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Market-Based Systems for Assigning Rental Value to Land

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**Introduction**

This paper describes systems for assigning rental value to land through markets for the use of land that are created and managed by government officials. The central idea of the paper is that the full rent of land can be collected, while achieving an efficient allocation of land, if the rent for improved sites is revised annually, based on offers for the use of similar sites for the current year. The efficient allocation of land requires neither the sale of land nor leases of long duration at fixed rents.

Two systems for assigning rental value to land are presented. One system employs a market in which land is actually turned over to bidders for their use, while the other employs a market in options to use land.

While these systems are applicable in many settings, they are particularly applicable to current conditions in the Soviet Union, where land is being transferred from public to private management. The new manager of each site will receive the profit or bear the loss from production on that site. The question

under consideration is, what process should be used to determine how much must be paid for the use of each site?

A standard response of economists to such questions is, "Sell everything to the highest bidder." In the context of land in the Soviet Union, this could mean selling, for a lump-sum amount, the right to use each site into the indefinite future. However, there a number of reasons why such an approach would be less attractive than selling the right to use sites for rent to be paid annually. First, the person who could make best use of the site might be unable to match a purchase bid from someone else, because of unequal access to lending markets (because of unequal wealth, for example). Selling land use rights for annual rent makes sites more available to users with relatively little in assets. Second, uncertainty about future political conditions would tend to depress purchase offers. Selling land use rights for annual rent requires the State to accept the risk of future unfavorable public policies, and thereby tends to promote favorable future conditions. Third, the high degree of general uncertainty about future economic conditions could lead to offers of less than the expected value of opportunities, simply because people had no idea how to guess what the opportunities would be worth. Selling land use rights on an annual basis permits many of the future uncertainties to be resolved before bids must be made. Finally, the return to future use of a site might more justly be claimed by future generations than by the present generation. Selling land use rights for annual rent allows each

year's population to claim that year's rent. While the proceeds of sales could be invested for the benefit of future generations, not collecting the money in advance helps preserve the heritage of the future against political predations. For all of these reasons, I assume that what is desired is a rental price to be assigned to each site for each year, rather than a purchase price.

#### **Renting Land One Year at a Time**

The idea of renting a site to the highest bidder is conceptually more complex than selling it to the highest bidder, because different users could be expected to desire to use a site for different spans of time. Suppose that one person bids 1,000 rubles per year for 20 years and another bids 1,100 rubles per year for 30 years. Which bid is higher? To compare these bids, one must know what someone else would pay for the use of the site for ten years, twenty years hence, and one must also know the appropriate discount rate for the next thirty years. These difficulties of comparing bids for different terms can be avoided by renting sites just one year at a time. Renting land one year at a time also guarantees future generations that they will not be disadvantaged by being bound by the terms of agreements in which they did not participate, and which disposed of their heritage for a small fraction of its value.

The idea of renting sites one year at a time may sound unpromising at first. The efficient use of land generally requires improvements that last for many years. How could entrepreneurs

be expected to improve land if they were only permitted to rent it for one year at a time? The answer is that entrepreneurs could be expected to make durable improvements to land, even if the rent was determined only one year at a time, if they were assured that they would be permitted to continue to use the land they had improved at a price that was determined in a fair and impartial manner.

The risks associated with uncertainties are customarily borne, for a price, by entrepreneurs. Uncertainty in the future price of using land, like uncertainty in the future price of any other input or product, can be accommodated by entrepreneurs.

The kind of uncertainty that will significantly deter potential investors is uncertainty associated with a climate that invites tax increases or other rule changes that extract additional money from investors, taking advantage of the fact that investment in durable improvements has occurred. To attract investment, governments must do what they can to commit themselves not to take confiscatory action once investment has occurred. This is accomplished by settled rules, by public respect for property in a democratic system, and by a system of public finance that provides adequate revenue for necessary expenditures and curbs the tendency of politicians to spend excessively. So the future rent of land can be uncertain without discouraging investment, provided that the process used to determine rent is settled and does not confiscate capital.

Thus the question at issue can be restated as, "What process might be used to determine the rent of land, one year at a time, in such a way that the full rent of land would be collected, while at the same time insuring that entrepreneurs would not be required to pay arbitrary, extra amounts by virtue of having made durable improvements to land?" Alternatively stated, the question is, "By what administrative process might it be agreed that the rent of land would be determined, year by year, to collect the full rent of land but no more?"

#### Defining "The Rent of Land"

To proceed, there must be an agreed definition of "the rent of land." From a conceptual or theoretical perspective, the rent of land is a residual. It is the difference between total revenue and costs other than land, when land is managed in such a way as to yield the greatest present value of net returns.

There are two practical difficulties with this definition. It yields an answer in terms of the present value of rent rather than an annual amount, and it does not provide an algorithm for public officials to follow. The two difficulties can both be overcome by using an operational concept of rent, defined in terms of what people are willing to pay. But before proceeding, it is useful to define some symbols.

Define  $V(0)$  as the present discounted value of the net returns from the use of a site from the present time onward, assuming that the site is now unimproved. Define  $V(1)$  as the present value, discounted to today, of the net returns from the use of

the site from one year from now onward, assuming that the site will be unimproved one year from now. The rental value of the site for the year beginning today,  $R(0)$ , may then be defined as  $V(0) - V(1)$ . The logic of this definition is that the rent for a site for the current year is the most that anyone is willing to pay for use of the site for the current year, if use of the site after the current year is contingent upon payment of amounts that have a present value of  $V(1)$ . Alternatively stated, rent for this year is what must be added to the value, as of today, of using a site from one year hence into the indefinite future, to produce a total equal to the value of using the site from today into the indefinite future.

This definition corresponds to the following operational conditions. Suppose that there are a number of identical sites, and suppose that people have the opportunity to bid for the use of one of these sites, under a rule that the use of the site will go to the highest bidder, who will be obliged to make an immediate payment equal to the amount offered by the second highest bidder.<sup>1</sup> This payment will entitle the highest bidder to use the site for one year. The highest bidder will also have the option of using the site into the indefinite future, upon payments of annual amounts  $R(1)$  for use in the year beginning at time 1,  $R(2)$  for use in the year beginning at time 2, and so on, where the

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1. Requiring a payment equal to the second-highest bid motivates each bidder to bid the full value of use to him. See Vickrey (1961).

amounts  $R(1)$ ,  $R(2)$ , ... will be determined by bids, under corresponding conditions, for identical sites in future years.

A bidder would reasonably expect that the sum of present values of the amounts  $R(1)$ ,  $R(2)$ , ... would be  $V(1)$ . If it were any less, an opportunity for profit would have been left unexploited. And if it were any more, at least one bidder would be heading for a loss. In these circumstances, a rational bidder who was able to put the land to its best use would offer  $V(0) - V(1)$  for use of the site for the year beginning at time 0. And this is the definition of the rent for the site for the year beginning at time 0.

The identification, in this analysis, of the period for which the rent applies as one year is arbitrary. A similar analysis could be undertaken using a month or a decade as the time period for the first rental payment. In practice, the appropriate period would be chosen by balancing the higher administrative costs of frequent rent changes against the costs of inaccuracies in rent from less frequent rent changes.

### **Consequences of Foreseeable Increases in Rental Value**

If the value of a site could be expected to rise in the future, bidders for the current use of the site would take that into account in their current offers. A potential user who wished to make long-lasting improvements to the site, of a sort that could not take full advantage of the future higher value of the site, could be expected to offer less for the site this year than if the site did not have future prospects that would raise

future offers from competing uses. On the other hand, a potential user who wished to use a site as a parking lot, requiring very little in durable improvements, would be virtually unconcerned with the prospect of higher future rents. Thus, to the extent that bidders could foresee future bids, sites where optimal use required a change in use in the near future would tend to be acquired by users who could relinquish use without suffering loss.

Of course, the future cannot be seen perfectly. People would sometimes experience losses as a result of unanticipated rises in the rent of the land under their durable improvements. To compensate for this risk, people who wished to use land for durable improvements would reduce, to some extent, their bids for land. They might also seek to purchase insurance against increases in the rent on the land under their improvements, just as they now purchase fire insurance. (The paper prepared for this conference by Steven Cord discusses measures for protecting the owners of improvements from increases in the rent of the land under their improvements.) The practice of setting each year's rent at the amount that someone was willing to pay in that year for the use of a similar site would ensure that some profit-oriented person (either the investor or the seller of insurance) would have an incentive to estimate carefully the opportunity cost of a site in future years before the site was committed for a long span of time to a particular durable improvement.



### Relaxing the Assumption of Identical Sites

The system described so far presumes that there are many identical sites, so that the rents offered for ones that are relinquished can reveal the value of the ones in continued use. In fact, every site has unique characteristics, in terms of the distances from other locations that are economically relevant, if no other. Nevertheless, it is possible to make good estimates of the rental value of all land from information about the rental value of a small percentage of sites. The reason is that the rental value of land tends to be a smooth function of location. Rents are highest in the centers of cities, diminishing gradually with distance from the center. Rents are also higher in places with characteristics such as proximity to transit facilities or an especially good view. Rents tend to be lower in places that are close to the source of a noxious smell or noise. Since the factors that affect rent tend to change smoothly with distance, it is possible to create a good map of land rents from information about a relatively small percentage of sites. Thus the assumption of a large number of identical sites, which was made in the initial explanation of the system, is not necessary.

To take account of the differences among sites, the officials in charge of renting land would annually examine the results of recent auctions and construct a revised map of land rents. In constructing this map, the rent that would be assigned to each site that was auctioned would be not the highest bid, but rather the second-highest bid. The reason for using the second-highest

bid is that this bid represents the actual opportunity cost of a site, what it would be worth to have one more vacant site.

To elaborate: Suppose that the highest bid for a site was 1,000 rubles per year, and the second-highest bid was 800 rubles per year, and suppose that an adjacent site, with virtually identical characteristics, is occupied by someone for whom continued use is worth 900 rubles per year. If this person were charged 1,000 rubles, he would relinquish the site, and the rent that could then be obtained for it would presumably be the 800 rubles that was offered for the adjacent site. Thus it is counterproductive to assign rent that is greater than the highest offer that was refused.

#### **Summary of the System Involving Actual Delivery of Land**

To operate the system for determining annual rents from bids for sites that are actually delivered for use, the officials in charge of renting land simply auction every site that is relinquished by its previous user. The terms of the auction are that the bid represents an offer of rent for the first year's use, with use of the site going to the highest bidder at a price of the second highest bid. The highest bidder also receives an option to continue to use the site into the indefinite future, upon payment of rent that will be determined, year by year, by rent maps that will be constructed from bids in auctions that will be conducted in the same way.

The user of any site is permitted to terminate his use at any time, provided that he restores the site to a condition of bare

land. To protect against the abandonment of sites in a condition in which it was expensive to restore them to an unimproved state, it might be necessary to require anyone who wished to build to post a bond against the cost of demolition.

Any user of land would be permitted to sell his improvements on a site and the right to continue renting the site to anyone else, for any price on which they mutually agreed. However, it could be expected that the prices that would be agreed would reflect little if anything more than the value of the improvements, because the right to use sites could be obtained at auction just by offering a small amount more than what others were offering for the first year's rent.

Each year the land-managing bureaucracy would construct a new map of land value, based on the second-highest bids for sites that had been auctioned recently. Rent bills for all land would then be sent out, based on this map.

#### **A System Based on Options to Use Land<sup>2</sup>**

The system described previously presumes that each year enough sites would be relinquished to the State for re-leasing to produce a current land value map with adequate accuracy. If sites were not relinquished frequently enough to determine the pattern of land rents with the desired accuracy, then, at the cost of somewhat higher administrative expenses, it would be

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2. This system has been described previously in Tideman (1990). See that paper for some additional characteristics of the system that are not described here.

possible to employ a system in which a specific market rent was assigned to each site each year.

The key for accomplishing this is the use of an options market. To create this market, the officials in charge of renting land solicit offers that would bind potential users to rent specified sites at specified rents, if any of the designated sites were to become available.

A potential problem with setting rents through options is that such a practice seems to expose entrepreneurs who make durable improvements to expropriation. A bidder for an option on an improved site could make an artificially high offer, taking advantage of the fact that the person who made the improvements would not want to relinquish the site on which they were made. The way to avoid this problem is to require bidders to bid for many similar sites, including some that have a significant probability of being relinquished.

Consider first how this would work if there were a large number of sites that were identical, except for the improvements on them. To motivate bidders to bid as much as the full rent of land, a fee (perhaps 1% of the rent collected) would be paid to the highest bidder. But if any site were relinquished, the highest bidder would be required either to take over the site herself and pay, for at least a year, the annual rent she specified, or to find someone else to take it over, compensating that person as necessary. As long as there were some sites with a significant probability of being relinquished, a bidder would

find it unwise to bid more than the true rent for these sites. And bidding less than the true rent would mean leaving an opportunity for profit unexploited.

### Mathematical Analysis of a Bidder's Calculations

The calculations of a bidder can be made more formal, in the following way. First, define some terms:

$Z$  The bidder's expected profit per site.

$p$  the bidder's subjective probability that she will be the one who names the highest rent.

$A$  The rent that the bidder names.

$f$  The fraction of rent that the highest bidder receives.

$g$  The bidder's subjective estimate of the average probability that a site will be relinquished by its current users.

$R$  the bidder's estimate of the true rental value of the site--the rent that the site would yield if its use were offered at auction.

$C$  the cost to the bidder of developing her rent estimates.

Putting all of the above terms together, the bidder's expected profit is

$$Z = p[Af - g(A - R)] - C. \quad (1)$$

It can be seen that both bids that are very high and bids that are very low will lead to negative profits. If a bid is very high, then  $p$  will be nearly 1 and  $g$  will be large relative to  $f$ , so that the  $-g(A - R)$  term will dominate the expression and will be negative, leading to negative profits. On the other hand, if

a bid is very low,  $p$  will be virtually zero and the  $C$  term will dominate the expression, leading again to negative profits. For intermediate bids, however, positive profits are possible. If  $A$  equals  $R$  and the bidder is confident of being the only bidder, then the expression for  $Z$  reduces to  $Af - C$ , which will be positive if  $f$  is generous enough to cover the cost of submitting a bid.

It can confidently be expected that at least one person would find it profitable to submit a bid, because if there were only one bidder, she could profit from the cursory effort involved in submitting a bid that was sure to be lower than the actual rent. The number of bidders would be in equilibrium if every existing bidder had positive expected profits, but any potential new entrant found the cost of developing bids not worth the expected return.

When a bidder's expected profit is maximized, the derivative of (1) with respect to  $A$ , the variable that the bidder controls, is zero. Thus,

$$\frac{dZ}{dA} = p[f - g - \frac{dg}{dA}(A - R)] + \frac{dp}{dA}[Af - g(A - R)] = 0. \quad (2)$$

One use that can be made of this expression is to determine the conditions that would lead profit-maximizing bidders to submit bids exactly equal to their estimates of the rent of sites. The excess in a bid is  $A - R$ . Solving (2) for  $A - R$ ,

$$A - R = \frac{p(f - g) + \frac{dp}{dA}Af}{p\frac{dg}{dA} + g\frac{dp}{dA}}. \quad (3)$$

A bidder will be motivated to report her estimate of the rent accurately if the numerator of the right-hand side of (3) is zero.

Denote the elasticity of  $p$  with respect to  $A$  by

$$s = \frac{A}{p} \frac{dp}{dA}. \quad (4)$$

Since  $dp/dA$  is non-negative,  $s$  is non-negative. The condition for motivating accurate rental estimates (the condition that the numerator of the right side of (3) be zero) can be expressed as

$$p(f - g + sf) = 0, \quad (5)$$

or

$$f = g/(1 + s). \quad (6)$$

Equation 6 expresses the "commission rate" that must be awarded to the highest bidder to motivate accurate bids. The parameter  $g$  could be estimated by the frequency with which sites were redeveloped. The parameter  $s$  could conceivably be estimated from patterns of bids and assumptions about expectations. If there were only one bidder, because everyone recognized her skill and reliability and thought it not worthwhile to compete with her, then  $s$  would be 0. Since  $s$  is non-negative, equation (6) implies that the commission rate that must be paid to motivate

accurate assessments is less than or equal to the probability that a site will be relinquished.

### **Relaxing the Assumption of Uniform Rent in the Options System**

The above analysis employs an assumption that there are many identical sites. When this assumption is relaxed, it is apparent that bidders must be permitted to submit different bids for different sites. Then the problem of avoiding excessive bids for sites with durable improvements re-emerges. If bids were completely unconstrained, bidders would bid extra amounts for sites with durable improvements, reflecting the low probability that those sites would be relinquished.

The way to avoid this problem is to take advantage, once again, of the fact that land rent varies smoothly over locations. Each bidder can be required to offer bids on enough contiguous sites to ensure that there is more than a minuscule probability of relinquishment for a reasonable number of the sites. The requirement could be stated in some such form as, "A bidder must bid on all sites within a convex polygon of the bidder's choosing, containing at least 200 sites." (A site is a contiguous area under the control of a single individual or firm.) A bidder's bid would take the form of a land rent function that applied to the whole domain on which she was bidding. The land rent function would be constrained to be a uniform amount per square meter, with additive or multiplicative adjustments for identified factors such as distance from the center of the city, distance from transit stops, and elevation.



### Operating the System Involving Options to Use Land

To operate the system involving options to use land, the officials in charge of renting the land would solicit options from anyone who was interested in bidding. A bidder would be required to post a bond amounting to something on the order of a quarter of one percent of the rental value being bid upon. The bidder would determine the area on which she wished to offer options, and then provide a bid per square meter as a function of characteristics of the site.

For each site, officials would compute the rent implied by each bid that included the site. The highest such bid would be the rent assigned to the site, and a corresponding bill would be sent to the user.

One might think that to be consistent with the earlier system, the second-highest rather than the highest bid would be used to determine the rent of the site. However, as long as the site is not relinquished, it can be presumed to be worth more to the existing user than to any other. Thus the highest option bid is in fact the second-highest bid overall, so that using the highest option bid is consistent with earlier practice. The person to whom the land is worth the most (the existing user) pays what is offered by the person to whom it is worth second-most (the highest option bidder).

As with the previous system, the user of a site would be permitted to sell the improvements on it and the right to continue renting the site, to any one at any price that was

mutually agreed. The user would also be permitted to relinquish the site at any time, upon restoring it to the condition of bare land. And again, a person who wished to build on a site might be required to post a bond against the cost of clearing his improvements when he relinquished the site.

#### **Using Land Rent Information to Manage Externalities**

Once a detailed land rent map has been created, one of the uses to which it can be put is to determine appropriate prices for activities that affect the rental value of surrounding land. For example, if the bidders for land include a negative adjustment for proximity to a factory that pollutes the air, then it is possible to determine, from the bids, how much greater land rents would be if the pollution were terminated. This amount can rightly be charged to the factory. Similarly, if the bidders include a positive adjustment for proximity to a private parking garage in a commercial district, it is possible to compute the amount that the presence of the parking garage adds to total rents. To motivate people to undertake an efficient amount of the activities that have such positive effects, the addition to rent that they generate should be turned over to them. Option bids result in detailed maps of land rent that reveal both the locations of activities that have positive and negative effects on land rent, and the magnitudes of those effects.

### Extensions to Other State-Allocated Privileges

The central idea of the systems developed here is that the price to be charged to someone who makes continuing use of a state-supplied privilege can be determined by annual offers for corresponding privileges. The idea can be applied not only to land but to other domains as well. One domain that comes readily to mind is use of the frequency spectrum. As with land, effective use of the frequency spectrum (as by radio stations, television stations, and cellular telephone networks) requires a social understanding that a particular individual or organization will be permitted to have exclusive use of particular parts of what is available. (In the case of the frequency spectrum, this means the exclusive right to broadcast in a given frequency band in a given geographical area.)

People who wish to use frequency allocations generally need to be assured that they will have continuing use of the portions of the frequency spectrum that are assigned to them, so that they will not be left with useless broadcasting and receiving equipment. If so few people ever wanted to use the frequency spectrum that there was never a shortage of band widths to be allocated, then it would be perfectly just and efficient to permit everyone who wished to use the frequency spectrum to state the band widths they wished to use and require others not to interfere. However, if band-width allocations are scarce, then justice requires that those who receive allocations compensate the rest of society for their privileged status. But how much should they pay?

The systems described in this paper can be applied to determine appropriate payments. If one wished to use a system involving actual transfer of broadcasting rights, then payments would be determined by occasional (second-price) auctions of the right to use a given band with for a single year. If one wished to have the greater information that is available with bids for options, then one would ask potential user of the frequency spectrum to make binding offers annually on a large number of contiguous band-widths, reward the highest bidders and use the highest bids to determine the payments required of continuing users of the frequency spectrum.

The general characteristics of the domains to which these bidding systems might usefully be applied are:

1. The domain contains many similar bundles of rights.
2. A bundle of rights in the domain must be held for a considerable span of time to be used efficiently.
3. The future value of the rights is much more uncertain than the current value of the rights.
4. In the cycle of use of the rights in conjunction with other inputs, times arise when it is possible for the person to whom a bundle of rights has been assigned to relinquish it without diminishing the usefulness of other inputs (as when land is cleared for rebuilding).

While land and the frequency spectrum have these characteristics, it might be noted that the first characteristic is generally not present either for mineral deposits or for enterprises.

Thus other systems would be needed for the privatization of these domains.

### **Precedents in Existing Institutions**

The ideas of offering land for rent under terms in which future rent depends on future market conditions, and of creating a market in options to use land, may seem unprecedented. In fact, there are precedents.

Many commercial leases contain escalator clauses, in which future rent is determined by the increase in some index, such as of building costs.<sup>3</sup> This is parallel to the idea of setting future rent according to future bids for the use of land.

Options markets have long existed for shares in companies and for commodities. Recently, the firm of London Fox proposed to set up futures markets based on the sale value of commercial and residential property and on commercial rents (Frampton, 1990). Thus the idea of options in land also has a precedent.

What is new is the idea that a society can receive, in all future years, the full rental value of land that it turns over to private management, if rent in each future year is determined by what people offer for the use of similar land for that year, when they know that future rents will be determined in the same way.

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3. I know this because my father has such a lease for the premises he rents for his business.

References

Frampton, Rachel. "News Analysis: London Fox's Proposals to Establish a Futures Market in Commercial Property are Gaining Ground," Estate Times (May 4, 1990), 12.

Tideman, T. Nicolaus. "Integrating Land Value Taxation with the Internalization of Spatial Externalities," forthcoming in Land Economics, August 1990.

Vickrey, William. "Counterspeculation, Auctions and Competitive Sealed Tenders," Journal of Finance 16 (May 1961), 837.