SUPPLY RESPONSE AND THE LAND CONVERSION
PROCESS IN THE RURAL-URBAN FRINGE
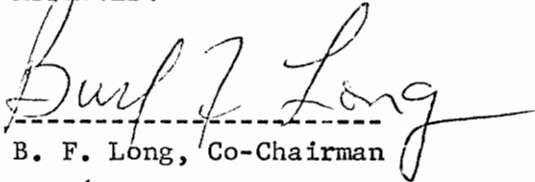
by

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INTRODUCTION

This chapter introduces the problem for analysis and presents
a brief outline of the organization of the dissertation. Section
1.1 presents the formal problem statement of the research. Section
1.2 discusses the relevance of the problem for land-use policy
analysis. The objectives of the research and hypotheses tested are
briefly discussed in section 1.3. Chapter I concludes with section
1.4 which outlines the remaining organization of the dissertation.

1.1 Problem Statement

The role of landowner supply-response behavior in the land con-
version process of the rural-urban fringe is not well understood.
This has resulted in policy analyses of land-use problems in the
fringe which are in many cases incomplete or misleading. Generally,
such policy analyses have either assumed a "typical" type of land-
owner behavior on an aggregate level or have ignored supply-response
entirely. In either case, the analysis of land-use policies is ef-
fectively hampered.

This problem is particularly acute when the focus of analysis
is on policies designed to affect landowner behavior as in the case
of use-value assessment programs. Assuming a "typical" type of
selling behavior at the aggregate level is inconsistent with much

observed landowner behavior in the rural-urban fringe. Ignoring
supply-response entirely has the effect of denying the relevancy of
landowner selling behavior in land use and conversion. An analysis
of landowner supply-response behavior in the rural-urban fringe
would be beneficial for providing an understanding of the land con-
version process in general and for understanding the consequences of
specific land-use policies on this behavior.

This study provides a microeconomic analysis of supply-re-
sponse behavior and its role in the land conversion process of the
rural-urban fringe. For the purposes of this study, land conver-
sion will refer to the dynamic process by which market forces act to
bring about a change in land use. While the theoretical model to be
presented is primarily concerned with supply-response behavior of
farmers in the fringe, conceptually it is sufficiently general to
deal with other types of landowners as well.

1.2 Justification

It is generally recognized that the workings of "the land mar-
ket" are not perfect. A plethora of socially determined land-use
problems results from the institutions which govern land ownership in
the United States. The existence of the multitude of land-use laws
and regulation designed to restrain the free operation of the land
market provides an indication that the actions of landowners do im-
pose negative externalities on their communities.

Currently, the various levels of government are considering
and implementing various land-use policies in an attempt to effect

a change in the results of the operations of the land market in their jurisdictional areas. The rural-urban fringe has served as the focal point for much of this activity. However, these policy alternatives designed to promote efficient and equitable growth around urban areas, to preserve "prime agricultural lands," to encourage family farm operations near developing urban areas, and to control the activities of land speculators, presuppose an understanding of the land conversion process which, in fact, does not exist. Central to the understanding of the land conversion process is the understanding of the selling behavior of the individual landowners involved. Since in many cases the purposes of the policy alternatives are to alter the behavior of these landowners acting in the market, a conceptual understanding of this behavior has immediate and important implications for the various policies now employed and those under review by governmental authorities.

1.3 General Objectives and Hypotheses

The principal objective of this research is to develop and test a dynamic microeconomic model of the land conversion process in the rural-urban fringe. While the theoretical model developed will be general in nature, specific attention will be given to farmer landowners. Specific objectives include:

1) The development and testing of the individual landowner's dynamic supply-response curve of agricultural land for urban uses. This curve may be defined as the schedule of quantities of land which agricultural landowners are

willing and able to offer to the urban market at a set
of difference prices, ceteris paribus.

2) The incorporation of this supply-response curve into a
general model of the land conversion process in the
rural-urban fringe.

3) The derivation and testing of hypotheses concerning
variables which affect the shape of this supply-re-
sponse curve.

4) An evaluation of Virginia's use-value assessment pro-
gram based on the developed theoretical framework.

The hypotheses tested are based on the predictions of the theoreti-
cal model. The tests will compare the predictions of the theoreti-
cal model with the results of a discriminant analysis of data col-
lected from a study area. The principal hypotheses tested are:

1) The farmer's dynamic supply-response curve of land
for urban uses is discontinuous.

2) The farmer's fixed capital investment as described by
his type of farm operation is a primary cause of this
discontinuity.

3) Farmers with different (less intensive) types of
operations will have different (more elastic and
less discontinuous) supply response curves.

4) Speculator's supply-response curves will be continu-
ous and more elastic than farmer's supply-response
curves.

1.4 Organization

The following chapter will review the literature concerning land-use in the rural-urban fringe, the problems posed by this unique area and the relevant findings concerning supply-response and landowner behavior. Chapter III presents the theoretical model to be used in the analysis. Chapter IV describes the study area, data set and statistical method used in the analysis. Chapter V presents the formal results of the empirical analysis and implications for the hypotheses. The implications of the model for Virginia's use-value assessment program are presented in Chapter VI followed by a discussion of the general conclusions, limitations and suggestions for further research in Chapter VII.

CHAPTER II

REVIEW OF LITERATURE

The literature treating some aspect of the rural-urban fringe
is voluminous. Nevertheless, few authors have dealt with the topic
of land conversion and fewer still have treated the specific topic
of landowner selling or supply-response behavior. This chapter
discusses the literature which has dealt with these important topics
as well as the related findings of other studies which reflect upon
the hypotheses and analytical model of the present study. Section
2.1 presents a general overview of the nature and problems of the
rural-urban fringe. Section 2.2 discusses the various studies of
the fringe area and their relevancy for the present study.

2.1 Nature and Problems of the Rural-Urban Fringe

While empirical definitions of what constitutes the land area
of the rural-urban fringe may vary, there is general agreement that
this area is very large. Conklin [11, p. 755] describes the rural-
urban fringe as "...broad belts that extend outward beyond the
closely settled suburbs of a city to the residential limits of a com-
muting population." Thus, conceptually, the fringe may be considered
to be the area between two concentric circles; the smaller circle
surrounding the city proper, and the other, larger circle extending
out to the commuting limits of the city. Conklin notes further that

fringes normally exist around cities whether they are growing or not and that because the area of a circle varies with the square of its radius, no one could realistically forecast that this huge present-day fringe area would be incorporated into the urban complex in less than a matter of decades.

The fringe area has become much larger since the middle 20th century as the distinction between urban and rural living, has become more clouded. Allee [1, p. 1297] notes that:

>good roads, the private car, electric, gas and
>phone service, the snow plow, large central
>schools, expanding health and welfare services,
>etc., have meant...the rural resident gives up
>much less than he did because of his choice of
>residence.

The rapid growth of this fringe area has resulted in many land-use problems. Moncrieff and Phillips [30] discuss the political and service problems associated with urban sprawl. The effects of negative externalities and increasing property taxes and their role in curtailing long-run investments and hence long-run economic viability of farming in the fringe are discussed by Conklin [11] and Allee [1]. The relationship between urban sprawl and inflated agricultural land price is discussed by Chryst [6] and Van Vuuren [44]. Raup [38] argues that many present public policies actually act as a subsidy for sprawl and its associated problems. He cites: (1) the public investments in highways, (2) the tax laws which encourage borrowing, which exempt bonds for municipalities and shelter municipal monopolies, which exempt the large portions of real estate that

are state or church owned, (3) the methods of housing finance, and (4) the average cost pricing of utilities.

Thus, it is evident from the literature that the rural-urban fringe encompasses a large area from which many complex land-use problems have emerged to challenge society. That the actions of governments have served to complicate and enlarge the problems of the fringe underscores the importance of understanding the land conversion process. The next section will discuss how it is felt previous studies have failed to provide this needed understanding.

2.2 Studies of the Rural-Urban Fringe

The introductory chapter argues that many land-use policy analyses may be incomplete or misleading because of their treatment of supply-response behavior in the land conversion process. The literature has generally ignored this important determinant of the land conversion process or has simplified this behavior to the extent that its conclusions may not be very useful to policy analysts.

For purposes of review, it is convenient to divide studies of the fringe into two groups; general descriptive and problem/policy specific studies. Of the first group, only those which at least implicitly deal with landowner behavior will be discussed. The second group of studies will be divided for discussion into those which deal explicitly with landowner behavior and those which hypothesize some specific type of supply-response curve.

General Descriptive Studies

The general descriptive studies have made valuable contributions through their discussion of land-use issues and research needs. However, the focus of such studies is generally too broad to be relevant for many types of research problems. The topic of supply-response is rarely discussed in such literature. When it is discussed, only very general cause and effect relationships are described. Hence, while it is possible and in many cases desirable to investigate only general relationships, such studies have only limited applicability to the present study. General descriptive studies cannot be used to address specific questions concerning the analysis of the role of supply-response behavior in the land conversion process. They may, however, be useful for investigating an appropriate setting for such an analysis.

Clawson's study, Suburban Land Conversion in the United States, is among the most thorough general descriptive studies. But while he does provide a description of the general factors which affect the land conversion process, he does not provide a theoretical synthesis of specific relationships. Also, Clawson begins his descriptive analysis after the farmer has already left the land and, as a consequence, he neglects much of the area of analysis relevant to the present study.

Schmid's Converting Land from Rural to Urban Uses also provides no theoretical synthesis of behavior in the land conversion process although it does provide much useful, general information. For example, Schmid does discuss the general factors which affect

landowners' ability to withhold supply (i.e., property tax levels, risk, discount rate) and comments on the overly optimistic expectation with respect to conversion displayed by landowners in the fringe. He does not treat owners of agricultural land in detail although he appears to believe the supply-response curve is perfectly inelastic [see 39, p. 40].

While Clawson and Schmid do provide for a general understanding of the complex nature of the economic forces which bring about land conversion in the rural-urban fringe, their broad method of inquiry is not suggestive of any means which may be used to deepen our understanding of such forces. A general descriptive study by Denman and Prodano [15] is more instructive in this regard. The Denman and Prodano study examines land use in terms of motivations for owning land, physical characteristics of the land, and tenure relationships. Land conversion is not discussed. The importance of this study for the present research lies in its focus. By concentrating their analysis on the "proprietary land unit," Denman and Prodano emphasize the importance of the micro-theoretic approach to land-use analysis. They define this "forgotten dimension" as "an area of land used as a single entity and coextensive in its physical dimension with vested rights of property, to use, to dispose and to alienate" [p. 24]. This definition is consistent with the unit of inquiry in the present study.

Problem/Policy Specific Studies

Problem/policy specific studies may be generally described as those studies of the rural-urban fringe that inquire into a particular problem or seek to analyze the effects of a specific policy on land use. Examples would include the use-value assessment literature and analyses of the problems associated with urban sprawl.

Clawson [8, p. 105] has pointed out that "though empirical data are lacking...one cannot but suspect that the personal desires, projections, and preferences of present landowners must be a major factor responsible for some tracts developing while other intermingled ones are not." Nevertheless, among the numerous problem/policy specific studies of the rural-urban fringe, the subject of landowner behavior has generally been avoided, even at the conceptual level. Goode [20] is one of the few authors who has specifically treated this important topic.

Goode attempts to explore the relationship between what he calls the "land conversion market" and urban development patterns. He adapts an optimization-over-time model to the simple world of one homebuyer, one developer, and two predevelopment (agricultural) landowners. Speculators are omitted. The behavioral assumption is that a predevelopment landowner seeks to maximize the present value of profit from the sale of his land subject to a current income constraint. He argues that the predevelopment landowner (who in some cases may also be the developer) gets an idea of the value of his land over time by observing neighboring sales. The landowner

believes the value will continue to increase and hence the problem reduces to:

$$\pi_p(t) = R(t)e^{-rt} - \int_o^t c'(t)e^{-rt} d$$

where:

$\pi_p(t)$ = present value of profit at time t,

e^{-rt} = continuous interest factor,

r = some external rate of return,

R(t) = what the landowner expects the value of his land will be at time t, and

C(t) = what the landowner expects the accumulated cost of holding his land will be at time t.

The maximum present value of profit obtains when

$$\dot{r} = \frac{R'(t) - C'(t)}{R(t)} = MIRR \text{ (Marginal internal rate of return)}$$

assuming the average internal rate of return exceeds the external rate.

Goode goes on to assume the landowner will be indifferent to a certain disposable income and a minimum acceptable marginal rate of return on his land. The indifference curve thus developed serves as a basis for the income constraint which may cause the landowner to sell before the optimal time. Goode also constructs a reservation price curve (that price which would yield the same profit level if he sold at the optimum time) and incorporates the other components into his model in order to deduce and test hypotheses.

Problems with Goode's model include his dependence on the present value of profit maximization criterion. This criterion implicitly assumes the individual possesses a linear utility function

with respect to profit and is particularly objectionable when considering farmer landowners who hold a great attachment to the land and to their occupation. Farmers as a group cannot be assumed to be predisposed to sell their land. They are in the business of farming, not selling real estate.

Another problem with Goode's model is the high degree of certainty he assumes. Given the "thinness" of the land market in the rural-urban fringe, the scarcity of information and the uncertainties involved in future growth patterns, it would seem more realistic to assume, as does the theoretical model in the present study, that the landowner would attempt to maximize profit or the utility from profit at discrete intervals of time. At such time that he actually receives an offer for all or part of his land, he could then re-evaluate past and present information and his expectations and make a decision whether to sell or hold.

Finally, Goode's model provides little information concerning the supply-response curve or factors which may affect this curve. He implies that the supply-response curve is perfectly elastic at some reservation price, but he does not address the problem posed by parcel-selling activities. (Goode implicitly assumes the sale is all land or nothing.) It is ironic that, in spite of the fact that speculators are omitted from the conceptual model, Goode's model and behavioral assumptions are probably more applicable to speculative landowners. Indeed, his model is very similar to the land speculation model presented by Bahl [2].

Other studies dealing with landowner behavior include Hansen, et al. [24], who like Schmid found evidence of landowners' overly-optimistic expectations with respect to conversion in the fringe. Kaiser, et al. [27], examined the role of landowner and property characteristics in determining whether or not a parcel of land was held or sold in the fringe within a 10-year period. Landowner characteristics were found to be significant with the authors claiming a 60 to 80 percent prediction accuracy.

An apparent paradox concerning farmers' behavior in the rural-urban fringe exists in the literature. Clonts and Gibson [9], after studying typical farm resource situations of farmers in Virginia counties near Washington, D.C., concluded only Grade-A dairy enterprises were sufficiently profitable in this area to be competitive with the urban uses of land. Less intensive beef cattle operations were not found to be competitive. These findings are inconsistent with observed farmer behavior in this area, however, as the number of dairy farms has decreased appreciably while beef cattle operations are becoming more prevalent [see Census]. This phenomenon is consistent with the findings of Cummins [13] who found evidence that dairy production in the Lake States has been driven out of the fringe areas. This paradox will be addressed in section 5.3 where the implications of the model for location theory will be discussed.

The problem/policy specific studies of the rural-urban fringe which argue for, or assume a specific elasticity for the aggregate supply-response curve, are also few in number. No supply-response curve has ever been directly estimated. Only Muth [32] presents a

numerical estimate of the "elasticity of urban supply" which he infers from a previous study. He argues:

> Since the total amount of land in any area is essentially fixed, the supply curve of urban land is this fixed amount less the agricultural demand curve for land [p. 289].

Hence, the elasticity of urban supply equals the negative of the agricultural demand for land (elasticities = 1.2). This treatment of the supply-response curve as a residual is totally unconvincing, however.

A variety of other aggregate supply-response elasticities have been argued for or assumed in the literature. Car and Smith [4] use a stock/flow analysis and argue supply-response is quite elastic at some reservation price. They recognize reservation prices among landowners may differ due to different preferences and high transactions costs associated with land sales and repurchases. McMillan [29] and Neutze [33] also argue that the supply-response curve is quite elastic.

Hushak [25] utilizes a point-in-time model and assumes a perfectly inelastic supply-response curve. Bentick [3] argues for a perfectly inelastic supply-response curve while Pasour [36] argues supply-response is quite inelastic.

While the above authors in many cases utilized different assumptions in constructing their conflicting arguments, it is nevertheless apparent that a great deal of confusion exists concerning the shape of the aggregate supply-response curve. In many cases, for example, it is impossible to decide whose supply-response curve they are discussing; whether the supply-response curves are farmers',

speculators', or some combination. However, a common thread does weave all of these studies together. None of the above authors have questioned the validity of the aggregate land market approach to land-use policy analysis in the rural-urban fringe. At least one author [Crowley, 12], however, has found evidence of "several" types of agricultural land markets (differentiated by geographical area only) and questions the appropriateness of treating land-use variables "as if they related to a homogeneously influenced land market" [p. 13].

This argument will be expanded in the next chapter where it will be argued that the aggregate market approach to land-use policy analysis in the rural-urban fringe is generally not appropriate. A disaggregated micro approach which focuses on the proprietary land unit will be offered as an alternative to the aggregate market approach to land-use policy analysis. Such an approach will define more clearly the economic forces which bring about changes in land use in the fringe and will seek to explain the confusion concerning supply-response behavior described in this chapter.

CHAPTER III

THEORETICAL MODEL

This chapter presents the theoretical model of supply response
and the land conversion process. Section 3.1 provides the justifi-
cation for the disaggregated micro approach. Section 3.2 discusses
the assumptions and components of the model. The dynamics of the
model are presented in section 3.3. Chapter III concludes with a
brief discussion of the advantages of the theoretical model in sec-
tion 3.4.

3.1 Justification for the Disaggregated Micro Approach

Since it is obvious that analyses of the land conversion proc-
ess are hampered when supply-response is ignored, this section will
concentrate on the practical inconsistencies and theoretical prob-
lems encountered by analyses which assume some sort of "typical"
supply-response curve. It will be argued that such analyses are
generally inappropriate and that the proper level of analysis is at
the disaggregated micro (proprietary) level.

The focus of all aggregate market analysis is on aggregate be-
havior. However, since aggregate curves are directly derived from
micro curves, aggregate economic analyses which proceed without an
understanding of the micro underpinnings of the aggregate curves
involved may be misleading. Such is the case for aggregate analyses

of "the land market" in the rural-urban fringe. The highly simpli-
fied smooth, continuous supply-response curves hypothesized or
assumed by previous authors encounter serious practical inconsisten-
cies as well as theoretical problems.

The practical inconsistencies of such models are positive in
nature. The smooth, continuous supply-response curves do not conform
well to observed selling behavior in the rural-urban fringe. For
example, such curves cannot explain the commonly observed phenomenon
of a farmer selling a small portion of his land and then holding the
rest for one final sale in the face of ever increasing demand.
Similarly, aggregate model manipulations cannot answer many relevant
land-use questions. For example, knowledge that a certain policy
will effect a leftward shift in demand and thus reduce the quantity
of land supplied is facile. It says nothing about who will reduce
the quantity supplied, how this supply will be reduced and, more im-
portantly for policy analyses of the fringe, where this reduction
is likely to occur. Also, the use of the aggregate supply-response
curve implicitly assumes all classes of landowners exhibit the same
general type of selling behavior. Thus, dairy farmers and land
speculators are lumped together, in spite of their obviously dif-
ferent motivations for owning land.

The practical inconsistencies of the aggregate land market ap-
proach described above stem from theoretical difficulties encounter-
ed when treating the land market in the rural-urban fringe as one
market. Intuitively, it may be argued that because every land trans-
action is negotiated separately, distinct land markets for each

proprietary land unit must exist. However, a more rigorous argument can be made. It is argued below that theoretically, a land market in the rural-urban fringe can only exist at the proprietary land unit level, and hence this level represents the appropriate level for analysis. The land market in the rural-urban fringe is a special case.

Part of the uniqueness of the land market in the fringe is due to land itself. Land is a special good. It is a productive asset for both the farmer and urban consumer. It may take on the added dimension of a consumer good, bought and sold for reasons beyond its usefulness as a productive asset. Because it is fixed in supply, it may be used as a store of value. However, the single most important attribute of land is location. Every parcel of land is perfectly differentiated from every other parcel if only with respect to location. Besides these attributes, the ownership of land may take on special meaning stemming from the complex man/land relationship embodied in the cultural, institutional and psychological make-up of a society.

For farmers in the fringe, the fact that a specific parcel of land is irreproducible in supply has important consequences. Farmers cannot reproduce the land parcels they offer up to the market for sale. Their decision to sell may require not only a change in location but the sacrifice of a desirable lifestyle as well.

Given the uniqueness of land and the subjective valuations this uniqueness may conjure up in different people, it follows that theoretically, the land market in the rural-urban fringe may only exist

at the proprietary land unit level and that the aggregation of these individual land markets is generally not valid.

While exact definitions of what constitutes an economic market vary, all definitions impute a price generating function to the market. Without the forces of supply and demand interacting to determine price, no market could be said to exist. Price is the critical item of information provided by the market. And yet no aggregate land market price exists in the rural-urban fringe. Only an average price exists at the aggregate level. Given the heterogenity of land, this average price level tells the individual farmer very little about the value of his land for urban uses. He must negotiate his own price given the particular attributes of his land.

If it could be assumed that all land in the fringe was homogeneous with respect to development potential and all farmers had identical utility functions and budgetary constraints, it could be argued that an aggregate land market price existed and that farmers would react similarly to changes in this price. Farmers in the fringe may be considered demanders of their own land until the marginal utility of the money offered for their land is equal to the marginal utility of owning their land. Beyond this point, they become suppliers of land to urban consumers. If the above strict assumptions held, all farmers in the fringe would be willing and able to begin supplying given amounts of land at the same reservation price. Even if the land homogeneity and identical budgetary constraint assumptions were relaxed, it could still be argued that, in general, supply-response behavior by all farmers would be similar. It can be demonstrated,

however, that farmers' utility functions are generally different and
hence the basic conditions of supply-response among farmers are dif-
ferent.

An individual farmer's utility function may be generally speci-
fied:

$$U_F = U\ (L_1,\ L_2\ \dots\ L_J,\ X_1,\ X_2\ \dots\ X_n,\ f(Z))$$

where:

U_F = total utility to the farmer.

$L_1,\ L_2\ \dots\ L_J$ represent the attributes of land (including
expected attributes in urban uses).

$X_1,\ X_2\ \dots\ X_n$ represent all other goods in the farmers' utili-
ty function.

$f(Z)$ represents the farmer's output production func-
tion (Z is not included in X).

The farmer's output production function is a valid argument in his

utility function and should be included at least implicitly. Like

other goods, the farmer's choice of a specific farming enterprise

provides a flow of consumption services per unit of time.

The production function defined by the farmer's choice of

enterprise may implicitly define his attitudes toward risk, uncer-

tainty and profit. It may also reflect to a large extent his train-

ing and experience. Thus, while it may be difficult to verify that

many arguments in all farmers' utility functions are different, it

is known that in many cases at least, the production function is dif-

ferent. It can therefore be argued that because farmers' utility

functions do differ, it is likely that their supply-response

behavior will also differ. Consequently, the forces of supply and demand interact to determine price only at the proprietary land unit level. This is not to argue that the larger macro forces of supply and demand will play no role in the determination of land prices. These forces do determine the environment in which the micro forces act. Nevertheless, it is the interaction of the micro forces which ultimately determine land price and conversion. Analyses of the land conversion process which fail to consider these micro underpinnings may be incomplete or misleading. A model of the land conversion process which focuses on this disaggregated micro market level will be presented in the next section.

3.2 Assumptions and Theoretical Components

Begin by assuming that landowners in the rural-urban fringe seek to maximize the utility from profits on land sales given their farming activity and the discrete intervals of time when sales opportunities present themselves. Also assume the psychic costs incurred are constant over all parcels of land sold by an individual owner and that the demand and cost relationships may be expressed in a linear manner.

Given these assumptions, the three cost and two demand components of the model may be developed as follows. A conventional price/quantity diagram is utilized. The hypothetical farmer is endowed with a stock of N acres of land (see Figure III.1).

The first cost component of the model is the rent component, C_1 (Figure III.2). C_1 represents the discounted present value of the
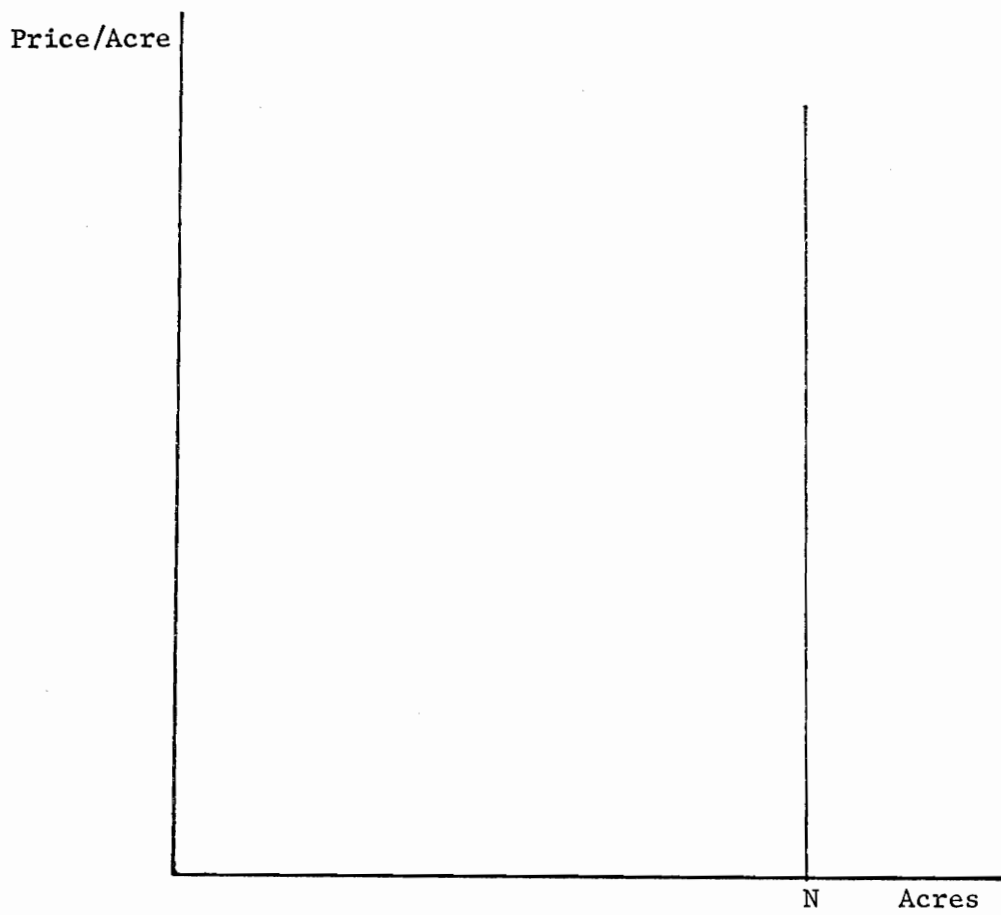
Figure III-1. Farmer's Land-Stock Supply Curve.

Price/Acre

C_1

N   Acres
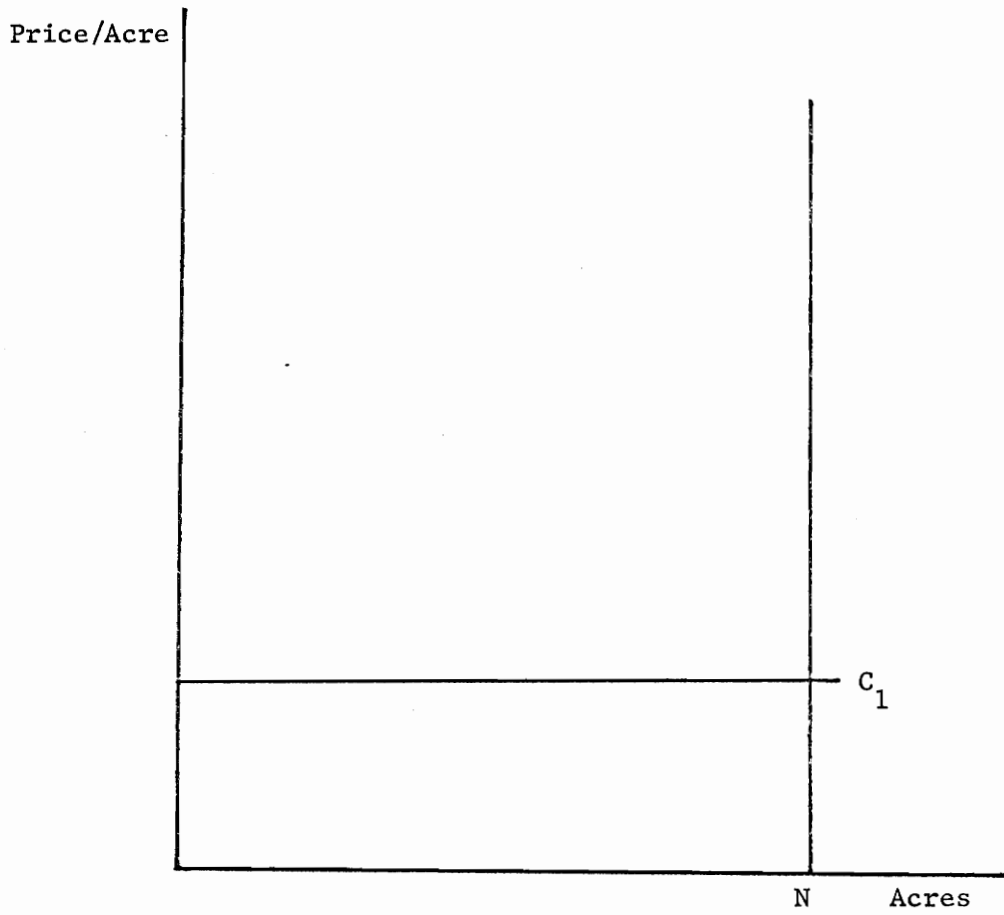
Figure III-2.   The C_1 Curve.

stream of net incomes which are equivalent to the returns the farmer could earn by leasing his land and attached improvements to another farmer in the immediate area. Hence, C_1 equals the discounted value marginal product (VMP) of his land and attached improvements in agriculture and represents the minimum price the farmer would accept for his land and attached improvements in an unforced sale. For simplicity, the C_1 curve in Figure III.2 is drawn perfectly horizontal. The farmer's land is assumed to be perfectly homogeneous: every acre is as productive in agricultural use as every other acre.

The next cost component of the model is the capital component, C_2 (Figure III.3a). C_2 represents the discounted VMP of a portion of the farmer's fixed capital investment which is applied to his fixed land resources. This portion is composed of the farmer's machinery, equipment and, in some cases, buildings which could be sold separately from the land for their discounted present worth. The C_2 curve is derived from the farmer's output expansion path (EP in Figure III.3b) and ultimately from the farmer's output production function. Assuming profit maximizing behavior on the part of the farmer with respect to output, he would have originally purchased and maintained the optimal capital compliment for his land resources given his choice of an output production function. He would, therefore, be operating on his expansion path equating the rate of technical substitution of land for capital with the capital/land price ratio. As parcels of his land are sold off over time (N - N' in Figure III.3b), the profit maximizing farmer would move back along his expansion path (e.g., from point A to point B). However, because

Price/Acre (a)

C_2

P_1 C_1

0 N   Acres

Capital (b)

EP

K_1 A

K_2 B

N' N   Land
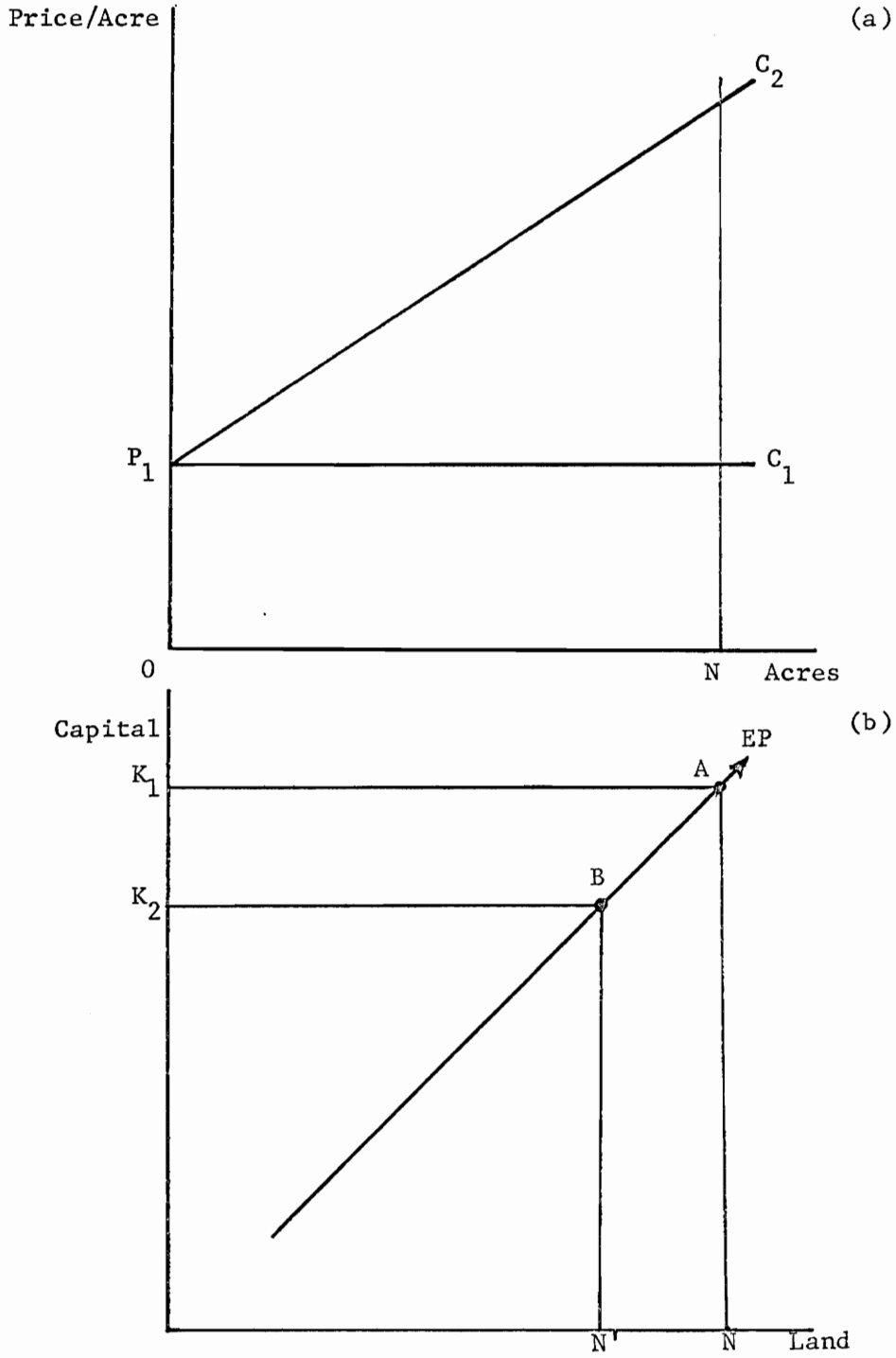
Figure III-3.   The C_2 Curve and its Derivation: (a) the C_2^2 Curve, (b) the Capital-Land Expansion Path.

capital inputs in most types of farming enterprises are generally "lumpy," he cannot sell portions of his original capital stock and instead must absorb the costs of this increasing excess capacity (equal to $K_1 - K_2$ x price of K in Figure III.3b). Hence, given the linear expansion path assumed here, the farmer's C_2 curve will be an increasing linear function of the amount of land sold.[1]

The total discounted present value of the entire farm in agricultural use is represented by area OP_1C_2N or the combined C_1 and C_2 areas in Figure III.3a. The psychic costs incurred by the farmer from sales of his land are measured by the C_2 price-axis intercept. These pyschic costs measure the farmer's subjective attachment to the land and are over and above the income producing potential of his land. Such costs may stem from a long family association with the land or may represent the negative externalities associated with selling off portions of the land. Since the C_2 price intercept is also the C_1 price intercept P_1, these psychic costs are assumed to be equal to zero in this example. If these psychic costs were greater than zero, the C_2 price intercept would shift upward thus shifting the entire C_2 curve upward.[2]

---

[1] Complications in the derivation of the C_2 curve such as those described by Johnson [22] may exist. If the VMP of a given C_2 asset, say Z_i, falls as a result of a land sale to the point where: $VMP_{Zi} <$ price of Z_i in salvage, the farmer may sell Z_i. This would have the effect of rotating the C_2 curve downward.

[2] It is assumed in the theoretical model and in the empirical model which follows in Chapters IV and V that the psychic costs and therefore the C_2 price intercept may vary over individual farmers engaged in the same enterprise. The C_2 slope, however, is assumed to be constant over all farmers engaged in the same enterprise.

There are two demand components in the model (Figure III.4). The actual demand curve (D_A) represents the schedule of quantities of land which urban consumers are willing and able to purchase from the farmer at a set of different prices, ceteris paribus. Evidence in the literature indicates that this "actual" demand curve is quite inelastic (see for example, Hushak, [25]). There is, however, no reason to assume that the farmer possesses as much information or as reliable information as the potentital urban consumers concerning the relative development potential of his land. Consequently, the farmer will possess a perceived demand curve (D_P) which embodies his perceptions and expectations concerning the value of the attributes of his land in urban uses.[3] Evidence in the literature indicates that farmers are generally overly optimistic concerning the development potential of their land. Consequently, it is apparent that this perceived demand curve is more elastic than the actual demand curve.

The disparity between the actual and perceived demand curves gives rise to the third and final cost component of the model. This is the opportunity cost component or C_3 (area $P_1 P_{pr} AB$ in Figure III.5). The C_3 area represents the perceived discounted present value of the cost of selling off a portion of the farmer's land, say parcel q, and not holding back this parcel for inclusion in one final sale. If parcel q were held back and sold for the perceived price

---

[3]The reader will notice the similarity between the demand components in the model and the demand component in Chamberlain's model of monopolistic competition [5].

Price/Acre

C_2

D_p

C_1

D_A N   Acres
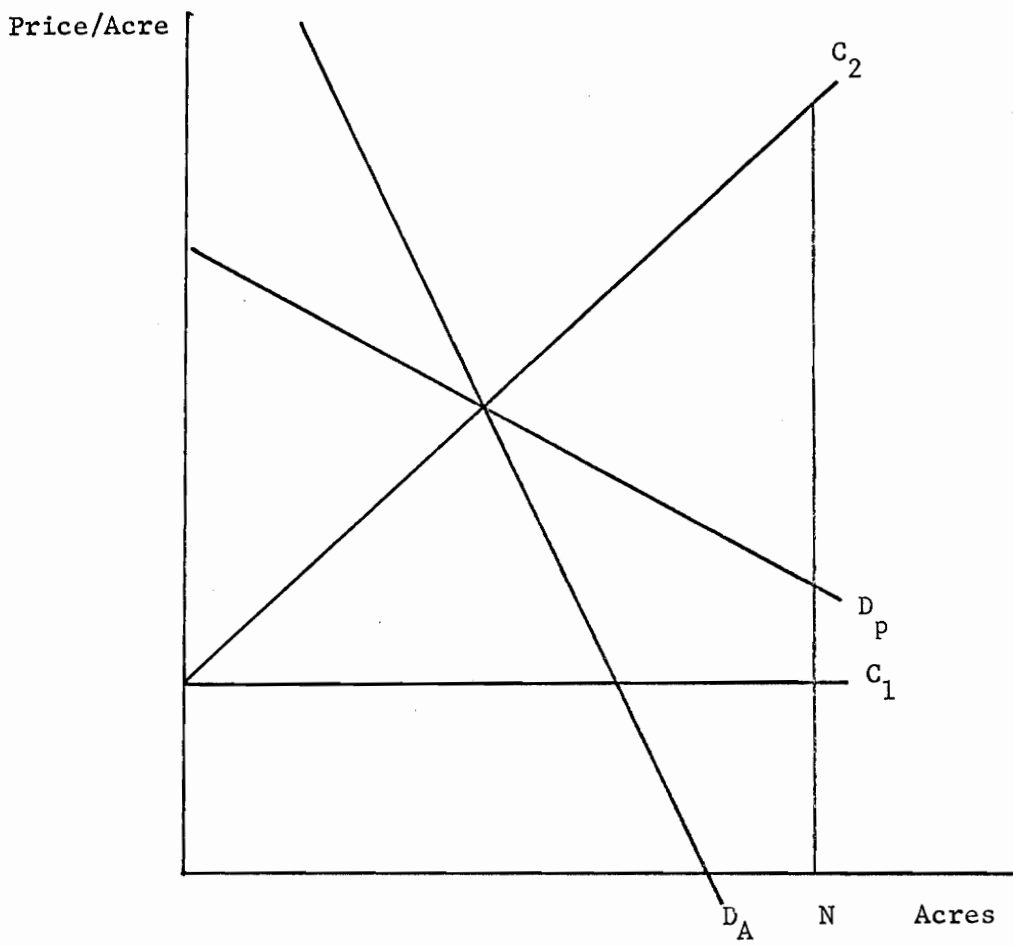
Figure III-4. The Demand Components.
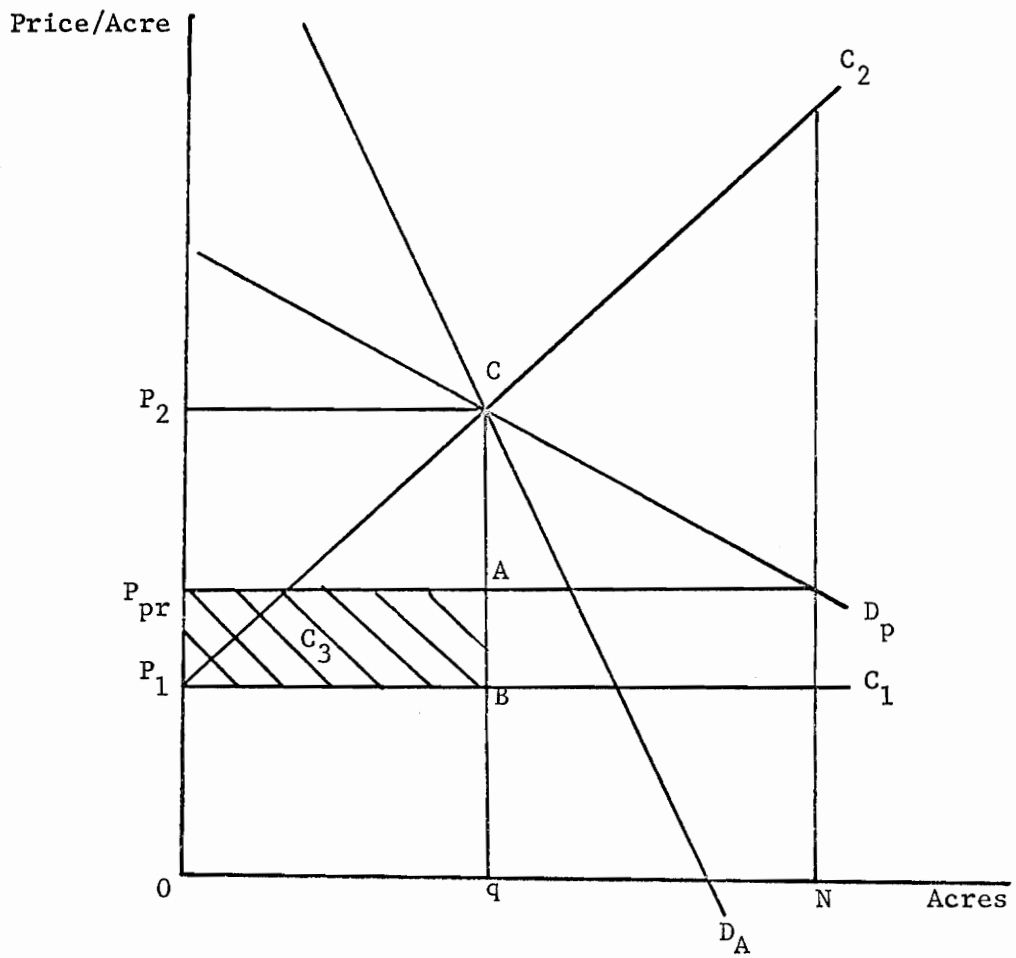
Figure III-5. The C_3 Cost Component.

of the entire farm (P_{pr}), the farmer would not have to incur the C_2 cost for that parcel (equal to P_1CB in Figure III.5). All of his machinery, equipment and buildings could be sold for their discounted present value at the time of the final land and fixed improvement (C_1) sale. Thus, the C_3 area represents a perceived opportunity cost to the farmer. The C_3 cost is greater than zero only when the perceived value of the entire farm in urban uses is greater than its agricultural value however.

3.3 Dynamics of the Model

The components and dynamics of the theoretical model will be better understood through the aid of a graphical example (Figure III.6a). In this example, we consider the situation of a farmer with land acreage = N on a fringe area of a city. Let line $P_1 C_1$ equal the discounted VMP in agriculture of each unit of land (C_1 cost). Now introduce an autonomous change in demand ($d_{a1} - d_{a1}'$) for development purposes for q_1 units of the farmer's total acreage. The farmer presumably becomes aware of this change in demand from observing neighboring sales or from contacts with an urban demander. Negotiations between the urban demander and the farmer occur. The urban demander is willing to pay P_1 for q_1 units of the farm. The farmer, however, is unwilling to offer for sale q_1 units at this price. The farmer realizes that as he offers up for sale each additional unit of land from 0 to q_1, he will incur the discounted present value of the costs of increasing excess capacity in machinery, equipment and buildings (C_2) in addition to the cost of sacrificing the present

Price/Unit

d_{A1}

P_1 ——————————————— $C_1 = VMP_{Ag}$

0

q_1 d_{A1} N   Units

(a)

Price/Unit

d_{A1} C_2

P_2

P_3

P_1 ——————————————— C_1

0   q_2 q_1 d_{A1} N   Units

(b)
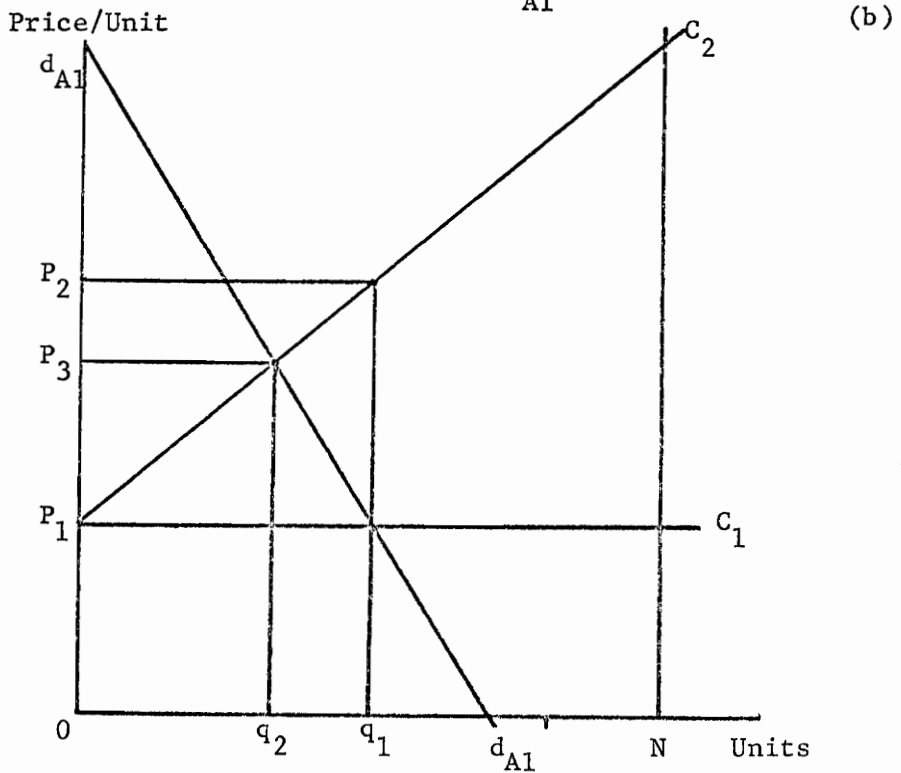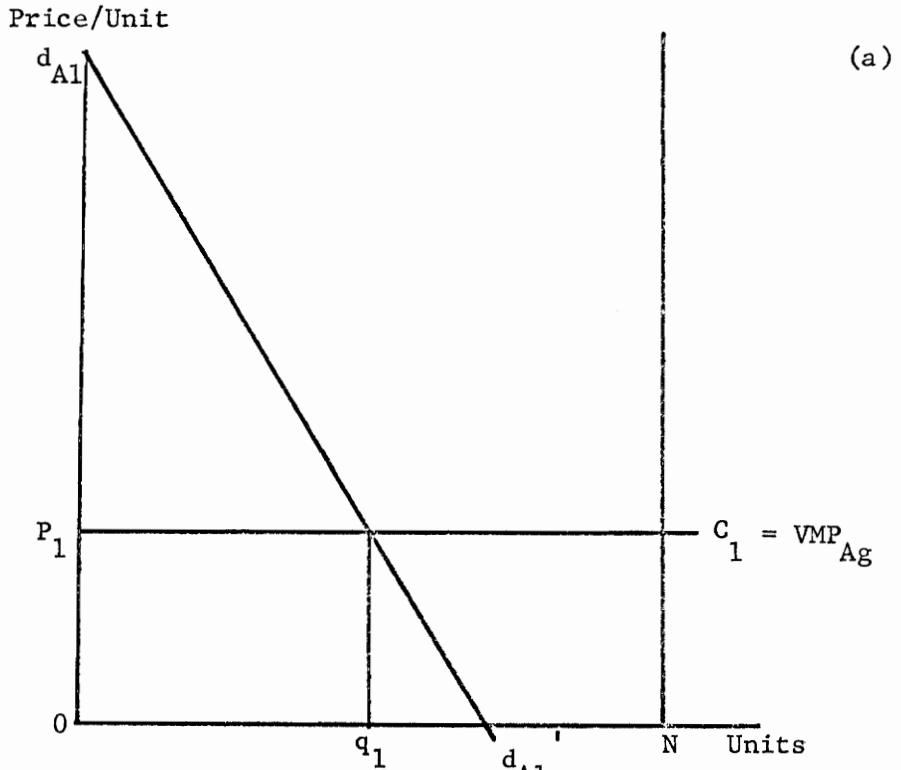
Figure III-6.   The Negotiation Process: (a) the Initial
Situation, (b) the Negotiation Process.

value of the stream of returns from agricultural activity for each
additional unit of land (C_1). The farmer will, therefore, implicitly
develop his C_2 curve (Figure III.6b). He would require a price of
P_2 for q_1 units in order to be adequately compensated for incurring
costs C_1 and C_2. Informal negotiations continue; the urban de-
mander moving up his demand curve, offering higher and higher prices
for fewer and fewer units of land, the farmer moving down his C_2
curve, offering fewer units of land for lower prices. Negotiations
are completed and a formal offer is made after both parties have con-
verged to the price/quantity relationship P_3 for q_2. From this one
formal piece of information, the farmer formulates his perceived de-
mand curve $d_{p1} - d_{p1}'$ (Figure III.7a) and determines what he believes
would be the market price for his entire farm in development.[4] This
perceived demand curve will typically have only one point in common
with the actual demand curve (the intersection of C_2 and $d_{a1} - d_{a1}'$).
And, because it is more elastic, the perceived value of the entire

[4] It is argued here that the nature of the price/quantity nego-
tiations precludes the acquisition of more land market information
by the farmer. Land market transactions of this type are typically
one on one. At best, the farmer may negotiate with two or three
urban demanders. Consequently, there is no compelling reason for
the farmer to believe the price/quantity offers made by the urban
demander as he moves up his demand curve represents "the" actual
market value of the units of land between q_1 and q_2. He may consider
the preliminary offers as a negotiation ploy on the part of the urban
demander (as indeed, they may be). The only relevant piece of infor-
mation for the farmer is the final price/quantity offer.
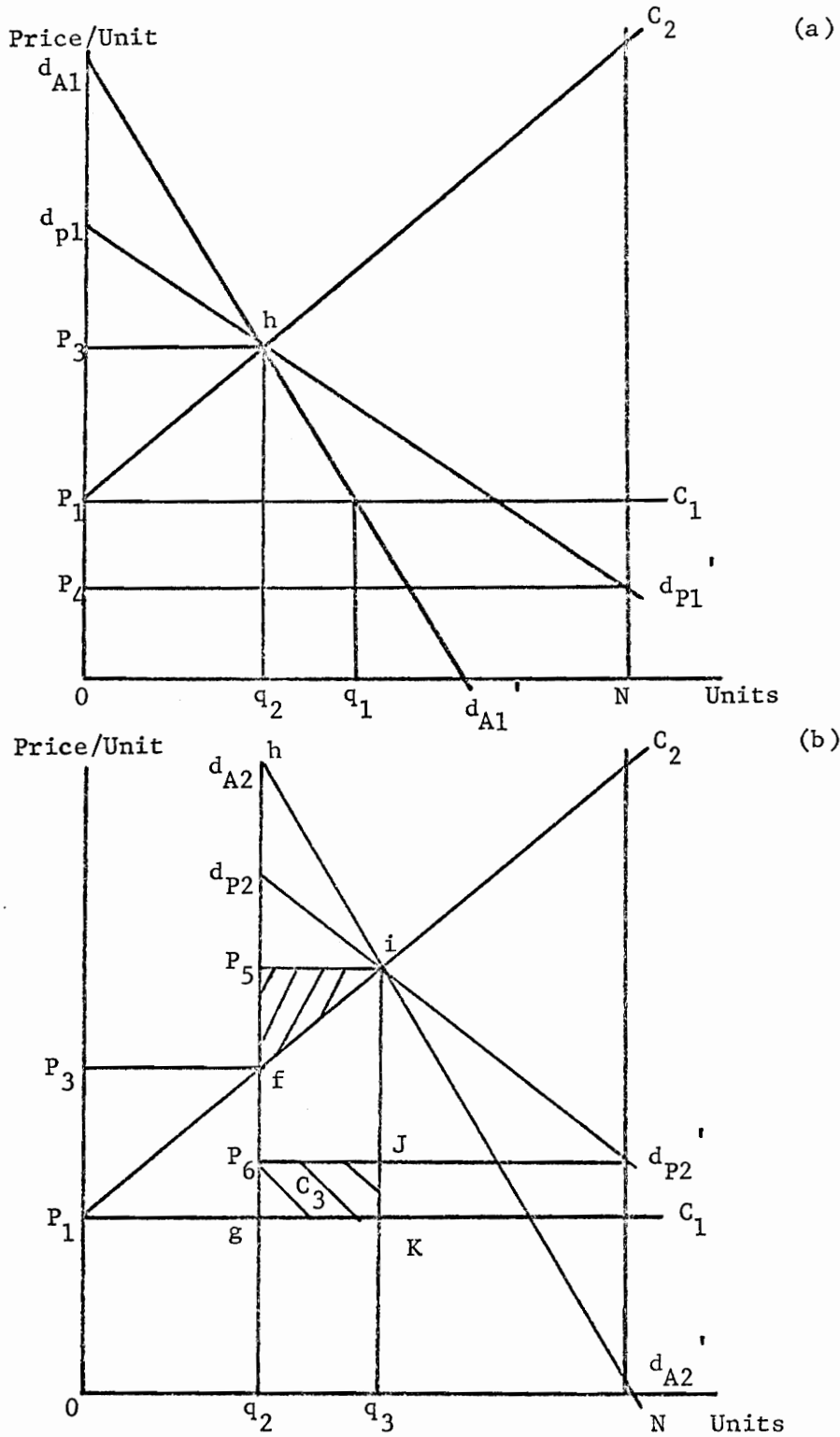
Figure III-7. The Negotiation Process Continued: (a)
the Formulation of Perceived Value of Land
in Urban Uses, (b) the Sell vs. Hold
Decision.

farm in development will be greater than its actual value in develop-

ment.[5] In the present case, the farmer believes he could receive

only P_4 for his entire farm if sold for non-agricultural uses.

Hence, he believes the present value of q_2, if held and sold with his

remaining acreage for development uses, is less than his floor price,

P_1 (or the VMP of this unit of land in agriculture, (C_1)). He may,

therefore, consider the formal offer only in light of C_1 and C_2 (the

C_3 area is equal to zero). The total revenue to be gained from the

sale of q_2 units equals OP_3hq_2. The discounted present value of

costs incurred from the sale of q_2 units equal OP_1hq_2 (i.e., the C_1

plus the C_2 costs for q_2 units) for a profit or return over costs of

P_1P_3h. He therefore would decide to sell q_2.

Now allow for a parallel shift in demand to $d_{a2} - d_{a2}'$ (Figure

III.7b). The relevant vertical axis is now q_2h. The urban demander

is now willing to offer P_5 for q_3 units and the farmer formulates

his new perceived demand based on this offer $(d_{p2} - d_{p2}')$. The farmer

now believes he could sell his total remaining farm acreage for P_6,

which is greater than the VMP in ag, (C_1). His decision proceeds as

follows. If he decides to sell, he will incur costs C_1 and C_2, but

he will also incur an opportunity cost (C_3) equal to area of gP_6JK.

For if he sells, the opportunity to sell these q_3 units of land with

all of his remaining land for P_6 will be lost forever. And, if he

---

[5]The principal determinant of the degree of disparity between
the actual and perceived demand curves is the amount of information
possessed by the farmer. It may well be that as time passes and
the farmer invests more time and money in the information search
process, the disparity would lessen.

decides not to sell q_3 units, but rather decides to hold them to

sell with the rest of his acreage at his perceived price P_6,[6] he will

not incur cost C_2. His decision will hinge on which area is larger -

the profit triangle fP_5i or the C_3 rectangle gP_6JK. If the triangle

is greater, he will sell; if not, he will continue to hold the land

and search for his reservation price (P_6) for his entire farm. In

the present example, let us assume the areas are equal: he will be

indifferent to selling q_3 units or holding all land for one sale.

From the farmer's point of view then, point i becomes a critical

point. Parallel shifts in demand to the left of this point would

imply the opportunity cost of selling is less than the profit tri-

angle of selling and hence the sale would occur. Parallel shifts in

demand to the right of this point would imply the opportunity cost of

selling is greater than the profit triangle and hence the farmer

would hold all land for one sale at his complete farm reservation

price. The C_1 and C_2 cost curves are relevant up to point i. At

this point, the C_3 area also becomes relevant. This has immediate

consequences for the farmer's supply-response curve of agricultural

land for urban uses.

---

[6]The time period involved in both prospective sales (parcel q_3
and the entire farm) is the same. The farmer has a firm offer of P_5
for parcel q_3 in time period t. His formulation of his perceived de-
mand curve leads him to believe the value of his entire remaining
acreage is equal to P_6 also in time period t. The fact that the par-
ticular urban demander he is presently negotiating with is not willing
to pay P_6 for the entire remaining acreage does not dissuade him from
believing such an offer will be immediately forthcoming (if not from
this urban demander, then certainly from another).

The general case of the farmer's supply-response curve is pre-
sented in Figure III.8. As opportunities to sell increasing amounts
of land occur over time, a point i will be reached where the per-
ceived opportunity cost of selling a given number of land units is
equal to the net returns gained from such a sale. Consequently,
only one sale will occur after point i is reached and this will be
the final sale of all remaining units of the farmer's land. Sup-
ply response is therefore an increasing function of price over some
small range.[7] Then it becomes discontinuous and perfectly inelastic
at N.

3.4 Advantages of the Model

Having presented the components and dynamics of the theoreti-
cal model, it would be beneficial to discuss briefly some of the ad-
vantages this model has over previous aggregate land market models.

---

[7]The continuous range over which partial sales occur may be
very small indeed. The possibility of the C_2 curve rotating down-
ward as partial sales occur has already been discussed in footnote
1, page 27. The C_1 curve may also shift downward as partial sales
occur. It is reasonable to assume that as partial sales occur, the
agricultural rent or C_1 for the remaining units of land may de-
crease. Thus, the C_1 curve for the remaining units of land may also
shift downward. The consequence of the downward shift of either or
both of these curves (C_1 or C_2) results in a larger C_3 opportunity
cost relative to the associated profit triangle for any remaining q
units of land. Thus, point i may occur at a point even closer to
the origin along the quantity axis.

Price/Unit
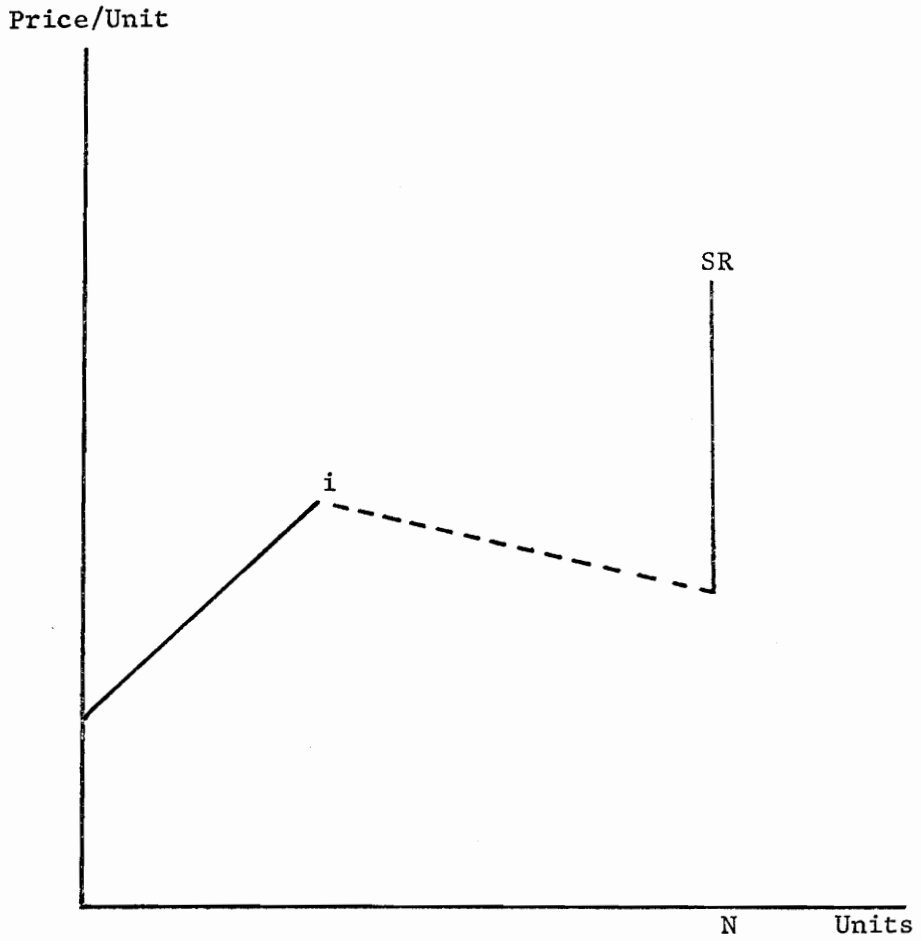
Figure III-8.   The Supply-Response Curve of Agricul-
tural Land for Urban Uses.

First, the model meets the practical inconsistency and theo-
retical objections to aggregate market models. The model presented
above is a true micro model; the focus is on individual farmer sell-
ing behavior and therefore emphasizes the role of the proprietary
land unit in the land conversion process. The model conforms well to
observed selling behavior in the fringe. The discontinous supply-
response curve explains why farmers in the fringe may choose to sell
off small portions of their land and hold the rest back for one
final sale. A real strength of the model is that the derivation of
the supply-response curve incorporates information from the indi-
vidual farmer's output production function and thereby explains the
role of fixed capital in the selling decision. Thus, the model al-
lows for much flexibility in dealing with the selling behavior of
different types of landowners given different land-use policies. The
effects of other factors which affect land-use may also be evaluated.
For example, the model provides a tool for analyzing the many agri-
cultural policy interface areas. In land-use policy analysis as in
any economic analysis, everything affects everything else. The
model provides a starting point for investigating the effects of
other policies which affect the farmer's output production function
on land use. Thus, the model may also be used to evaluate the ef-
fects of water resource policy, energy policy, pest management pro-
grams, etc., on land use in the rural-urban fringe.

Another advantage is that the emphasis of the model is on the
dynamic process of land conversion. It is intuitively clear that a

dynamic model is superior in many respects to comparative static

models when a process is being described and analyzed.

Finally, the predictions of the model allow for the testing of

hypotheses and hence provide a means of investigating the validity

of the model for land-use policy analysis. The empirical tests of

the model will be described in the next two chapters.

CHAPTER IV

PROCEDURES AND ANALYSIS OF DATA

This chapter deals with the procedures used for gathering and analyzing the data collected for testing the analytical model. Section 4.1 describes the study area selected and section 4.2, the data gathering procedures and variables included in the study. Chapter IV concludes with a discussion in section 4.3 of the statistical technique utilized in the analysis of data.

4.1   The Study Area

The area selected for study comprised the central portion of Prince William County, Virginia near the city of Manassas. This area of approximately 15,000 acres of land represents some of the best agricultural land in the county and is characterized by very gently rolling hills and well drained soils.

Prince William County was selected for study primarily because of its proximity to a large, growing urban center. Situated in the northeastern portion of the state with Manassas, the county seat, located only 26 miles from the nation's capital, agriculture in Prince William County has been subjected to heavy urban development pressure since the early 1950's. This urban pressure is evidenced by the remarkable population growth of Prince William County of 121.8% from 1950-1960 and 121.5% from 1960-1970 [43]. This heavy and consistent

development pressure resulted in the implementation of a use-value assessment program in 1973.

The selection of a study area which exhibited heavy and consistently growing urban development demand over time was considered to be critical for the testing of the model. Such a situation would allow for a minimum of time periods in which exceptional growth or stagnation occurred. Hence, the sudden entrance or exit of speculators in the market for individual parcels would be kept to a minimum. The relative demand for each parcel in the study would, therefore, be expected to shift out to the right at a more or less constant rate over time, thus allowing for the inclusion of either implicit or explicit measures of time in the empirical model to act as demand curve shifters.

Other factors which influenced the choice of Prince William County included the existence of reliable and consistent public records over time. Readily available tax and property records existed back to 1954 with general reassessments at regular intervals. The existence of comprehensive property maps and recent air photos also proved to be invaluable. The presence of helpful and knowledgable public employees in the extension and tax assessment offices insured that the data gathered would be interpreted properly and consistently. The limited number of types of agriculture present also proved to be advantageous. Since "dummy variables" representing the types of farms were to be employed in the empirical model, it was important to select an area which had relatively few predominant types of

agriculture over time. This condition would facilitate obtaining an adequate number of observations for each type of agriculture studied.

Finally, it was considered important that the area selected would contain a minimum amount of recreational land. It was felt that the close proximity of   lakes, mountains, etc., would serve to confound the analysis by introducing additional recreational arguments in the supply and demand functions for land. Since the focus of this study is on the conversion of agricultural land to urban uses, areas in Prince William County which exhibited overt recreational amenities were avoided.

4.2   Data Gathering Procedures

Information on owners and their tracts of land were obtained in the following manner. Using 1977 ownership maps and recent aerial photos, the ownership of all tracts of land in the study area were traced to their "original" 1954 ownership. 1954 was the year of the first general reappraisal on current tax records and represented the starting point for the study. All tracts of land were cross-checked with county-owned aerial photos. Those tracts of land which were primarily wooded were omitted from the study. Thus, the study concentrates on the selling behavior of owners of primarily "good" agricultural land.

A total of 87 useable observations on owners/parcels were obtained on an area of more than 5,000 acres. Of the 87 observations, 42 were on partial sales, 15 on complete sales, and 30 were on owners who engaged in no selling activities. The data were obtained

from courthouse and tax assessment records and from public officials

in the tax assessment and extension offices. A complete description

of the data gathered for the analysis follows:

1) Acre: The acreage transferred.

2) Price: The transaction price taken from assessment rec-

ords or inferred from tax stamps on the property

deed.

3) Year: The year of the transfer.

4) FT: Farm Type. A dummy variable assigning a "1" to

observations on dairy farm operations and a "0"

to other less intensive (primarily small-scale

beef cattle operations) farm types. Informa-

tion concerning farm type was obtained from the

local extension agent. In cases where the

agent didn't know or was uncertain, the farm

type was inferred from appraisal records. For

example, if appraisal records indicated the

presence of a dairy barn and silo, a dairy opera-

tion was inferred. If an owner changed his type

of operation, the farm was treated as two dif-

ferent observations. The death of the principal

owner generally indicated a change in farm type.

5) TOL: Time on Land. An estimate of the length of time

an individual parcel was owned by a family. Be-

cause appraisal records didn't include transfer

dates prior to 1954, ownership was assumed to

extend previously to 1948. A maximum of 30
years was assigned to this variable in all
cases where land was held from 1954-1977.

6)   LOL: Lives on Land. A dummy variable indicating
whether the principal owner lived on his parcel
of land ("1") or lived elsewhere ("0"). The
address on record at the assessment office was
used in determining the value of this variable.

7)   FM: Full Time Farm Operator. If the principal oc-
cupation of the owner was some type of farming,
this variable took the value of "1" ("0" other-
wise).

8)   Spec: Speculative Landowner. Took the value of "1"
("0" otherwise) if the principal occupation of
the owner was off-farm work and the owner
leased his land or left it idle.

Information for (7) and (8) were also obtained from the exten-
sion agent and/or inferred from assessment records. If, for example,
the acreage of the farm was considered too small for a viable farm-
ing operation, the owner was classified as either Spec or the omit-
ted classification included in the constant term (owner who farmed
his own land but also had extensive off-farm work). This distinc-
tion was based on other variables (e.g., LOL, FT, etc.).

9)   DPA: Deflated Price Per Acre. Equal to the price
per acre divided by the consumer price index
(CPI) for the year of the sale.

10) Comp: Took the value of "1" if the sale was complete, "0" if incomplete, and "2" if the land was held (no selling activity).

11) NPPS: Number of Previous Partial Sales. The number of previous sales made by the present owner. A new observation was taken after each sale.

12) Acreb: The acreage of the parcel before the sale.

13) Specs: Speculative Buyer. Took the value of "1" if the principal occupation of the new owner was off-farm work and he either leased the land or left it idle ("0" otherwise).

The derivation of values for (13) was similar to (7) and (8) above although this information was assumed to be more reliable as in most cases it was more recent. The omitted category again corresponds to farmers who have substantial off-farm work.

14) Dist: A Distance Variable. Actually the lesser of two straight line distances to the center of the major road frontage for each parcel. It was assumed that development pressure in the area could emanate from either the central business district of Manassas or from the Manassas I-66 interchange.

15) CPI: Consumer Price Index for the year of transfer [42].

Appraised values of land and improvements and use-values/market values for selected years were also gathered.

Problems with some of the above variables are apparent. In particular, the values for (4), (7), (8), and (13) may be subject to measurement error. Also, the explicit association of variables (8) and (13) with a distinct speculator class is of concern. People who hold land and lease it to farmers may have other motivations besides land speculation. Similarly, full-time farmers and developers may also be engaging in land speculation. Since the ex ante definition of an exclusive group of land speculators is impossible, the approach taken in this analysis is to identify groups which would be expected to tend towards more speculative activity. Hence, variables (8) and (13) represent individuals more likely to have greater speculative motivations for buying and holding land than the others.

Problems exist with other variables as well. The time on land (TOL) variable has obvious limitations as it can take on a maximum value of only 30. Also, TOL may in fact measure two different and off-setting phenomena. As the time of ownership of a parcel of land increases, it may reasonably be expected that the owner's subjective attachment to the land would increase. Conversely, as the time of ownership increases, the principal owner ages and in some cases could be expected to consider retiring from the land (i.e., be more inclined to sell the land). Thus, TOL may be measuring two opposing forces on the owner's selling decision.

A caveat must be raised for the farm type (FT) variable as well. There is conceivably an interpretational problem associated with this variable which might affect to some extent the testing of hypotheses. One of the principle hypotheses of the model is that a

farmer's selling behavior will be determined to a large extent by his fixed capital investment. FT represents a proxy variable for the more capital intensive dairy farming operations. It should be noted however, that FT may in fact be measuring other factors associated only with dairy farmers other than fixed capital investment.

4.3 Quantitative Technique of Analysis

Discriminant analysis was the multivariate technique selected for the analysis of data. Discriminant analysis allows the researcher to pursue either of two objectives: classification and analysis. Known groups are distinguished by discriminant functions developed from a set of independent variables. As a classification tool, the developed discriminant functions provide a classification criterion which permits the researcher to predict the group membership of new cases or observations. Discriminant analysis has been utilized as a classification tool primarily in various areas of business. The classical use of discriminant analysis in this area is the problem of classififying as either "poor" or "good" the loan repayment likelihoods of various bank loan applicants.

In economics, discriminant analysis has been used primarily as a tool of analysis. The technique allows the researcher to investigate the degree to which different groups may be differentiated and to analyze the importance of different variables in achieving the differentiation. Because the focus of the technique is different when analysis is the primary objective, it may be appropriate to disregard information provided by the "insignificant" discriminant

functions developed by the analytical procedures. This could only
be appropriate however when more than two groups are being analyzed.
As a tool of analysis, discriminant analysis has been used by Ladd
[28] to rank the importance of the objectives of dairy bargaining co-
operatives. Currin [14] utilized discriminant analysis in an inves-
tigation of the relationship among various production efficient mea-
surements and income groups of dairy farmers in Virginia. Gram [21]
used discriminant analysis to inquire into the factors affecting the
desired labor force status of married women teachers. Hallberg [23]
discussed the theoretical and practical limitations of the method and
used it to investigate the factors affecting cooperative members' re-
actions to a proposed merger. In the general area of land-use analy-
sis, discriminant analysis has been used by Kaiser, et al., [27] in
order to investigate the factors determining whether or not a parcel
of land was held or sold within a 10-year period.

Essentially, discriminant analysis attempts to statistically
separate and distinguish two or more groups of observations on the
basis of a set of known characteristics. "The mathemathical objec-
tive of discriminant analysis is to weight and linearly combine the
discriminating variables in some fashion so that the groups are
forced to be as statistically distinct as possible" [33, p. 435].
In the general case of a two group model,[1] let

X_{Ji} = the ith observations value of the Jth independent (dis-
criminating) variable,

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[1]This general mathematical exposition follows closely that of
Morrison [31], p. 156.

b_J = the discriminant coefficient for the Jth variable,

D_i = the ith observation's discriminant score, and

D_{cr} = the critical value for the discriminant score.

The discriminant analysis procedures develop a discriminant score for each observation which is a linear function of the discriminating variables:

$$(1) \quad D_i = b_0 + b_1 X_{1i} + b_2 X_{2i} + \ldots + b_n X_{ni}$$

The observation is classified in group 1 if $D_i > D_{cr}$ and in group 2 if $D_i < D_{cr}$. Hence, the classification boundary is the locus of points where:

$$(2) \quad b_0 + b_1 X_{1i} + b_2 X_{2i} + \ldots + b_n X_{ni} = D_{cr}.$$

When three groups are present in the analysis, the classification boundary is a two-dimensional plane in three-dimensional space.

If it may be assumed that the discriminating variables are distributed in a multivariate normal manner and that the variance-covariance matrices of these variables for each group are equal, the interpretation of the weights (the b_J's in equation 2) is straight forward.[2] These weights provide an estimate of the relative importance of each variable in the value of the discriminant function. The sign on each b_J denotes whether the variable is making a positive or negative contribution to a single group. The "percentage of cases correctly classified" provides an overall indication of the explanatory power of the discriminant function. Thus, for the purposes

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[2] The tests for equality of the variance-covariance matrices derived from the discriminant analyses are presented in Appendix A.

of the present study, discriminant analysis allows for the analysis of the effects of different variables on the selling behavior of different individuals and provides an indication of the relative power of the classification criteria developed.

A well-known statistical problem exists, however, for the indication of the relative power of the classification criteria. If the same data used to develop the discriminant function is then used to verify (test) that same function, a substantial upward bias due to samplying error may exist. Frank, et al., [18] present two tests for estimating the magnitude of this bias. The results of these tests on the data used in the present study are presented in Appendix B.

CHAPTER V

ANALYSIS OF RESULTS: TEST OF HYPOTHESES

This chapter presents the results of the analysis of data and
the implications of the results for the research hypotheses. Sec-
tion 5.1 presents the results of the discriminant analyses. In sec-
tion 5.2, the hypotheses of Chapter I are tested by comparing the re-
sults of the empirical model with the prediction of the theoretical
model. Section 5.3 presents some general implications of the tested
model.

5.1 Analysis of Data: The Results and Interpretation of the Dis-
     criminant Analyses

Two discriminant analyses were performed. The first discrimi-
nant analysis sought to discriminate among the three groups of fringe
landowners; those who made partial sales, those who made no sales,
and those who made complete sales of all of their land. The second
analysis sought to discriminate only among the two groups which en-
gaged in some selling activity.

The first discriminant analysis utilized the complete set of
data (n = 87). The resultant Discriminant Function I was of the
general form:

Comp = f(FT, TOL, LOL, FM, Spec, Acreb, Dist)

where Comp took the value "0" if partial sale occurred, "1" if a complete sale, or "2" if the owner engaged in no selling activity.

Because three groups were involved in the analysis, two pairwise comparisons were necessary and two discriminant functions were derived.[1] The fact that more than one discriminant function was derived served to complicate not only the interpretation of the functions but also presented the problem of deciding how many discriminant functions were necessary to adequately explain the discriminating variance. Since discriminant analysis was to be used for the purpose of analysis and not for further classification however, it was considered appropriate to concentrate only on the significant discriminant functions. The method provided by the SPSS computer program for deciding how many functions were significant utilized changes in Wilks' Lambda and their associated chi-square tests of significance.

The results of the first discriminant analysis are presented in Table V-1. The two standardized discriminant functions are presented. The eigenvalues and their associated canonical correlations denote the relative ability of each function to separate.the groups. Thus, it may be seen that the first discriminant function explains 81.8% of the dispersion present in the data and hence the second function may be ignored; the change in Wilks' Lambda after the information from the first function has been removed is very high (.9296) and

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[1]The following interpretive description of discriminant analysis draws heavily upon that of the Statistical Package for the Social Sciences, [34], pp. 434-444.

Table V-1. Results of Discriminant Function I

Discriminant Function	Eigenvalue	Relative Percentage	Canonical Correlation	Functions Derived	Wilks' Lambda	Chi-Square	D.F.	Significance
1	0.34024	81.79	0.504	0	0.6936	29.633	14	0.009
2	0.07573	18.21	0.265	1	0.9296	5.913	6	0.433

Standardized Discriminant Function Coefficients

Variable	Function 1	Function 2
FM	1.21110	-0.46775
Dist.	-0.43927	-0.04444
FT	-0.40936	0.10815
LOL	0.21938	-0.91918
Spec	0.19305	-1.18707
TOL	-0.09974	0.43373
ACREB	-0.09085	-0.11545

Centroids of Groups in Reduced Space

	Function 1	Function 2
Group 0	0.05628	-0.27144
Group 1	0.92671	0.30964
Group 2	-0.54214	0.22519

Prediction Results

Actual Group	No. of Cases	Predicted Group 0	Group 1	Membership Group 2
0 (parcel sellers)	42	25 (59.5%)	10 (23.8%)	7 (16.7%)
1 (complete sellers)	15	5 (33.3%)	7 (46.7%)	3 (20.0%)
2 (Holders)	30	15 (50.0%)	2 (6.7%)	13 (43.3%)
Totals	87	45	19	23
Percent	100	51.72	21.84	26.44
Prior Probabilities		0.4828	0.1724	0.3448

Percentage of Cases Correctly Classified = 51.72%

insignificant indicating that little discriminating power still
exists in the discriminating variables. (The higher Wilks' Lambda,
the lower the amount of discriminating power.) Thus, the analysis
will proceed utilizing only the first discriminant function.

The interpretation of the derived function and coefficients may
proceed as follows. Having established that only the first discrimi-
nant function is significant, the next step in the analysis is to
determine which groups are being discriminated in the function.
This is done by referring to the "centroids of groups in reduced
space." These centroids represent the average standardized score of
all observations in each group. Comparing the centroids for each
group in the discriminant function gives an indication of the extent
of discrimination among groups. Thus, it can be seen that this one
discriminant function distinguishes very well among the three
groups. The centroid for group 0 is close to zero while that for
group 1 is highly positive and for group 2, highly negative.

The standardized coefficients for the derived discriminant
function provide the heart of the analysis and are of great analyti-
cal importance for the interpretation of the results in light of the
model developed earlier. The standardized coefficients have been
adjusted for measurement scales and variability in the original vari-
ables. Therefore their interpretation is somewhat analogous to the
interpretation of the beta weights in regression analysis. For
example, the coefficients for function 1 indicate the FM (full-time
farm operators) variable is by far the most important being almost
three times as important as Dist (distance), the next most important

variable. Similarly, it may be seen that Acreb is the least import-
ant of the variables. The interpretation of the signs on the coef-
ficients are again similar to regression analysis, indicating a posi-
tive or negative contribution to the value of the function. In this
case, however, reference must be made to the signs of the centroids
for each group in the function in order to determine to which dis-
tinguished group the contribution is made. Thus, for function 1, it
can be seen that if the owner lives on his land (LOL), he is more
likely to be in one of the seller groups.

Table V-1 also provides a measure of the over-all classifica-
tion efficiency for the developed discriminant function. The "Pre-
diction Results" or so-called "confusion matrix" indicates that
51.72% of the observations were placed in their correct group by the
discriminant function. This percentage includes an upward sample
bias, however. An indication of the magnitude of this bias is pre-
sented in Appendix B. The effect of the removal of this bias is to
lower the percentage of cases correctly classified. Nevertheless,
this percentage is still greater than that which would be expected to
result from a chance classification procedure. While this measure of
over-all classification efficiency is less than would be desired, it
is felt that the discriminant function does do an acceptable job of
discriminating among groups and that the parameter estimates de-
veloped are reliable.

The second step in the analysis of data was to estimate a dis-
criminant function based only on sales data. This analysis sought to
investigate if partial seller and complete seller groups could be

distinguished from each other based on a set of discriminating independent variables. A total of 36 observations were available for the analysis; 26 partial sales and 10 complete sales. Because of the small sample size, a different method of inquiring into the magnitude of the sample bias was utilized (see Appendix B).

The general form of Discriminant Function II was:

Comp = f(Dist, FT, FM, DPA, Spec, NPPS, Acreb, Specs)

where Comp took the value of 0 or 1 for a partial or complete sale.

The results of the analysis are presented in Table V-2. The relatively low value for Wilks' Lambda and its associated Chi-square test of significance indicates that a great deal of discriminating power exists in the independent variables. Since only two groups are included in the analysis, only one discriminant function is derived. The standardized coefficients, the prediction results, and the centroids of groups in reduced space are also presented in Table V-2. A total of 91.67% of the cases were correctly classified.

5.2 Tests of Hypotheses

This section discusses the implications of the empirical results for the hypotheses presented in Chapter I. Since all hypotheses are derived from the theoretical model of the land conversion process in the rural-urban fringe, the tests of hypotheses will involve comparing of the predictions of the theoretical model with the results of the empirical analysis. The results of the three-group discriminant analysis of Table V-1 indicate the following:

Table V-2. Results of Discriminant Function II

Discriminant Function	Eigenvalue	Relative Percentage	Canonical Correlation:	Functions Derived	Wilks' Lambda	Chi-Square	D.F.	Significance
1	1.35938	100.00	0.759	0	0.4238	25.752	8	0.001

Standardized Discriminant Function Coefficients

Variable	Function
Specs	0.62931
FM	0.37050
Dist	-0.33974
DPA	-0.20113
NPPS	-0.19431
Acreb	-0.18544
Spec	-0.18397
FT	0.01691

Centroids of Groups in Reduced Space

	Function
Group 0	-0.46416
Group 1	1.20682

Prediction Results

Actual Group	No. of Cases	Predicted Group Membership Group 0	Group 1
0 (parcel sellers)	26	26 (100.00%)	0 (0.0%)
1 (complete sellers)	10	3 (30.0%)	7 (70.0%)
Totals	36	29	7
Percent	100.00	80.56	19.44
Prior Probabilities		0.7222	0.2778

Percentage of Cases Correctly Classified = 91.67%

(1) The coefficient for the highly capitalized dairy farm operations (FT) is large and negative indicating that dairy farmers are likely to fall into the land holding group and engage in little selling activity. This is consistent with the theoretical model and provides evidence that the capital curve (C_2) is more inelastic for the highly capitalized farmer. In Figure V-1, the hypothesized selling behavior of two different types of farming operations are being compared. The more steeply sloped C_2' curve is representative of a more highly capitalized farming operation. The flatter C_2 curve is representative of a less intensive farming operation. Due to the construction of the theoretical model, point i (i') is reached at a point on the horizontal axis relatively closer to the origin for the more highly capitalized farming operation. Hence, the theoretical model predicts and the empirical evidence supports the proposition that the more highly capitalized farmers will engage in fewer parcel-selling activities. Furthermore, the highly capitalized farmer will hold his land longer as he searches for his (higher) complete-farm reservation price.

(2) The sign and magnitude of the coefficient for full-time farm operator (FM) is consistent with the theoretical model. It is highly positive indicating that this group of individuals is highly associated with complete sales. The model suggests that landowners who are strongly attached to the land as in the case of full-time farmers, will have a higher C_2 price-axis intercept thus making partial sales unlikely. Figure V-2 illustrates this point. The higher
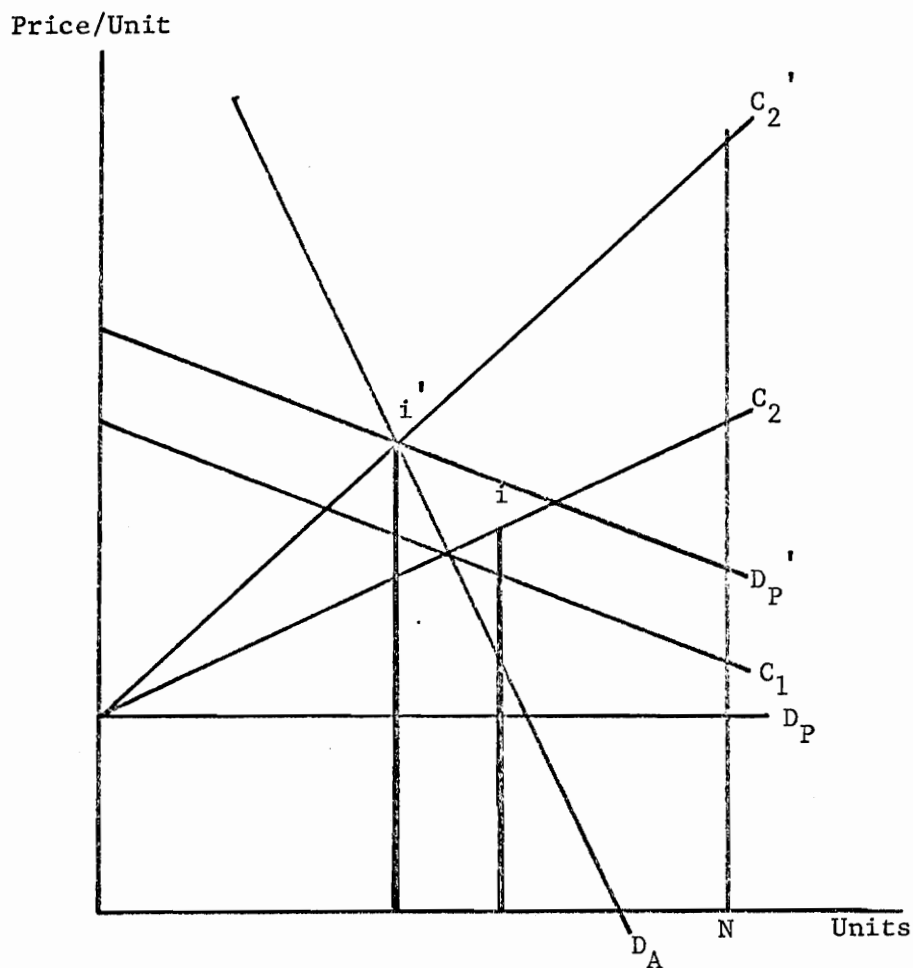
Figure V-1. Effects of Different C_2 Slopes.

Price/Unit
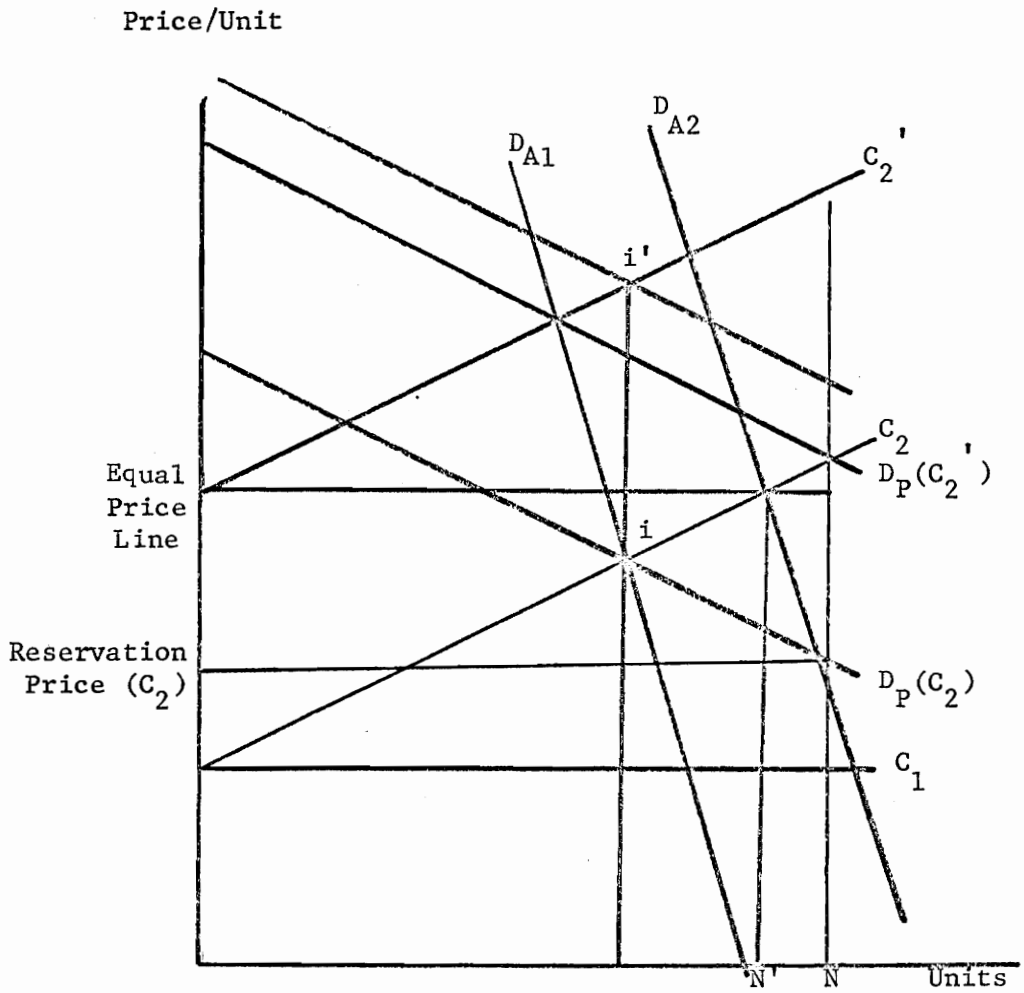
Figure V-2. Effects of Different C_2 Intercepts.

C_2' price-axis intercept for an individual landowner will not only raise his schedule of reservation prices for any partial sale relative to an identical individual with a lower C_2 intercept, it will raise proportionately his perceived demand curve and resultant complete-farm reservation price. The individual possessing the higher C_2 price-axis intercept (C_2') would be willing to engage in partial sales if his higher reservation prices were met. However, because his reservation prices are higher throughout (for both partial and complete sales), it is unlikely that he would be able to engage in partial sales. Given the choice between these two homogeneous tracts of land, urban demanders would choose to purchase land from the individual with the lower C_2 price-axis intercept (C_2), due to lower relative prices, until point N' is reached. N' is beyond point i (i') for the individual with the higher C_2 price-axis intercept, however, so that when this individual is able to begin making partial sales, he is unwilling. He will tend to wait until urban demand is sufficient to meet his whole-farm reservation price and then sell out completely.

(3) The two other independent variables which, from the model, would be expected to shift the C_2 price-axis intercept upward are time on land (TOL) and lives on land (LOL). Only LOL has a positive sign, however. The coefficient for TOL is small and of the opposite sign. This inconsistency is thought to stem from the measurement problems associated with this variable discussed in section 4.2.

(4) The coefficient for the speculative owner of land (Spec) is of the sign consistent with the theoretical model. The fact that

speculators are not associated with the holding group is considered significant and indicates that the speculator's C_2 curve is more elastic. (The specific type of selling behavior engaged in by the speculators will be demonstrated more clearly in the discussion of Discriminant Function II.)

(5) The coefficient for the acreage variable (Acreb) is very small, suggesting that this variable is relatively unimportant in discriminating among the three types of landowners. This variable will become more important below when its effect on the type of selling behavior is demonstrated in the discussion of Discriminant Function II.

(6) The coefficient for the distance variable (Dist) is large and of the sign consistent with the theoretical model. The distance variable represents the only level-of-demand shifter in this model. The empirical results indicate that as distance from the center of development pressure increases, it becomes more likely that the owner of a parcel of land will engage in no selling activity. This is simply a level-of-demand phenomenon and is consistent with the model.

The second step in the two-step discriminant analysis involved estimating a discriminant function investigating only selling behavior in the fringe. Holders of land were omitted. This allows for the inclusion of price information in the discriminant function and presents the opportunity to compare and contrast the selling behavior of different classes of landowners. The results of the second discriminant analysis (Table V-2) are also consistent with the theoretical model and include the following:

(1)   The speculative purchasers of land (Specs) are highly associated with whole farm purchases (see Figure V-3). The model suggests that the entrance of speculators into the market for an individual tract of land has the effect of shifting the demand curve to the right, thus enabling the speculators to meet the reservation price established by the farmer for his entire landholdings.

(2)   Full-time farm operators (FM) are again highly associated with whole-farm sales. FM again acts as a proxy for the hypothesized greater subjective attachment farmers have for the land. Thus, the sign and magnitude of the coefficient is consistent with the model. Full-time farmers will generally have a higher C_2 price-axis intercept and hence engage in fewer parcel sales.[2]

(3)   Increasing distance (Dist) is associated with partial sales. This is consistent with the theoretical model and, again, is simply a level-of-demand phenomenon. Short distances to the center of urban development pressure would be associated with higher levels of demand and hence more complete sales. As distance increases, however, the relative demand for each tract of land decreases to the point where only portions of the farmer's land are demanded.

(4)   The deflated price per acre (DPA) is associated with partial sales. The fact that increasing price per acre is associated with partial sales is considered an important empirical finding with implications for the principal hypothesis of this research (i.e., the dynamic supply-response curve is generally discontinous). If, in

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[2] See the discussion of FM for Discriminant Function I above.
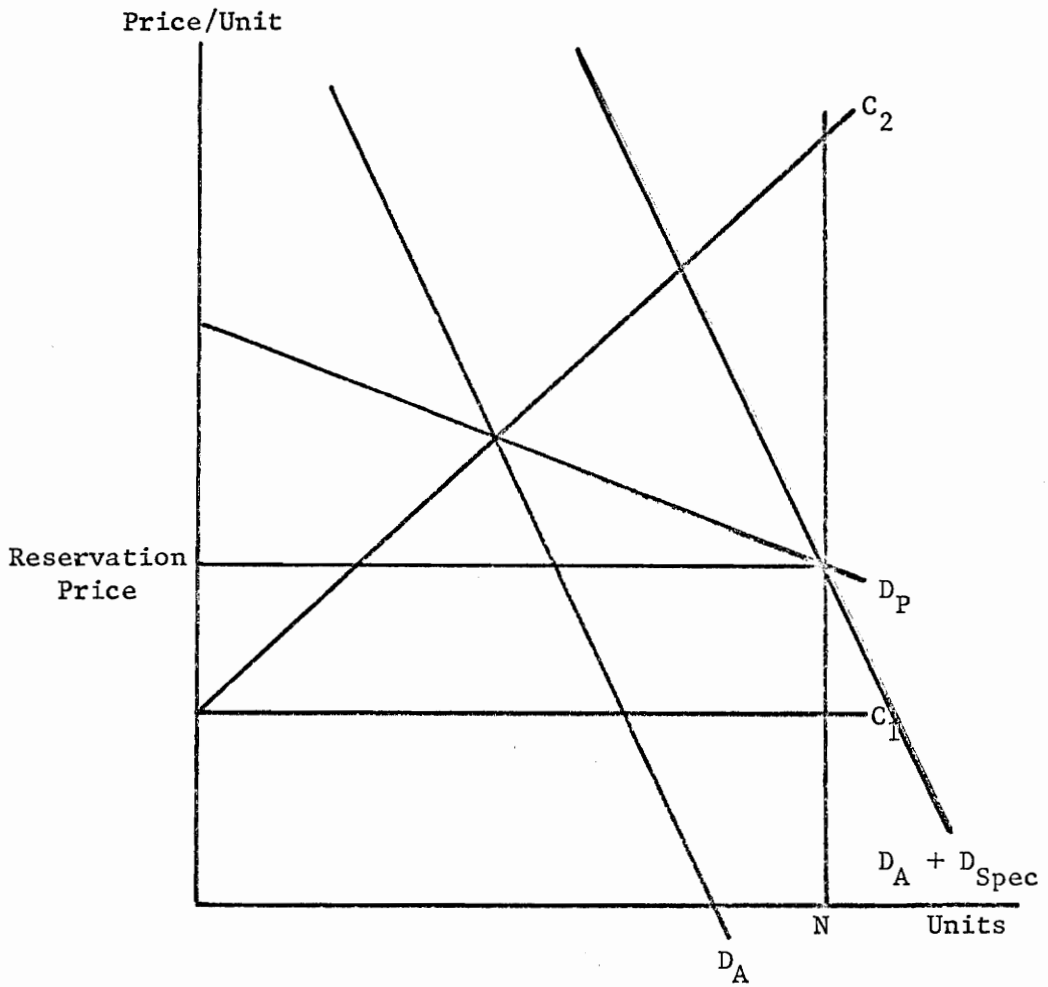
Figure V-3. Effects of Speculators Entering the Market.

fact, this discontinuity did not exist, the expected value for the DPA coefficient would be zero. That is, if smooth, continous supply-response curves adequately described landowner behavior, higher prices per acre would not be associated with either partial or complete sales. The theoretical model clearly demonstrates that, due to the discontinuity of the supply-response curve, prices per acre should generally be higher for partial sales and hence is in agreement with the empirical findings.

(5) The number of previous partial sales (NPPS) is associated with more partial sales. This variable was included in the study to act as a relative pointer along the C_2 curve. The fact that as the number of previous partial sales increases, it is more likely that the next sale will also be a partial sale has important implications for the hypothesized shape of the speculator's C_2 curve discussed in (7) below. Landowners who are predisposed to make partial sales (those who possess more elastic C_2 curves as in the case of speculators) are likely to continue making partial sales. This is also consistent with the theoretical model.

(6) Increasing acreage of the original tract (Acreb) is associated with partial sales. This empirical finding is also consistent with the model and provides further evidence concerning the discontinuous nature of the supply-response curve. Given two land-tract sizes (N and N' in Figure V-4), the smaller land tract, N, is more likely to be held. The level of urban demand has reached point i_N for tract N indicating that this tract would be held while the owner searched for his reservation price. Thus, the demand curve for
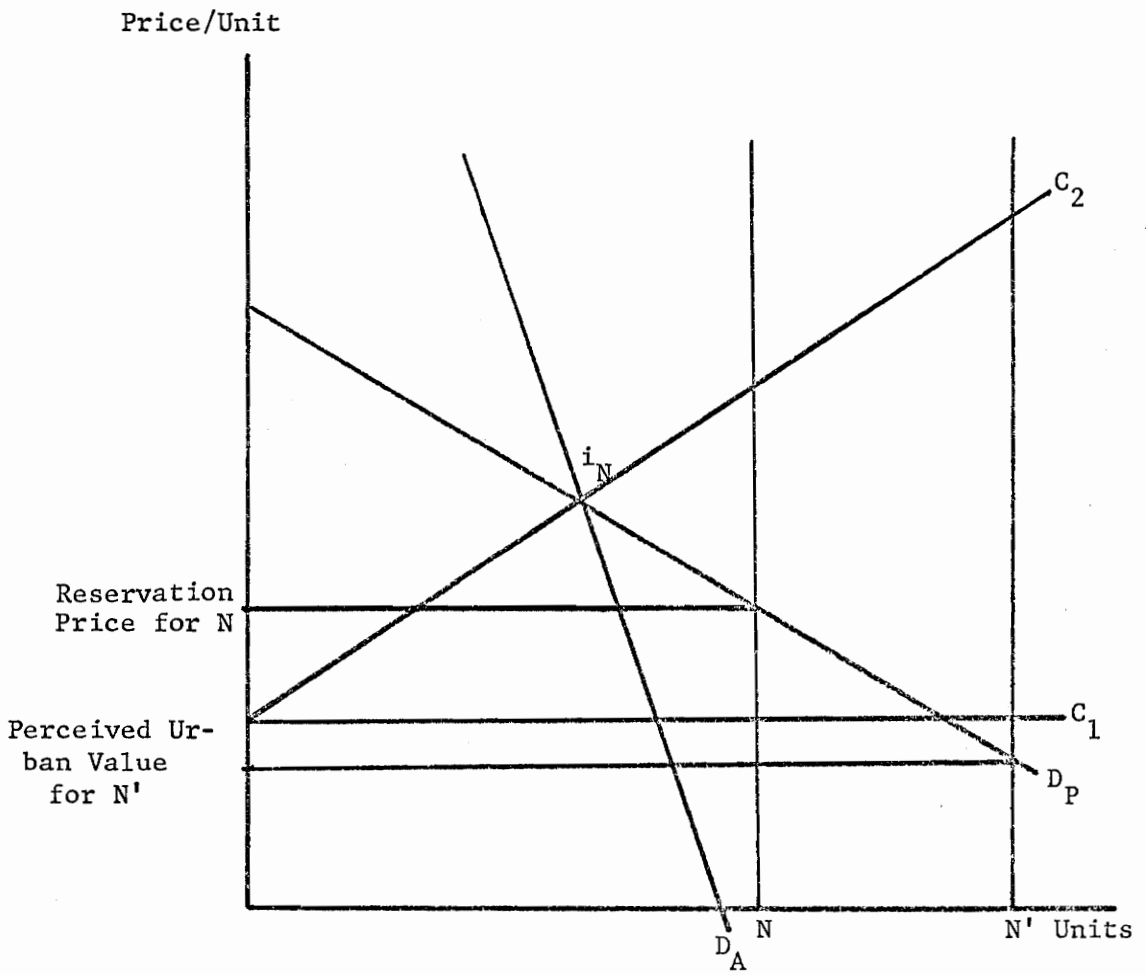
Figure V-4. Effects of Tract Size on Selling Behavior.

tract N will intersect the supply-response curve in the discontinuous region. For the larger parcel N', however, point i has not been reached and the landowner is likely to make the partial sale of q units of land.

(7) Speculators (Spec) are associated with partial sales. This is consistent with the theoretical model as speculators, who by definition have little or no fixed capital investment associated with their landholdings, will have a more elastic C_2 curve and resulting supply-response curve. So elastic will the speculator's C_2 curve be, in fact, that point i will never be reached and the supply-response curve will be continuous. Consequently, as demand shifts out to the right over time, the speculator will continue to make partial sales.

(8) Highly capitalized farms (FT) are associated with whole farm sales. While the coefficient is very small, its sign is consistent with the theoretical model. Since highly capitalized farms would have a steeper (more inelastic) C_2 curve, few partial sales would be made. Sales on such farms will tend to be complete if indeed any sales are made. (See No. 1 under the discussion of Discriminate Function I.) Since most highly capitalized farmers are also full-time farmers, it is very unlikely that these individuals will make other than complete sales.

The above results of the two-step discriminant analysis reinforce each other and lend credence to the theoretical model. The data and statistical problems outlined above and in the appendices notwithstanding, it can be argued that the theoretical model does do an acceptable job of explaining the land conversion process in the

rural-urban fringe. At the very least, it can be argued that the model is supported by the empirical findings. Consequently, it is concluded that the hypotheses listed in Chapter I are also supported by the empirical evidence and that the theoretical model is relevant to land-use policy analysis in the rural-urban fringe.

5.3 General Implications of the Theoretical Model

Given that the hypotheses have been supported by the empirical findings and that the model is relevant to land-use policy analysis in the rural-urban fringe, this section will explore, reiterate, and expand upon some of the general implications which follow from the theoretical model.

First of all, consider the importance of the relative location of point i when hypothesizing the type of selling behavior in which an individual landowner will engage. In Figure V-1, two different types of farms were compared. The more inelastic C_2 curve (C_2') corresponds to the highly capitalized farm. The elastic C_2 curve (C_2) corresponds to the less intensive farm. Due to the construction of the theoretical model, point i (i') is reached farther to the left for the highly capitalized farm. Consequently, highly capitalized farms should make relatively fewer parcel sales and more complete sales than the less intensive operations. Speculators, because of their even more elastic C_2 curves, will tend to make parcel sales only. Because little or no fixed capital is associated with the fixed land resources of speculators, point i is never reached and their supply-response curves will tend to be elastic and continuous.

The implication of the model for land transactions in the fringe is clear. Fringe areas near growing cities which are dominated by highly capitalized farms should be subject to more "outsider" speculative activity. That is, because speculators are more likely to purchase whole farms, they can be expected to gain ownership control of these landholdings as the highly capitalized farmers make complete sales. These speculators would more likely be absentee "land investors" and their buying and selling activities would be affected more by investment possibilities in other sectors of the economy. The fringe areas around growing cities dominated by less intensive farm operations would witness a more gradual conversion with the "original" landowners retaining ownership control over most of their landholdings. As time passes, these less intensive farmers would phase out their farming operations in favor of more overt speculative activities. The buying and selling activities of these "home grown" speculators would be more dependent upon conditions in the local economy.

Another implication of the model involves the apparent land-use pattern observable in the fringe near any growing city. That is, as one approaches the city, one encounters fewer highly capitalized farms (e.g., dairy farms) and more less intensive farm operations (e.g., small-scale beef-cattle operations). The highly capitalized farms one does encounter are generally in various stages of disrepair. The model suggests one reason for the occurance of this phenomenon, that being that owners are seeking to increase selling flexibility by decreasing the C_2 cost.

As demand increases over time and the possibility of some type of land sale increases, there is pressure to reduce the C_2 cost which would be incurred through any parcel sale. Because of the more elastic (overly optimistic) perceived demand curve, this pressure is all the more intense. Farmers are beginning to anticipate land sales and, in reaction to this perceived pressure, seek to prepare for them by minimizing costs that result from such sales. Farmers can do virtually nothing about the C_1 cost (VMP of land and attached improvement in agriculture). The C_2 cost can be reduced however. But because capital equipment, machinery, and buildings in agriculture are generally "lumpy" in nature, the reduction in the C_2 cost can be accomplished only through depreciating the C_2 capital expense or by going out of the more highly capitalized operation in favor of a less intensive operation. Both methods would shift the C_2 curve downward and reduce the C_2 cost incurred from any parcel sale and both provide one explanation for the apparent land-use pattern in the rural-urban fringe.

It should be pointed out that the land-use pattern around a growing city described by the model is exactly the reverse of that suggested by Von Thunen [Hall, 22]. Von Thunen argued that economic rent was the primary determinant of land-use around a city. Because highly intensive agricultural enterprises could extract more rent, these enterprises would tend to out-bid less intensive enterprises and thus control the lands immediately surrounding the city. Due to the costs incurred in transporting the agricultural products to the market place however, the economic rent for each type of enterprise

would have a spacial dimension with rent declining as the distance
to the market place increased. Because different products have dif-
ferent transportation costs, the highly intensive enterprises would
control the land only out to the point where the rent minus the
transportation cost was equal to the rent from another type of enter-
prise minus its transportation cost. The result of Von Thunen's
model is a land-use pattern composed of farms of decreasing intensi-
ty as one moves farther from the city. This pattern of land-use is
exactly the reverse of the pattern that is generally encountered
around cities today and the pattern described by the theoretical
model of the present study.

This paradox of land-use patterns around cities has already
been alluded to in the literature review. It was pointed out in
section 2.2 that previous studies have demonstrated that although
intensive farming enterprises are more profitable near the city, they
are nevertheless being replaced by less intensive and less profitable
farming enterprises. At least one author [Sinclair, 40] has pre-
sented an alternative theory of location to explain this paradox.

Sinclair notes that Von Thunen's model concerns a static city.
Von Thunen could not have foreseen the dynamic consequences of urban
expansion on land-use patterns in the fringe. Sinclair bases his
model on the consequences of a rising "air of anticipation" that
landowners near the city possess concerning the future development
potential of their land. He argues:

> As the urbanized area is approached from a distance,
> the degree of anticipation of urbanization increases.
> As this happens, the ratio of urban to rural land

values increases. Hence, although the absolute
value of the land increases, the relative value
for agricultural utilization decreases. Conse-
quently, the capital and labor investment in agri-
culture...decreases. The result of this process
is a basic agricultural land-use pattern which is
the reverse of that found in Von Thunen's time [p.
78].

Agricultural land-use zones become increasingly less intensive as the

city is approached because the land's "value for agriculture" de-

creases at different rates for different intensity levels of agricul-

tural investment. Intensive types of agriculture "pay off in greater

returns at a distance from the city."

Despite the vagueness present in much of the description of his

model, Sinclair's basic arguments are in agreement with those of the

theoretical model of the present study. Anticipation, the intensity

of agriculture, and distance are certainly related to land-use in the

fringe. However, Sinclair does not explain to a satisfactory degree

the linkages of these three determinants of land-use in the fringe

nor does he include in his model many other factors which may affect

land use. Finally, Sinclair's model does not provide a framework

for analyzing the effects of change on his proposed land-use pat-

tern. For example, his model cannot be used to investigate the con-

sequences for land-use patterns in fringe areas of changes in farm-

ers' output production functions (i.e., shifts in C_1 and C_2),

changes in "anticipation" (i.e., shifts in the demand curves), or

the effects of different land-use policies. Thus, in many respects,

Sinclair's model is as "static" as is Von Thunen's.

Another implication of the model points out one of the services speculators provide farmers and society in the rural-urban fringe. The effect of the entrance of speculators into the land market for an individual farm has the effect of shifting the demand curve to the right. Hence, speculators are able to meet the complete-farm reservation price of the farmer. This has efficiency implications for the farmer and society in general. For the farmer, this means that he does not have to wait as long to make his final sale. He gets out faster and doesn't have to disinvest as much as he searches for his reservation price. For society, it means that speculators tend to remove at one time all land, labor, capital, and managerial ability. This would generally be considered to be a more efficient manner of removing inputs from agriculture.[3]

Still another implication of the model is that some of the land-use problems of the rural-urban fringe are perhaps more costly to society than previously presumed. For example, the problem of losing prime agricultural land may involve more than the loss of a few highly productive acres to urban uses. The model suggests that the highly productive lands near these converted acres will also be affected; not only through the increased partial selling activities of owners of adjacent lands, but also through pressure to alter the production

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[3]While land, labor, managerial ability and most capital inputs would be free to seek their opportunity cost elsewhere as a result of the purchasing activities of speculators, the productive services of a portion of the C_1 cost (attached improvements) might represent a social cost. This is a normative issue however and is beyond the scope of this research.

functions of neighboring farms. Sales of land into urban uses affect the actual and perceived demand curves of neighboring farmers and induce owners of these farms to prepare for possible future sales. Thus, the owners of nearby farms may be induced to disinvest, or to go out of their highly capitalized farming operations in favor of a less intensive operation. The result is that these nearby highly productive lands may be used in less productive uses and the costs to society may be proportionately higher. Thus, some of the problems which confront society in fringe areas may be more insidious and certainly more complicated than previously thought.

A final general implication of the model which should be mentioned involves the vast amounts of information which will be required if future land-use patterns and the effects of policies on these patterns are to be predicted. The model suggests that supply-response information is as important as future demand information. Not only will information on the physical and geographical properties of specific parcels of land be required, but also a great deal of information on owners in the rural-urban fringe. But the model suggests more than this. The model suggests that in order to predict future land-use patterns in a specific rural-urban fringe, the information about specific parcels of land and their owners will have to be tied together. Only then will selling behavior in a particular fringe be predictable. This has obvious implications for the use of census or other aggregate data for purposes of predicting future trends in land use in a particular fringe area.

While the above implications are of interest, they are somewhat incidental to the main purpose of this research. The principal objective of this research was to develop a theoretical model of the land conversion process which could be utilized as a tool in land-use policy analysis. In the next chapter, the use of the theoretical model will be demonstrated by examining a very common policy prescription for the problems of the rural-urban fringe.

CHAPTER VI

IMPLICATIONS OF THE MODEL FOR VIRGINIA'S
USE-VALUE ASSESSMENT PROGRAM

This chapter discusses Virginia's use-value assessment program
in light of the theoretical model. Section 6.1 briefly describes
Virginia's use-value assessment program and mentions some of the
criticisms directed towards it. Section 6.2 presents a brief re-
view of the use-value literature. Chapter VI concludes with a dis-
cussion of the implications of the model for Virginia's use-value
assessment program in section 6.3.

6.1 Virginia's Use-Value Assessment Program

Use-value taxation plans may be generally described as taxation
plans which allow the landowner in a specific geographical area to
have his land assessed at a lower "use-value" rather than at the
"market value" if his land meets certain minimum requirements. Pro-
vision for a "roll-back" tax are generally included to recapture
some of the deferred taxes and become operative if the landowner
sells all or a portion of his land into a non-qualifying use. Such
a tax may or may not be equal to the proportional sum of deferred
taxes plus interest.

Virginia's use-value assessment program results from the Gener-
al Assembly's stated policy declaration that:

> (it is) in the public interest a) to encourage the
> preservation and proper use of such real estate in
> order to assure a readily available source of agri-
> cultural, horticultural, and forest products, and
> of open space within reach of concentrations of
> population...and b) to promote a balanced economy
> and ameliorate pressures which force the conver-
> sion of such real estate to more intensive uses
> and which are attributable in part to the assess-
> ment of such real estate at values incompatible
> with its use and preservation for agricultural,
> horticultural, forest or open space purposes [41,
> p. 3].

The program enacted by the state legislature defines four special

classifications of land which may, at local option, be assessed at

their lower use-values. Minimum entrance criteria for each class of

land and provisions for a "roll-back" tax are also established by

legislation.

Since its inception, Virginia's use-value assessment program

has come under increasing criticism from private individuals and pub-

lic officials throughout the state. Such criticims include:

(1) the administrative difficulties created by the program.

(It is argued that the program which requires that double

assessment entries (use and market) be made and maintain-

ed is too costly in terms of the manpower available to

tax assessment offices),

(2) the argument that the tax burden is shifted unfairly to

urban owners of land who do not benefit proportionately

from the program,

(3) the revenue problems faced in many counties as a result

of the shrinking assessed tax base,

(4) the charge that the program serves to subsidize specu-
lative activity and, therefore, raise land prices, and

(5) the program is ineffective because it does not keep
land in agriculture.

This chapter will treat specifically only criticisms (4) and (5).
More generally, this chapter will attempt to evalute the effective-
ness of the program in Prince William County with respect to the
stated goals of the General Assembly. First, however, a brief re-
view of some relevant use-value assessment literature will be under-
taken.

6.2 Use-Value Assessment Literature

A great deal has been written about use-value assessment pro-
grams around the country. Nevertheless, in spite of the obvious
relevancy of supply-response behavior to use-value programs, the dis-
cussion of this important determinant of land conversion has been
very limited.

Schmid [39] seems to imply that the supply-response curve of
agricultural land for development is very inelastic at some reserva-
tion price. He states that the effect of preferential tax assessment
on fringe land "could be expected to increase the asking prices of
fringe land and to increase landowner gains" [p. 45]. Gloudemans
[19] also seems to imply the supply-response curve is extremely in-
elastic when he notes that "because of the elasticities of the de-
mand and supply curves involved, the speculator is likely to

maintain his profit margin by paying the farmer less for his land and passing part of the cost on to the developer or homebuyer" [p. 42].

While the above authors do make obtuse reference to the supply-response curve, more generally, authors simply ignore discussing specifically the effects of use-value assessment programs on the supply-response curve. Instead, authors base their analysis of such programs on the results of empirical studies. (See for example, Hansen and Schwartz [24], Dopson [16], Conklin and Bryant [10], and Conklin and Lesher, [11].) But while the subject of supply-response has generally been ignored in the use-value literature, other interesting and relevant findings have evolved.

Pasour [35, 37] and Hushak [25] have shown that property taxes are capitalized into agricultural and residential property values. Conklin and Lesher [11] and Epp [17] argue that use-value assessments may be helpful in preventing premature and excessive disinvestment in the agriculture of a fringe area. Conklin and Lesher also take notice of the fact that the usefulness of the remaining farm decreases after the sale of a parcel. This reduction is attributable to reduced farm scale and external effects and is supported indirectly by Hansen and Schwartz [24] and Gloudemans [19]. Gloudemans also demonstrates the different effects of use-value assessment programs on three different types of farmers. Gloudemans' farmers are differentiated only with respect to distance, however. The effect on the type of farm enterprise is not

demonstrated. The next section will show the effects of such differentiation based on the theoretical model.

6.3 Implications of the Model for Virginia's Use-Value Assessment Program

The purpose of this section will be to evalute Virginia's use-value assessment program in light of the theoretical model. Specifically, this section will inquire into the likelihood that the use-value assessment program can achieve the stated goals of the Virginia legislature with respect to land-use settlement patterns in the rural-urban fringe.

The specific consequence of the program for an individual participant (assuming the effective land property tax does indeed fall) will be an upward shift in the C_1 curve and a consequent rise in the C_2 price-axis intercept. Net returns and hence the use (agricultural, horticultural, etc.) value of the land will rise.

The first implication of the model concerns who will participate in the program. Since participation is voluntary assuming minimum entrance requirements are met, the individual (who is a farmer in this case) has to make a positive decision to enter the program.[1]

Consider the situation of the hypothetical farmer described in Figure VI-1. The relative level of non-agricultural demand for his property has reached point i. He is indifferent between selling parcel q_1 for P_1 and holding on to q_1 to sell with his remaining acreage

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[1]The participant may also have to pay an entrance fee (i.e., $10.00 in Prince William County).

Price/Unit
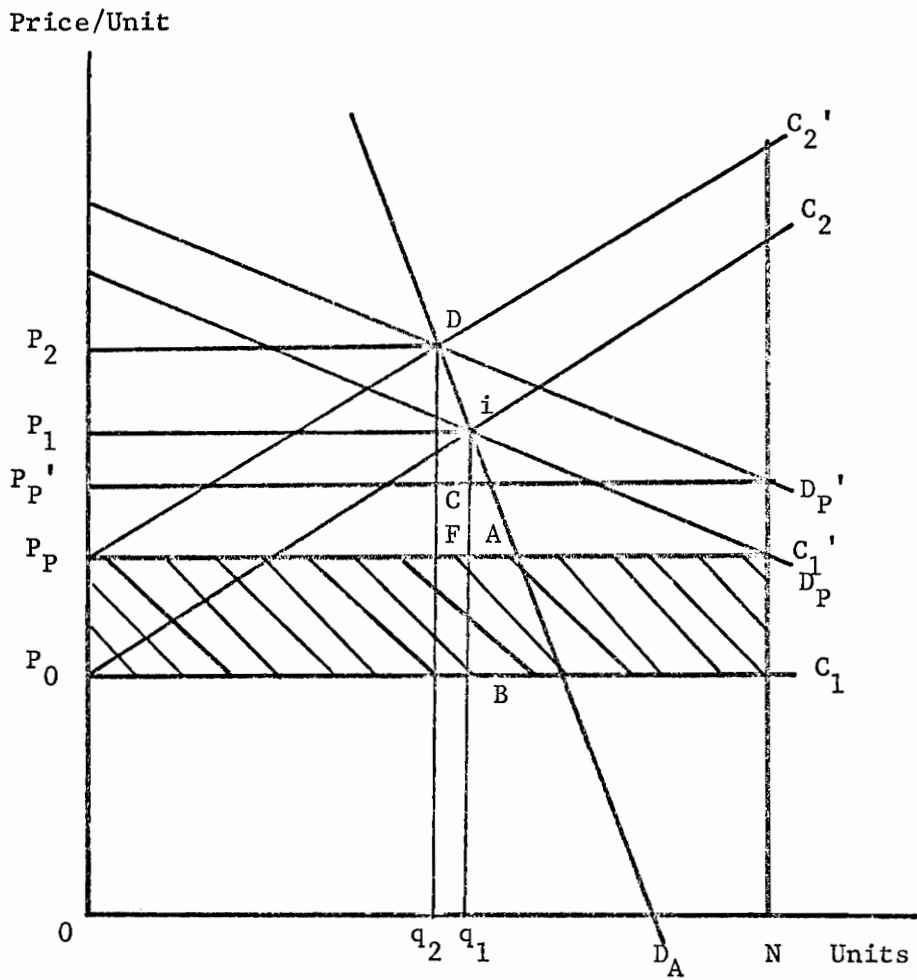
Figure VI-1. Returns to the Farmer at Point I When He Stays Out of the Program.

at price P_p. Now assume that a use-value assessment program becomes
available to him. Provisions of the program would reduce his proper-
ty taxes and raise the agricultural value of his land (C_1) to C_1'
(exactly equal to his perceived nonagricultural value of his entire
farm in this example). Provisions of the program also include a
"fair" roll-back tax. If, for example, the farmer would enter the
program and then sell-off parcel q_1, he would pay tax and interest
penalties equal to $P_p ABP_0$.

The farmer must make the decision either to enter the program
or stay out. It is assumed that the farmer wishes to make the deci-
sion on the basis of which option would provide greater returns. If
the farmer stays out of the program, his perceived net returns will
be equal to $P_0 P_p C_1' C_1$ (the shaded rectangle in Figure VI-1). These
perceived net returns will be his whether he sells parcel q_1 or not.

If the farmer enters the program, the agricultural value of
his farm (C_1) will shift up to C_1' equal to the previously perceived
value of his farm in nonagricultural uses. C_2 will also shift up to
the new price-axis intercept P_p, raising the perceived nonagricul-
tural value of his farm proportionately to P_p'. The result of the up-
ward shifts in C_1 and C_2 causes the new intersection of C_2', D_A and
D_p' to occur at point D closer to the origin along the quantity axis.
Hence, as a result of entering into the program, the farmer is no
longer at point i, but rather at a point at which he would favorably

consider further parcel-selling activities (parcel q_2 for P_2).[2] If

the farmer enters the program, his perceived net returns would be

equal to the shaded area EC D_p' C_1 for the parcel q_2N in Figure VI-

2. For parcel Oq_2, which the farmer would sell for P_2, however, he

would obtain perceived net returns equal to only the shaded area

GHDC. When the farmer sells Oq_2, he would receive net revenues

equal to $OP_2Dq_2 - (C_1 + C_2 + C_3 + \text{roll-back tax (equal to } P_oP_p \text{ FE}))$.[3]

Hence, the farmer's decision to enter the program depends upon which

shaded area of net returns is larger, the area shaded in VI-1 or VI-

2. In this case, the net perceived returns are greater if the farm-

er stays out of the program. This will be the case at point i when-

ever the increase in C_1 due to the program is less than or equal to

the perceived value of the entire farm before the program. If the

C_1 curve is shifted upward to the point where the agricultural value

of the entire farm is greater than the perceived value of the farm

in nonagricultural uses, then the farmer would enter the program.

It is unlikely that the tax relief from such programs now in

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[2]Such parcel-selling activities are actually encouraged by the
Virginia law dealing with use-value assessments. Section 13 states
that such "separation or split-off of lots, pieces or parcels of land
from real estate (currently in the program)...shall not impair the
right of each subdivided parcel...to qualify for (the program)...in
any and all future years, (provided it continues to meet the minimum
requirements)." Section 13 states further that the "remaining real
estate" (the remaining acreage of the original landowner) will also
be allowed to remain in the program provided it continues to meet
the minimum requirements [41, pp. 9-10].

[3]$C_1 = OP_oEq_2$, $C_2 = P_pDF = P_pP_2D$, and $C_3 = P_pP_p'CF$.

Price/Unit
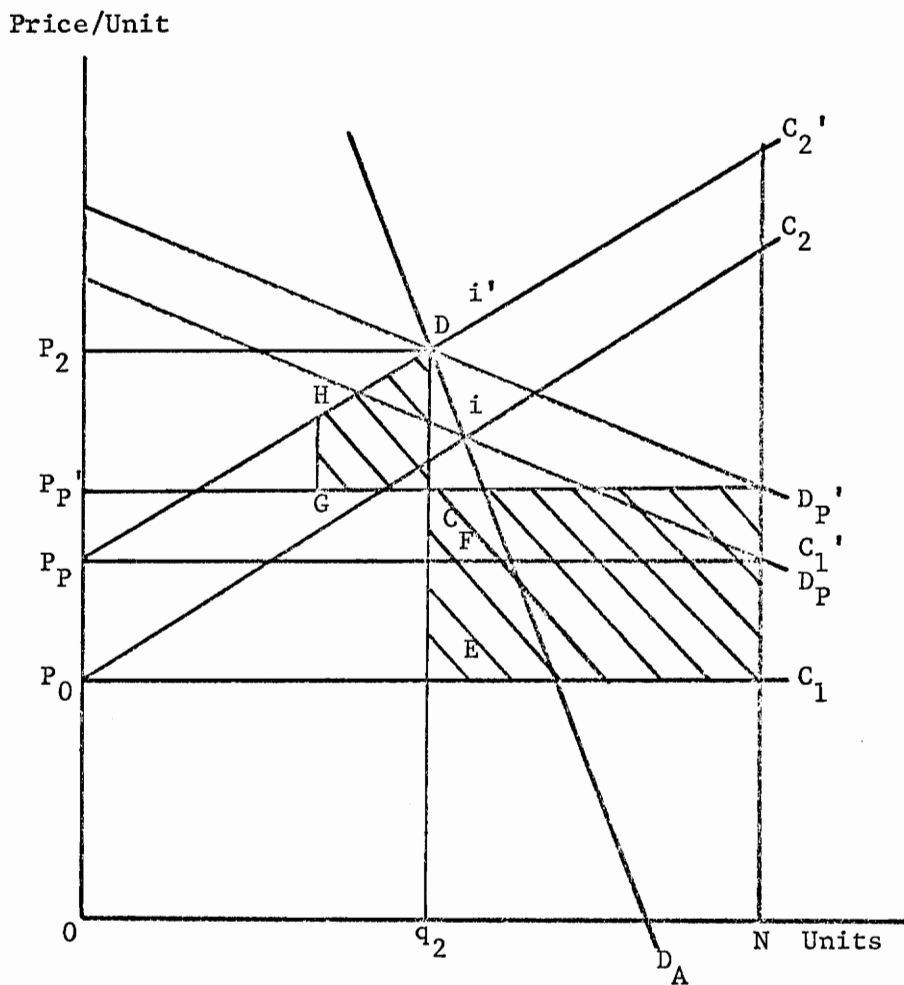
Figure VI-2. Returns to the Farmer at Point I When He
Enters the Program.

existence would be sufficient to raise C_1 to that level for farmers at point i, however.

Another complication in the behavior of farmers towards the program exists at point i. This complication concerns the relative magnitude of the roll-back tax. If this tax penalty plus interest is "unfair" (i.e., smaller than the increase in C_1 for any given parcel), then farmers may participate in the program at point i even if the increase in C_1 is less than the perceived value of the entire farm. If the size of the roll-back tax is grossly unfair (the deferred tax plus interest is much smaller than the increase in C_1), there would be incentives for the farmers to enroll in the program even beyond point i.[4]

The above notwithstanding, generally it will be the case that point i will serve as a cut-off point for who will enter and who will stay out of the program. Landowners facing relative demand curves to the left of point i will enter the program. Landowners under heavy demand pressure (relative demand curves intersect C_2 to the right of point i) will stay out of the program. Hence, the relative position of point i is again critical and this critical point allows further implications to be made concerning Virginia's use-value assessment program.

Since farmers will generally participate in the program only up to point i, Virginia's use-value assessment program will not reach

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[4]If an individual's land is appreciating at a rate higher than the interest penalty (6% in Virginia), the roll-back tax will be proportionately more "unfair."

many of the closer-in farmers who are under heavy urban demand pressure. The relative level of demand is an important determinant of program participation. The theoretical model suggests that rates of participation will vary directly with the distance from the city proper. Hence, many of the landowners for whom the program was designed will not enroll.

Farmer program participation rates will also be affected by the type of farm operation. Since the relative location of point i is dependent upon the slope of the C_2 curve, farmers with less capital intensive operations will be more inclined to participate in the program, ceteris paribus. And because the speculator's C_2 curve is the most elastic (point i is never reached), speculators will tend to participate heavily in the program if they can meet the minimum entrance requirements. Thus it can be seen that theoretically at least, criticism number (4) in section 6.1 is justifiable.

The model also indicates that owners with greater subjective attachments to the land (e.g., a higher C_2 price-axis intercept) will tend to participate heavily in the program. Also, large landholding, ceteris paribus, will more likely be enrolled in the program than smaller landholdings.

Although enrollment into the program will have little effect on the basic selling behavior of the landowner involved (i.e., the slope of the C_2 curve and consequent supply-response curve will not be affected), it will tend to raise asking prices (i.e., shift the supply-response curve upward and to the left). The program will provide only very short-term incentives to refrain from disinvestment due to

the inelastic nature of the actual demand curve. The $D_A - C_2'$ inter-
cept is shifted only slightly to the left of the new point i (i' in
Figure VI-2). Similarly, provisions for the roll-back tax will have
only a very marginal effect on selling behavior. The relative magni-
tude of the roll-back tax will affect program participation rates
and resultant selling behavior only for individuals approaching point
i. Thus, Virginia's use-value assessment program is very unlikely to
produce the desired results of the state legislature (see above, sec.
6.1). While the program will shift supply-response to the left, it
will affect actual and perceived demand only marginally through in-
creased holding costs (higher taxes) for urban consumers of land.

The major policy implications of the theoretical model for use-
value assessment programs lies in the recognition of the limitations
of such programs. Use-value assessment programs will not generally
"save" agricultural operations under heavy nonagricultural demand
pressure. Participation rates in such programs will be affected by
such variables as the type of farm operation, size of landholding,
individual psychic costs, distance from the city proper, the relative
magnitude of the roll-back tax and the amount of actual tax relief.
Problems with speculators' participation in such programs will con-
tinue; the associated land-use controls such as large lot zoning
often associated with agricultural district zones notwithstanding.
Such zoning ordinances will only affect the selling behavior of the
more highly capitalized farming operations. The behavioral response
of landowners with more elastic C_2 curves (lower intensive farming
operations, speculators, etc.) will be largely unaffected.

A final policy implication of the model suggests that, contrary to conventional beliefs, use-value assessment programs may be more successful in achieving their stated goals if they are undertaken in areas on the outlying edge of the rural-urban fringe. In such areas where little urban demand is present, the affect of such a program would cause little or no increase in C_1 for the large numbers of farmers in this area. However, by raising taxes on future prospective urban demanders, the program would discourage them from locating in the area. Thus, the affect of such a program farther out in the fringe would be primarily on the demand side, limiting the growth of actual and perceived demand.

CHAPTER VII

SUMMARY AND CONCLUSIONS

This chapter summarizes the research and presents the major conclusions of the study. Section 7.1 presents the summary and conclusions. Chapter VII concludes with a discussion of the limitations of the study and suggestions for further research in section 7.2.

7.1 Summary and Conclusions

The research problem investigated in this dissertation concerns the role of landowner supply-response behavior in the land conversion process of the rural-urban fringe. It is argued that previous studies have failed to adequately treat this important determinant of land conversion. In spite of the obvious relevance of supply-response behavior to many land-use problems in the rural-urban fringe, these studies have generally either assumed "typical" supply-response curves at the aggregate level which are inconsistent with observed selling behavior in the fringe and which encounter serious theoretical difficulties, or have ignored supply-response entirely. In either case, it is argued, land-use policy analysis has been effectively hampered. The evaluation of the land-use alternatives currently being considered and implemented by the various levels of government requires the use of an analytical tool capable of

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describing the role of supply-response behavior in the dynamic process of land conversion in the rural-urban fringe.

The literature demonstrates that (1) the rural-urban fringe encompasses a large area from which many complex land-use problems have emerged to challenge society and that (2) the actions of governments have served to complicate and enlarge the problems of the fringe thus underscoring the importance of understanding the land conversion process in this area. Particular attention is paid to the inadequacies of previous studies in dealing conceptually with the supply-response curve of agricultural land for urban uses. It is argued that these studies have ignored the fundamental proprietary supply unit which determines to a large extent land use in the rural-urban fringe.

A theoretical model of the land conversion process which is based on this fundamental unit is developed. The disaggregated micro approach of the model is justified because of the practical inconsistencies and theoretical problems generally encountered whenever the aggregate land market approach to land-use policy analysis is used. It is argued that the land market in the fringe is unique and that this uniqueness does not normally allow for the aggregation of individual supply-response behavior in the land markets into a single land market in the rural-urban fringe. The theoretical model developed is composed of three cost (agricultural rent, fixed capital and opportunity cost) and two demand components (actual and perceived demand). The interaction of these components results in a dynamic supply-response curve of agricultural land for urban uses

which is discontinuous over a wide range for many landowners in the rural-urban fringe.

To test the theoretical model, data were gathered from a study area and analyzed using discriminant analysis. The study area was comprised of a portion of Prince William County, Virginia. This area has been traditionally an agricultural area although it has been under heavy urban development pressure for many years. Data was gathered on the land transactions which have occurred in the area since 1954. The data included information on landowners over time, the physical characteristics of the tracts of land, transfer information, and demand variables. The discriminant analysis procedures allowed for the analysis of the effects of these different variables of the selling behavior of the individuals involved.

The results of the analysis lend support to the hypotheses incorporated into the theoretical model. Specifically, empirical evidence is found to support the hypothesis that individual farmers' supply-response curves of land for urban uses are generally discontinuous. Evidence is also found which supports the hypothesis that the farmers' fixed capital investment is a primary cause of this discontinuity. Evidence indicates that farmers with less fixed capital investment (less intensive farm enterprises) generally have more elastic and less discontinuous supply-response curves. Similarly, evidence is found which indicates that speculators, who by definition have little or no fixed capital investment associated with their land resources, have highly elastic and continuous supply-response curves.

Since the theory is supported by empirical evidence, many inferences and implications concerning land use in the fringe can be drawn. The theoretical model indicates that different types of supply-response behavior will be expected to give rise to different land-use patterns for agricultural uses. For example, highly capitalized farmers should make fewer parcel sales and more complete sales than less intensive farmers. Speculators will tend to make whole farm purchases and sell-off their land little by little as increases in demand permit. The land-use pattern described by the model is the reverse of that suggested by Von Thunen. The land-use pattern which results from the dynamic process of land conversion in the fringe area is one which exhibits decreasing intensity as distance to the city decreases.

The primary advantage of the theoretical model is that its conceptual development is sufficiently general to allow for the evaluation of many different policies and factors on land use in the fringe. The model is used to evaluate the effectiveness of Virginia's use-value assessment program. It is found that such a policy will have little effect on the basic selling behavior of the owners of qualifying land. The program will not "save" agriculture under heavy development pressure but will raise land prices and subsidize speculative activities. The model can also serve as an important contribution to the understanding of how other factors and policies (i.e., energy policy, water policy, pest management programs) might affect land-use patterns in the rural-urban fringe.

7.2 Limitations of the Study and Suggestions for Further Research

While the empirical evidence presented in the research is supportive of the developed theoretical model, a more rigorous and definitive test of the model would be desirable. Such a test would incorporate continuous measures for many of the qualitative variables used in the present study. For example, the use of the 0-1 "dummy" variable FT as a measure of intensiveness could be improved upon by using a continuous measure such as gross sales per acre or an estimate of the value of each farmer's machinery, buildings and equipment. Similarly, the full-time farmer (FM) 0-1 variable could be improved upon by using a measure of off-farm income or an estimate of the number of days worked off the farm. The use and interaction of such different "dummy" proxy variables for the various components of the model has the effect of reducing the measured variation in the empirical model. This reduced variation is thought to be the major cause of the low level of significance in the first discriminant model. The use of continuous variables could be expected to increase the variability of the data and the amount of discriminating variance in the sample.

Other improvements could be made in the empirical model. A larger sample size, particularly for the second discriminant analysis, would be desirable. It would be of interest to test the model in a lower urban demand area and/or analyze the selling behavior in an area with a different agricultural output mix by analyzing data from areas with different quality soils and production potentials.

The effects of shifts in the C_1 curve, which is controlled for in the present study, could then be studied.

The rigor of the empirical test of the model could also be improved by utilizing different statistical techniques. The theoretical model suggests that the parameters for aggregate supply-response and demand curves could be estimated simultaneously for the small continuous regions of the micro supply-response curves. Because the model suggests that speculators' supply-response curves are continuous throughout, it should be possible to estimate the parameters of the entire aggregate supply-response curve for this group of landowners if a distinct group of speculators can be empirically isolated for an area.

The theoretical model may also be extended and clarified. Explicit consideration of risk and uncertainty effects is not included in the behavioral model. That these factors have considerable effects on the selling behavior of individuals given the nature of the land conversion process in the rural-urban fringe is intuitively clear. The role of land speculation and its effect on landowner risk and uncertainty should be addressed. Also, the normative implications of the model should be assessed.

The general implications of the model discussed in Chapter V should also be subjects for further research and analysis. Many of these implications offer testable hypotheses which relate directly to the validity and applicability of the model to land-use policy analysis. And finally, the model should be extended to the analysis of other agricultural and land-use policy prescriptions which have

been suggested as possible solutions to the complex problems encoun-
tered in the rural-urban fringe.

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APPENDIX A

VARIANCE-COVARIANCE MATRICES DEVELOPED
FROM THE STUDY AND TESTS FOR EQUALITY
OF VARIANCE-COVARIANCE MATRICES

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VARIANCE-COVARIANCE MATRICES DEVELOPED
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A critical assumption of linear discriminant analysis is that

the individual variance-covariance matrices of discriminating vari-

ables among groups may be considered to be equal. This assumption

is necessary in order to assure that the differences in the mean

values of the variables are significantly different from one another

and that this difference is not due to merely differences in vari-

ance. The failure to satisfy this assumption results in an upward

bias in the "percentage of cases correctly classified."

The method of testing for the equality of the variance-covari-

ance matrices among groups in the analysis was provided by the "Dis-

crim" procedure of the SAS76 statistical package. A Chi-square test

of the homogeneity of the within-group variance-covariance matrices

is performed by the procedure. The Chi-square values and the par-

tial correlation coefficients computed from the pooled variance-co-

variance matrices for the two step discriminant analyses are given

below:

A.1) Partial Correlation Coefficients Computed from the Pooled 3-Group Discriminant Analysis Variance-Covariance Matrix.

	FT	Tol	LOL	FM	Spec	Acreb	Dist
FT	1.000	.1105	.3013	.7120	-.5554	.2127	-.2105
TOL		1.000	.4432	.2638	-.4092	.0813	.1284
LOL			1.000	.4560	-.5500	.0497	-.0288
FM				1.000	-.7953	.3119	-.0009
Spec					1.000	-.2767	.0155
Acreb						1.000	.0095
Dist							1.000

Chi-square test value = 66.8098 with 56 degrees of freedom.

Probability $>$ Chi-square = .1528.

Thus, it was concluded that the individual variance-covariance matrices among the three groups could be considered to be equal.

A.2) The Partial Correlation Coefficients Computed from the Pooled

2-Group Discriminant Analysis Variance-Covariance Matrix.

	DPA	NPPS	FT	FM	Spec	Dist	Acreb	Specs
DPA	1.000	-.0727	-.1388	-.2194	.3147	-.3730	-.2284	.1618
NPPS		1.000	.1444	.0771	-.0541	-.0753	-.0743	-.1866
FT			1.000	.8442	-.6615	-.3386	.3412	-.3011
FM				1.000	-.7871	-.2165	.4858	-.3031
Spec					1.000	.2642	-.3834	.3402
Dist						1.000	.0303	.3669
Acreb							1.000	-.1717
Specs								1.000

Chi-square test value = 50.69% with 36 degrees of freedom

Probability $>$ Chi-square = .0530.

Hence, it was concluded that the individual variance-covariance matrices among the two groups could also be considered to be equal.

APPENDIX B

ESTIMATES OF SAMPLE BIAS PRESENT
IN THE DISCRIMINANT FUNCTIONS

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ESTIMATES OF SAMPLE BIAS PRESENT
IN THE DISCRIMINANT FUNCTIONS

Whenever the same data set used to develop a discriminant func-
tion is used to validate (test) that same function, a substantial up-
ward sample bias in the "percentage of cases correctly classified"
may exist. In order to inquire into the magnitude of this sample
bias for the two developed discriminant functions, we may begin by
determining the proportion of correct classifications which might be
achieved purely by chance. Morrison [31] describes this proportional
chance criterion as:

P (correct) = P(correct/classified Type I) P (classified Type

I) + P(correct/classified Type II) P(classified

Type II)

which reduces to:

$$P(correct) = p_1 \alpha_1 + p_2 \alpha_2 + \ldots p_n \alpha_n$$

where:

P_i = the true proportion of type i observations, and

α_i = the proportion classified as type i.

It is assumed that $P_i = \alpha_i$ in the present study.

For the 3-group discriminant analysis then, the proportional

chance criterion is:

$$P(\text{correct}) = (.483)^2 + (.172)^2 + (.345)^2$$

$$= .382$$

.382 is the proportion of observations which could be expected to be classified correctly by chance. Discriminant Function I correctly classifies 51.72 percent of the observations.

For the 2-group discriminant analysis, the proportional chance criterion is:

$$P(\text{correct}) = (.722)^2 + (.278)^2$$

$$= .599$$

Discriminant Function II correctly classifies 91.67 percent of the observations. Hence, it appears that both discriminant functions do a good job classifying the observations. Because of the sample bias present in the analysis however, the above "percentage of cases correctly classified" is overstated.

In order to get an estimate of the magnitude of the sample bias present in each discriminant function, two validation procedures suggested by Frank, et al. [18] were utilized. The first (preferred) procedure involves splitting the sample into two equal halves (the V_1 procedure). The discriminant function developed from the first half is used to predict the classification of the second half. In this manner, the sample bias is removed.

Because of the larger sample size, this validation procedure could be used for Discriminant Function I. 41.86 percent of the observations in the second half were classified correctly. This compares with the proportional chance criterion value for this 3-group

analysis of 38.2 percent. Thus, it can be seen that the improvement
using Discriminant Function I is small and insignificant at conven-
tional levels of α.

Because the sample size for Discriminant Function II was small,
a different verification procedure (V_2) suggested by Frank, et al.
was used. This modified simulated-sample approach involved randomly
reassigning individual observations into different groups. The
ability of the newly developed discriminant function to classify or
predict this "nonsense" provides a measure of the sample bias in the
original data and discriminant function. This procedure has the ad-
vantage of "maintaining approximately the same variance-covariance
matrices as in the original analysis" [p. 255].

The results of this modified V_2 procedure indicated that approx-
imately 75 percent of the observations could have been classified
correctly through chance and sample bias. This compares with the
91.67 percent of cases actually classified correctly using Discrimi-
nant Function II. Thus, Discriminant Function II does make a sig-
nificant improvement over and above the appropriate chance criterion.

VITA

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SUPPLY RESPONSE AND THE LAND CONVERSION
PROCESS IN THE RURAL-URBAN FRINGE

by

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(ABSTRACT)

The objective of this research was to investigate the nature of
landowner supply-response behavior as it related to the land conver-
sion process in the rural-urban fringe. Emphasis was placed on the
derivation of the farmer's dynamic supply-response curve of agricul-
tural land for urban uses since the nature of this curve has impor-
tant implications for land-use policy alternatives in fringe areas.

It was argued that the aggregate land market approach to land-
use policy analysis in the rural-urban fringe is generally inappro-
priate for practical and theoretical reasons. Consequently, a dis-
aggregated micro model based on the proprietary land unit was de-
veloped to explain the land conversion process. The theoretical
model is composed of three cost and two demand components. The in-
teraction of these components results in a dynamic supply-response
curve of agricultural land for urban uses which is discontinuous over
a wide range for many classes of landowners.

The theoretical model was tested through discriminant analyses
of data collected from a study area where there exists heavy urban

demand for agricultural land. The data included information on land-owners over time, physical characteristics of the tracts of land, transfer information and various demand variables. Results of the empirical analyses provided support for the hypotheses incorporated into the theoretical model. Specifically, empirical evidence was found to support the hypotheses that (1) individual farmers' supply-response curves are discontinuous over a wide range, (2) farmers' fixed capital investment is a primary cause of the discontinuity, (3) farmers with less fixed capital investment will generally have more elastic supply-response curves which are discontinous over a smaller range, and (4) speculators' supply-response curves will generally be highly elastic and continuous.

Various implications of the theoretical model for land-use policy analysis and land-use patterns in the rural-urban fringe are discussed. Particular attention was given to an analysis of Virginia's use-value assessment program based on the theoretical model. It was found that such a program will not "save" agriculture in fringe areas but will raise land price and subsidize speculative activities. Such a program might be more successful in achieving its stated goals if it were implemented in areas on the outlying edge of the rural-urban fringe.