Invited Presentation

The Optimal Quantity of Land in Agriculture: Discussion

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Agricultural land preservation has been a persistent public policy concern in the U.S. for at least two decades. The issue gained a sense of urgency in the early 1970s when questions were raised about the adequacy of the diminishing land base for meeting future demands for food, fiber, and fossil fuel substitutes and as agricultural land loss became equated in public debate with environmental degradation and loss of cultural heritage (Brenneman and Bates; Crosson; Keene and Coughlin; Steiner and Theilacker). Most states have enacted legislation to preserve farmland, but policy remains unsettled. State and local governments continue to take and deliberate on new actions, and policy analysts in a variety of disciplines continue to debate the appropriate role, ends, and means of all levels of government in farmland preservation (Duncan; Rose).

Professor McConnell finds the current debate to be unduly acceptant of the idea that farm land should be preserved. His concern is that policy may be biased towards an inefficiently high level of preservation. He suggests that we need more discussion about the benefits and costs for society of saving farm land, and how much we ought to be preserving. Argument for more attention to economic efficiency concerns in deliberations on farm land preservation is not entirely new but deserves reiteration. It is useful in this context to recall some remarks of B. Delworth Gardener and Emery Castle. Gardener, commenting in 1977 when several states were considering strict zoning laws, argued that the philosophical rationale as well as the economic costs and benefits of land preservation had not been adequately considered. His paper is widely cited for its defense of the efficiency of agricultural land markets except where open space amenity values are involved. The conclusions he draws from his analysis of the economic foundations for preservation probably represents the opinion of many economists and are worth repeating (p. 1035):

> Perhaps the most apt way to sum up is that agricultural land retention legislation is the wrong thing at the wrong time and for the wrong reasons. The number of people clamoring for enactment and the power of the governmental agencies supporting the idea do not alter this basic conclusions.
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> It has not been adequately demonstrated that more American land than the market will make available will be needed to produce food and fiber in the decades ahead. Granted that the market will not provide optimal quantities of open space and that more can be justified, what sense does it make to use agricultural productivity criteria to select the land parcels desired? Additionally, even if urban growth needs to be better managed and agriculture needs to be more profitable to shore up rural economies and communities, why should immobilizing land in agricultural use be an efficient way of reaching these goals? Even if all these ends were achievable by employing the means of preserving agricultural land, what is more inequitable than requiring agricultural landowners to bear the costs in the form of foregone increases in land prices?

At least the last of Gardener's concerns has been addressed as alternatives to zoning involving payments to farmers (e.g., conservation easements, transferable development rights) or tax relief have been used increasingly to promote farm land preservation.

Castle's remarks were made in 1982, shortly after the National Agricultural Lands study was published and stimulated great concern about the adequacy of agricultural land to meet future demands. He notes that (p. 816):

> The recent swell of concern about the adequacy of agricultural land has created an educational opportunity for agricultural economists. It is obvious there is great concern outside the farming community—probably much more than there is inside—about the adequacy of agricultural land . . . Tools of economics can help the lay-person to a better understanding of the essentials of the problem. Too frequently economists have accepted the implicit assumptions in the

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question "Are we in danger of running out of farmland?

Castle goes on to say (p. 817):

> The retention of agricultural lands may be a nonissue with respect to aggregate agricultural output, but it certainly is an issue at the state and local level. Land use control is the principal, albeit often crude, tool local areas use to control their destinies. The land market has many imperfections in solving rural-urban fringe problems. But it is not just the market that fails. Local and state governments often contribute to such problems by unwise zoning or land-use control policies and by the location of public facilities, including highways.

The past contributions by Castle, Gardener and some others including Mulkey and Closer, Raup, and Wolfram provide a rich intellectual foundation for McConnell's argument for making economic efficiency the central issue in the debate on farm land preservation and for focusing on market failure related to open space amenity services of agricultural land as the primary basis for land-saving action. Most economists probably agree with this message, but some words of caution are in order before we accept the optimal amount of farm land as the economically efficient level.

Economic concepts of optimal conservation and preservation are based on utilitarian values which are not always well-received in natural resource policy decisions. The frustration of the earliest generation of natural resource economists with the seeming lack of attention to rigid standards of cost benefit analysis in water resource development is a classic case. More recently, pollution policy is a similar example. Economists have developed a large and elaborate literature on the optimal level of pollution and the optimal means for achieving it in the 1960s and 1970s. This literature has had only a limited impact on pollution control policy, not because economists have not been assertive, but because the theories and their underlying assumptions have not been consistent with political and regulatory realities. Recent literature on the topic shows economists' concern for the opportunity costs of pollution control but accepts the validity of politically determined targets and recognizes informational, political, and other limits on rational planning.

Farm land preservation is similar to these earlier policy issues. Despite repeated economic arguments for the proper primacy of efficiency considerations in land use planning, nonutilitarian ethical concepts seem to predominate the farm land preservation debate. Agricultural land preservation appears to be more an ethical and cultural issue for many than an economic one. Hence, while we agree with Castle and McConnell that economists have an obligation to inform and help shape the debate, the reception of economists who equate optimal preservation with Pareto efficient preservation will be limited, at least in the short run, because of conflict with the values motivating the demand for land-saving action. This general approach is consistent with what Randall identifies as the "rational planning model" of natural resource economics, which is increasingly being discredited. We hasten to add, however, that our discussion will not degenerate into institutional nihilism. Even though neoclassical economic analysis may not prescribe politically acceptable solutions, it can provide insights to understand policy outcomes. More, rather than less, of such analysis would be helpful as long as we remember its limits.

Summarizing Professor McConnell's analysis, his model determines the optimal growth in farmland by the growth rates in the social demand for farmland relative to the growth rates in the social demand for farmland relative to the growth rates in social opportunity costs in the form of forgone urban and other nonagricultural uses of the land. If the growth in the willingness-to-pay for nonfarm uses, including externalities, exceeds the growth rate in the willingnes-to-pay for agricultural land, also including externalities, then the optimal quantity of farm land should be declining. This conclusion can easily be accepted subject to the caveats mentioned above. The application to the Maryland case is an interesting demonstration of using simple and stylized models to arrive at policy relevant insights with little data. However, caution is warranted before concluding that resources allocated to farm land preservation are used inefficiently because the optimal quantity is diminishing since the pace of conversion and the lands converted by the market may remain suboptimal.

To illustrate this point and some others, consider recasting of Professor McConnell's model into a form more consistent with the Von Thunen tradition of contemporary land-use and urban economics (eg. Smith, Rosen, and Fallis). For simplicity, we imagine a featureless line (rather than the usual plain) that can be allocated among urban, agricultural, and nonfarm rural uses. Per acre rents for

all uses are declining with distance from the urban center due to transportation costs. Unlike Professor McConnell's model, the total supply of land is not fixed. Yet we can obtain similar conclusions about the efficient allocation of land while obtaining richer results in the form of differential rents and location of efficient agricultural land-saving action. First, consider the allocation of land uses and rents under market behavior. Let:

$R^u(D)$ = urban bid rent function
$R^a(D)$ = agricultural bid rent function
$R^r(D)$ = private nonfarm rural land bid rent function (e.g. rural residences, resorts, hunting camps, etc.), and
D = distance from Central Business Area (CBA).

Assume:

$$R^u(D) \gtreqless R^a(D) \text{ for } D \gtreqless D'_u,\ D'_u > 0,$$

$$R^a(D) \gtreqless R^r(D) \text{ for } D \gtreqless D'_a,\ D'_a > D'_u,$$

and

$$R^r(D'_r) = 0,\ D'_r > D'_a.$$

As illustrated in Figure 1, under these assumption the market equilibrium will occur with:

$R^u(D'_u) = R^a(D'_u)$, D'_u being the urban margin,
$R^u(D'_a) = R^r(D'_a)$, D'_a being the margin of cultivation, and

$R^r(D'_r) = 0$, D'_r being the geographic margin.

Comparative statics results from growth in the bid rent per acre for urban and nonfarm rural land relative to agricultural land similar to McConnell, would include:

1. The urban margin would be expanding while the margin of cultivation shrinks. Agricultural land is reduced by both urban and rural-recreational land uses. The geographic margin would also be expanding.
2. Rents per acre may be rising or falling at the urban margin and the margin of cultivation depending on the growth rates in demand for agricultural land.
3. Urban and nonfarm rural land prices will be rising. Prices on remaining farm land will depend on the growth in demand for farm land. Farm land near the urban margin and the margin of cultivation will be rising in price as the higher rents that will be earned after conversion are capitalized.

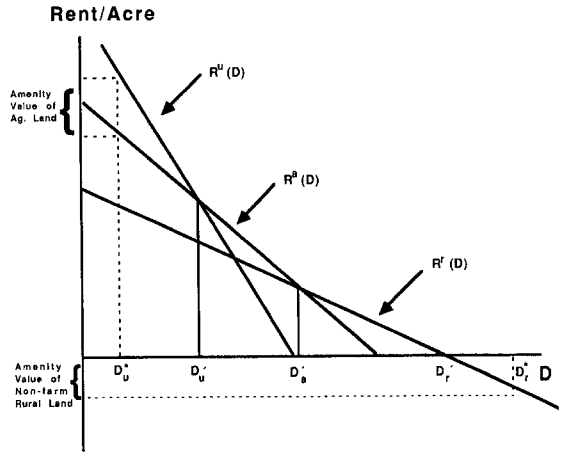

Figure 1. Amenity Values of Open Space and Optimal Urban, Agricultural and Rural Nonfarm Land Use

Now consider the optimal allocation when nonexclusive amenity values of agricultural and nonfarm rural open space are introduced. Let θ_a be the amount of farm land and θ_r be the amount of nonfarm rural land within the geographic margin. Furthermore, let the (nonexclusive) amenity value of open space be given by $B(\theta_a, \theta_r)$.[1] The simplifying assumption that the open space benefit function is independent of the location of the open space implies generally that urban land will be at the center followed spatially by farm land and then nonfarm rural land in an efficient allocation. Accordingly, we can assume that $\theta_a = D_u - D_a$ and $\theta_r = D_a - D_r$, $0 < D_u < D_a < D_r$, where D_u, D_a, and D_r denote generally the urban margin, the margin of cultivation, and the geographic margin. The distribution of land uses that maximizes the "social rent" is found by maximizing

$$J = \int_0^{D_u} R^u(D)dD + \int_{D_u}^{D_a} R^a(D)dD + \int_{D_a}^{D_r} R^r(D)dD + B(D_u - D_a,\ D_a - D_r)$$

[1] It is worth noting here that our analysis of voting for farm land preservation Debra Israel indicates that forest land is a substitute for agricultural land as open space in Pennsylvania. It is also worth noting that tentative results of our work with Waddington supports previous studies showing a willingness-to-pay for the amenity and other nonmarket values of agricultural land. Furthermore, this research supports Castle's views that land preservation may be more a local public goods issue than a national policy problem since we find that the willingness-to-pay diminishes with distance.

with respect to D_u, D_a, and D_r given $0 < D_u < D_a < D_r$. The first order conditions are:

$$\frac{\partial J}{\partial D_u} = R^u(D_u) - R^a(D_u) - \frac{\partial B}{\partial \theta_a} = 0, \quad (1)$$

$$\frac{\partial J}{\partial D_a} = R^a(D_a) - R^r(D_a) + \frac{\partial B}{\partial \theta_a} - \frac{\partial B}{\partial \theta_r} = 0, \text{ and} \quad (2)$$

$$\frac{\partial J}{\partial D_r} = R^r(D_r) + \frac{\partial B}{\partial \theta_r} = 0. \quad (3)$$

The first condition means that the urban rent per acre will equal the agricultural rent per acre plus the marginal amenity value of agricultural open space at the urban margin. The second means that the agricultural rent per acre plus the marginal amenity value of agricultural open space will equal the nonfarm rural rent per acre plus the amenity value of nonfarm rural land at the margin of cultivation. If agricultural and rural nonfarm open space are equally valued at the margin (i.e., $\partial B/\partial \theta_a = \partial B/\partial \theta_r$), then the rents per acre are equal at the margin of cultivation. The third condition means that the nonfarm rent per acre will equal the negative of the marginal amenity value of nonfarm rural open space at the geographic margin.

These conditions have implications about the market solution relative to the efficient solution at any point in time. In Figure 1 D_u^* is the urban margin and D_r^* is the geographic margin in the efficient solution. The optimal margin of cultivation is not depicted explicitly in Figure 1. It would lie between D_u^* and D_r^* and could be to the left or right of D_a'. Among the implications are

1. The urban margin is farther from CBA in the market solution than it would be if the amenity value of open space were captured by the market. Correspondingly, urban rents are lower at and near the urban margin than they would be if the opportunity costs of agricultural open space were captured by the market.
2. The geographic margin is closer to the CBA in the market solution than in the efficient solution and there is no public recreation area in the market solution. The efficient amount of public recreational area is represented by $D_r^* - D_r'$.
3. The market solution has more urban space and less open space than the efficient solution. The efficient allocation of open space between agricultural and nonfarm open space will depend on the relative market and nonmarket values. The greater the non-market amenity value of agricultural land relative to nonfarm open space the greater the proportion of open space that is farm land.
4. Rents per acre for farm land, excluding its marginal social amenity value as open space will be higher at or near the urban margin. They may be higher or lower at or near the margin of cultivation depending on whether this margin is closer to or farther from the CBA.

The value of this simple modeling exercise in the present context is to emphasize two points. First, land saving action may be efficient even though the efficient amount of farm land is diminishing. Second, location matters. In this analysis, efficient land saving action slows the expansion of the urban fringe and perhaps the contraction of the margin of cultivation.

Considerable economic reasoning and evidence supports the view that land markets maintain adequate levels of agricultural productive capacity in areas where it is cost-effective to have it. These areas tend to be in regions with better climates, soils, agricultural infrastructures and lesser development pressure than in the New England and Middle Atlantic regions. It is, therefore, in high density, high growth areas with a rapidly growing urban fringe such as New Jersey, Maryland and eastern Pennsylvania where the amenity value of farm land is a relatively large proportion of its social value that the analysis of the amount and location of farm land as well as farm land use becomes especially critical. It is for these areas that a shift in the debate from preservation of national or regional productive capacity to supplying a mix of country-side amenities is especially needed. As advocated by McConnell, economic analysis to identify, measure, and value the desirable and undesirable characteristics of agricultural land such as Bergstrom and Stoll and Waddington, should help to produce this kind of shift and move planning along fruitful lines.

This economic analysis could also consider that the market may result in the wrong kind of agriculture at the urban fringe as well as too

rapid an expansion of the fringe. Insofar as preferences are defined over attributes of the use of land within categories as well as among categories and locations, policy relevant analysis must address not only the amount and location of agricultural land saving-action but also the appropriate types of agricultural activities in alternative types of locations. For example, the highly intensive mixed crop-livestock farming found on the urban fringe in much of the Middle Atlantic region may be an inefficient use of urban fringe farm land when agricultural amenities and disamenities are considered. Although less profitable, low intensity small grain or beef cow-calf operations may be more efficient urban fringe use because they provide greater amenities and/or fewer disamenities.

In concluding, Professor McConnell has hopefully opened the door for increasing neoclassical analysis of agricultural land preservation. If his model is not given a normative interpretation, his limiting assumptions need not be as troublesome as he indicates. For example, the fixed land quantity causes joint consideration of land uses—see Shumway, Pope, and Nash—so that separability may not be unduely restrictive. Theoretical and policy insights are apparent in both his and our models, even though both have limiting assumptions. More fruitful comprehensive analysis will only be forthcoming after considerable theoretical and empirical analysis such as we are considering in this session.

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