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Bid Rent and Location Gradients: The Importance of Relative Location

Much of the theory of urban land use is based on the work of Alonso (1964) and Muth (1969) and draws on concepts from microeconomics. Within this theory, patterns of land use are determined by land values that are, in turn, related to transportation costs. We will find that each type of urban activity will have its own bid rent function and the combination of several bid rent functions will define the rent gradient. To illustrate the theory, it is useful to begin with an extremely simplified example.

To begin, we will examine how different firms use urban land. Later we will introduce how households use land. Because theories and models of urban land use seek to uncover a set of general characteristics, a set of simplifying assumptions is required. These assumptions are not meant to reflect the reality of cities. Rather, assumptions allow us to focus attention on the most important aspects of the inquiry. As we proceed, some of these assumptions will be relaxed so we can introduce more realism into our theories and models. For the moment, let us assume the following:

1. The city is comprised of many identical producers that operate in a perfectly competitive environment.
2. All land is privately owned.
3. Since all firms are identical and sell in competitive markets, each firm generates a normal rate of profit, can sell as much as it wants, and faces the same set of production costs as all other firms.
4. The market place for goods and services is located in the center of city such that all goods and services must be sold there. Consequently, for a firm to sell its product it must be transported to the market located at the city's center.
5. Transportation costs are a linear function of distance. Therefore, total costs to the firm will be higher for firms located at greater distance from center.
6. The city's population is evenly distributed and households have uniform tastes for housing.

Because transportation costs are low near the CBD and higher away from the CBD, firms locating near the CBD are willing to pay more for centrally located parcels of land in order to minimize their transportation costs. Similarly, because added transportation costs at more distant locations will reduce profits, firms will not be willing to pay as much for land at more distant locations. Because all firms are

assumed to generate the same level of profit, and firms at more distant locations will incur higher transportation costs, they will only be willing to bid up to the amount at which lower land costs are exactly off-set by their higher transportation costs. Similarly, the higher value of land at the CBD reflects the capitalization of transport cost savings into the price of land. This feature of urban land use theory causes land values to decline with distance from the center city.

In the jargon of land economics, the amount one pays for the use of land is called rent and the way in which rent changes with distance is called location rent. The users of land are conceptualized as participating in an open bidding process such that the highest bidder for a parcel of land will occupy that parcel. Because all persons involved in the bidding process have complete information about costs at alternative locations (assumption #1), and no one will bid more for land than the land is worth, the bidding process continues until bid rent exactly equals location rent. The graph that describes how rent declines with distance from the CBD is called the bid rent function and illustrates how the value of land reflects its accessibility to the CBD. The basic shape of the bid rent function is illustrated in Figure 2.

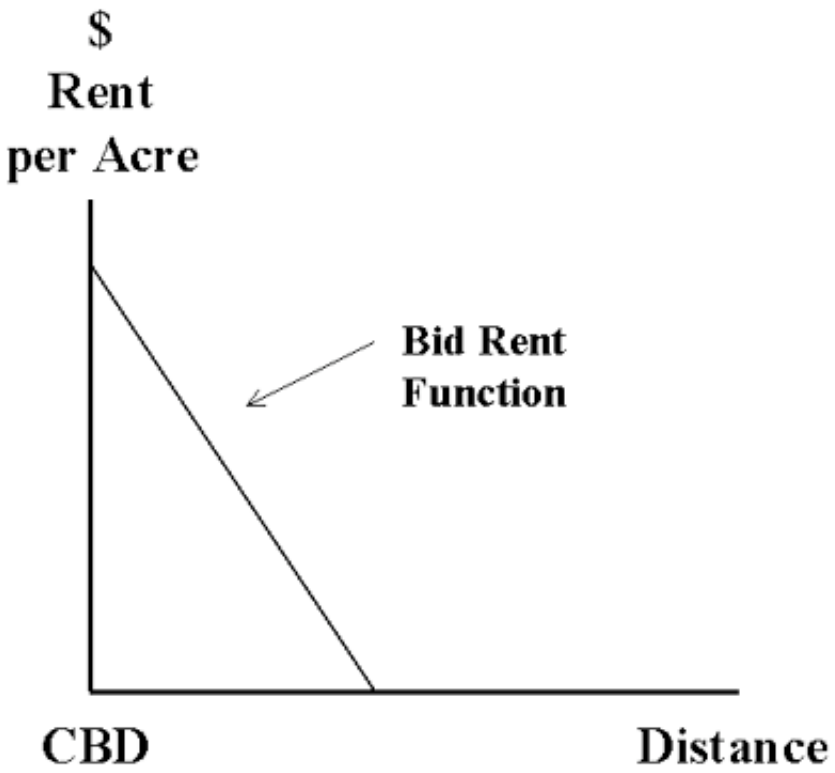

Figure 2 The Bid Rent Function

What happens when we allow more than one type of firm? Suppose we relax the first assumption above and instead of having one type of economic activity we now have two, say, retailing and manufacturing. Each type of activity will place a different value on accessibility. How will land be divided between these two activities? If

retailers value access to consumers more than manufacturers, and the population is evenly distributed throughout the city, then retailers will want to locate in the center to maximize access to consumers. In addition, there may also be agglomeration economies for retailers because clustering facilitates both contact between entrepreneurs and comparative shopping by customers. For manufacturers, access to markets and labor is important, but less important than for retailers. Under this condition, the slope of the bid rent function for manufacturing will be flatter than the bid rent function for retailers as seen in Figure 3.

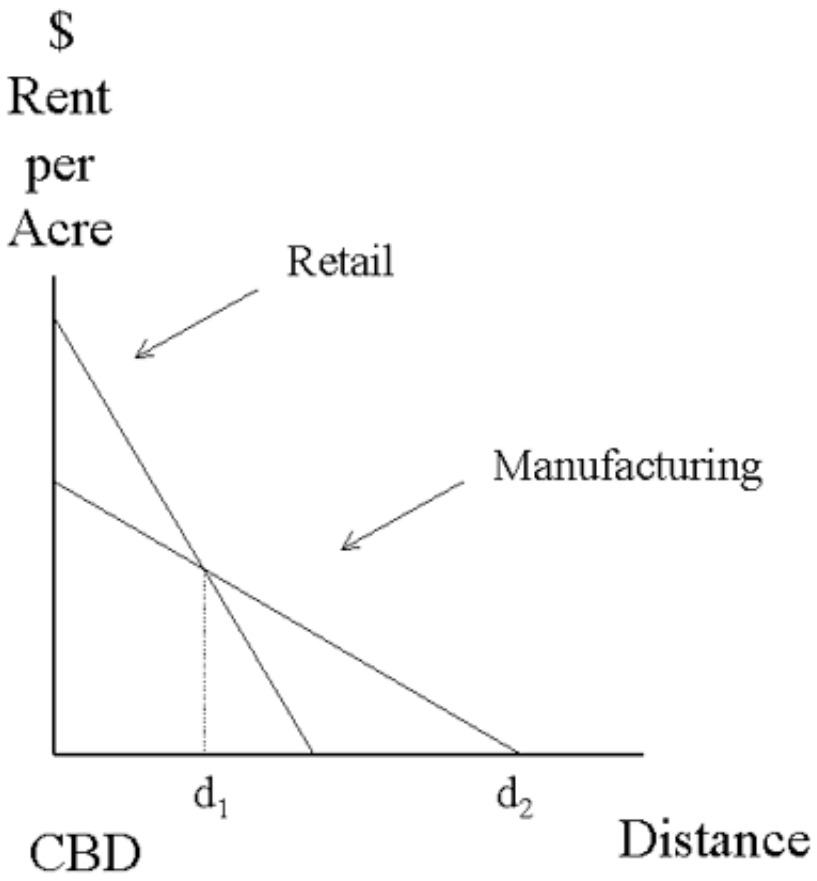

Figure 3 Bid Rent Functions for Retail and Manufacturing

In Figure 3, the intersection of the two bid rent functions (point d_1) defines the point at which land use changes from retail activities to manufacturing activities. We can draw a line from the intersection of these bid rent lines down to the x-axis and mark the x-axis at d_1. According to this graph, retailers would occupy land from the CBD out to the point d_1. Up to this point, the retail bid rent line is above the bid rent line for manufacturing. Thus, up to the distance d_1, retailers would be willing to out-bid manufactures for the use of land. Beyond d_1, the bid rent line for manufacturing is above the retail bid rent line, so manufacturers would be willing to out-bid retailers

for land from d_1 to d_2. Thus, under these conditions we would expect to find retail activities at a distance of d_1 from the CBD and manufacturing activities at a distance of d_1 to d_2.

Figure 3 also helps highlight some important outcomes from the theory of urban land use. The first such concept is that of spatial equilibrium. In this case, spatial equilibrium is a condition in which there is stability in the pattern of land use. Stability of land use occurs when there is no incentive for, say retailers, to out-bid manufacturers for land beyond d_1 (at least in this example). Similarly, manufacturers have no incentive to out-bid retailers for land between d_1 and the CBD. If the conditions that gave rise to this pattern did not change over time, the pattern of urban land use would not change and would be said to have reached a condition of spatial equilibrium. Why would equilibrium be achieved in this example? We can draw on the concept of highest and best use to answer this. Highest and best use refers to the notion that land is allocated to the use that earns the highest location rent (Stutz and deSouza, 1998). Recall that in equilibrium bid rent will equal location rent and in our example land has been allocated to activities that are willing to pay the highest rent at any given distance.

So far, we have discussed only land uses for firms. In order to introduce the location of households, we must drop the assumption of even population distribution (assumption #6) and allow households to compete for land in the same manner as firms. It is likely that while many households will value access to the CBD to minimize on commuting costs, many households will also value open space and lower density lifestyles. If this is the case, then households will have a bid rent function for urban land that is flatter than the bid rent line for manufacturers. This is illustrated in Figure 4.

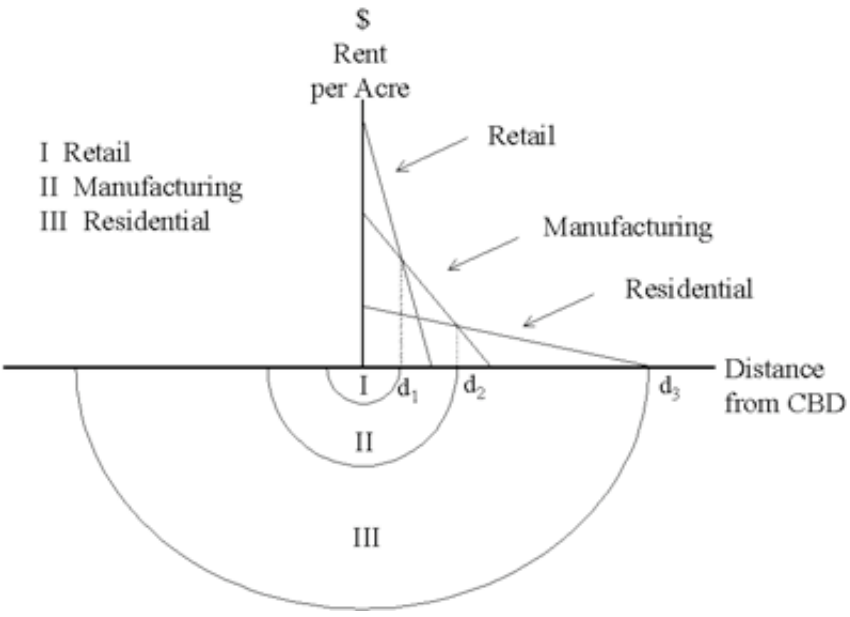

Figure 4 Allocation of Land Between Three Uses

In Figure 4, we have three types of users of urban land: retail, manufacturing and residential. The bid rent functions for retail and manufacturing are similar to those shown in Figure 3. Because of the flatness of the bid rent line for residential use, we would expect to find households (residential land use) at the furthest distance from the city's center. The point at which land changes from manufacturing use to residential use is marked on the x-axis at point d_2. Beyond d_2, households would out-bid manufacturers for land and residential land use would extend to the distance d_3. Beyond d_3, urban users do not value land and its value falls to the value of agricultural land. If the city is symmetrical (which is never really the case) the pattern of land use will form a set of concentric rings as show in Figure 4.

Tracing only the upper-most portions of each bid rent function renders the land rent gradient, as illustrated in Figure 5. The rent gradient indicates the rate at which the value of urban land declines with distance from the CBD. It is also worthy to note that because land prices increase closer to the CBD, centrally located land will be tend to be used more intensively. The intensity of urban land use is correlated with the height of buildings (generally taller buildings being located on higher valued land) which helps explain why tall buildings are found in central business districts. As one moves away from the CBD both the value of land and its intensity of use decline, as do the height of structures. The accompanying photograph of the Charlotte, North Carolina CBD provides a good illustration of this point. The tallest building in the photograph is the corporate headquarters of Nations Bank located in the heart of the CBD. Note how the height of buildings declines with distance from the Nations Bank building.

Downtown Charlotte, NC. Note the steep rent gradient implied by the height of buildings. Click on the image to enlarge. *Photo by David Hartgen*

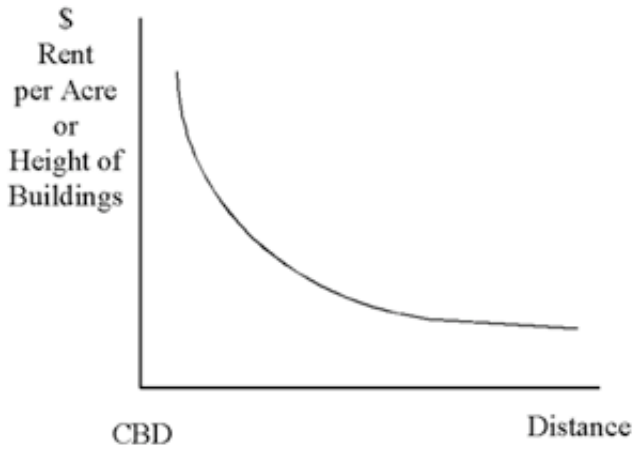

Figure 5 Generalized Urban Rent Gradient

While no city conforms exactly to the concentric ring pattern of land use, it is nevertheless a useful concept in our discussion of urban land. To this day, most major cities have a traditional core that is identifiable by its concentration of tall buildings. Although traditional core areas of cities have lost some of their functional importance, they continue to be the symbolic center of the city. In reality, most cities represent a kind of composite form of the three models of urban land use discussed earlier. The multiple nuclei model, for example, can be thought of an urban form that has several nodes, or centers of commerce with each node surrounded by a set of rings of different land uses.

Residential land use occupies the largest portion of land in any urbanized area. Over time, patterns of residential land use change as does the composition of neighborhoods within that class of land use. With this mind, we should further explore some of the patterns and dynamics of residential land use.

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