



Winter 1977

## An Economic Analysis of Transfer of Development Rights

David Berry

Gene Steiker

### Recommended Citation

David Berry & Gene Steiker, *An Economic Analysis of Transfer of Development Rights*, 17 NAT. RES. J. 55 (1977).

Available at: <https://digitalrepository.unm.edu/nrj/vol17/iss1/4>

This Article is brought to you for free and open access by the Law Journals at UNM Digital Repository. It has been accepted for inclusion in Natural Resources Journal by an authorized editor of UNM Digital Repository. For more information, please contact [disc@unm.edu](mailto:disc@unm.edu).

# AN ECONOMIC ANALYSIS OF TRANSFER OF DEVELOPMENT RIGHTS

DAVID BERRY\* and GENE STEIKER\*

## INTRODUCTION

The increasing and often urgent concern with protecting valuable landscapes or landmarks from expanding urban development has induced a strong awareness among many people of the public, non-economic value of what has traditionally been viewed as private property. These landscapes and landmarks are not easily amendable to recognition in the land market since their value is largely non-economic, i.e., not based on gains from exchange. Among the kinds of valuable resources threatened by expanding urbanization are:<sup>1</sup>

1. historically or archaeologically significant sites or buildings
2. architecturally important buildings
3. landscapes having
  - a. locally representative or locally unique plant and animal communities
  - b. aesthetic and contemplative values
  - c. hazardous natural processes (such as recurrent floods)
  - d. beneficial natural processes (such as aquifers which supply drinking water)
  - e. recreational potential, or
  - f. agricultural value

Behind the conversion of valuable landmarks and landscapes lies the temptation of money to be made on the exchange of land. In fact, land speculation is an old American tradition. From the earliest European settlements on the east coast of North America through the post-revolutionary war expansion into the south and midwest up to the present day land dealings on the rural-urban fringe, speculation has been an important element in the exchange of land.<sup>2</sup>

---

\*Each author is a Research Associate, Regional Science Research Institute, Post Office Box 8776, Philadelphia, Pa. 19101.

1. See J. Costonis, *Development Rights Transfer: An Exploratory Essay*, 83 Yale L.J. (1973) for a discussion of threatened buildings; and Berry, *Preservation of Open Space and the Concept of Value*, 35 Am. J. of Econ. & Soc. 113 (1976) for a discussion of landscape values.

2. Trewartha, *Types of Rural Settlement in Colonial America*, 36 Geog. Rev. 568-96 (1946); M. Rohrbough, *The Land Office Business* (1968); C. M. Green, *American Cities in the Growth of the Nation* (1965); and *The Public Lands* (V. Carstensen, ed. 1962).

On the rural-urban fringe, a pattern of rising land prices is common. Figure 1 summarizes the pattern of land prices on agricultural and undeveloped parcels larger than ten acres along part of the rural-urban fringe of suburban Philadelphia. Several cases are represented, all occurring within ten miles of each other in the period from January 1970 through January 1973. The pattern took the form of three stages, including: 1) an incipient stage of speculation and development which can gradually evolve into 2) a transitional stage characterized by either a number of recent sales near the parcel in question, or a major road near the parcel in question, or some development near the parcel in question, and which may eventually evolve into 3) a state of active development where a number of recent sales have occurred near the parcel in question, a major road lies near the parcel in question, and development abounds near the parcel in question.

For land on the rural-urban fringe the gap between the exchange value for potential conversion and the exchange value for the purposes of maintaining current use such as agriculture or woodland<sup>3</sup> is often dramatic. Similarly, the potential gain from demolishing a valuable landmark and putting up a new building or opening up a parking lot are often enormous. Thus, the economic penalty for not participating in speculation and conversion falls heavily on the preservationist so that maintaining current uses during this rush to speculate and convert is often difficult.

Associated with speculation in land are a number of other social problems. For example, farmers on the rural-urban fringe may cease investments in their farms in anticipation of the big development which may or may not ever materialize. As a result, unconverted farmland may be prohibitively expensive to return to agricultural production.<sup>4</sup> Further social problems may be caused by an uncontrolled pattern of expansion of urban land uses, which can cause unnecessary increases in aggregate transportation costs and provision of public services. Leapfrogging and strip development are often accused of such economic inefficiencies.<sup>5</sup> As a final example, the use of the police power to restrict noxious agricultural activities and the taxation of rural land to serve urban interests, such as water or sewer

---

3. It should be kept in mind that not all land on most rural-urban fringes will or can be converted to urban uses. There is simply too much land and not enough people to accomplish this.

4. H. Conklin and R. Dymsha, *Maintaining Viable Agriculture in Areas of Urban Expansion*, N.Y. St. Off. of Planning Serv. (1972).

5. Coun. on Env'tl. Qual., 5th Ann. Rep. (1974); and Real Estate Res. Corp., *The Cost of Sprawl* (1974).

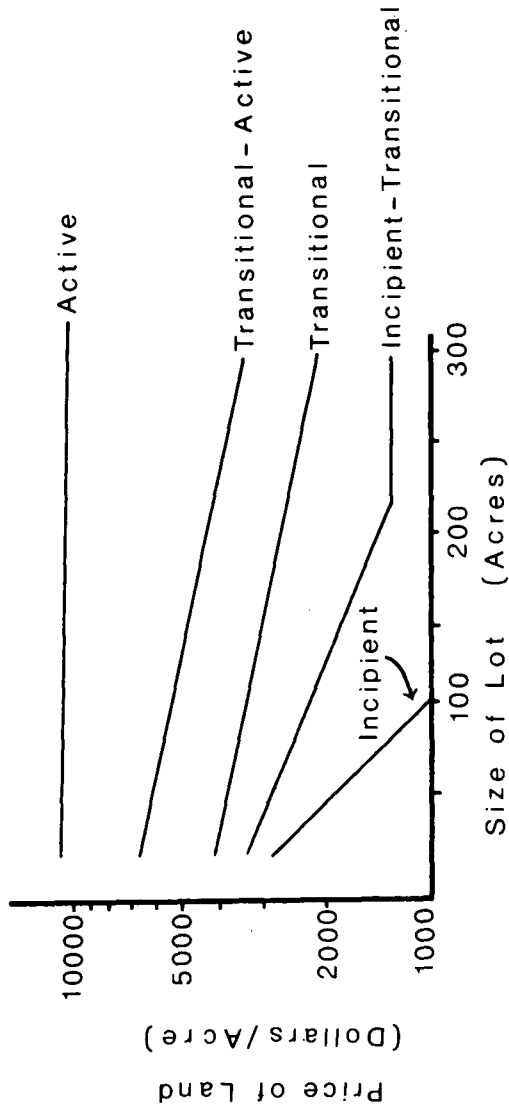


FIGURE 1

EVOLUTION OF LAND PRICES NEAR A PORTION OF THE RURAL-URBAN FRINGE OF PHILADELPHIA (1970-JANUARY 1973) BY STAGE OF SPECULATION AND DEVELOPMENT

Source: D. Berry and R. E. Coughlin, *Economic Implications of Preserving Ecologically Valuable Land in Medford, New Jersey*, Regional Science Research Institute, Philadelphia, 1973.

districts, all may serve to hasten the disappearance of agricultural activity.

In response to the problems of more urbanization, either within an existing core city or on the fringes of the metropolis, a number of methods have been proposed, and some implemented, to protect valuable landscapes and landmarks and to generally control the spatial pattern of growth. Six are especially prominent:

1. tax incentives, such as preferential assessment<sup>6</sup>
2. zoning, including agricultural and open space zoning<sup>7</sup>
3. public purchase of certain development rights on valuable landscapes and landmarks<sup>8</sup>
4. public purchase of the fee on valuable landscapes and landmarks<sup>9</sup>
5. rural districts, such as New York's agricultural districts<sup>10</sup>
6. transfer of development rights<sup>11</sup>

When compared along three major criteria, cost to the public, effectiveness in preserving the valuable landscape or landmark, and the issue of taking private property without compensation, transferable development rights (TDRs) fare very well on paper. It is argued that TDRs impose little cost on the public since it is essentially a market operation. Further, they are arguably very effective and relatively difficult to thwart when properly planned, and they provide compensation to landowners whose development rights are restricted so as to protect designated landscapes or landmarks. Each of the other methods fares worse on at least one of the three criteria.

Although transfer of development rights has yet to be carried out on a large scale, a number of rural-urban fringe municipalities are

---

6. R. Gloudemans, *Use-Value Farmland Assessments, Theory, Practice, and Impact*, International Assoc. of Assessing Officers (1974); J. Keene et al, *Untaxing Open Spaces*, C.E.Q. (1975).

7. F. Bosselman, D. Callies, and J. Banta, *The Taking Issue* (1973); Kingham, *State and Local Wetlands Regulations: The Problem of Taking Without Just Compensation*, 58 Va. L. Rev. 876 (1972); *The Use of the Land* (W. Reilly, ed. 1973).

8. W. Bryant, *Farmland and Preservation Alternatives in Semi-Suburban Areas*, N.Y. St. Col. of Agric., Cornell, A.E. Ext 75-5 (1975).

9. Strong, *Incentives and Controls for Open Space*, in *Metropolitan Open Space and Natural Process* (D. Wallace, ed. 1970); Reilly, *supra* note 7.

10. Conklin & Bryant, *Agricultural Districts: a Compromise Approach to Agricultural Preservation*, 56 Am. J. of Agric'l. Econ. (1974).

11. Bennett, *Transfer of Development Rights*, Penn. Env't'l. Coun. (1976); W. Bryant, *supra* note 8; J. Costonis, *supra* note 1; Chavooshian & Norman, *Transfer of Development Rights: a New Concept in Land Use Management*, Extension Leaflet 492, Rug. U.; Rose, *The Transfer of Development Rights: a Preview of an Evolving Concept*, 3 Real Estate L. J. 330 (1975); Shlaes, *Who Pays for Development Rights?*, 40 Planning 7 (1974); Shlaes, *The Economics of Development Rights Transfers*, 42 Appraisal J. 526 (1974); & Woodbury, *Transfer of Development Rights: a New Tool for Planners*, 41 J. Am. Inst. of Planners 3 (1975). For a recent bibliography see Helb, Chavooshian & Nieswand, Leaflet 533, Coop. Extension Serv., Rut. U.

considering it.<sup>12</sup> It therefore seems prudent to go beyond previous legal and planning investigations to undertake a study of the economics of TDRs. Since actual experience with TDRs is minimal, our analysis must of necessity be in terms of principles and expected occurrences.

In outline, our argument begins with the concept of development rights assuming equilibrium in the markets for land, development rights, and housing and commercial building, the last being summarized in the commodity, floor space. We then dissect this equilibrium situation by first looking at just the market for development rights. Next, the nature of the equilibria in the markets for development rights, land and floor space are simultaneously examined in terms of the demand for floor space and the production function for floor space in a competitive market. Finally, we list our conclusions. Further technical analyses are presented in the appendices.

#### TRANSFER OF DEVELOPMENT RIGHTS AND THE PRIVILEGE OF PROPERTY

Land in the United States is considered property. As such, it is regarded as a bundle of privileges: the privilege of use, the privilege of exchange, and the privilege of conversion.<sup>13</sup> Economists have been primarily interested in land because it is a factor which is exchanged impersonally in a market and commands a rent.<sup>14</sup> We shall classify exchanges by whether they are intended to preserve the current use of the land or whether they are intended to eventually result in conversion. It is not necessary that the intention to convert actually materialize, since speculators may guess wrong and "lose their shirts." From our introductory comments it is not surprising that rents resulting from exchanges of landscape, or landmarks in urban areas or on the rural-urban fringe are often dominated by a conversion-exchange value.

When public action in the form of the police power is proposed to protect certain landscapes or landmarks from conversion, the landowner's privilege of conversion, but not use or exchange, is severely restricted. Hence, a large potential rent is lost. Whether and in what circumstances the police power imposes a taking without com-

12. See Woodbury and Rose, *supra* note 11.

13. This is essentially Driver's classification of the privileges of property except that the privilege of destruction has been replaced by the privilege of conversion: H. Driver, *Indians of North America* (1969). See also M. Herskovits, *Economic Anthropology* (1940).

14. In general, all exchanges are not for money or impersonal. A farmer may give or sell his land for a nominal price to his son or land may be given as part of a reciprocal agreement in an exchange between friends or in a business relationship, whether legal or illegal. For a discussion of the concept of economic rent see J. Eaton, *Political Economy* (1966).

pensation, however, is a question open to debate. Some writers<sup>15</sup> feel that compensation is usually required and there are numerous recent court decisions to support this view.<sup>16</sup> On the other hand, Bosselman, Callies, and Banta<sup>17</sup> argue that over the long run, spatially coordinated regulation of land use to protect demonstrable public values, such as valuable landscapes and landmarks, does not constitute a taking requiring compensation. There are court decisions to support this view as well.<sup>18</sup> Essentially, this latter view regards restrictions on the privilege of conversion as acceptable, but views restrictions on the privileges of current use and exchange as requiring compensation.

Transfer of development rights is a scheme whose aim is to effectively control land use in response to public values at minimal public cost and to neatly sidestep the taking issue. How this scordatura zoning is supposed to work is outlined in the paragraphs below. Since the discussion of TDRs in the literature is daily growing, we shall not belabor the points but refer the reader to these other papers for details.<sup>19</sup>

The first step in establishing TDRs is the identification of zones for development and zones for preservation, growth and no-growth zones. Each growth zone must have associated with it an upper limit on development density while the no-growth zones are limited to little or no further development. The upper limit in a growth zone may be nothing more than the previous zoning constraint or it may be a new constraint based upon estimates of development in the absence of a TDR scheme or upon environmental considerations or other criteria. In general, the new upper limit on development is relatively low so that higher densities, which may be necessary to accommodate households excluded from no-growth zones, are potentially profitable. To build at higher densities, developers will have to purchase transferable development rights that allow them to legally exceed the upper limit on development in proportion to the number of transferable development rights obtained. There may be, however, an upper limit on the number of TDRs one can use on any site.

✓The second step involves the creation of development rights and their allocation to land owners in the no-growth zone. These rights

---

15. W. R. Bryant, *supra* note 8.

16. *E.g. Morris County Land Improvement Co. vs. Parsippany-Troy Hills Township*, 40 N.J. 539, 193 A.2d 232 (1963). See also W. Reilly, *supra* note 7.

17. The Taking Issue, *supra* note 7.

18. *E.g. Just v. Marinette County* 56 Wis.2d 7, 201 N.W.2d 761 (1972).

19. See note 11, *supra*.

may be in the form of certificates allowing the construction of so many square feet of dwelling units or commercial buildings. There may even be different kinds of certificates for different kinds of construction. Certificates may be allocated to land owners in the no-growth zone in a number of ways. For example, they may be assigned in proportion to acreage owned, appraised development value, assessed value before the TDR scheme, or estimated development in the growth and no-growth zones before the TDR scheme.<sup>20</sup> Thus, land owners in the no-growth zones will be given an exchangeable commodity, transferable development rights, for the loss of the privilege of conversion and compensation for the loss of this privilege is purported to be made.<sup>21</sup>

To summarize the intended role of TDRs, we refer to Figure 2. The vertical axis is dollars per acre and the horizontal axis is distance from the central business district. Assume that distance is the only feature which differentiates the quality of land so that the diagram may be simply presented. At equilibrium, curve  $X_1$  represents the land rent which could be squeezed from the economic surplus of the builders of floor space before the TDR program is put into effect. Economic surplus is the excess of revenues from the sale of floor space over the material, managerial, and labor costs of supplying the floor space. Of course, this surplus ultimately derives from the consumers of floor space. Rents on land and development rights are treated as residual distributions out of surplus. Now let the TDR program go into effect. Some land can no longer be developed and higher densities can be achieved on land in the growth zone only if development rights are purchased presumably increasing the economic surplus of producing floor space in at least some of the growth zone. At equilibrium, the new rent at any distance is represented by

---

20. The problem with actually assigning development rights in proportion to expected growth before the TDR plan is established is estimating expected growth for each location. General growth patterns can, of course, be forecast, but there are considerations of the effect of land prices, construction costs, income, demographic factors, and so on all of which will influence the demand for growth. In addition, attempts to make fine distinctions among adjacent parcels of land in order to determine where growth is more likely may be a fruitless endeavor and assignment of development rights would thus seem most equitable and efficient using a simple formula.

21. More general uses for TDRs have been considered. For example, all land could be stripped of development rights and then zoned for various kinds of development. Transferable development rights could then be awarded to all land owners but developers would have to purchase the requisite number of rights before building anything. This scheme attempts to smooth out inequities resulting from all zoning decisions and not just from preservation zoning. The conclusions from our more restricted analysis are easily generalized to cover this broader situation but because preservation uses seem more likely to be enacted in the next few years than more general TDR schemes, we have limited our analysis to the preservation approach.



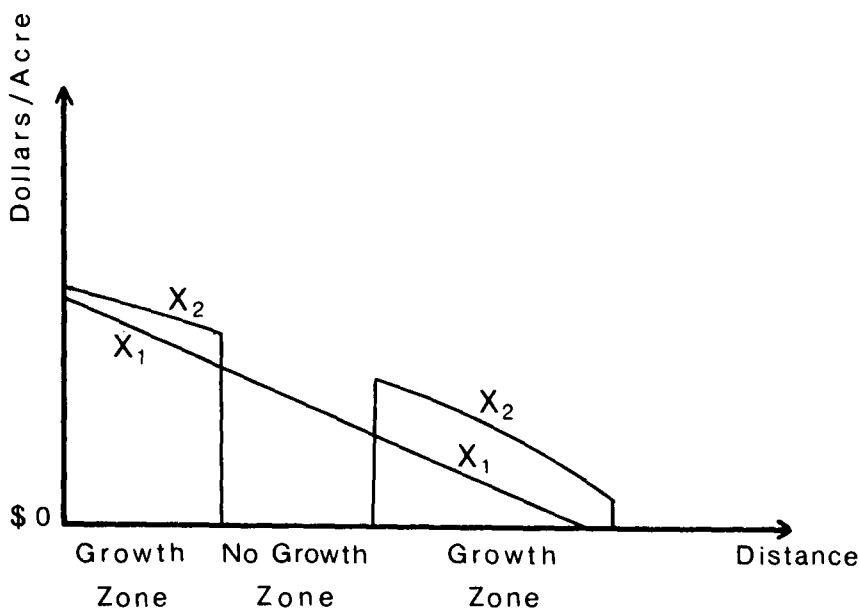


FIGURE 2

EQUILIBRIUM RENTS BEFORE TDR PROGRAM ( $X_1$ ) AND  
AFTER TDR PROGRAM ( $X_2$ )

curve  $X_2$ . This is the sum of land rent per acre plus the rent on development rights divided by acres per development right.<sup>22</sup> The magnitude of these two rents is the subject of the following sections.

#### THE MARKET FOR DEVELOPMENT RIGHTS

In order for the sale of development rights to offset, to any extent, the loss of the exchange-for-conversion value of land zoned for preservation as open space or other uses, the dollar value of development rights must approach the conversion value of the land minus its exchange value if conversion were prohibited. Having reviewed the basic mechanism of TDRs assuming equilibrium in the markets for land, development rights, and floor space, we now address the issue of the rent and market for such rights. In this section, we shall assume that the rent on land is given. This assumption will be relaxed in the next section.

Insofar as a developable parcel of land has a certain degree of

22. Note that curves  $X_1$  and  $X_2$  refer only to urban uses of land, not agricultural or other "underdeveloped" uses.

accessibility, amenities, soil characteristics, zoning restrictions, and social and political characteristics spilling over from neighboring land that are more desirable than other parcels of land, that parcel commands a differential rent when exchanged. In addition, a parcel of land may command an absolute rent when exchanged which reflects the scarcity of all developable land in the region. This scarcity may be induced by zoning restrictions or political boundaries as well as by a natural limitation on the quantity of land.

Development rights, being a homogeneous good, can command an absolute rent when exchanged. Their exchange value depends upon their relative scarcity which in turn is determined by the number of development rights created and the bid rent function for development rights. In particular, the supply of these rights is created by law and is shown as one of the vertical curves designated  $S_i$  in Figure 3. Since availability of these rights does not depend upon some production process, concepts of marginal cost are irrelevant and so the supply curves are price inelastic. Given a rent on land, the bid rent for development rights is analogous to a demand curve, and it is

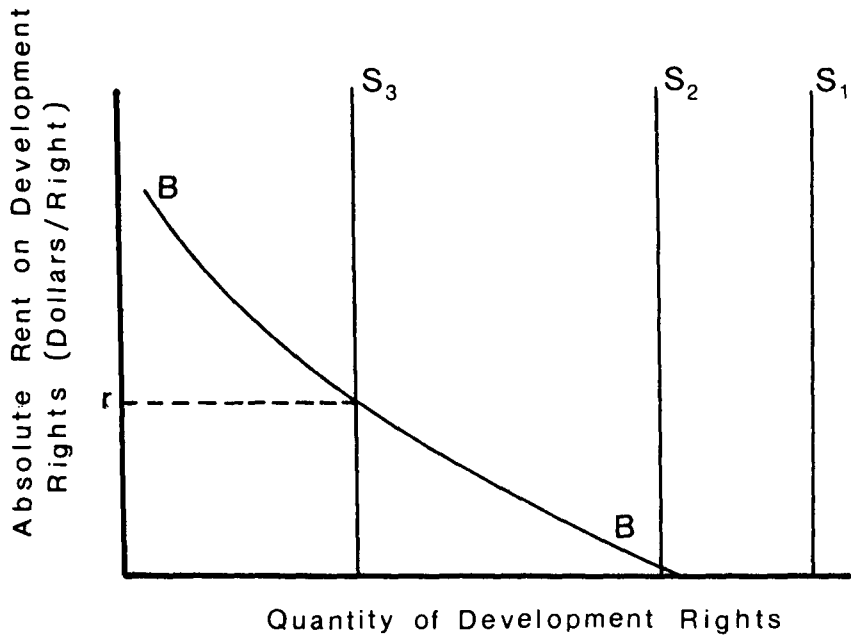


FIGURE 3

THE MARKET FOR DEVELOPMENT RIGHTS GIVEN THE RENT ON LAND:  
BID RENT, B; SUPPLY, S; AND ABSOLUTE RENT

shown as curve. It is the aggregate marginal surplus of developmental rights in the floor space industry in the region and is downward sloping to reflect the assumed decreasing marginal surplus per development right as the number of these rights used in the production of floor space increases.

From the diagram it is quite apparent that the absolute rent of the development rights depends on the number of rights created. If that number is relatively large, such as that represented by curves  $S_1$  and  $S_2$ , the bid rent for all the rights on the market would be at or near zero. If they are relatively scarce, as represented by curve  $S_3$ , their rent will be bid up to  $r$ . Thus, in order to make the market for development rights yield an absolute rent large enough to suffice as compensation for the loss of the privilege of conversion, the number of rights created must be carefully contrived with a knowledge of the shape of the bid rent curve.<sup>23</sup>

Another issue related to the price of development rights is the possibility of speculation in these rights. If the bid rent curve is expected to shift outward over time because the demand for new construction becomes more certain or increases, then development rights holders can engage in speculation. They might refuse to sell their certificates in the early stages of development in the growth zone in anticipation of obtaining larger rents later on. Consequently, the constricted supply in these early years would increase the rent during this time period. As before, the increase in price is a function of the number of rights actually put on the market during the early stages.

Parenthetically, we note that the owners of land in the growth zone will be at least as likely and probably more likely to exchange their land for conversion purposes if some other land is designated for no growth and thereby removed as competition. Hence the expected rent, rent multiplied by the probability of actually making a sale, of a land owner in the growth zone is likely to increase under a TDR program.

How is Figure 3 related to Figure 2? At any distance from the

---

23. One way to help insure the scarcity of development rights is through an intermediary monopoly holder of development rights, such as a government agency or designated agent which can deliberately withhold rights from the market in order to guarantee a high rent. The withholding action may be by 1) public purchase of development rights at some "parity price," 2) refusing to give out (or create) all the development rights in the first place, or 3) only the agency selling development rights and limiting sales so as to gain a high rent; the monopolist would then distribute the rents to the landowners in the no-growth zone in proportion to their losses of exchange value. All three remedies require administrative costs and the first requires a large initial expenditure (or bond issue) before substantial revenue from sales can be obtained.

central business district in Figure 2 each producer of floor space buys development rights until his marginal surplus of doing so equals the market rent represented by  $r$  in Figure 3. Hence, the rent per acre curve after development rights have been purchased,  $X_2$ , will sit above curve  $X_1$  (assuming  $X_1$  is the given rent on land) such that the vertical difference between the curves multiplied by acres per development right is the rent  $r$  in Figure 3. If acres per development right are the same everywhere then curve  $X_2$  will be parallel to  $X_1$  (outside the no-growth zone). Finally, if no developer can afford the rent on TDRs in a particular location, development rights will not be used there.

### EQUILIBRIUM IN THE MARKETS FOR LAND AND DEVELOPMENT RIGHTS

So far, we have established the basic workings of the market for development rights and the conditions necessary to obtain a positive rent for those rights. However, we must still address the issue of whether the exchange value of the transferable development rights is adequate to compensate TDR holders for the inability to convert their land. To evaluate the issue of adequate compensation it is necessary to simultaneously investigate the relationships between the bid rents for land and development rights, the availability of each, and the demand for floor space which is produced by combining land, development rights, and managerial, material, and labor inputs.<sup>24</sup> To facilitate the discussion a numerical example is used.

The central concept in our analysis is the "surplus function." This function associates combinations of land, development rights, and other inputs with surplus, surplus being the dollar value of revenues from the sale of floor space minus the material, managerial, and labor costs of producing the floor space. Rents on land and development rights are not considered as predetermined costs here but are to be derived according to bid rents based upon the surplus maximizing behavior of developers. That is, the rents are bid out of surplus. The object of this analysis is to evaluate the distribution of rent

24. Floorspace measured in units such as square feet will be taken as a homogeneous product in the analysis. Product differentiation due to factors such as location, neighborhood effects, housing styles and layout although extremely important in housing markets is disregarded to avoid unnecessary complication. This may be incorporated in the analysis by distinguishing between qualitatively different types of floorspace as subject to separate markets. Producers of all types of floorspace require inputs of land and development rights, however, so that the derived local demand schedules for these resources might be similarly determined and summed to develop the aggregate bid rent curves. These curves in combination with the resource supplies determine the rents of land and development rights in the local market. Production of each type of floorspace given these factor prices and availability could then be determined.

between landowners and holders of development rights once a transfer of development rights program is implemented.<sup>25</sup>

Implicit in the surplus function are, of course, the sales price of floor space and the costs of materials and other inputs. We shall assume that the costs of materials and labor are given and that the developers act as price takers when these inputs are considered. With regard to the price of floor space we make the following observation. Transfer of development rights arrangements will probably be tried as pilot programs before an entire metropolitan area becomes committed to the scheme. Thus, we can expect TDRs to be instituted, at least initially, for only one or a few townships within a larger metropolitan area. In this case, housing prices will be determined by the overall metropolitan area housing market so that developers in the pilot township will be unable to influence the price of floor space as competitive producers. The analysis assumes such a situation.

Including the additional assumption of constant returns to scale in the production of floor space, the surplus function will exhibit constant returns to scale. This implies that by doubling all inputs, twice as much floorspace could be produced generating exactly double the amount of surplus. These conditions were chosen because they are the most general assumptions for the numerical example.<sup>26</sup>

These assumptions also suggest that the developers in the pilot township are constrained only by resource limitations on land and transferable development rights, since any quantity of floor space may be produced and sold profitably without influencing housing prices determined in the larger metropolitan market. It should be kept in mind, however, that the assumption of constant returns to scale does not mean that the group of developers in these few townships are price takers with respect to land rents; rather the surplus they can generate, will determine their bid rent curves for land and development.<sup>27</sup>

If material, labor, and managerial inputs are treated as one composite input, then surplus maximizing developers can be assumed to act so that the marginal surplus of this composite input equals zero.

---

25. See Appendix for a more detailed discussion of the analytical methods used.

26. It is by no means necessary to use a surplus function with constant returns to scale. Increasing returns or decreasing returns to scale may also be possible in the production function for floorspace and if the demand for floorspace is downward sloping, the surplus function must exhibit decreasing returns to scale over at least part of its range. This latter case is precluded in examining only a small sub-area of a metropolitan region where producers act as competitive producers in a large market. Constant returns to scale in production was considered the most general and realistic assumption in the absence of further empirical information. See the appendix for a discussion of a surplus function with decreasing returns to scale.

27. That is, one must avoid the fallacy of composition as Samuelson warns in his text.

Consequently, the surplus function may be rewritten in terms of land and development rights only. Figure 4 shows the surplus function for the competitive developers in the pilot township as a function of developable land,  $L$ , and transferable development rights,  $D$ . The

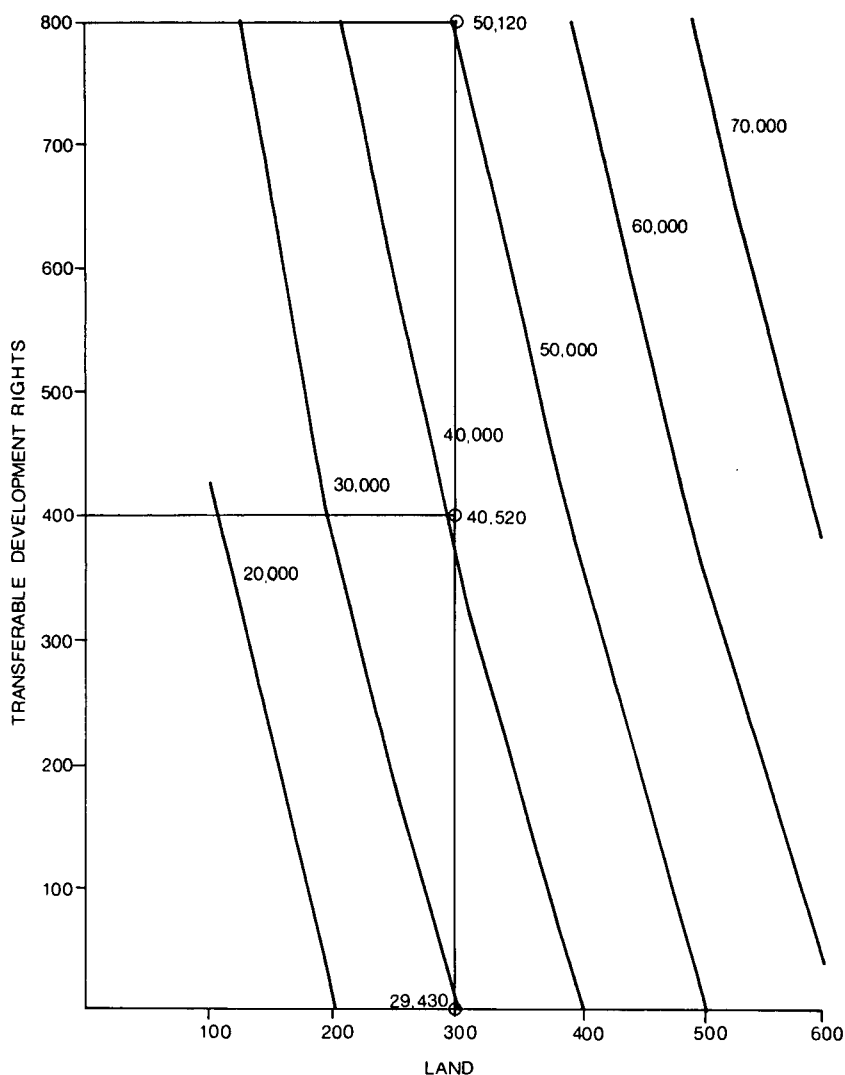


FIGURE 4

ISO-SURPLUS CURVES AS A FUNCTION OF LAND  
AND TRANSFERABLE DEVELOPMENT RIGHTS

more acres of land and the more development rights used, the greater the surplus. In the example, each acre of land has associated with it two non-transferable development rights according to local zoning regulations. Transferable development rights are assigned to various landowners and then may be purchased by developers wishing to exceed the initial zoning limitations on density inherent in non-transferable development rights.

The bid rents on land and development rights may be determined from Figure 4 by slicing the surplus function vertically, in the case of TDRs, and horizontally, in the case of land. Along any slice, we can calculate the increase in surplus of an increment in land or development rights holding the other factor constant. This marginal surplus is the bid rent for the factor, given the quantity of the other factor. Families of bid rent curves for land and development rights, respectively, appear in Figures 5 and 6.

In our pilot township the quantity of developable land is fixed by its political boundaries, the TDR plan and the quantity of development rights is fixed by government action. If these quantities are 300 acres; implying 600 non-transferable development rights, and 400 transferable development rights then, according to Figure 4, the total surplus is \$40,520. The bid rent for 300 acres of land given 400

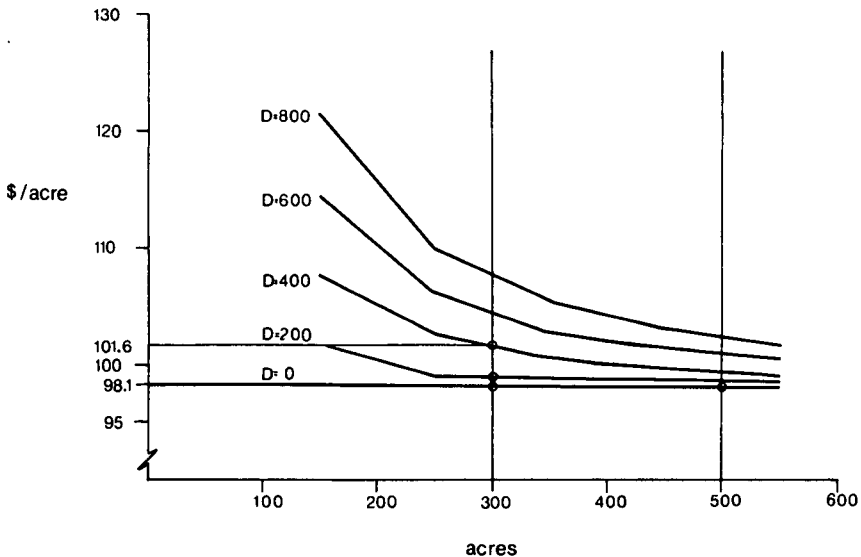


FIGURE 5

FAMILY OF BID RENT CURVES FOR LAND AS TRANSFERABLE  
DEVELOPMENT RIGHTS,  $D$ , VARY

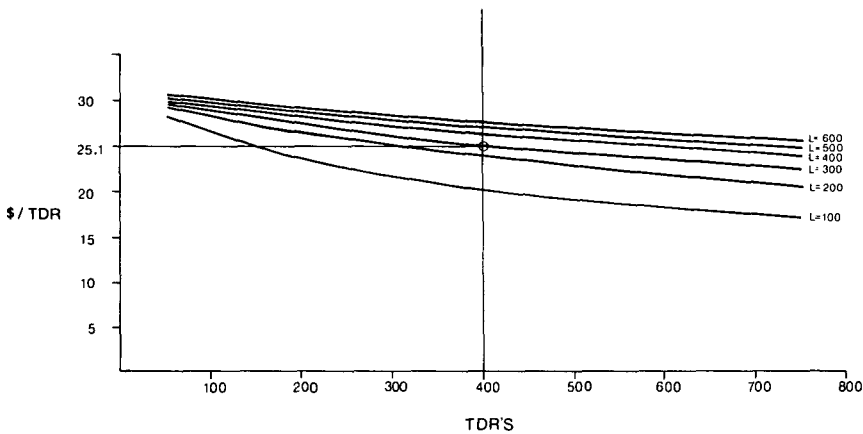


FIGURE 6

FAMILY OF BID RENT CURVES FOR TRANSFERABLE  
DEVELOPMENT RIGHTS AS LAND, L, VARIES

transferable development rights is \$101.6 per acre and the bid rent for 400 transferable development rights given 300 acres of land is \$25.1 per development right. Because of constant returns to scale in the surplus function total rent equals  $(300)(\$101.6) + (400)(\$25.1) = \$40,520$ , the total surplus.

We now turn to the question of the magnitude of rents on land and development rights and the degree to which development rights holders are compensated for the loss of the privilege of conversion of their property. To do this we consider five cases of land use in the pilot township. Let the township be divided into two regions, A, (300 acres) and B, (200 acres) which will become growth and no-growth zones, respectively, upon the implementation of a TDR scheme.

*Case 1.* An initial case in which all local land is developable, and before the TDR arrangements are put into effect, will be taken as the base of reference. Supposing that there are 500 acres of developable land, each acre associated with two non-transferable development rights, the total land rent would be \$49,050 or \$98.1 per acre captured from the surplus of construction of 490.5 units of floor space sold at \$100 per unit. See Figures 4 and 5 where the supply of inputs is 500 acres of land and no transferable development rights. The results are referred to in Table 1 as Case 1.

*Case 2.* Next consider a case in which the 200 acres of land in region B are zoned as non-developable without any compensation to



TABLE I  
SUMMARY OF LAND USE CASES\*

VARIABLES	CASE 1	CASE 2	CASE 3	CASE 4	CASE 5
LAND USE (acres)					
Developable	500	300	300	300	300
Protected	0	200	200	200	200
Total	500	500	500	500	500
DEVELOPMENT RIGHTS ALLOCATION (number)					
Nontransferable rights	1000	600	600	600	600
Transferable rights	0	0	400	200+200	900
Total	1000	600	1000	1000	1500
RENTS (\$ per unit)					
Land	98.1	98.1	101.6	99.0	109.4
TDRs	-	-	25.1	27.7	21.7
TOTAL RENTS (\$)					
Accruing to land owners in Region A (growth zone)	29430	29430	30480	29700	32820
Accruing to land owners in Region B (no growth zone)	19620	0	-	-	-
Accruing to TDR holders	-	-	10040	11080	19530
Total rents	49050	29430	40520	40780	52350

\*Case 1 = No protected land  
Case 2 = 200 acres of land protected but no compensation (zoning)  
Case 3 = Simple TDR scheme with no increase in total development rights over case 1  
Case 4 = Modified TDR scheme (government intervention in TDR market)  
Case 5 = TDR scheme with increase in total development rights over case 1

the landowners. The results of Case 2 are also summarized in Table 1. Less floorspace will be built, barring relaxation of zoning density requirements on developable land, and therefore less total rent will be generated. The owners of the land in the no-growth zone suffer the entire loss of \$98.1 per acre or \$19.620.

*Case 3.* A third case illustrates the effects of implementing the TDR scheme. Again the 200 acres of land in region B are set aside as a no-growth zone but the total number of transferable and non-transferable development rights is kept constant. Four hundred transferable development rights, two for each acre of land, are awarded to land owners in the no-growth zone. Tracing through the evolution of land and development rights markets to their equilibria in the example, the market exchange value of the development rights will be \$10040. Although clearly better than no compensation, the figure nevertheless represents considerably less than the initial development value of \$19620 for 200 acres of land.

Two points should be noted about the results of the TDR arrangements. First, both the quantity of floor space produced, 405.2 units selling at \$100 per unit, and the total rents generated, \$40,520, are less than the base case where all land may be developed even though the total number of development rights is not diminished. This is due to the fact that both land and transferable development rights add to surplus and are subject to diminishing marginal productivity. Removing quantities of either factor without increasing the other forces producers to combine them in different and less productive proportions.

Secondly, rents on developable land increase from \$98.1 to \$101.6 per acre as the result of implementing the TDR scheme. Since the available supply of land has been reduced, its price quite naturally increases. This might be considered an undesirable effect of TDR arrangements since landowners who have no claim to compensation are benefiting at the indirect expense of those who do. However, this effect may also attract support for the TDR schemes since many landowners will benefit from the innovation.

Because both total rents generated decline and the value of developable land increases when going from Case 1 to Case 3, holders of development rights can never be fully compensated as the result of the basic TDR arrangements. However, "just" compensation might not necessarily imply full compensation, especially considering the speculative unearned nature of rent. Unlike economic profits, rents have little importance in motivating further socially desirable activity since landowners are not able to produce more land as the rent increases.

*Case 4.* Basic TDR arrangements may be modified to alter compensations. One variant might be to regulate the market in order to maintain larger rents on TDRs. This could be accomplished by the government restricting the supply of transferable development rights either by buying them back at a guaranteed price or by distributing them to landowners incrementally over longer periods of time. The results of such an approach, within the context of the example, appear as Case 4 of Table 1 where it was assumed that no more than half the TDRs would be distributed to landowners at any time. That is, the government would not allow the second 200 developments rights to enter the market until the first 200 were sold. Rent on TDRs is thus raised slightly while rent on developable land is less than that found in the simple TDR arrangement. In fact, in the example, it is impossible to maintain a rent on TDRs equivalent to full compensation since to do so would price development rights out of the market.

Thus, government supervision of the TDR market appears to be rather ineffectual. However, this is because the extreme elasticity of bid rent curves for TDRs, found in the example, may not generally be realistic. In any event, it seems that severe restrictions on supply would be required to significantly alter the distribution of rents. This might drastically increase the costs and administrative requirements of such a program.

*Case 5.* A more effective approach to increase the value of development rights would be to relax average density constraints in the pilot township and allow more development in the growth zone than was previously permitted. Indeed, the preservation of large open space tracts made feasible by TDR arrangements could create amenities sufficient to justify higher densities. Case 5 in Table 1 indicates that increasing the supply of transferable development rights would raise the total rents accruing TDR holders to approximately full compensation levels, although the rent per development right falls below that in Case 3.

## CONCLUSIONS

Transfer of development rights arrangements have been proposed as an innovation to avoid difficult problems of compensation which hamper the effectiveness of land use controls, in a practical if not a legal sense. An attempt has been made here to apply economic analysis to examine the implications of such an approach. The conclusions, summarized below, are generally favorable to the efficacy of the TDR idea used intelligently.

- A. TDRs are generally superior to other methods of protecting valuable landscapes and landmarks because they impose relatively little cost on the public, they are essentially self-working market operations that are difficult to thwart if properly planned, and because they provide some compensation to landowners whose privileges of conversion are restricted.
- B. Implementing a TDR program requires a sophisticated understanding of the interrelationships between the various sub-markets for housing, commercial floorspace, land, etc. Without such knowledge, use of TDRs may prove ineffectual or frustrating.
- C. If applied on a limited scale; to protect isolated no-growth zones within a large metropolitan area, the TDRs may be expected to have an exchange value so long as the local land market is relatively active.
- D. Within the boundaries of regions where development rights are freely transferable, the rent paid per development right will be everywhere the same.
- E. There is no *a priori* guarantee that the total value of TDRs will equal the total conversion value of protected land if expected average local densities are held constant or even if they are increased somewhat.
- F. Provisions for no-growth zones, combined with TDR arrangements, will tend to increase the value of developable land in the local land markets.
- G. Whether or not the sum of the rents for both land and development rights after a TDR scheme is implemented is more or less than the total land rent prior to institution depends upon a number of factors: the revenues generated and costs associated with development, the amount of land put in the no-growth zone, and the number of development rights created.
- H. Implementation of a coordinated TDR scheme over an entire metropolitan area would be a more difficult undertaking than for a small part of the metropolis because more elaborate management would be required to insure scarcity in the aggregate supply of development rights which, in turn, insures their exchange value.
- I. The division of the metropolitan area into smaller subregions between which development rights are not transferable may therefore be a more feasible regional approach to zoning with TDR arrangements. In such a situation, possible reductions in compensation due to overly optimistic estimates of future development would not be as widespread. If there is more than one region within which development rights are transferable but between which they are not, the rents on development rights in the different regions may be different.

Finally, we observe that a successful TDR scheme constitutes a form of protective control over the landscape such that the distribution of rents accruing to landowners in the growth and no-growth zones is in some narrow sense equitable. But the TDR approach does not take into consideration the larger question of the equity of the consumers of floor space paying rents ultimately to owners of land and development rights. Rather, this method passively accepts the transfer of wealth from consumers of floor space to land owners and development rights holders and deals only with the redistributive aspects of land use control within these narrow confines.

## APPENDICES

### *A. Derivation of a Simple Surplus Function*

A general production function identifies the relationship between output (Q) and various combinations of inputs, designated land (L), development rights (D), and all other inputs, including labor and materials (M), as the relevant factors of production.

$$(1) \quad Q = f(L, D, M)$$

Given the production function, profits ( $\pi$ ) are defined as revenues minus the cost of inputs,

$$(2) \quad \pi = p \cdot f(L, D, M) - r_L L - r_D D - cM$$

where  $r_L$  and  $r_D$  are rents per unit on land and development rights,  $c$  is the cost of other inputs and  $p$  is the market price for floorspace. Note that in conventional economic terminology a minimum return on capital, included above in  $M$ , is considered a cost, while profits are returns to producers exceeding this rate of return.

Surplus ( $S$ ) is revenues minus the costs of non-rent earning inputs,

$$(3) \quad S = p \cdot f(L, D, M) - cM$$

or substituting (3) into (2)

$$(4) \quad S = \pi + r_L L + r_D D$$

Since rents do not exist independently of the demand for floor-

space, from the point of view of producers as a group, they are determined simultaneously with profits and quantity of floorspace produced. Thus, we assume that all producers of floor space behave as surplus maximizers rather than merely profit maximizers. The motivation to maximize surplus is, in part, induced by land and development rights owners who wish to obtain the maximum bid rent for their factors thus forcing the producers of floor space to gain as much surplus as possible so as to successfully bid against each other for land and TDRs.

Under competitive conditions, the bid rent for land is the marginal surplus of land, which equals the marginal revenue product of land:  $\frac{\partial S}{\partial L} = p \frac{\partial f}{\partial L}$ . Similarly for TDRs  $\frac{\partial S}{\partial D} = p \frac{\partial f}{\partial D}$ . Assuming constant returns to scale and no indivisibilities, producer profits are zero, rents absorb the entire amount of surplus, and the sum of all factor rents plus input costs are equal to total revenues in competitive equilibrium. With decreasing returns to scale the value of the marginal products for rent earning factors will be less than the total surplus generated. Thus, producers will earn positive profits under competitive conditions.

If increasing returns to scale are assumed, the marginal revenue products associated with rent producing inputs will exceed the total surplus generated. Under competitive conditions therefore, producers would operate at a loss and force either some readjustment of rents away from competitive levels or require the combination of resource extraction and ownership to support production. This latter case may explain the prevalence of concentration and vertical integration in many resource industries. Indeed, in the oil industry where strong economies of scale exist, an oligopolistic market structure prevails with the major companies dominating extraction and marketing as well as production. In addition, the larger firms insist that their refineries operate at a loss. Builders and developers also commonly perform a dual role as land speculators.

### *B. Derivation of the Surplus Function Used in the Example*

The example used in the text to evaluate compensation under TDR arrangements assumed the following Cobb-Douglas type production function with constant returns to scale:

$$(5) \quad Q = L^{.3} (D + 2L)^{.5} M^{.2}$$

Note that the term in parenthesis ( $D + 2L$ ) indicates that two non-transferable development rights are associated with each developable

unit of land and transferable development rights (D) are used in addition to these.

The resultant surplus function is therefore,

$$(6) \quad S = p [L \cdot^3 (D + 2L) \cdot^5 M \cdot^2] - cM$$

According to this expression, higher density housing, expressed in terms of a larger ratio of development rights to land and material inputs, is assumed to be most productive of surplus. Increments of structural quality, more labor and materials, generate surplus somewhat less rapidly.

Assuming surplus maximizing developers, we know that the marginal surplus of M in (6) will equal zero which allows us to solve for M in terms of L and D,

$$(7) \quad \partial S / \partial M = .2p [L \cdot^3 (D + 2L) \cdot^5 M^{-8}] - c = 0, \text{ and}$$

$$(7a) \quad M = \left[ \frac{.2p}{c} L \cdot^3 (D + 2L) \cdot^5 \right]^{1.25}$$

Substituting (7a) into (6) gives the expression used to generate the isosurplus function represented in Figure 4.

$$(8) \quad S = pA \left[ \frac{.2p}{c} A \right] \cdot^{.25} - c \left[ \frac{.2p}{c} A \right]^{1.25}$$

$$\text{where } A = L \cdot^3 (D + 2L) \cdot^5$$

$$\begin{aligned} p &= 100 \\ c &= 50 \end{aligned}$$

The actual form of a relevant surplus function is, of course, an empirical question and results would vary using different relationships. However, the example was chosen to exhibit general characteristics including decreasing marginal productivity for all factors and constant returns to scale so that the major conclusions derived from the analysis should be valid.

### C. A More General Surplus Function

The surplus function used in the main body of this paper exhibited constant returns to scale due to two assumed conditions. First, the production function for floorspace was assumed to have constant returns to scale. Second, the local developers were regarded as being competitive producers of floorspace in the larger metropolitan area both individually and as a group. Therefore, the total

quantity of floorspace produced locally would not significantly alter the overall market and any amount of floorspace might be produced locally and sold at a constant price determined in the larger market.

Examining the results of implementing TDR arrangements for a large sector of a metropolitan area, as opposed to a single small municipality, requires the second condition to be relaxed so that the floorspace producing industry would realistically be facing a downward sloping demand curve. This refinement poses no serious difficulties in the methodology used above. Given a more general demand relationship in terms of the price of floorspace,  $p$ , and the quantity of floorspace,  $Q$ ,

$$(9) \quad p = g(Q),$$

and a production function as before (1), the surplus function would be modified as follows,

$$(3a) \quad S = g(Q) \cdot f(L,D,M) - cM$$

where  $Q = f(L,D,M)$ .

An interesting result in this more general case is that given a production function with constant returns to scale, the surplus function will exhibit decreasing and even negative returns to scale over part of its range because increases in output will now reduce floorspace prices. Using the same production function as in the original example (5) and the simple demand curve shown below,

$$(9a) \quad P = a - bQ$$

the resulting surplus function would be quadratic in  $Q$ ,

$$(10) \quad S = (a - bQ) [L^3 (D + 2L)^5 M^2] - cM$$

or, substituting for  $Q$ ,

$$(10a) \quad S = a[L^3 (D + 2L)^5 M^2] - b[L^3 (D + 2L)^5 M^2]^2 - cM$$

This function, illustrated in Figure A-1, will no longer increase in surplus value indefinitely with output but rather will reach a peak and then fall after some level of floorspace production has been reached. Thus, developers would now be effectively constrained by resource limitations on transferable development rights and land only over a finite range of production. At output levels where marginal surplus is negative, resource constraints would not be binding. If the supply of TDRs were sufficient to exceed this level, their value would evaporate and thereby introduce an additional consideration for TDR planning at the regional level.



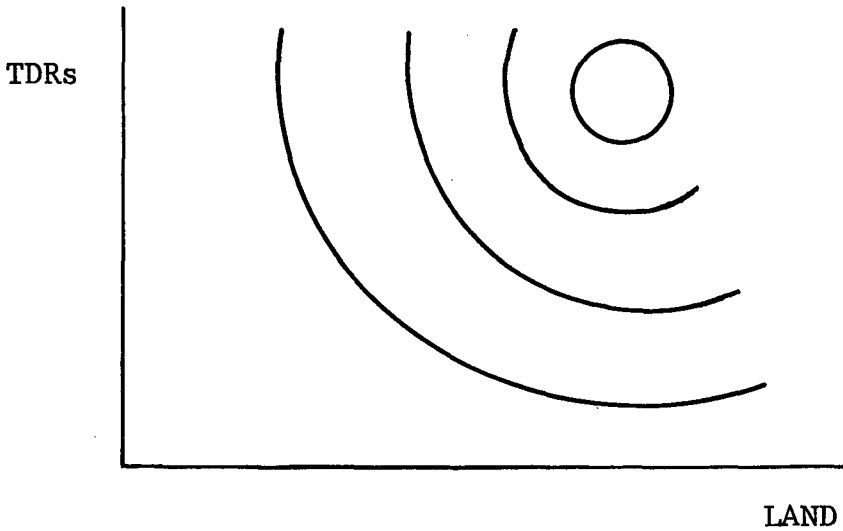


FIGURE A-1

ISO-SURPLUS CURVES AS A FUNCTION OF LAND AND DEVELOPMENT RIGHTS GIVEN A DOWNWARD SLOPING DEMAND CURVE FOR FLOORSPACE

*D. The Consistency Between Zoning Constraints on Density and the Number of Development Rights Created*

An important planning consideration involves zoning constraints on population density. As noted in the text, developers purchasing TDRs might use them to exceed existing zoning limitations on density in growth areas. Thus, for example, a developer obtaining TDRs from owners of non-developable land would be permitted to build two housing units on an acre of land in a growth area originally zoned for residential development on one acre lots. As a practical consideration, however, there would probably be limitations on how much the original zoning regulations might be exceeded. In the same example, the developer might not be allowed to build higher density garden apartments even with the addition of a sufficient number of TDRs. Thus, upper limits on density act as controls for planning authorities over the configuration of development.

Density restrictions also affect the market exchange value of TDRs and therefore, should be part of a community's TDR plan. In particular, they will depress the total rent accruing to development

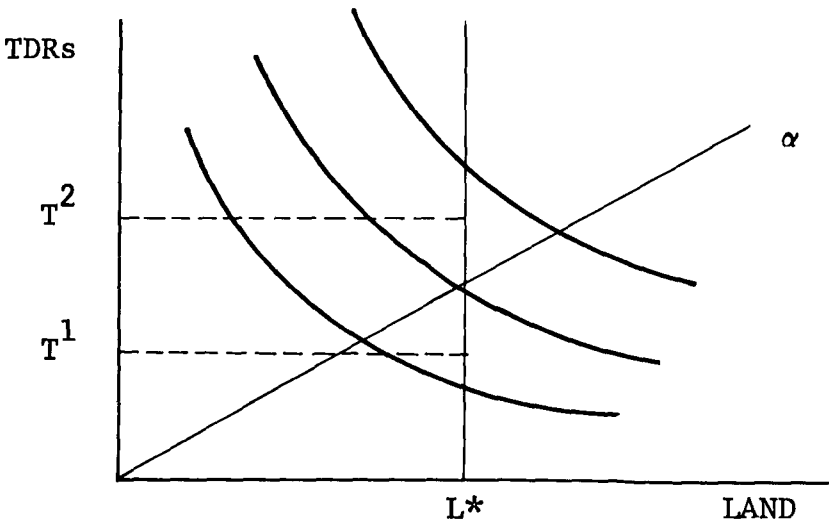


FIGURE A-2

## ISO-SURPLUS CURVES AND A ZONING DENSITY CONSTRAINT

rights holders if they are set so low that not all transferable development rights can be legally used. To see how an inconsistency between the number of transferable development rights created and the density limitations in a community can arise and to see the effects of this inconsistency we turn to Figure A-2. The diagram shows isosurplus curves for floor space construction, a land constraint ( $L^*$ ) for the community, and a density constraint ( $\alpha$ ). Density is interpreted as the ratio of housing units embodied in transferable development rights per unit of land and this appears as a ray emanating from the origin. Combinations of land and TDRs below the ray satisfy the zoning constraint while those above the ray exceed the permitted number of housing units added per acre with TDRs. In the figure a supply of transferable development rights limited to the quantity  $T^1$  constrains developers to an area below the density limits and the TDRs will command a positive market exchange value. If the number of TDRs issued, however, is  $T^2$  developers will not be able to employ the full supply without exceeding the density constraint. If these density ordinances are enforced, therefore, the TDRs will not be in scarce supply and will have little value. The effect of the density constraint is to produce a truncated bid rent curve for TDRs as illustrated in Figure A-3.

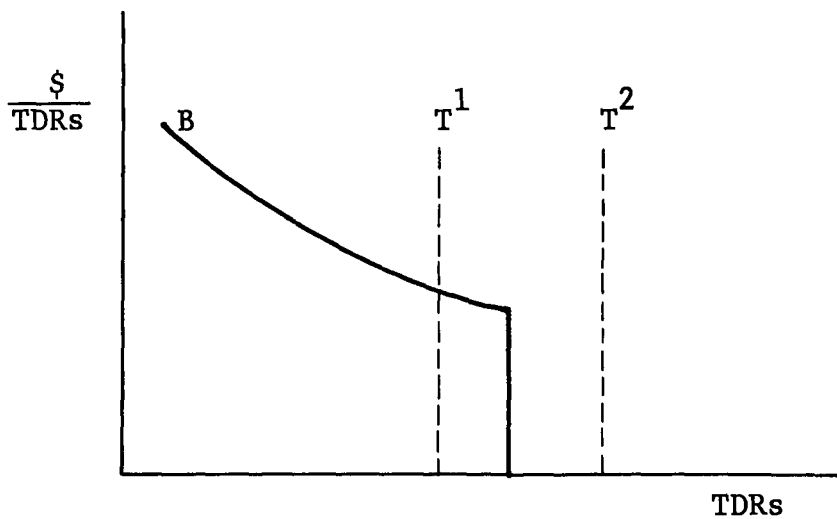


FIGURE A-3

TRUNCATED BID RENT CURVE FOR TDRs (B) AND SUPPLY OF  
TDRs NOT EXCEEDING DENSITY CONSTRAINT ( $T^1$ ) AND  
EXCEEDING DENSITY CONSTRAINT ( $T^2$ )