectrum to Encourage Innovation in the Use of New Technologies*, 8 FCC 6589 (1993).

[33] The transition began later, however, with the acceptance of applications for new technology services. As it turned out, the voluntary negotiation period for PCS licensees in the A and B blocks began on April 5, 1995. *Second Report and Order Re: Amendment to the commission's Rules Regarding a Plan for Sharing the Costs of Microwave Relocation*, 12 FCC 2705 (1997). Under the initial proposal, the transition would have begun in December 1993, on the effective date of the rule for re-channelizing higher frequency microwave bands. *Second Report and Order Re: Redevelopment of Spectrum to Encourage Innovation in the Use of New Technologies*, 8 FCC 6495 (1993).

[34] *Second Report and Order*, *supra* note 33.

[35] *Third Report and Order*, *supra* note 32.

[36] *Memorandum Opinion and Order Re: Redevelopment of Spectrum to Encourage Innovation in the Use of New Technologies*, 9 FCC 1943 (1994).

year mandatory negotiation period. After that, a PCS licensee could move a public safety incumbent if it provided the incumbent fully comparable relocation facilities and paid all relocation costs. The Commission also required that the replacement facilities be fully built and tested before an incumbent was compelled to relocate. In November 1994,[37] the commission shortened the voluntary negotiation period for public safety incumbents to 3 years, and increased the mandatory period to 2 years. The total time that public safety incumbents were given the right to stay remained the same, but they were required to start negotiating earlier. In February 1997, when the commission shortened the voluntary negotiation period for non-public safety incumbents in the C, D, E, and F blocks, it did not change the negotiation periods for public safety incumbents in these blocks.

In April 1996,[38] the commission put a time limit on the application of the right-to-move-with-compensation rule, after which incumbents would be reduced to secondary status. The Commission required that microwave incumbents still operating in the 2 GHz band ten years after the voluntary period had commenced will be required to pay for their own relocation expenses or terminate operations if an emerging technology licensee requires use of the spectrum.[39] The Commission's decision took into account an efficiency margin not discussed in the foregoing analysis—the incumbents' investment decision when equipment wears out. The Commission argued that incumbents will have too little incentive to relocate to another band on their own when their equipment needs to be replaced if new entrants are required to pay for all costs of relocating from the current band.[40]

In addition to circumscribing the spectrum rights of incumbents, the commission took several other actions to reduce negotiation costs. It decided in July 1993[41] that if incumbents and new entrants could not agree on whether replacement facilities were comparable, the negotiating parties were required to use alternative dispute resolution (ADR) before referring the case to the commission. Then in November 1994,[42] the commission decided that independent estimates of the cost to replace an existing facility be used in resolving disputes between incumbents and new service providers in the case of mandatory

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[37] *Second Memorandum Opinion and Order Re: Redevelopment of Spectrum to Encourage Innovation in the Use of New Technologies*, 9 FCC 779 (1994).

[38] *First Report and Order and Further Notice of Proposed Rule Making Re: Amendment to the commission's Rules Regarding a Plan for Sharing the Costs of Microwave Relocation*, 11 FCC 8825 (1996).

[39] The obligation to pay relocation costs sunsets ten years after the voluntary negotiation period begins for the first emerging technology licensees in a service. This is April 4, 2005 for PCS licensees. *Microwave Relocation*, *supra* note 38, at para. 65.

[40] *Microwave Relocation*, *supra* note 38, at para. 67.

[41] *Third Report and Order*, *supra* note 32.

[42] *Second Memorandum Opinion*, *supra* note 37.

relocation. In April 1996,[43] the commission clarified rules for mandatory negotiations, holding that common law principles be considered when interpreting the obligation to negotiate in good faith, that the parties be required to share pertinent information, and that providing cost estimates for comparable facilities be the burden on the party alleging bad faith. Specific factors by which to judge good faith were also laid out. The Commission went on to define "comparable" facilities as those that are equivalent with respect to communications throughput, system reliability, and operating costs. Furthermore, the order limited compensation to incumbents for increased recurring costs associated with the replacement facilities to a 5-year time period during an involuntary relocation and limited reimbursement of incumbents' transactional costs during an involuntary relocation to 2 percent of the "hard costs."

The Commission also provided a cost-sharing mechanism to reduce the free-rider problem that could arise when relocating a microwave link freed up spectrum for more than one PCS licensee. Under the plan, adopted in April 1996,[44] PCS licensees receive "reimbursement rights" once they sign a relocation agreement with a microwave incumbent. Subsequent PCS licensees that would have caused harmful interference to relocated links are required to reimburse the holder of the reimbursement rights for a *pro rata* share of the actual cost of relocating microwave facilities, excluding any premium that the PCS licensee might pay to the incumbent as an incentive to move during the voluntary negotiation period. The formula provides for straight-line depreciation of the reimbursement rights over a 10-year period so later entering PCS licensees, who benefit less from the microwave relocation, pay less of the relocation costs. The Commission established a cap of $250,000 reimbursement for each microwave link plus an additional $150,000 where a new tower is required. Moreover, this cost-sharing plan would apply to co-channel interference only. In August 1996,[45] the commission designated the Personal Communications Industry Association (PCIA) and the Industrial Telecommunications Association (ITA) as the clearinghouses to administer the commission's cost-sharing plan for microwave relocation. In February 1997,[46] the commission decided to allow incumbents who voluntarily relocate themselves to collect reimbursement under the same cost-sharing formula applied to PCS licensees.

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[43] *Microwave Relocation*, *supra* note 38.

[44] *Microwave Relocation*, *supra* note 38.

[45] *Memorandum Opinion and Order Re: Amendment to the commission's Rules Regarding a Plan for Sharing the Costs of Microwave Relocation*, 11 FCC 9394 (1996).

[46] *Second Report and Order*, *supra* note 33.

## 5.3 Experience

The spectrum currently allocated to PCS contained approximately 4,500 microwave links before the reallocation.[47] The licensees were mostly petroleum companies, utilities, railroads, and local governments. By January 1998 over half of these links had been moved out of the band.[48] About 90 percent of the moved links relocated to alternative microwave bands, and 10 percent shifted to fiber or copper wire, or ceased operation.[49]

The experience with microwave relocation in PCS seems roughly consistent with the above theory. While there are no public records of payments made for relocation, it appears that the microwave incumbents have been able to extract some premiums, but that the premiums have been limited. Good faith negotiations appear to have been the norm, although there are numerous reports of large demands for rapid settlement. According to Thomas Wheeler, president of the Cellular Telecommunications Industry Association (CTIA), "[V]oluntary relocation negotiations with the majority of microwave incumbents in critical sections in each of the newly licensed markets, notably the urban areas where potential subscriber population is the greatest, have been or are being conducted in good faith by all parties."[50] But there have been reports of incumbents demanding premiums of several times actual relocation costs to relocate before the involuntary relocation period, as illustrated by the following specific case.

> The PCS licensee surveyed the incumbent's 1.9 GHz system and an equipment manufacturer quoted a relocation price of $225,000 per link, inducing an upgrade of equipment. The incumbent demanded $400,000 in cash for each relocated link. ... The PCS licensee's negotiator took the incumbent's demand back to the licensee for consideration. During the interim, the incumbent attended a seminar on the "value" of these frequencies to PCS licensees. The incumbent then rescinded its $400,000 offer and stated that it would not take less than $1,200,000 per link.[51]

While providing incumbents with a limited right to stay may have increased transaction costs in some cases, in many cases there was little or no efficiency loss. Before the PCS entrant is ready to begin service, accommodation is efficient. Even after service is up, many links can be worked around. For

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[47] Letter from Mark Golden, Vice President, PCIA, to Reed Hundt, Chairman of the FCC, September 22, 1995.

[48] 2,185 relocated links have been registered with the PCIA microwave relocation clearinghouse. *PCIA Microwave Clearinghouse Semi-Annual Report to the commission*, WT Docket No. 95-157, February 2, 1998. 370 relocated links have been registered with the clearinghouse operated by the ITA. *Third Semi-Annual Report to the commission of the ITA Microwave Relocation Clearinghouse*, WT Docket No. 95-157, February 2, 1998.

[49] Estimate by Mark Crosby, President, ITA, meeting November 24, 1997.

[50] Thomas E. Wheeler, "Electro-magnetic Spectrum Policy," Hearing Before the U.S. Senate Committee on Commerce, Science, and Transportation, 104th Congress, 2nd Session, March 27, 1996.

[51] Letter from Mark Golden, Vice President, PCIA, to Reed Hundt, Chairman of the FCC, September 22, 1995, attachment E, p. 1.

example, NextWave, the largest winner in the C-block auction, estimated that of the approximately 500 microwave links in its markets 40 percent will not require immediate relocation.[52] Relocation is expensive and often unnecessary.

The right to move with compensation is especially desirable under these circumstances. There is no bias toward relocation. The sole bias is for accommodation over termination. Since termination is least likely to be desirable, this rule is apt to minimize transaction costs. Giving the incumbent the right to stay for a limited period of time increases transaction costs, but the increase is bounded. However, such a concession to the incumbent may be just what is needed to get the incumbents to agree to the reallocation.

# 6   Application to Digital Television

The approach used to relocate microwave incumbents in PCS spectrum may prove useful in thinking about how to shift other occupied spectrum to more valuable uses. For example, the allocation of television spectrum has become far from efficient. At present, 402 MHz of prime spectrum is devoted to providing analog television service (NTSC). With more efficient digital technology, an equivalent free over-the-air television service could be provided using less than one-third of this spectrum.[53] Thus it would appear at least technologically possible to free as much as two-thirds of the current VHF and UHF TV spectrum for flexible use with no reduction in free service.[54] While the current plan for transitioning to DTV is well underway and unlikely to be altered significantly, it may be possible to produce a more efficient outcome with marginal rule changes modeled after the approaches used in PCS.

As part of its proceeding on the implementation of digital television, the FCC has considered how to recover spectrum now devoted to analog television. The FCC has assigned all existing full-service (full-

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[52] June 19, 1996, *PCS Week*, p. 2.

[53] There is no market with more than 26 channels of service except Los Angeles, which has 33. FCC Public Notice "Television Channel Utilization," April 3, 1997. If, as often claimed, a single DTV channel can accommodate at least 4 channels of standard definition service, then the amount of spectrum needed for 26 channels in an area is $(26/4) \times 6 = 39$ MHz. Tripling this to 117 MHz would allow the replication of this capacity throughout the United States using a 3 cell pattern so that co-channel stations are not in adjoining cells. In Los Angeles the deficit of 7 program channels (requiring 10.5 MHz in digital format) could be restored by reducing the spectrum in each of the two adjacent (less populous) cells by 5.25 MHz, that is, from 39 to 33.75 MHz. This would reduce the number of program channels in those areas from 26 to 22, which is still likely to be more than they have now.

[54] The amount of spectrum available for flexible use could be substantially less if the goal is not just to maintain the current level of free TV but to increase it either in quantity or quality. The FCC's original purpose in initiating the proceeding that led to DTV was to increase the quality of free TV from standard definition to high definition. However, the rules finally adopted by the FCC allow broadcasters to decide between HDTV and other uses of the digital signal, including additional standard definition services on either a free or subscription basis. Broadcasters are required only to provide one free service in standard definition.

power) television broadcasters an additional 6 MHz channel for digital broadcasting.[55] By 2006, broadcasters are required to return one of their channels, and they could also be required to change their DTV channels to permit the aggregation of recovered spectrum into contiguous blocks.[56] The Balanced Budget Act of 1997 bars the commission from renewing analog broadcasting licenses to provide service after 2006, with several exceptions.[57] If any of the exceptions prevail in a television market, the commission must extend the date in that market. The most important exception is if 15 percent or more of the television households in the market do not have at least one digital television receiver or analog television with a digital converter capable of receiving the digital signals of the television stations licensed in that market and do not subscribe to a multichannel video programming service (for example, cable or direct broadcast satellite) that carries one of the digital signals of each television broadcaster in the market. The act also requires that by 2002 the commission auction licenses for the recovered television spectrum.

A potential drawback to clearing NTSC spectrum by this approach is that broadcasters have no incentive to return their analog channels to the government before required, even when it would be efficient to do so. Under the current plan, analog channels could continue in use well beyond 2006 if the commission finds that any of the exceptions specified in the Balanced Budget Act exist. Also, until the spectrum is auctioned for new uses no other private party has a significant incentive to see that the analog channels are turned back quickly, because no private party has the right to spectrum that will be released when the channels are returned.

In this context the analog television channels are like the incumbent microwave users in the PCS case. The Commission could create and immediately auction overlay licenses in the television broadcasting band analogous to PCS licenses, where the new entrant would have the right to use any unoccupied spectrum, including spectrum that becomes available by moving an NTSC television channel. Our analysis suggests that a relocation mechanism to consider in this context would be to give the overlay licensee the right to move with compensation.

There are some issues to resolve, however. The most significant arises from the need to consider the interests of television viewers as well as those of licensees. Terminating an NTSC channel early for a cash payment to the licensee could be inefficient even if both the new entrant and the incumbent licensee are better off, because viewers with NTSC television sets would be worse off. One possible way to address

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[55] *Memorandum Opinion and Order on Reconsideration of the Sixth Report and Order* 63 FR 13546 (1998).

[56] *Memorandum Opinion and Order on Reconsideration of the Fifth Report and Order* 63 FR 15774 (1998).

[57] Balanced Budget Act of 1997, Pub. L. 105-33, 111 Stat. 251 (1997), Sec. 3003.

this problem would be also to require the overlay licensee to compensate viewers by providing comparable free replacement service, including any necessary receiving equipment to allow such service to be displayed on standard NTSC receivers. The most obvious way to do this would be for the overlay licensee to provide viewers with digital-to-analog converter boxes and to devote a portion of a DTV channel's capacity (whether its own or leased) to providing a replacement service that could be displayed in the NTSC format with the use of these converter boxes. This raises questions as to who should be eligible to receive free converter boxes and for how long. Should households who can receive the programming over cable or who already have DTV television sets be eligible? Should households that have two or more NTSC television sets that are not connected to cable and receive their signals over the air be entitled to multiple converter boxes? One approach would be to use the standard set in the Balanced Budget Act for extending the termination date for analog broadcast stations. An additional complication with this approach is that the cost of providing a converter box for one channel is virtually the same as for multiple channels. Unless there is a single overlay licensee a cost-sharing mechanism would be needed to pay for the equipment when NTSC channels are moved by multiple overlay licensees.

There is also a question of how to compensate the NTSC licensees for moving before 2006. One possibility is to require the overlay licensee to provide the moved NTSC licensee with free carriage on a DTV channel with comparable coverage to the removed NTSC channel. This would ensure continued provision of the broadcaster's current free service pending the build-out of its own DTV station.[58] For this to provide adequate compensation the overlay licensee must also satisfy the requirement described above that a sufficient proportion of television viewers in the relevant television market have equipment to display the signal. An additional complication is that to provide large contiguous blocks of spectrum it may be necessary to "repack" the DTV channels. Under the current FCC plan, after the analog stations have been shut down the FCC can require DTV licensees to move to other frequencies. If instead, the FCC auctioned overlay licenses now, it could give the overlay licensees the right to move a DTV licensee to an equivalent channel if it pays for all relocation costs. One question with this alternative is whether efficient repacking can be achieved with the television band divided among more than one overlay licensee. With multiple overlay licensees, negotiations would be required to move a DTV licensee from within the frequency boundaries of one overlay licensee to within the boundaries of another.

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[58] This could be defined as a bridge service that would cease when the broadcaster has completed the build-out of its own DTV station. The FCC has adopted a mandatory build-out schedule for DTV. The staggered schedule requires build-out by the affiliates of four major networks in market 1-10 by May 1, 1999; affiliates of four major networks in markets 11-30 by November 1, 1999; all other commercial stations by May 1, 2002; all non-commercial stations by May 1, 2003. Free service would continue after build-out under the FCC's requirement that broadcasters provide one free digital video programming service on their DTV stations. *Memorandum Opinion and Order on Reconsideration of the Fifth Report and Order* 63 FR 15774 (1998).

The main possible advantage of this approach compared to the current policy is that analog television channels would be removed more quickly where the value of the new use is greater than the cost of band clearing. It would provide a new mechanism for removing analog television stations prior to 2006 and could reduce the number of markets after 2006 where analog stations could remain under the exemption limiting the loss of service to no more than 15 percent of television households. There are difficult issues to be resolved that are peculiar to this spectrum, because of the public good nature of broadcasting and other potentially conflicting policies. However, the potential gain from an efficient allocation of this valuable spectrum could be large. Moreover, the procedural risks are reduced by building on the knowledge and experience gained in the successful application of the approach in PCS.

# 7 Conclusion

As a result of technological progress, prior spectrum allocations are far from efficient. To correct this problem the FCC has begun reallocating encumbered spectrum. The assignment of property rights between entrant and incumbent plays an important role in determining whether this spectrum is put to its best use. Efficient relocation is promoted by establishing a relocation rule that minimizes the need for costly negotiation. An indefinite right to stay gives incumbents too much power in negotiating large premiums for relocating or terminating. Holdout problems can lead to large bargaining costs. These costs can be reduced by giving entrants the right to move the incumbent. This rule works especially well when the cost of relocating the incumbent can be objectively estimated and entrants are required to compensate incumbents for clearing the spectrum. Under this right-to-move-with-compensation rule, both the entrant and the incumbent compare the cost of relocation with their private values. If the entrant's value of clear spectrum is greater than the cost of relocation, the entrant will insist on relocation. Then the incumbent will terminate or relocate depending on whether the incumbent's value of the spectrum is less or more than the cost of relocating. Efficiency occurs without negotiation in all but one case. Negotiation is needed only when the incumbent's value of the spectrum is less than the entrant's value and the entrant's value is less than the cost of relocating. In this case, the entrant may inefficiently accommodate the incumbent if negotiations fail. However, this negotiation is simplified by the fact that the amount under negotiation is bounded by the cost of relocation.

The right-to-move-with-compensation rule also has desirable distributional consequences. It guarantees that the incumbent is at least as well off as under the prior allocation and strictly better off whenever the incumbent terminates. Hence, this rule may be acceptable to politically powerful incumbents, yet, unlike the right-to-stay rule, the right-to-move-with-compensation rule favors the incumbent while minimizing the need for difficult negotiation.

Adopting an efficient relocation rule is especially important in a setting like PCS, where the reallocation brings much needed competition to wireless telephony. The benefits to consumers from a rapid introduction of competition in wireless services are substantial. Paying attention to the transaction costs associated with different rules is essential to reaping these consumer gains.

# References

Ayres, Ian & Eric Talley, Solomonic Bargaining: Dividing A Legal Entitlement To Facilitate Coasean Trade, 104 *Yale Law J.* 1027-1117 (1995).

Binmore, Ken, Ariel Rubinstein and Asher Wolinsky, The Nash Bargaining Solution in Economic Modelling, 17 *Rand J. Econ.* 176-188 (1986).

Calabresi, Guido & A. Douglas Melamed, Property Rules, Liability Rules, and Inalienability: One View of the Cathedral, 85 *Harvard Law Rev.* 1089-1128 (1972).

Coase, Ronald H. The Federal Communications Commission, 2 *J. Law & Econ.* 1-40 (1959).

Coase, Ronald H. The Problem of Social Cost, 3 *J. Law & Econ.* 1-44 (1960).

Cramton, Peter. Dynamic Bargaining with Transaction Costs, 37 *Management Science* 1221-1233 (1991).

Cramton, Peter. Strategic Delay in Bargaining with Two-Sided Uncertainty, 59 *Review Econ. Studies* 205-225 (1992).

Cramton, Peter, Robert Gibbons & Paul Klemperer, Dissolving a Partnership Efficiently, 55 *Econometrica* 615-632 (1987).

Cramton, Peter and Joseph Tracy, Wage Bargaining with Time-Varying Threats, 12 *J. Labor Econ.* 594-617 (1994).

De Vany, Arthur S., Ross D. Eckert, Charles J. Meyers, Donald J. O'Hara, and Richard C. Scott, A Property System for Market Allocation of the Electromagnetic Spectrum: A Legal-Economic-Engineering Study, 21 *Stanford Law Rev.* 1499-1561 (1969).

Demsetz, Harold. When Does the Rule of Liability Matter? 1 *J. Legal Studies* 13-28 (1972).

*First Report and Order and Further Notice of Proposed Rule Making Re: Amendment to the commission's Rules Regarding a Plan for Sharing the Costs of Microwave Relocation*, 11 FCC 8825-8926 (1996).

*First Report and Order and Third Notice of Proposed Rule Making Re: Redevelopment of Spectrum to Encourage Innovation in the Use of New Technologies*, 7 FCC 6886-6902 (1992).

*Memorandum Opinion and Order on Reconsideration of the Fifth Report and Order* 63 FR 15774-15784 (1998).

*Memorandum Opinion and Order on Reconsideration of the Sixth Report and Order* 63 FR 13546-13563 (1998).

*Memorandum Opinion and Order Re: Amendment to the commission's Rules Regarding a Plan for Sharing the Costs of Microwave Relocation*, 11 FCC 9394-9406 (1996).

*Memorandum Opinion and Order Re: Redevelopment of Spectrum to Encourage Innovation in the Use of New Technologies*, 9 FCC 1943-1957 (1994).

Myerson, Roger B. and Mark A. Satterthwaite, Efficient Mechanisms for Bilateral Trading, 28 *J. Econ. Theory* 265-281 (1983).

*Notice of Proposed Rule Making Re: Redevelopment of Spectrum to Encourage Innovation in the Use of New Technologies*, 7 FCC 1542-1549 (1992).

*PCIA Microwave Clearinghouse Semi-Annual Report to the commission*, WT Docket No. 95-157, February 2, 1998.

Rubinstein, Ariel. Perfect Equilibrium in a Bargaining Model, 50 *Econometrica* 97-109 (1982).

*Second Memorandum Opinion and Order Re: Redevelopment of Spectrum to Encourage Innovation in the Use of New Technologies*, 9 FCC 7797-7804 (1994).

*Second Report and Order Re: Amendment of the commission's rules to Establish New Personal Communications Services*, 8 FCC 7700-7875 (1993).

*Second Report and Order Re: Amendment to the commission's Rules Regarding a Plan for Sharing the Costs of Microwave Relocation*, 12 FCC 2705-2731 (1997).

*Second Report and Order Re: Redevelopment of Spectrum to Encourage Innovation in the Use of New Technologies*, 8 FCC 6495-6588 (1993).

*The FCC Report to Congress on Spectrum Auctions*, Federal Communications Commission, Wireless Telecommunications Bureau, September 30, 1997.

*Third Report and Order and Memorandum Opinion and Order Re: Redevelopment of Spectrum to Encourage Innovation in the Use of New Technologies*, 8 FCC 6589-6620 (1993).

*Third Semi-Annual Report to the commission of the ITA Microwave Relocation Clearinghouse*, WT Docket No. 95-157, February 2, 1998.

Wheeler, Thomas E., "Electro-magnetic Spectrum Policy," Hearing Before the U.S. Senate Committee on Commerce, Science, and Transportation, 104th Congress, 2nd Session, March 27, 1996.