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Why oppose TDRs?: Transferable development rights can increase overall development

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Abstract

Economists have long argued that systems of marketable permits are a cost-effective means of regulating externalities. Though these ideas have only recently been implemented in the field of pollution control, transferable development rights (TDRs) have been used for decades by city planners in many locales. Most opponents of permit trading contest the granting of property rights to the originators of harmful effects on ethical grounds, and rarely argue that such schemes increase the total external harm. This paper formalizes the second argument by showing that in a partial equilibrium model of urban zoning, replacing a uniform height zoning rule with a TDR system can lead to greater overall development.

Keywords: Transferable development rights; Marketable permits; Zoning

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1. Introduction

Since Dales (1968) first introduced the idea of marketable regulatory permits to economists, the ensuing literature has focused mainly on pollution regulation, and has concluded that allowing polluters to trade the rights to pollute leads to cost-effective regulations.[1] Only recently, however, have these ideas been incorpo-

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[1] Such regulations are cost-effective in the sense that they meet a given regulatory target at least cost. They are not necessarily efficient in a Pareto sense. Yet because cost-effectiveness is a necessary condition for Pareto efficiency, it is an important first step.

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rated into US environmental regulatory policy in a serious way. The 1990 Clean Air Act, which allows electric utilities to trade sulfur dioxide emissions permits, and regulations governing smog-generating activities in Los Angeles are the only large-scale examples.[2] In contrast, in the area of urban real-estate development zoning, city planners have been applying the principles of marketable permits for two decades. Since the mid-1970s, when developers in New York City were first allowed to trade development rights, a growing number of jurisdictions have adopted flexible zoning regulations known as Transferable Development Rights (TDRs). Today the list of jurisdictions using TDRs includes cities such as Chicago, San Francisco, and Seattle, as well as rural and semi-rural areas such as New Jersey's Pinelands and Maryland's Montgomery County.

Opponents of marketable permit schemes have expressed concerns about the ethics of granting the property rights to polluters or developers, rather than to citizens at large.[3] The textbook answer to this concern usually involves some reference to Coase (1960), implying that an efficient outcome will be realized regardless of the initial distribution of regulatory property rights (Tripp and Dudek, 1989). Other opponents express the more practical fear that permit trading will result in concentrations of harmful activity. 'The theory is ingenious, but in practice, it may create problems. Dense shadow patterns and spot overpopulation and crowding can result'. (Urban Land Institute, 1982). The validity of this objection depends on the goal of the regulation: reducing overall activity or changing its distribution. It may be that some distributional sacrifices are worth making in exchange for cost-effective achievement of overall reduction.

One objection to marketable permits that one rarely sees, however, is that the overall level of harmful activity can be greater under the trading scheme than it would be under a rigid standard applied uniformly. Oates et al. (1989) make this point empirically in a comparison of traditional command-and-control environmental regulations to marketable pollution permits. This paper demonstrates a similar result in a simple model of urban zoning with TDRs. The intuition for both results is the same. If the uniformly stringent regulation constrains some developers while leaving others unaffected, then the total amount of development will be less than the allowable amount. If the TDR plan allows unconstrained developers to sell their surplus, then it will increase the total amount of development. Of course, if the initial uniform regulation is stringent enough that it constrains all developers, the switch to a TDR system will have no effect on total development. While TDR proponents typically advertise the latter case, the former may be likely in practice.

[2]See Hahn (1989) for a list of reasons why earlier attempts at marketable permit regulations failed.

[3]Steidlmeier (1993) contains a discussion of the moral arguments for and against transferable permits.

2. TDRs in practice

One of the oldest examples of TDR programs exists in New York City (James and Gale, 1977). The New York law allows building heights to vary so long as maximum density limits are observed. For example, areas zoned as 'R10' have a maximum allowable floor area ratio (FAR) of 10. The FAR is the ratio of square feet of developed property to the total area of the zoning lot. So a developer owning a 1000 square foot lot can 'by right' (without needing a zoning variance) erect a building with 10 000 square feet of residential space. This building could occupy the entire lot and be ten stories high, or one-half the lot and be twenty stories high, so long as the ratio of floor area to lot size does not exceed 10.[4]

New York's zoning rules allow developers to exceed the maximum FAR via several mechanisms. In practice, the most important of these is the zoning lot merger. Zoning lot mergers simply require adjacent developers to file notice that they are merging zoning lots, without necessarily merging ownership of the lots. For example, consider a developer with a 1000 square foot empty lot adjacent to a second 1000 square foot lot occupied by a 5000 square foot building, where both lots are zoned with a FAR of 10. The two lots could be merged into one 2000 square foot zoning lot, allowing the first developer to erect a 15 000 square foot building, 15 stories on the original lot, leaving the second building untouched. The 20 000 total square feet of building on the new 2000 square foot zoning lot complies with the FAR of 10, although the 15 000 square feet on the original 1000 square foot zoning lot would not have. This arrangement restricts the future development activities of the owner of the adjacent property in perpetuity, and usually involves a compensating financial transaction—a purchase of development rights.

Zoning lot mergers have had a significant influence on development in New York. Thirty-six of the 77 new residential buildings constructed from 1978 to 1988 on the upper east side of Manhattan included zoning lot mergers, comprising 12.5 percent of the total new floor area constructed (Department of City Planning, 1989). Predictably, these developments inspired protests. One citizens' group lamented the fact that 'massive development on the Upper East Side—with the encouragement of incentive zoning—transformed a neighborhood of low to medium-rise buildings and continuous streetwalls into an urbanistic jumble' (Civitas, 1991).

Maryland's TDR program has met similar criticisms. In 1980 Montgomery County restricted development on 88 000 rural acres. To compensate landowners whose property value decreased, a TDR program was instituted. For every five

[4]Set-back provisions, variances in exchange for public amenities, and other exceptions modify the zoning formula slightly, but the basic structure is as described.

undeveloped acres, landowners were granted one TDR. Each TDR entitled its owner to build one additional housing unit. Real estate agents broker trades of these TDRs, and as of 1987 more than 3700 TDRs had been used to construct houses in 27 subdivisions, at a market price of about $5000 per TDR. Maryland's TDR program, like New York City's, generated complaints of congestion and overbuilding. One long-time County Council member rated the issue 'about a 10' in terms of controversy (Washington Post, 1987).

As with marketable pollution permits, the supporters and opponents of these programs seem to speak different languages. Supporters argue that marketable permits limit the total amount of development in the least costly way by ensuring that the permits go to those who value them most.[5] Opponents are leery of granting such rights to developers, and some express concern that permit programs increase the amount harmful activity. The next section develops an economic model that supports this latter argument. Given a simple set of assumptions, and a reasonable overall development limit, TDRs can in theory increase total development in a region.

3. A model of urban zoning

The model of TDRs outlined below incorporates institutional details of both the New York and Maryland programs. Building height limits are set relative to property sizes as in New York, and region-wide transfers are allowed as in Maryland. The market failure addressed by zoning regulations is the external effect of development on city-wide rents. Each developer contributes to overall congestion, as reflected by rents that are a negative function of city-wide development.[6]

Consider a city in which there are N landowners, each of which has a plot of land of size a^i, $i = 1...N$, where i indexes landowners. In order to model a marketable permit scheme, there needs to be some variation among landowners. Thus let there be two types of lots in this city: m type-1 lots on which rents are high and $N-m$ type-2 lots on which rents are low.[7] Thus the total high-rent area is $\Sigma_{i=1}^{m} a^i = A_1$ and the total low-rent area is $\Sigma_{i=m+1}^{N} a^i = A_2$. On each lot rents are a

[5] Mills (1980) presents Dales' result in the context of transferable development rights.

[6] Other goals for zoning may include eliminating spot crowding, the segregation of residential, commercial, and industrial properties, and architectural aesthetics, such as Santa Fe's requirements that building exteriors reflect the 'Santa Fe style.' This paper examines only the zoning goal of reducing excess development, without regard for its distribution. (The problem is analogous to reducing overall levels of pollution emissions without regard for their source.)

[7] To avoid general equilibrium complications that would result if lot quality were determined endogenously through development, I will assume that the lot qualities are determined exogenously, as by proximity to some natural amenity. High- and low-rent lots could be segregated into neighborhoods, as if the natural amenity were a waterfront, or dispersed throughout the city, as if the natural amenity involved localized phenomena such as major thoroughfares or hilltops.

decreasing function of city-wide density, $D=\Sigma_{i=1}^{m} a^i h^i + \Sigma_{i=m+1}^{N} a^i h^i$, where h^i is the height of the building on lot i, and $a^i h^i$ is therefore the total floor space on lot i. On the high-rent lots, however, let rents per square foot of floor space be $r_1(D)$, while on the low-rent lots let them be $r_2(D)$, where $r_1(D)>0$, $r_2(D)>0$, and $r_1(D)>r_2(D)$, for the relevant range of D. Also, let it be the case that $r_1'(D)<0$ and $r_2'(D)<0$. This last assumption models the externality that the zoning regulations will attempt to correct.[8]

The annualized cost per square foot of building, $c(h)$, is a function of the height of the building, h, where $c'(h)>0$, independent of the type of lot. In other words, the average cost per square foot of the entire building increases with its height. (Note the implicit simplifying assumption that h^i is continuous.) In keeping with tradition, let us first examine the unregulated equilibrium, then calculate the planner's optimum, and then compare different types of government intervention, paying special attention to uniform zoning rules and TDR schemes.

4. The unregulated result

Individual developers maximize profits without taking into account their effect on the overall density. A developer's problem can be written

$$\max_{\{h^i\}} \pi^i = r_j(D)a^i h^i - c(h^i)a^i h^i, \tag{1}$$

where $j=1$ if developer i owns a type-1 lot and $j=2$ if developer i owns a type-2 lot. The first-order condition of this problem indicates that each developer will build until

$$r_j = c(h^i) + c'(h^i)h^i. \quad \forall j=1,2. \tag{2}$$

Each builder will increase height until the rental rate (per square foot) equals the marginal cost of adding another square foot, which is composed of the cost of building another floor plus the increased cost this imposes on the inframarginal development.[9]

Because there are only two types of lots, high-rent and low-rent, buildings in the unregulated equilibrium will come in only two sizes: $\tilde{h}_1$ and $\tilde{h}_2$. Total unregulated

[8] It certainly seems plausible that rents initially rise with D, as rents reflect agglomeration economies and access to desirable activities. However, this model is meant to capture rents in a congested city center, which I assume to be on the monotonically declining portion of $r(D)$.

[9] Perhaps the first-order condition is more easily interpreted if multiplied by a^i: $r_j a^i = c(h^i)a^i + c'(h^i)h^i a^i$. The benefit of adding an entire floor, $r_j a^i$, is equal to the cost of the additional floor, plus the additional cost imposed on all of the inframarginal floors.

development will be $\tilde{D}=\tilde{h}_1 A_1+\tilde{h}_2 A_2$. Because $r_1(D)>r_2(D)$, and the cost functions are assumed to be identical, $\tilde{h}_1>\tilde{h}_2$.

5. The planner's optimum

The next logical step is to calculate the optimal height that would be allowed by an omniscient city planner maximizing the welfare of city residents and developers. To simplify the problem, I focus on the case in which the demand for real estate is perfectly elastic and there is no consumer surplus from development. This might approximate the situation faced by a small community in a large metropolis, or a downtown area of small extent. Given this assumption, the planner's goal is to maximize developers' total profits:

$$\begin{aligned}\max_{\{h^1...h^N\}} W &= \sum_{i=1}^{N} \pi^i \\ &= \sum_{i=1}^{m} \left[r_1\left(\sum_{j=1}^{m} a^j h^j + \sum_{j=m+1}^{N} a^j h^j \right) a^i h^i - c(h^i) a^i h^i \right] \\ &\quad + \sum_{i=m+1}^{N} \left[r_2\left(\sum_{j=1}^{m} a^j h^j + \sum_{j=m+1}^{N} a^j h^j \right) a^i h^i - c(h^i) a^i h^i \right]. \end{aligned} \tag{3}$$

Maximizing W with respect to $\{h^1...h^N\}$ yields the following first-order conditions:

$$\begin{aligned} & r_1(D) + r_1'(D) \sum_{i=1}^{m} (a^i h^i) + r_2'(D) \sum_{i=m+1}^{N} (a^i h^i) = c(h^k) + c'(h^k) h^k \\ & \forall k = 1...m \\ & r_2(D) + r_1'(D) \sum_{i=1}^{m} (a^i h^i) + r_2'(D) \sum_{i=m+1}^{N} (a^i h^i) = c(h^k) + c'(h^k) h^k \\ & \forall k = m+1...N. \end{aligned} \tag{4}$$

In other words, the city planner should set the height for each lot such that the rent earned from the marginal floor, less the external costs it imposes on all landlords in the form of lower rents due to higher density, is equal to the marginal cost of increasing the building's height by an additional floor. Since lots come in only two varieties, the city planner needs to set only two heights: a height limit for high-rent plots, h_1^*, and a height limit for low-rent plots, h_2^*. In the planner's optimum there will thus be two zoning rules, and because $r_1(D)>r_2(D)$, in the optimum $h_1^*>h_2^*$.

Eqs. (2) and (4) together show that developers of both types will be constrained by the zoning regulation (h_1^*, h_2^*). For any developer of type j that builds to the maximum height, $h_j{}^*$, Eq. (4) ensures that

$$r_j(D^*) + r_1'(D^*)D_1^* + r_2'(D^*)D_2^* = c(h_j^*) + c'(h_j^*)h_j^* \tag{5}$$

where $D_1^* = h_1^* A_1$ and $D_2^* = h_2^* A_2$. Because the second and third terms on the left side of Eq. (5) are negative, it will also be true that

$$r_j(D^*) > c(h_j^*) + c'(h_j^*)h_j^* \, . \tag{6}$$

This last equation states that at h^* the marginal return to an individual developer of either type from building an additional floor exceeds the marginal cost of doing so, and developers will thus desire to exceed the zoning ordinance.

Eqs. (2) and (4) together also show that there is a Pigouvian solution to the problem. If the planner could impose a tax equal to the externality at the optimum amount of density, developers would be forced to take into account the externality they impose on other developers. In this case, the necessary tax is $\tau = r_1'(D) \sum_{i=1}^{m} (a^i h^i) + r_2'(D) \sum_{i=m+1}^{N} (a^i h^i)$, the second and third terms on the left hand side of Eq. (4). This decentralized solution does not require the planner to distinguish good lots from bad, because the same tax per square foot is imposed on both types. It only requires the planner to know the proportion of lots of each type city-wide. However, city planners in the United States have relied on height and density limits, and movements towards more market-based zoning rules have taken the form of TDRs rather than development taxes. Consequently, TDRs are the focus of this paper.

The problem faced by the city planner can be represented graphically, as in Figs. 1 and 2. The problem amounts to choosing two height limits, h_1^* and h_2^*, so that rents city-wide are maximized. Since total rental earnings on type-1 lots are a function of city-wide development, they can be depicted as a function of both h_1 and h_2. The rent per square foot, from the perspective of individual owners of type-1 lots who do not take into account the externality they impose on other developers, is represented in Fig. 1 by the surface labeled 'private return.' From the city planner's perspective, the externality matters, and each additional floor adds less to total city-wide rental earnings because of the decrease in city-wide rents caused by any increase in the heights of type-1 buildings. The marginal rental earnings per square foot, from the perspective of the city planner, is also depicted in Fig. 1 and is labeled 'social return.' The surface corresponds to $r_1(\cdot) + r_1'(\cdot)A_1h_1 + r_2'(\cdot)A_2h_2$ (the left side of Eq. (4)) and lies below the individual developer's surface because the second and third terms are negative.

The marginal cost of building on type-1 lots is a positive function of the height of type-1 lots only, and is depicted as the surface $c(h_1) + c'(h_1)h_1$. It is increasing in h_1 and constant in h_2. The intersection of this marginal cost surface with the two rent surfaces consists of two lines (in three dimensions). The top line maps the optimal choice of height for individual type-1 developers, given the height of all other lots. The bottom line maps the optimal choice of height for type-1 lots from the planner's perspective, taking into account the externality development of type-1 lots imposes on all other type-1 lots as well as on type-2 lots. These two

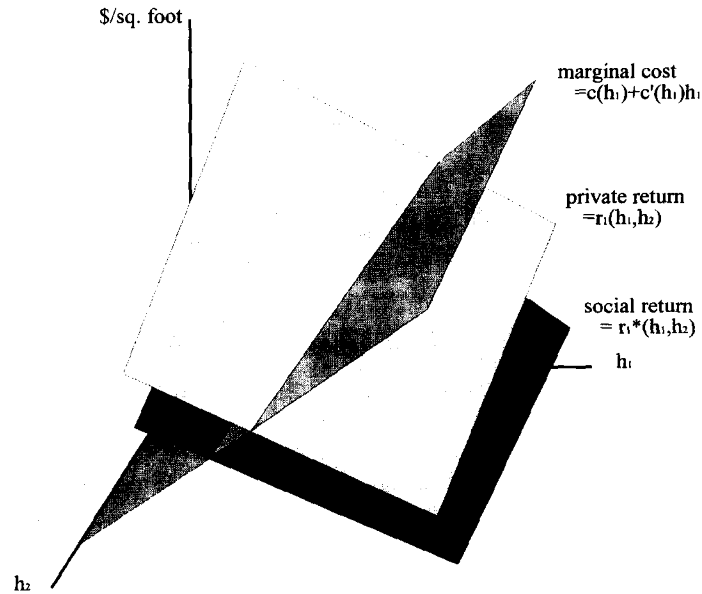

Fig. 1. Rent and cost as a function of development for type-1 (good) lots [h_1 = height of buildings on 'good' lots; h_2 = height of buildings on 'bad' lots; $c(h_1)$ = cost per square foot of building to height h_1; $r_1(h_1, h_2)$ = rental earnings per square foot; $r_1^*(h_1, h_2)$ = marginal rental earnings per square foot from planner's perspective $= r_1(A_1h_1 + A_2h_2) + r_1'(A_1h_1 + A_2h_2)A_1h_1 + r_2'(A_1h_1 + A_2h_2)A_2h_2$].

reaction curves, projected down into (h_1, h_2) space, are depicted in Fig. 2, and are labeled $h_1(h_2)$ and $h_1^*(h_2)$, respectively.[10]

A completely analogous three-dimensional graphical analysis of the optimal choice of height for type-2 lots as a function of type-1 lots would yield the reaction curves $h_2(h_1)$ and $h_2^*(h_1)$ in Fig. 2. The unregulated equilibrium occurs where $h_1(h_2)$ and $h_2(h_1)$ intersect. The city planner's optimum is the point where the planner's curves intersect, labeled (h_1^*, h_2^*). Because of the assumption made about the nature of rents on the different lots, $h_1^* > h_2^*$. It should also be clear from Fig. 1 that at (h_1^*, h_2^*) both types of developers are constrained by the zoning ordinance, because $h_2(h_1)$ is always greater than $h_2^*(h_1)$ and $h_1(h_2)$ is always greater than $h_1^*(h_2)$. Given that all type-1 developers have built to height h_1^* and that all type-2 developers have built to height h_2^*, type-1 developers and type-2 developers will both desire to build taller buildings.

Zoning boards can and do set rules like those above, that differ by type of

[10] Fig. 2 is 'upside down' in order to depict clearly its relationship to Fig. 1. The lines $h_1(h_2)$ and $h_1^*(h_2)$ represent the intersections of the surfaces in Fig. 1 projected into (h_1, h_2) space.

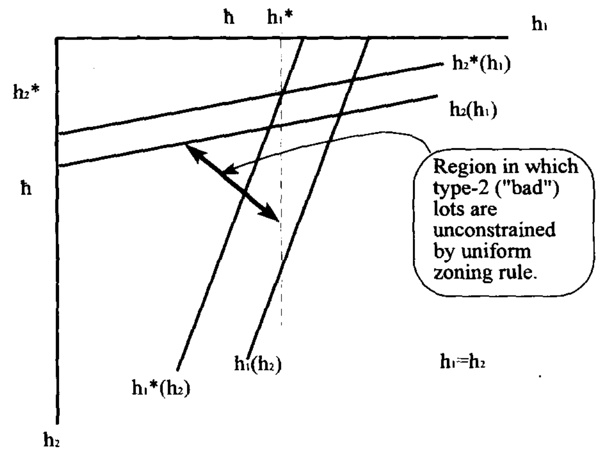

Fig. 2. The planner's optimal zoning rule and a uniform height rule [h_1 = height of buildings on 'good' lots; h_2 = height of buildings on 'bad' lots; $h_1(h_2)$ = individual developers' optimum height for type-1 ('good') lots, given that type-2 ('bad') lots are built to height h_2; $h_2(h_1)$ = individual developers' optimum height for type-2 ('bad') lots, given that type-1 ('good') lots are built to height h_1; $h_1^*(h_2)$ = social planner's optimal full-information zoning rule for type-1 ('good') lots, given that type-2 ('bad') lots are built to height h_2; $h_2^*(h_1)$ = social planner's optimal full-information zoning rule for type-2 ('bad') lots, given that type-1 ('good') lots are built to height h_1; $\bar{h}$ = a possible uniform height rule in which the type-2 ('bad') lots are unconstrained].

property. However, they do not set a different rule for every different type of property. This is likely due to information or administrative costs: the cost of determining the optimal rule for each property type or implementing a multitude of individual zoning rules may be prohibitive. Because planners either do not know the details of lot qualities, or cannot feasibly write a different regulation for each lot, they resort to regulations that are uniform across broad categories. The two lot types in this model are meant to capture variety that is either unobserved by city officials or that varies too widely to be regulated specifically. The natural alternative zoning regulation for city planners faced with such variety is a uniform height rule. The inefficiencies that result from uniform regulations are merely the result of information asymmetries between developers and planners. These are exactly the inefficiencies that the TDR system is supposed to correct.[11] Below I model the problem faced by a city planner who cannot distinguish between type-1 and type-2 lots, and thus must set a single height limit for both.

[11]This problem is analogous to that faced by an environmental regulator that does not know the marginal abatement costs of each individual firm, but must set an industry-wide emissions cap. Such pollution control regulations are dubbed 'command-and-control' regulations.

6. A uniform height regulation and TDRs

Suppose that city officials know the fraction of lots in the community that are of each type, but cannot identify which particular lots are type-1 and which are type-2. Under this premise, the simplest way to conceive of a uniform height regulation is to let the uniform height be $\bar{h}=D^*/A$ where D^* is the optimal total development allowed under the fully-informed height regulations h_1^* and h_2^*, and A is the total land area in the city. Note that in this case $\bar{h}$ will be a weighted average of h_1^* and h_2^* where the weights are the areas of the two types of lots, A_1 and A_2:

$$\bar{h}=\frac{(A_1h_1^* + A_2h_2^*)}{(A_1+A_2)}\,. \tag{7}$$

This seems to be a perfectly reasonable zoning rule: the total permitted development is exactly the same as would be allowed in the planner's optimum by a fully-informed city planner, and $h_1^*>\bar{h}>h_2^*$.

An alternative, equally plausible mechanism would be to let the city planner set the optimal city-wide uniform height by solving the problem

$$\begin{aligned}\max_{\{\bar{h}\}} \bar{W}=&\sum_{i=1}^{m}\left[r_1\left(\sum_{j=1}^{m} a^j\bar{h}+\sum_{j=m+1}^{N} a^j\bar{h}\right)a^i\bar{h}-c(\bar{h})a^i\bar{h}\right]\\ &+\sum_{i=m+1}^{N}\left[r_2\left(\sum_{j=1}^{m} a^j\bar{h}+\sum_{j=m+1}^{N} a^j\bar{h}\right)a^i\bar{h}-c(\bar{h})a^i\bar{h}\right]. \end{aligned}\tag{8}$$

where $\bar{h}$ is the uniform height limit. Solving this yields a first-order condition that can be rewritten to illustrate that $\bar{h}$ will in this case also be a weighted average of the optimal full-information height limits, h_1^* and h_2^*:

$$\frac{A_1[r_1+r_1'\bar{D}]+A_2[r_2+r_2'\bar{D}]}{A}=c(\bar{h})+c'(\bar{h})\bar{h}\,, \tag{9}$$

where $\bar{D}=A\bar{h}$. Except under rather strict assumptions about the rent functions, these two approaches will lead to different uniform heights. Nevertheless, both amount to weighted averages of the optimal height, and will lie somewhere between h_1^* and h_2^*. For simplicity, this paper will pursue the implications of the simplest uniform height rule, that $\bar{h}=D^*/A$.[12]

Comparing the constrained planner's uniform height with the planner's optimum in Eq. (4), it can be seen that under the constrained optimum, (a) type-1 developers will always be constrained by $\bar{h}$, and (b) type-2 developers may not be constrained

[12]Note that the alternative uniform height rule, from solving Eq. (9) implicitly for $\bar{h}$, is a second-best planner's optimum. It imposes the constraint that $h_1=h_2$. The simpler alternative that I explore, shown in Eq. (7), is actually third-best, because it imposes the additional constraint that $\bar{h}=D^*/A$.

and therefore may not build to the uniform maximum height $\bar{h}$. The first proposition is relatively easy to show. If the city planner sets the uniform maximum height at $\bar{h}=D^*/A$, and lots of both types are developed to their limit, then total development will be the same under both scenarios, the full information zoning rule (h_1^*, h_2^*) and the uniform height rule $\bar{h}$. As a consequence, rents in both regions will be the same under both scenarios. Since type-1 developers were constrained by the full-information height limit h_1^*, they will certainly be constrained by the uniform height limit $\bar{h}<h_1^*$. Furthermore, this is true regardless of whether or not type-2 developers build to the uniform maximum height. This outcome is illustrated in Fig. 2. Potential values of $\bar{h}$ lie between h_2^* and h_1^* along the uniform height line $h_1=h_2$ (the hypotenuse of the dashed right triangle in the figure). This line segment is everywhere less than the line $h_1(h_2)$. (Recall that $h_1(h_2)$ represents the height to which type-1 developers would want to build, given heights on type-2 lots.) Thus graphically, type-1 developers will always wish to build higher than allowed by the uniform height rule.

As for the second proposition, type-2 developers may or may not be constrained by the uniform height rule. If all lots are developed to their limit, rents will be the same as under the planner's optimum, at which type-2 developers were constrained. However in this case $\bar{h}>h_2^*$, and so it is possible that type-2 developers would not be constrained by the uniform limit $\bar{h}$. This can also be seen in Fig. 2. A segment of the uniform height line from h_2^* to h_1^* lies above $h_2(h_1)$, indicating that if the uniform height limit is set in that range, type-2 developers will not be constrained by it. That segment is represented by the dark arrow in Fig. 2. How large this segment is, and if it exists at all, will be determined by (a) the size of the externality, (b) the shapes of the rent functions in relation to one-another, and (c) the relative areas covered by the two types of lots, A_1 and A_2. The appendix contains a numerical example demonstrating the third effect.

If the uniform height rule does not constrain type-2 developers, then they will have excess development rights. In this case, not only does the uniform height rule inefficiently distribute total development, but it provides less than the socially efficient total amount of development. A TDR system would correct both inefficiencies by allowing type-2 owners to sell development rights unused under a uniform height rule to type-1 owners, bringing type-1 lots to h_1^*, type-2 lots to h_2^*, and total development back up to D^*, the planner's optimal level. As a result, total development under a TDR system would be higher than under a uniform height rule.

7. Conclusion

A uniform height zoning rule imposes a regulatory requirement without equalizing marginal compliance costs, and as a consequence it achieves the total overall externality reduction in a less than cost-effective manner. Marginal compliance costs (lost rents to developers) are higher in this example for type-1 landowners than for type-2 landowners. The same total development could be achieved at higher value by shifting some development from type-2 to type-1 lots. If the shift is enabled through a TDR system and if type-2 owners do not build to the uniform height limit, type-2 owners will sell their excess development to type-1 lot owners who were constrained by the uniform height limit, and overall development will unambiguously increase. The simple intuition for this is that some developers over-comply under the one-height rule, whereas there is no overcompliance under a TDR system.

The overcompliance that may occur under a uniform height rule is socially costly, but from the perspective of an anti-development advocate it may be a desirable outcome. People who place a high value on the external costs of development thus may be quite rational to argue against TDR systems on the grounds that they will increase overall development.

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Appendix 1

A numerical example with different relative lot sizes

Suppose that there are ten developers of ten lots, and that each lot has 100 square feet. Let the cost of building be $c(h)=h$. In addition, let five of the lots be high-rent (type-1) and five be low-rent (type-2). (So in the nomenclature of the text, $m=5$, and $A_1=A_2=500$.) Rents on type-1 and type-2 lots are

$$r_1(D)=10-\frac{D}{1000} \quad r_2(D)=5-\frac{D}{1000}\,. \tag{10}$$

Individuals maximize $\pi_j=r_jha-c(h)ha$. The first-order condition for this problem yields the individual rule that

$$h_j=\frac{r_j}{2}\,. \tag{11}$$

If all developers adhere to this rule, then $D_1=A_1r_1/2=250r_1$ and $D_2=A_2r_2/2=250r_2$. Plugging $D=D_1+D_2$ into Eq. (10) above and solving yields the unregulated equilibrium values of r_1 and r_2: $\tilde{r}_1=\frac{15}{2}$ and $\tilde{r}_2=\frac{5}{2}$. Eq. (11) gives us the unregulated equilibrium heights $\tilde{h}_1 = \frac{15}{4}$ and $\tilde{h}_2 = \frac{5}{4}$. Total development without zoning would be $\tilde{D} = 2500$.

If the city planner were to maximize total rents, its first-order conditions would be as in Eq. (4). Using the numbers here, they are

$$10 - \frac{h_1 + h_2}{2} - \frac{h_1}{2} - \frac{h_2}{2} = 2h_1 \quad 5 - \frac{h_1 + h_2}{2} - \frac{h_1}{2} - \frac{h_2}{2} = 2h_2. \tag{12}$$

Solving for optimal values of h_1 and h_2 yields the results that $h_1^* = 3\frac{1}{8}$ and $h_2^* = \frac{5}{8}$. Eq. (10) gives us the market values of rents at these levels of development: $r_1^* = 8\frac{1}{8}$ and $r_2^* = 3\frac{1}{8}$. Applying these to individual developers' height rule in Eq. (11) makes it clear that both types are constrained by these zoning regulations. Total development under this zoning rule would thus be $D = A_1 h_1^* + A_2 h_2^* = 1875$.

Now suppose that the city planner does not differentiate high-rent lots from low-rent lots, and imposes a uniform zoning rule where $\bar{h} = D^*/A = 1\frac{7}{8}$. Under this rule rents are the same as under the full-information zoning rule, and so desired heights are (using Eq. (11)) $\tilde{h}_1 = 4\frac{1}{16}$, $\tilde{h}_2 = 1\frac{9}{16}$. Type-1 developers are constrained by this uniform height rule ($\tilde{h}_1 > \bar{h}$) while type-2 developers are not ($\tilde{h}_2 < \bar{h}$). This demonstrates a situation in which a TDR program that sets the number of permits equal to the planner's optimal level of development would increase the total amount of development.

This result, that TDRs lead to more development, depends upon the parameters of the model. Consider, for example, a case identical to that outlined above except for the fact that there is one type-1 lot and there are nine type-2 lots ($m = 1$, $A_1 = 100$, and $A_2 = 900$). In this case the market outcome, with no zoning, will be $\tilde{r}_1 = 8\frac{1}{6}$, $\tilde{r}_2 = 3\frac{1}{6}$, $\tilde{h}_1 = 4\frac{1}{12}$, and $\tilde{h}_2 = 1\frac{7}{12}$. The city planner's optimal full-information zoning rule would be $h_1^* = 3\frac{5}{8}$, and $h_2^* = 1\frac{1}{8}$. Total development would thus be $D^* = 1375$, and rents would be $r_1^* = 7\frac{1}{4}$ and $r_2^* = 2\frac{1}{4}$. At these rents, desired heights would be $\tilde{h}_1 = 4\frac{5}{8}$ and $\tilde{h}_2 = 1\frac{13}{16}$. If the city planner were forced to set a uniform height rule $\bar{h} = D^*/A = 1\frac{3}{8}$, both types of developers would be constrained.

The intuitive explanation for the fact that changing the relative amounts of the two types of real estate is that the uniform height rule is a weighted average of the two optimal heights. Increasing the number of low-rent lots increased the weight put on h_2^* in the calculation of $\bar{h}$. (See Eq. (7).) As a result, $\bar{h}$ must be lower, and type-2 lots are more likely to be constrained. Graphically, in Fig. 2, the uniform height rule is more likely to be at the upper left edge of the $h_1 = h_2$ line, above the $h_2(h_1)$ line, where it will be binding for type-2 developers.

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