Urban Use of Agricultural Land:
A Case Study of Fort Collins, Colorado

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Farmland in the United States is currently being urbanized at the rate of 2.2 million acres a year. This rate is up nearly 50 percent from the 1.5 million acres annually converted at the beginning of this decade. Nearly 20 percent of all farms, representing approximately 25 percent of the total agricultural sales, are within urban areas [Getschow, p. 1].

At least two problems are posed by this trend: 1) the ability of U.S. agriculture to continue to supply consumers at current prices, and 2) the loss of open space around and between urban areas. The former problem has been addressed by a number of studies [e.g. Krause and Haire, pp. 1-26.] The latter problem is the subject of this study. Ultimately, of course, the value of urban agricultural land is a function of both of these concerns.

Specifically, this paper is concerned with the market allocation of land to urban and agricultural uses in urban areas. The hypothesis is that the present institutional arrangement allows for market failures such that land is allocated to its highest priced use, rather than its highest value use. That is, third party effects are not internalized in the market for land.

The city of Fort Collins, Colorado, provides a typical example of the problem under discussion. The city developed during the late 1880s as an agricultural based community surrounded by irrigated farmland. As the city has grown, urban land uses have continuously outbid agricultural uses for land on the urban fringe. Between 1880 and 1950 the city grew slowly from a population of 1,356 and area of 932 acres to a population of 14,937 and area of 1,853 acres. During the

past 25 years, however, the city's population has grown to nearly 56,000 and its area has expanded to 10,606 acres. In fact, according to *Sales Management* magazine, Fort Collins is the center of the fifth fastest growing metropolitan area in the country.

The most recent incursion into the farmland surrounding Fort Collins is the purchase of 168 acres of land by Hewlett-Packard, an electronics manufacturing company. The land is located two miles southeast of Fort Collins and is level, well-drained, irrigated farmland used mainly for the production of sugar beets, corn, and barley. Soil Conservation Service ratings indicate that 84 percent of the land is prime agricultural land. Moreover, the surrounding area is also irrigated farmland with very little development, even on the land between the site and the city limits

The purpose of this paper is to assess the relative values of the site selected by Hewlett-Packard for both industrial and agricultural uses. The paper first presents a conceptual model of the spatial allocation of land uses and then the results of an empirical valuation of these uses in the particular case of the Hewlett-Packard site.

Conceptual Model

The point of departure for considering market failures in the allocation of land between urban and agricultural uses is Alonso's model of location and land use. Each participant in the land market is assumed to have a family of bid price curves, which indicate the set of prices per acre that the participant would pay at various distances while deriving the same level of welfare. Although these curves incorporate a spatial component, they are similar to demand curves in that they represent willingness to pay. The curves are

downward sloping and parallel, such that curves closer to the origin represent greater satisfaction. The highest bidder for land at a given location will be the one with the most to lose by taking land at a less favorable location. That is, the participant with the steepest bid price curve will purchase land closest to the city center. The lowest bid price curve which just allows one participant to bid away from the participant with the next-steepest curves enough space to maintain the level of welfare given by that curve represents the effective bid price curve of that participant.

Figure 1 represents the effective bid price curves for agricultural (ag), residential (r), and industrial (i) uses of land. The vertical axis measures price of land per acre ($/acre) and the horizontal axis measures distance from the center of town (t miles). The curves represent willingness to pay. Thus, the market allocates land from the city center to distance t_1 to industrial use, t_1 to t_2 to residential use, and land beyond t_2 to agricultural use.

In practice, spatial forces are much more complex than the single attraction of the center of town. In a city such as Fort Collins, which has several outlying industrial parks and no clearcut distance division between residential and industrial areas, it seems appropriate to aggregate these activities into a category of simply urban use (u). Thus, figure 2 indicates the spatial allocation of land between urban (u) and agricultural (ag) uses of land, with the demartion between these uses occurring at distance t_2.

Besides private benefits, certain uses of land also generate social benefits. In particular, agricultural land, in providing open space, provides collective benefits in terms of its scenic beauty and function of separating communities and limiting strip development. Moreover, the practical irreversibility of urbanization and the uncertainty of future food production needs creates a social option demand for agricultural land. Society as a whole has a bid price curve (s) for agricultural uses of land, too. Aggregating the private and social bid price curves in figure 2 indicates that the optimum allocation of land to urban uses would cease at t_0 rather than the private market solution of t_2. That is, the private market for land ignores social values of open space and, thus, over-allocates land to urban uses.

Empirical Analysis

The objective of the empirical analysis is to assess the performance of the market in allocating the future Hewlett-Packard site to industrial use. The analysis seeks to determine whether or not the summation of agricultural and social bid price curves for farmland exceed the urban or industrial bid price curves at this location. That is, could open space interests bribe the agricultural owner of this site to maintain it in farming and still be at least as well-off as before?

According to the County Recorder's Office, Hewlett-Packard paid $3,585 per acre for the

Fig. 1. Effective bid price curves for industrial, residential, and agricultural land uses.
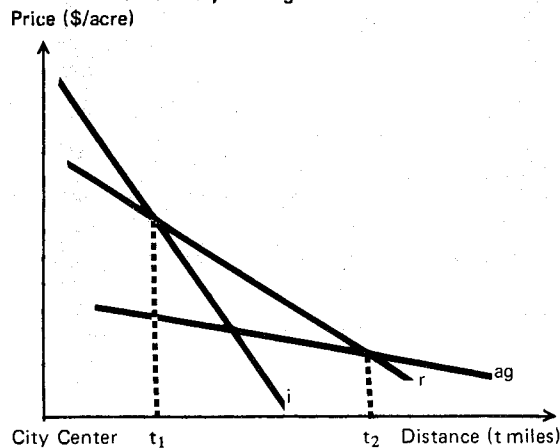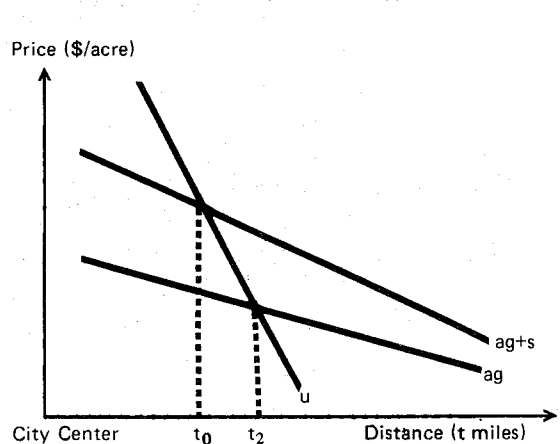

Fig. 2. Effective bid price curves for urban, agricultural and social land uses.

first 53 acre parcel of land purchased so far. At this rate, the total industrial value of the 168 acres is $602,280. The agricultural value of the land is $2,000 per acre or a total of $336,000. The difference between the price paid by Hewlett-Packard and the agricultural price of this land is $266,280 and represents the minimum amount society must value the agricultural use of this land if it is to be maintained in farming.

That Fort Collins residents do value open space is evidenced by the fact that the city has allocated $2,350,000 for open space acquisition over the next seven-year period. [City of Fort Collins.] The empirical problem is to estimate the social value of open space at a particular location and over time. Some indication of this value is provided by recent purchases of open space and parkland, as indicated in table 1.

Sufficient data are not available for a detailed statistical analysis of the value of open space in Fort Collins. What is needed, however, is a "ball-park" estimate. Too often a great deal of time and effort are expended upon detailed analyses designed to determine what base the runner is on, but fail to establish if he is playing in Shea Stadium or Candlestick Park. It is the latter more gross information which is necessary and, often, sufficient for many public decisions. With this in mind, the following analysis attempts to generate a rough estimate of the value of the Hewlett-Packard site for open space over time.

Two important determinants of the value of open space for urban use are the location of the site and the intensity of local development. These variables are observable for the recent open space and parkland acquisitions listed in table 1 and are graphed in figures 3(a) and 3(b). The location of the open space site is defined in terms of distance from the city limits, where negative distances refer to locations within the city. The observed relationship is one of declining value and intensity of development with increasing distances beyond the city limits. Intensity of development is defined as the product of the density of development (i.e., houses per square mile) and the dollar value of that housing. The observed relationship is one of increasing value of open space with increasing intensity of development.

In order to consider the Hewlett-Packard site in this relationship, a projection of the location of the site with respect to the city limits is constructed in figure 3(c). This projection is simply a linear extrapolation of the historical growth of the city limits.

By combining figure 3(a), 3(b) and 3(c) it is possible to construct figure 3(d), which indicates the dollar value per acre of the Hewlett-Packard site for open space over time. These estimates, however, must be qualified in part, since some of the current open space values utilized are for areas with public access and not solely for open space.

The indication is that the open space value of the Hewlett-Packard site will be increasing over time. Although the current value of approximately $1,400 per acre is not sufficient to justify maintaining this land in agricultural use, the value of open space at this site in the year 2000 approaches $4,000 per acre. The present value of this site in open space is the discounted value of such use over time and appears sufficient to justify the maintenance of this site as farmland.

Conclusion

The indication is that the proposed Hewlett-Packard site is more valuable in its present agricultural use than as an industrial development. While the market price of the land is greater for industrial rather than agricultural use of the land, the difference in value is attributable to a social benefit from the open space the agricultural use affords.

This implication has obvious limitations. Perhaps the most important limitation is that this conclusion assumes city limits contiguous with the site. This may not be a valid assumption. Before a more definitive analysis can be conducted, a determination of the ultimate city limits is required and this may be an impossible task. It was for this study.

Finally, the important conclusion of this paper is that there is a substantial social value to the maintenance of agricultural land around the urban area, a value which is ignored by the market. The conceptual tools used in this study could aid planners in determining the stage of growth at which this social value justifies an effort to

Table 1. Recent purchases of open space and parkland by Fort Collins

Tract	Area	Price/Acre	Total Expenditure
Edora Park	19.8 acres	$6,818/acre	$134,996
Martinez Park	56.0 acres	$3,858/acre	$216,048
Aranci Tract	70.0 acres	$2,763/acre	$193,410
Foothills Tract*	648 acres	$1,475/acre	$955,800
			$1,500,254

*Proposed

Fig. 3.   Derivation of open space value of Hewlett-Packard Site
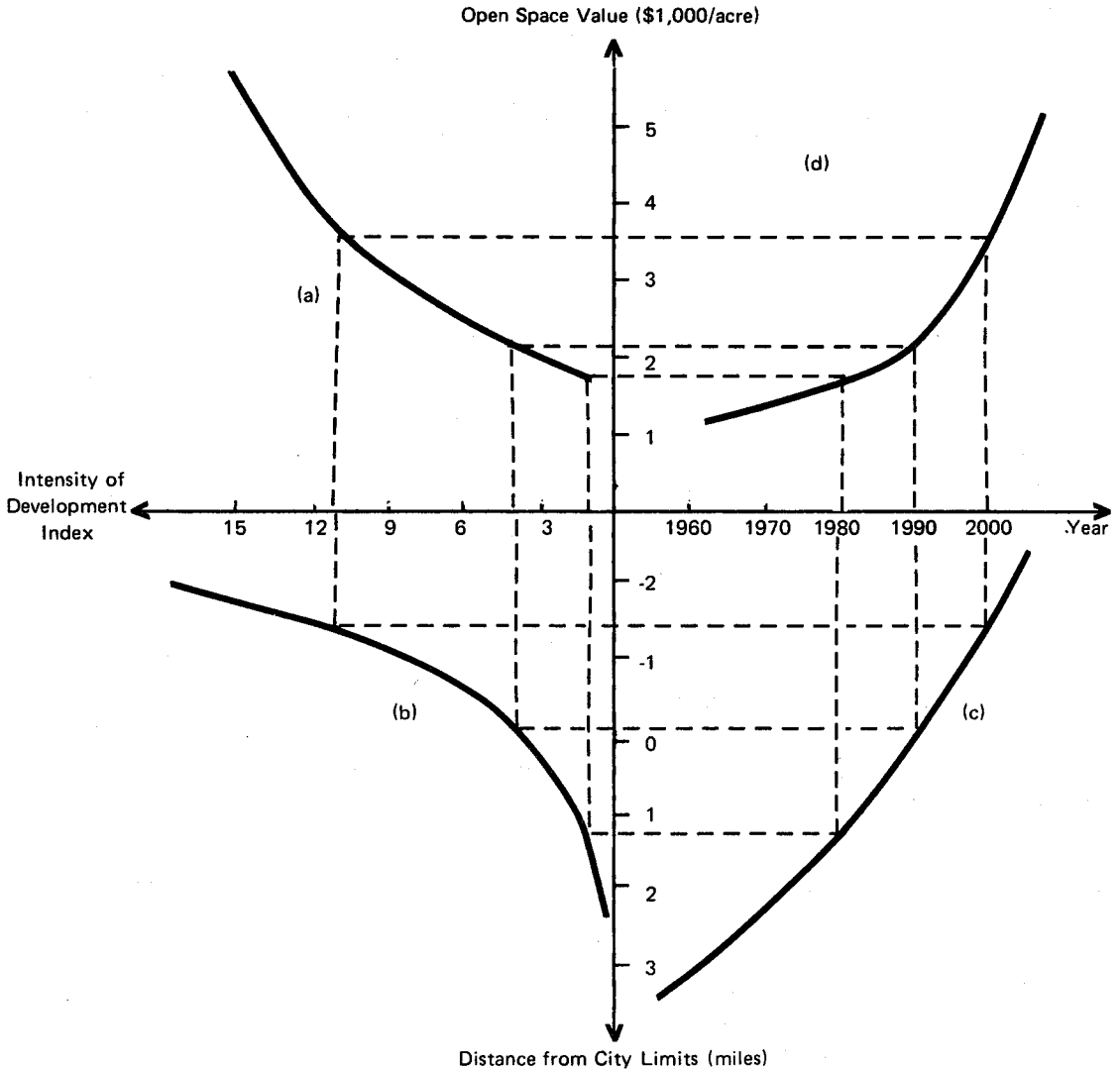
preserve this resource. The task for planners is to develop long-range programs based upon public as well as private land use values. Reliance on the market, or even just market indicators, is not sufficient for planning that maximizes social welfare.

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