Title
Zoning and the Distribution of Income

Author
Berck, Peter

Publication Date
1977

Division of Agricultural Sciences
UNIVERSITY OF CALIFORNIA

Working Paper No. 73

ZONING AND THE DISTRIBUTION OF INCOME

by

Peter Berck

California Agricultural Experiment Station
Giannini Foundation of Agricultural Economics
January 1977

ZONING AND THE DISTRIBUTION OF INCOME

By Peter Berck

Planners and politicians speak of spillovers, traffic congestion, air pollution, lack of "open space," and outright nuisance (auto body shops next to theorem factories) as reasons for zoning. In fact, zoning is an issue of taking. In the context of a simple locational model, it is shown that, given any initial allocation and zone, all zoning changes lead to blocked allocations. Moreover, almost all zoned allocations are outside the core; those zoned allocations that are within the core are achievable as competitive equilibria. Given the above theorems, why zoning? Zoning generates important (if not desirable) income transfers. These income transfers are demonstrated in the context of two (competing) groups of city dwellers, agriculture, and landlords.

The Model

The model to be used follows Alonso [ ]. Land is distributed uniformly along one dimension (t) which is interpreted as distance from the center of a city (or central business district). Land closer to the center is more desirable than land further away from the center. Consumers of homogeneous classes value land and labor (and, in a later example, food). Consumers have the peculiar characteristic that the disamenity from living at distance t is a lump-sum loss of amount k(t). Thus, a consumer with income y who chooses to live at distance t has disposable income y - k(t); k(t) is a transport cost paid in terms of the numeraire y, the endowment of labor.

The only price that varies is that of land (r). Consumers of type U are adequately described by their utility functions U(q, x)--where q is land and x is labor--their indirect utility functions V[y - k(t), r], or their expenditure function e(U, r).

Given a set of prices and transport charges $[r(t), k(t)]$, each consumer chooses the t at which his utility is maximized. This mobility assumption leads to equal utility for all members of a given class. Thus, $V[y - k(t), r(t)] = \overline{U}$ for all consumers with indirect utility V and income y. Every consumer of a given class is equally well off regardless of where he lives. It is the rental rate of land that equalizes consumer utility. If consumers of a given class live in an interval or zone, $I = (t_1, t_2)$, then, for every t in I,

(1) $$\frac{d}{dt} V[y - k(t), r(t)] = 0$$

or

(2) $$\frac{d}{dt} [y - k(t)] - e(\overline{U}, r) = 0.$$

The first statement is obvious--utility does not change within the interval; the second statement says much the same--everyone in the interval will have just enough income to attain utility level $\overline{U}$. By using a basic identity of the expenditure function, $D_r\, e(p, r) = q(\overline{U}, r)$, the second equal-utility statement can be reexpressed as

(3) $$\dot{r} = \frac{-\dot{k}}{q}.$$

Thus, the knowledge that a group of consumers occupies only the interval I = (t_1, t_2) allows the calculation of an equilibrium from (3) above and by choosing $r(t_1)$ so that

(4) $$\int_I \frac{1}{q}\, dt = N_0$$

where N_0 is the total number of members of the class. The term under the integral sign is the number of people per unit of land where it is assumed there is one unit of land at every distance. Each consumer pays rent in the amount $r(t)\,q(t)$. This rent goes to a landlord who lives nowhere and spends all his income on the single nonland good.

Consider a city of finite size (t_1, t_3) to be divided between two groups, A and B, whose bid rent curves and $r^A\,(t_1, t_2)$ and $r^B\,(t_2, t_3)$. Arbitrarily, it is assumed that each group lives in only one interval and that all conceivable allocations have group A closer to the center than group B. The competitive allocation is specified by the following: (1) Group A lives at t only if $r^A\,(t) > r^B\,(t)$ and vice versa and (2) $r^A\,(t_2) = r^B\,(t_2)$.

One suspects that group A will not benefit from decreasing the land area available to it. Consider a differential change in the boundary:

$$\frac{d}{dt_2}\left(\int_{t_1}^{t_2} \frac{1}{q}\,dt - N_A\right) = \frac{1}{q}$$

or moving in the boundary a little means that room must be found for an extra $1/q$ people. This means all members of group A must consume less land. On the assumption that land is not a Giffen good (demand curves slope down), it must be true that $r^A\,(t_1, t_2) < r^A\,(t_1, t_2 - dt)$.

One sees increased rent by the following argument. Because of the no-Giffen good assumption, rent must be higher for some t, say t_1 (it does not really matter which t one chooses). Denoting new values by "hats," one gets $\hat{q}(t_1) < q(t_1)$ and $\dot{r} = -k/q$ so $\hat{\dot{r}} < \dot{r}$ or rent declines faster at the new equilibrium than it did at the old equilibrium. Can the two rent profiles cross or touch? No. Suppose $\hat{r}(t^*) = r(t^*)$. Then $\hat{q}(t^*) = q(t^*)$ and $\hat{\dot{r}} = \dot{r}$. Thus, r and $\hat{r}$ would be identical over a nonempty interval. But since r is assumed analytic, r and $\hat{r}$ would be identical everywhere which contradicts the assumption that $\hat{r}(t_1) > r(t_1)$.

By the same sort of argument, people of type B benefit from having more land. As a class, landlords may lose, benefit, or not care. Suppose, for instance, that both A and B types have Cobb-Douglas utility functions. Then landlords always receive the same share of after-transport expense income; any zoning change that decreases total transport costs benefits landlords as a class. Other utility functions produce other answers. In summary, decreasing the interval a group may occupy decreases its utility and increases its rent. The group's expenditure on land is indeterminate.

The model under discussion assumes that people of a given group are assigned to an interval. In fact, people are free to move. The essence of zoning is that it makes certain land undesirable for certain groups. For the moment, assume a culture of renters. Give group A the power to zone in interval I. By zoning it for the size lots they prefer, they do no damage to themselves. But what of group B? Group B's bid rent curve without zoning was predicted on maximizing utility without any restriction on lot size. Zoning implies a lot size restriction; thus, group B operates under an additional constraint which (if binding) lowers the group's bid rent for the zoned land. If groups A and B are different enough--and it is assumed that they are--the restriction on lot size or density will preclude the victimized group from occupying the zoned interval just as effectively as an absolute prohibition. A graphic example is shown in Figure 1 which shows the competitive situation. The dividing line between the groups is defined by $r^A(t_2) = r^B(t_2)$. Now consider what happens if group A has zoning power that extends to $\hat{t}_2$ (Figure 2).

FIGURE 1

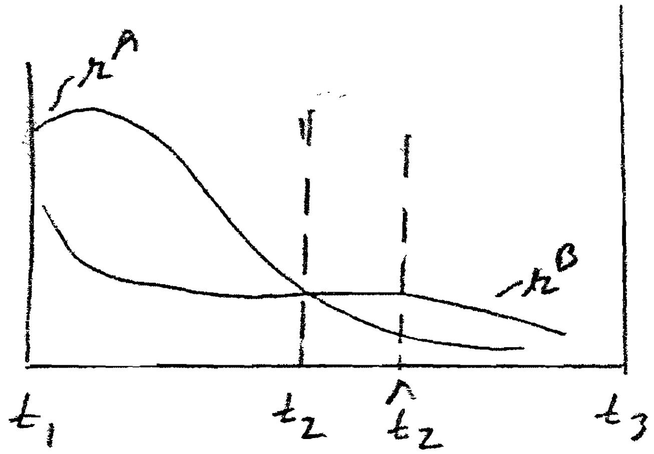
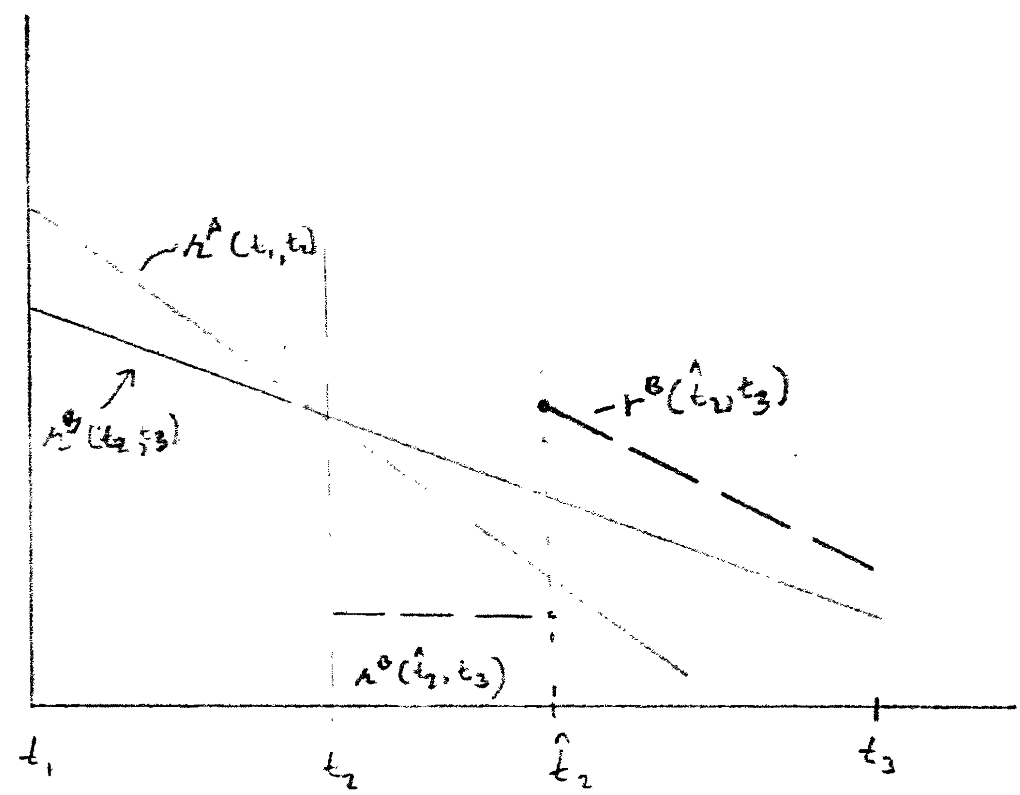


FIGURE 2



Group A requires that, in the interval $I = (t_1, \hat{t}_2)$, lot size be $q^A (t_1, \hat{t}_2)$. Group B lives at $t \varepsilon I$ only if $r^B (t) > r^A (t)$. Group B's bid rent problem becomes

$$\max U^B (q, y)$$

subject to

$$y - k(t) = rq + x \quad t \not\in I$$

$$\max U^B (q, x)$$

subject to

$$y - k(t) = rq + x \text{ and } q = q^A \quad t \varepsilon I.$$

Because $t \varepsilon I$ implies an additional restriction, the utility achievable at a given set of prices must be lower or, to put it the other way, a lower r is needed to achieve the original level of utility. If r^B is to be lower by very much, then people of type B will no longer live in I.

If people of type B no longer live in I, then (as argued above) (1) their bid rent for the land they do live on must go up and (2) their utility must go down. Figure 2 compares the pre- and postzoning bid rent curves for group B.

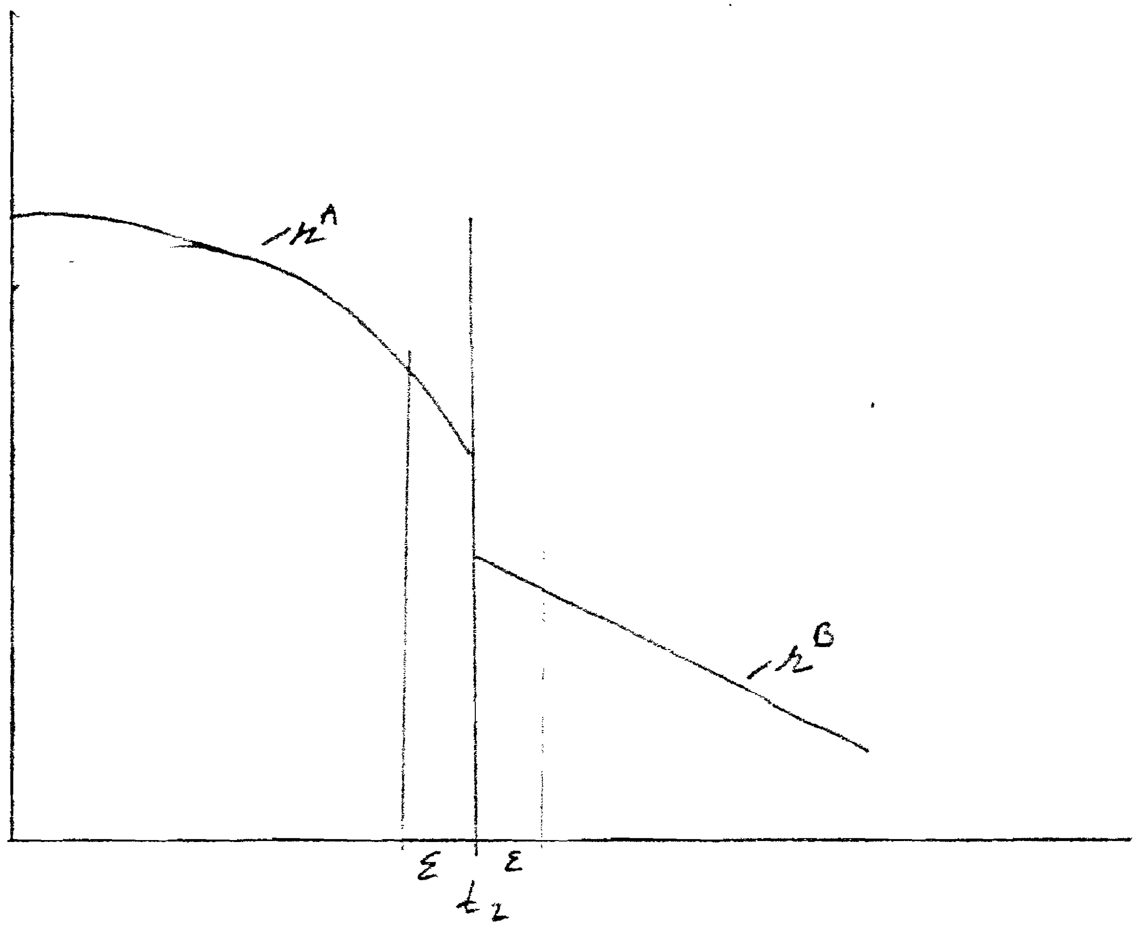
The story for group A is just the reverse. Group A has decreased rent and increased utility. Examination of the graphs shows that specific landlords lose and gain. All postzoning landlords of the B category gain, while those of the A category lose. To be effective, zoning must have some losers.

Efficiency

While the analysis above shows that rezoning necessarily entails making someone worse off, it would be interesting to know if there are any efficient zoned allocations. The only zoned allocation that is efficient is the competitive equilibrium.

First, we prove a lemma. If the bid rent curve is discontinuous, an allocation is not efficient (Figure 3).

FIGURE 3



Consider consumers living within ε of t_2. The marginal rate of substitution between x and q (labor and land) for group A is at least $r^A (t_2)$, while that of group B is at most r^B; thus,

$$\frac{MU_q^A}{MU_x^A} \geq r^A > r^B > \frac{MU_q^B}{MU_x^B}$$

for consumers living anywhere in the interval $(t_2 - \varepsilon, t_2 + \varepsilon)$. Consider moving a small number of consumers from $(t_2 - \varepsilon, t_2)$ to $(t_2, t_2 + \varepsilon)$ and spreading out the consumers who remain. Clearly, the consumers who remain gain if any consumers leave their interval.

The movers take land from the type B people and compensate them, r^B, which leaves the type B people indifferent. The type A movers now have $r^A - r^B > 0$ to enjoy. Or do they? In fact, the movers must pay higher commuting costs k(t). If k is continuous, $k(t_2 - \varepsilon) - k(t_2 + \varepsilon)$, the maximum transport cost difference can be made arbitrarily small by choice of ε. But $r^A - r^B$, the benefits of reallocation, are unchanged by choice of ε. Thus, the movers can pay the added transport costs. Since the new allocation is Pareto preferred to the old allocation, the old allocation was not efficient.

Because $r^A (t_1, t_2)$ is monotonically decreasing in t_2 while $r^B (t_2, t_3)$ monotonically increases in t_2, there is only one efficient zoned allocation. It coincides with the competitive equilibrium.

Why Zone?

A remarkably naive question--one that could only have been formed by an economist--presents itself. If zoning either reproduces the market or is inefficient, why zone? The standard justification for zoning is nuisance.

Nuisance takes two forms. One, called racism in its more extreme forms, is group A's dislike for B (and vice versa). If by chance these groups should have coincident bid rent curves, both groups would be made happier (assuming uniform hatred) by separating the two groups through zoning. The second type of nuisance--and the one more usually cited--consists of attempts to build at high density in low-density neighborhoods. In the context of this simple model, people value the spaciousness of their neighborhoods. All other things equal, each consumer views an allocation in which there are fewer other people living near him as a better allocation. That is, utility is now also a function of the density at t; $n(t) = 1/q$. Equivalently, $U(x, q, n)$, this is a standard externality problem and leads to an inefficient allocation. Each agent uses too little land because he disregards the effects of his small plot on his neighbor's utility. The competitive equilibrium picture has the usual appearance, but the rent schedule $\hat{r}^A$ that would lead type A consumers to the competitive allocation _if_ they took account of the externality is greater than r^A. Let $q(t)$, $x(t)$ be the competitive allocation to group A; it results from

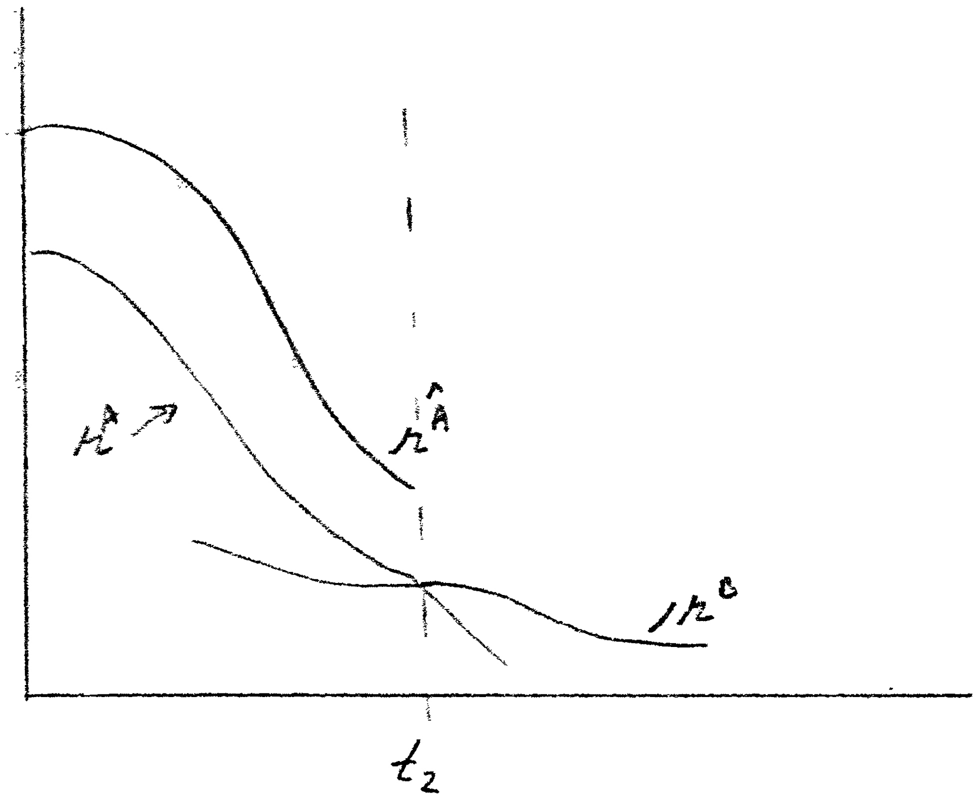
$$y - k(t) = x + rq$$

$$\frac{MU_q}{MU_x} = r.$$

Let $\hat{r} = MU_q - \frac{1}{q^2} MU_n / MU_x$ evaluated at the competitive allocation. Because $MU_n < 0$, $\hat{r} > r$. Thus, the proper picture is Figure 4.

When there is an externality, the bid rent curve that accounts for the externality, $\hat{r}$, is above the bid rent curve that does not account for the externality. The market bid rent, r, is used to determine the market equilibrium and meets the end conditions of continuity with the competing group. The true bid rent, which

FIGURE 4



would result if land allocations were decided in a town meeting or if everyone agreed to copy the offer curves of a representative consumer, is above the other bid rent and is not continuous with the competing group's bid rent. Since the bid rent curves of the two groups do not meet the condition, $\hat{r}^A(t_2) = r^B(t_2)$, the allocation is not efficient.

From the other assumptions and from the diagram, it is easy to see that moving the point of intersection to the right--that, is, giving more land to the consumers of type A--will eventually result in an allocation in the core. As has been shown above, such a change will result in the consumers of type A being made better off, while the consumers of type B are made worse off. Much as efficiency is to be desired, a single group of consumers legislating the zoning rules for the land on which they live cannot make themselves better of (by spreading themselves out) without making some other group worse off. Zoning, even to correct an externality, is a matter of income distribution as much as it is a matter of nuisance.