RSP 21(1): 67-99.

THE FARMERS' PROTEST AND THE SURFACE OF THE LAND RENT CONE OF GREEN BAY

Bruce W. Meier

Public policy decisions often are based on rhetoric and conjecture. A quantifiable approach to growth management policies can clarify the issues. Quantification cannot tell us what good policy is, but it can serve to measure the effectiveness and fairness of existing policies. It also may allow us to predict the impact of policy changes.

One controversial policy issue surfacing across America during the last 40 years is preferential taxation for farmland. Traditional legislative remedies rely more on belief than quantification. A typical case is described in the following newspaper headlines:

- "Valuation Irks Farmers" (Green Bay Press-Gazette [51]);
- "Farmers Get No Tax Help" (Green Bay Press-Gazette, [13]);
- "Farmers Lose Battle Over Assessments" (Green Bay Press-Gazette [14]).

The article below the first headline describes the issue:

> ... a group of far East Side farmers complained ... that the valuation ... placed on their farmland is too high .... One farmer complained, 'The taxes will force me out.' Another said, 'All my (life's) work is down the drain.' A third said, 'If your rent (charged for the land) can't pay the taxes, you're in trouble .... [The] City attorney ... in answer to a question ... responded, 'The problem these people face is the same farmers [sic] th[r]oughout the country in urban areas are facing'... [Farm]land in the Town[ship] of Eaton, adjacent to Green Bay property, is assessed at between $50 and $600 an acre ... This compares with $1,700 to $1,800 an acre in the city.

This story and other news accounts (Green Bay News-Chronicle [1, 7, 24, 41], Green Bay Press-Gazette [15, 19, 51]) typify newspaper coverage of tax protests throughout the country. Real estate historically has been taxed according to market value (*ad valorem*). Farmland near cities often is valued more highly for prospective urban use than for its current agricultural use. Taxes reflect market value, which can lead to a rise in taxes without a corresponding increase in farm income. Farmers who own land adjacent to cities may experience a squeeze on their profitability that can lead to premature withdrawal of land from agricultural use.

The Green Bay protest illustrates the host of problems arising from the zone of urban land speculation surrounding cities. In considering

preferential property taxation, policy makers lack the benefits of systematic analyses of land values for both urban and agricultural uses. Measurement of the zone of speculation would identify the amount of pressure urban-induced land values exert on individual farms. The urban side of this zone is identifiable by visual observation, but the rural boundary has no obvious indicators.

This study offers a model for determining the location of the zone of speculation, a keystone of farmland preservation and growth management policies.

Status of Current Research

Some of the pressures on farmland adjacent to cities are due to taxation policies that make farming unprofitable. This process is a vicious circle, as illustrated by Barrows in Figure 1. The zone of speculation surrounding cities is diagramed in Figure 2.

The land rent cone model (Figure 3) best describes land values in urban and rural areas. The peak of the cone—called the *pole of high rent*—represents the point of greatest competition for land, usually an intersection within the central business district.[1] The cone slopes downward from the edge of a city to some point in the country, where prospective urban uses no longer compete for land. This model shows the "relative levels of land rents or land values associated with the highest and best uses of sites located at different distances from central markets" (Barlowe [3, Figure 9-3, p. 229]). Adapted to this study, cone surfaces A and B portray market values of land in urban use and cone C represents anticipated urban use values of farmland. From the end of cone C and beyond (plane surface D), all prospective purchasers of land regard farming as its highest and best use.

Sinclair [47, p. 79, note 17] suggests that there may be a ring of depressed land value at the intersection of cone surface C and plane surface D. This intersection represents the area where buyers consider it too early to buy land for anticipated urban development. At the same time, owners feel it is too late for agricultural reinvestment. In Figure 4, this area is the intersection of lines R (cone surface C) and V (plane surface D). Sinclair's hypothesis suggests that cities located in farm country are surrounded by a dead ring of investment activity at the furthest extent of the cone.[2]

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[1]The terms *pole of high rent, one hundred percent location, and peak value point* are synonymous.

[2]The term *dead ring* first was used by the author in "What is the Nature of Speculation in Farmland Near Cities?," a presentation to the annual meeting of Association of American Geographers [35].

Policy issues involving farmland under the land rent cone have sparked decades of political agitation.[3] Surprisingly, no systematic examination has been undertaken to describe the pattern of causal economic forces. Market values have received the most attention. Circumstantial evidence found in the published record supports the idea of land rent cones next to the built-up city.[4] These studies all examine areas that are transects or sectors of the compass rose of land rent cones. All find that market values decrease with distance from the city, and all implicitly assume that the lowest market values represent agricultural use values. These studies differ from each other by their modes of presentation—tables, graphs, scatter diagrams, regression coefficients—and their units of analyses. These units range from individual parcels to multi-county averages.

Nelson [39], looking at farmland next to an urban containment line around Salem, Oregon, finds data to support a portion of Sinclair's hypothesis. Market values exhibit the pattern of line V in Figure 4. On the urban side of the containment line, market conditions are interrupted by an outside (legislative) force. Here land values mirror line R, decreasing with distance from the built-up city until they near line V. They then reverse the trend and rise to the line, due to amenities provided by green space on the rural side of the line.

Both agricultural use valuation and prospective urban use value form the market value of land in cone C. To date, agricultural use value has received almost no attention. This researcher conducted one investigation separating land values for prospective urban uses from those for agricultural uses. This study measured a sample of farms (one per mile) in a sector of Madison, Wisconsin's cone surface. The study produced graphic findings similar to those illustrated by cone C in Figure 3 (Meier [34]). It found no evidence of the ring of depressed land values suggested by Sinclair. This may have occurred because the sample (designed for another purpose) was not dense enough to record the ring of depressed land values.

It is possible that the surface of cone C could be more complex than shown in Figure 3. Examinations of the cone surface within the city by Hoyt [26, pp. 279-367] and more recently by Hays [21] show significant undulations.

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[3]The issue has been discussed in many works during the past 30 years. Those of more recent publication that have particular relevance to this study are Roberts and Brown [45], Fischel [17], Redfield [43, pp. 95-97], Jackson [27, pp. 185-190], Mather [32, pp. 234-236], and Barrows [4, pp. 31-44].

[4]See Arnold and Montgomery [2], Parcher [40], Vargha [52], Harris and Allee [20], House [25], Murray and Reinsel [37], Dopson and Miller [11], Heaton [23], and Chicone [8].

The political response to tax protests has not been accompanied by research of the problem. Legitimate complainants under the cone can not be separated from others beyond it, because the extent of the cones had not been determined.[5] If such research had been undertaken, the extent and magnitude of the cone could be predicted by city size and growth rate. To date, published research has not systematically sought agricultural values, although the necessary appraisal tools have been in use for decades. Tax protests, however, have caused part of the property tax burden across America to be shifted from certain farmlands to all other real property (Furuseth and Pierce [18]).[6]

Purpose of Study

Systematic measurement of the land rent cone beyond the edge of the built-up city needs to be undertaken. Knowledge of the cone's magnitude, surficial form, and penetration into rural areas has central implications for property tax, farmland preservation, and urban growth management policies. A more detailed examination may reveal the land value depression suggested by Sinclair and surficial undulations similar to those within the city.

It is the purpose of this study to delineate the surface of the land rent cone of Green Bay, Wisconsin. Green Bay, an area of active farmer protest in the late 1970s, provides a setting in which to measure the magnitude, surficial form, and extent of a land rent cone surface. It also offers an opportunity to examine (and quantify) the economic factors prompting political agitation. This study examines the cone surface in greater detail than previous research and identifies farmland jeopardized by urban-induced land value pressures. The study offers the closest look to date of the land rent cone beyond the edge of the built-up city and provides the first systematic search for the ring of

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[5]During the period that preferential taxation crested as a political issue in both California and Wisconsin, it was the author's observation that complainants came from farmland across the state. There was no attempt to differentiate farmland experiencing higher taxes because of a general rise in value from land that contained an additional increment from urban land speculation.

[6]Wisconsin's legislature passed farmland preservation legislation in 1977 (*Chapter 91, Wisconsin Statutes*). The legislation had no opportunity to influence the market value of the farmland in the study area because said legislation could be applied to farmland only with the approval of each county's elected board of supervisors. Brown County, of which Green Bay is the county seat, had not adopted the policy at the time of this protest. The success of such policies, or lack thereof, is discussed by Roberts and Brown [45] and especially Dowall [12].

depressed land value hypothesized by Sinclair. The Green Bay findings present a model that can be used to delineate farmlands needing protective policies.

The land parcel was selected as the unit of analysis for this study. This allows findings to be integrated into a system designed to predict the extent and magnitude of land rent cones for cities of given sizes and growth rates.

Methodology

Study Area

The focus area for this study is a transect radiating from the pole of high rent to a distance of 15 miles. The transect's end points are shown on Map 1. Measuring approximately four miles wide, the study area includes much of the area of protest. This area includes part of the town[ship] of Bellevue (where some urban development has occurred) and townships where farming predominates.

A transect length of 15 miles was established. Madison generated a cone nine miles from its pole of high rent in an earlier study (Meier [34]). Considering that Madison had twice Green Bay's population and that these cities have grown at similar rates, a 15 mile transect was considered ample for the Green Bay study.

The study area is homogeneous in several important ways:

- It has been carpeted by farms since the forest was cleared by American and European settlers;
- Dairying has been the predominant activity for the past half century;
- Cultivated crops common to the area are corn, oats, and hay;
- The land surface is level in appearance, broken from time to time by uncultivatable (unusually swampy) spots of glacial origin;
- The soils are moderately productive and have a productivity rating of Class III or IV (*Soil Survey of Brown County* [48]);
- A system of all-weather roads following the one mile checkerboard grid of the Public Land Survey System long has covered the area. This road system was built to ensure that milk could be transported from farm to creamery without interruption;
- An inspection of Wisconsin Department of Agriculture records shows that a farm-to-creamery delivery pattern crisscrosses

the area, which eliminates the possibility that transportation cost advantage may affect agricultural use value of land;[7]

- Prospective urban use is the only competitor for agricultural use; forestry and recreation, the other major competitors for rural land in Wisconsin, are not active competitors for land in the study area.

Sample Area

The sample area is diverse, encompassing parts of five political jurisdictions. (See Map 1.) The areas are the city of Green Bay and four civil townships whose character varies considerably. Sample locations are described in Table 2. Green Bay has a large area of farmland within the city, resulting from its absorption of the town[ship] of Preble during the 1960s. The reappraisal of this area sparked the 1978 protest. The town[ship] of Bellevue, close to the built-up area, had installed some urban infrastructure. The town[ship]s of Eaton, Humboldt, and New Denmark were rural in nature.

The sampling frame chosen is approximately four miles wide and centered on the transect to allow adequate coverage of the area of protest.[8] The sample is stratified by distance from the pole of high rent. Accessibility to the city is a direct function of distance,[9] and the orientation of the road system supports that stratification.[10] The strata consist of legally defined sections of land; the section is the basic unit of the Public Land Survey System and spatially serves to stratify the sample. (See Map 1.) Parcel density is approximately four times greater than the previously cited Madison sample.

The sampling unit is a land parcel that contains 40 acres. This is the smallest parcel for which farmers can be expected to bid. To be useful to this study, land must have the potential to attract both farm and nonfarm buyers. Parcels smaller than 40 acres tend to be less

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[7]The Wisconsin State Veterinarian maintained a tabulation that listed for each creamery the location of every dairy farm from which they obtained milk. This tabulation is a by-product of a legal requirement that all milk-producing herds must be free of brucellosis.

[8]A systematic unaligned stratified point sample selected the parcels because this procedure has the highest level of accuracy for the smallest number of points (Berry [6], Morrison [36]).

[9]A good general discussion of the relationship between accessibility and land value relevant to this study can be found in Healy and Short [22, pp. 114-116].

[10]The transportation pattern adjacent to the Fox River reflects a previously established French Long Lot System of land parcelization, not the American Public Land Survey System that dominates the surrounding area.

attractive to farmers unless located close to the home farm (Luening [29, 30]). All land in this sample is farmed.

Valuation of Land

Land valuations in the sample area are the major focus of this study because they determine the tax base of Green Bay farmland. To have value, an item must have utility and scarcity.[11] The value of these two attributes is measured by price. Price can be estimated by a variety of appraisal tools.

Luening and Mortenson write: "Appraisal is an art as well as a science" [31]. The science of appraisal formulas must be tempered by the judgment required to estimate the value of farmland. Two characteristics of the farm marketplace must be considered:

- First, each parcel of land is unique and cannot be replicated;
- Second, there is no continuous market for farmland—an individual farm may come to market only once in decades.

Appraisals of the same parcel of farmland will vary depending on the purpose of the appraisal and the amount of detail required in each computation. Appraisals most commonly are made for tax assessment, condemnation, loan value, estate or inheritance taxation, easements for utility or scenic purposes, and purchase or sale (Murray, *et al.* [38, p. 44]). Details vary with purpose, time, and cost.

The two systems of appraisal most commonly used to value farmland are the comparable sales (comparative) and the income capitalization (use value/earnings) approach.[12] Near cities, the difference between use value for farming and market value is the urban-induced increment of value. The land rent cone (cone surfaces A, B, and C in Figure 3) rises above the plane of agricultural values (plane surface D) showing the urban-induced increment of value. These methods are used to determine the magnitude, surficial form, and extent of the land rent cone.

The comparable sales method of appraisal is used to establish the market value of farmland. In rural areas, market value of farmland and use value for agricultural production should be identical. Near cities, these two values are not equal.

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[11] A good general discussion of the origins of value is found in Suter [49, pp. 50-51].

[12] Comparable sales and income capitalization are two of the three standard methods of appraising real property. The third method is replacement cost, which is not relevant to this study.

Comparable Sales

Market value is established when property is sold, but only if the sale is a valid one.[13] Between sales, value must be estimated because the availability of land is not uniform. Periods between sales of farms and nearby farmland can be decades. An appraisal that estimates price occurs yearly as part of the administration of the property tax. This appraisal estimates the market value of land.

A parcel of land is valued according to prices paid for similar parcels in the neighborhood. Appraisals for tax assessment usually are made on a mass basis (Murray, *et al.* [38, p. 6]). More accurate appraisals could be made, but this type of appraisal is most commonly responsible for the property tax on farmland.

In Wisconsin the yearly administration of the property tax places a comparable sales appraisal on land. In some states, political pressures allow appraisal (called assessed value) to be maintained at an artificially low level. This is not so in Wisconsin. A statutory mandate requires state property taxes to be distributed equitably to local governments (i.e., according to accurate market valuation of property). Appraisals are the product of the combined efforts of each township, village, or city assessor and the Wisconsin Department of Revenue. Assessors set values based on comparable sales within their jurisdictions. The Department of Revenue reviews these values and frequently adjusts them to the department's estimate of market value. Valid sales of comparable properties throughout the region establish market value. Each class of property—agricultural, commercial, residential, etc.—is assigned an equalizing ratio. Full or market value is determined by applying this ratio to the assessed value set by local tax assessors. Equalizing ratios for agricultural land ranged from 32 percent in the town[ship] of Bellevue to 126 percent in the City of Green Bay. Market value per acre of farmland parcels is based on real estate tax rolls using the following formula:

$$MV = (AV \times ER) / Ac$$

where:

MV = Market value;
AV = Assessed value (*Real Estate Tax Roll* [42]);

[13] A valid sale is one that involves a willing buyer and a willing seller, when neither is under unusual pressure to buy and sell. Excluded are sales between parties closer than arms length, such as members of the same family.

ER = Equalizing ratio ("Equalizing Ratios for Class D [agricultural] Land" [56]); and

AC = Acreage of the parcel (*Real Estate Tax Roll* [42]).

Income Capitalization

Because there is no continuous market for farmland, the appraiser, in the words of Murray *et al.* [38], "must provide estimates of value not provided by the farmland marketplace." The primary appraisal tool for deriving these estimates is the income capitalization approach.[14]

Using the income capitalization approach, the value of farmland is based on the productive capacity of its soil. In traditionally rural areas (plane surface D in Figure 3) where no topographic variations of productive significance are present, uniform values can be assumed for farmland. These values are based on the land's capacity to produce crops or fodder.

Although agricultural land use appraisal requires the consideration of many elements, two are of primary importance. The first element that must be considered is the highest and best use. In this sample, the test for highest and best use involves a mix of environmental and economic limiting factors.[15] Dairy farming has dominated this region for the past half century and easily meets this test. Accordingly, agricultural use value of this sample becomes dairy use value.[16]

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[14]There are many expositions of the income capitalization approach to appraisal. An easily accessible general presentation of this approach is Barlowe [3].

[15]A crop combination that tillable land appears best suited to produce, a livestock enterprise best suited for pasture, and location relative to markets or offering price advantage all add up to a most profitable farm type (Murray et al. [38, pp. 31-32]).

[16]Procedures for estimating an agricultural value of land, such as the one used here, have been established in states that have differential assessment legislation. The approach used here is a modification of that suggested for use by Wisconsin if such legislation were adopted. See Russel A. Williams [54], *The Use of Soils Data to Develop Land Appraisal Units*, Wisconsin Department of Revenue Bureau of Property Taxation (Sparta Office, March 1969). It appears to be a modification of the method used in Illinois that is based on the yield of corn, soybeans, wheat, and oats. See an attachment to Williams entitled "Tract Productivity Index (Illinois)." The Illinois method appears to be a modification of that used by Iowa that is based on the soil's yield of corn. See T. E. Fenton, [16] *Soil Productivity Ratings and Their Use in Agricultural Land Valuation in Iowa*, Iowa State University Department of Agronomy (presented at the Midwest Regional Technical Service Center Course, "Developing Resource Data for Planners," October 6, 1972).

After establishing best use, the income capitalization approach can be applied to the problem of determining value of farmland. The basic formula is:

$$V = \frac{I}{R}$$

where:

V = Value of land;
I = Income from land (annual rent); and
R = Rate of return on invested capital.

The I portion of the formula is the annual income an owner/operator would make farming the land (Murray *et al.* [38, p. 27]). This value requires estimating the land's productive capacity and the probable earnings from the yield of feed for dairy cattle. Many levels of precision in measuring farmland productivity are possible. They range from the imprecise measure determined from the soil's yield of corn silage to the precision obtained from on-site soil testing and inspection.

The formula for determining I is:

$$I = G - E$$

where:

G = Gross income from land; and
E = Expense of producing income.

Values for G and E are obtained by the method detailed in Table 3.

The second element that must be considered is the rate of return on invested capital (R). As the denominator in the basic equation, rate of return on invested capital is central to determining value of land (V). Unlike the numerator (I), which is computed, the denominator is selected. Suter [49, p. 265] writes: "the appraisers [sic] job is to select the capitalization rate the amount the typical ... farm operator will pay for the right to receive the income stream." Still, there is no established method for the selection or derivation of that rate. Suter notes that annual rates of return on farm real estate often have been lower than rates of return on treasury bills, savings accounts, or corporate bonds. Suter observes that farmland is a good hedge against inflation. Although liquidity of farmland is low and it requires some supervision, farmland historically has appreciated in value.

Documented capitalization rates are difficult to obtain. Murray *et al.* [38, p. 113] reports that a 17 year average rate of return from

unimproved Iowa farmland was 5.1 percent. This capitalization rate comes from an annual statewide survey conducted by the Iowa Chapter of the American Society of Farm Managers and Rural Appraisers and the Economics Department of Iowa State University. The Iowa rate agrees with Luening's [29, 30] observation of the Wisconsin farmland market: "over time, four to six percent has been considered an adequate rate of return by farmers purchasing farmland." Luening cites the same reasons reported by Murray *et al.* For this study, 5 percent was selected as a reasonable capitalization rate for estimating dairy use values.

To complete the computation, dairy use values (V) were derived by dividing per acre annual net cash income (I) by the capitalization rate of 0.05 (R).

Findings

Dairy use values in the study area are shown by the scatter plot in Figure 5 and Table 1. The distribution's generally planar character reflects the dominance in the study area of the Kewaunee and Manawa Silt Loams (*Soil Survey* [48]). These soils are equally productive for growing crops in support of dairy farming, further illustrating the homogeneous character of the transect.

In contrast, the scatter plot in Figure 6 and Table 1 shows market values of the land in this study. They decrease steadily from the edge of the city and eventually level. The decrease outward suggests a decline in the expectation of anticipated urban use. At some distance from the urban center, this implies that market and agricultural values coincide. This pattern is similar to those suggested in previous research at various scales of examination.[17]

Between eight and ten miles from the pole of high rent, there is a hint of the ring of depressed values suggested by Sinclair. Perhaps the density of the sample reveals a pattern not found by previous researchers. They may not have looked closely enough or may have aggregated their data and obscured this pattern.

The expectation of urban development causes the rise in market values near the city. This contention is supported by the presence of sewer service in the part of the study area located under the rising curve. (See Figure 6 and Table 1.) In 1967 the city of Green Bay extended its sewer system approximately three miles into the study area. (See Map 1.) Most land in the Green Bay area will not support septic systems (Reiche [44, p. 17]). On these soils, sewers are the key to urban expansion.

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[17]Neither forestry nor recreation, the other major competitors for rural land in Wisconsin, is active in the study area.

The presence of the sewer heightened the expectation of urban development, even on unsewered farmland nearby. Five years after the sewer installation, farmland values had quadrupled over previous levels. Although market values of land rose, most of the sewered area remained in farm ownership and use more than ten years after the installation. Urban development had been slower than anticipated. Some farmland owners requested that their ten year payment deferral schedules for the cost of sewer installation be extended (Reiche [44, p. 19]).

The land rent cone shown in this study was computed by comparing agricultural use and market values for the length of the transect and then smoothing the resulting scatter plot into a continuous surface. Specifically, market values are expressed as a percentage of agricultural use values. Agricultural values then become a statistical surface as envisioned in the illustration of land rent cones (plane surface D in Figure 3).

To illustrate, a hypothetical scatter plot of an area for which farming was the highest and best use is shown by Figure 7. Market values theoretically should coincide with agricultural values (plane surface D in Figure 3), but imperfections in both the land market and appraisal processes may cause them to differ slightly.

The scatter plot in Figure 8 shows their distribution. The impact of anticipated urbanization on the value of farmland is evident. The land rent cone is obvious. Figure 9 shows that farmland in the city of Green Bay is subject to the greatest pressure of competition for urban uses. The effect of competition is significant (although less marked) farther away in the town[ship] of Bellevue. This is the result of the building of some subdivisions and infrastructures in the area. Sample parcels in the town[ship]s of Eaton, Humbolt, and New Denmark approximate the distribution expected from an area where farming is the highest and best use. The hint of a land value depression suggested by Sinclair (shown by Figure 6) appears with more certainty.

To summarize the distribution in a form similar to the cone surface illustrated in Figure 3, a rent-distance curve[18] was computed.[19] Figure

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[18]The term *bid-rent curve* often is used in this context. The term rent distance curve used by Fischel [17] seems better to express the locational nature of the relationships of interest.

[19]The rent-distance curve resulted from a robust locally weighted regression smoothing procedure (Cleveland [9, 10]). This method smooths scatter plots by fitting the value at X_k that is the value of a line fitted to the data by means of weighted least squares. The weight for X_i, Y_i increases as X_i approaches X_k and decreases the farther X_i is from X_k. Wilkinson [53, p. 540] writes: "it lets the data speak for themselves." The procedure was performed using Sygraph 1.0 (Wilkinson [53]) with the F parameter set at F = 0.5 (i.e., 50 percent of the data points are included in each running smoothing window.)

10 shows that the curve drops from a magnitude of 300 percent at the edge of the city (three miles from the pole) to agricultural values at seven to eight miles. This is cone surface C in Figure 3. The curve continues downward below agricultural values, then rises to agricultural values again at 11 to 12 miles, continuing to the edge of the study area. The depressed ring, not observed in previous studies, is supported by the data.

The depression of land values between cone C and plane D requires further consideration. Additional samples will be required, and additional transects should be examined, before this can be viewed as a definitive validation of Sinclair's hypothesis. If confirmed, this depression in land value reflects buyer recognition that it is too soon for urban usage and owner recognition that it is too late for long-term farm investment. If these early indications prove valid, we are seeing the marriage of Sinclair's two diagrams: economic rent and distance from market and value for agriculture and distance from urban area shown in Figure 4.

There is also fragmentary anecdotal evidence lending credence to Sinclair's hypothesis. Following an oral presentation to the Wisconsin Society of Farm Managers and Rural Appraisers [33] by this researcher, a professional farm manager commented that he managed a farm "in that ring." Until now, the farm manager could not understand why the owner's behavior differed from others whose farms he managed. At the same meeting, a property appraiser from the Milwaukee area pointed to the ring and said he found comparable sales appraisals there most difficult to make because "there were so few sales to which a property could be compared.[20]

Conclusions

This study takes the closest look to date at a land rent cone beyond a built-up city. The study measures the magnitude, surficial form, and extent of the cone. It provides the first evidence in support of the hypothesized ring of depressed land values at the furthest extent of the cone.

This study offers a record that is replicable. Future researchers will be able to return to the sample area and measure change of the city's impact on farmland values. This will allow the dynamics of the Green Bay land rent cone to be examined over time. Comparisons with land rent cones of other cities will provide information on the suitability of this procedure for predicting the dynamics of land rent cones by city size and growth rate.

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[20]An oral presentation, Bruce W. Meier [33], "Changing Agricultural Values Under Urban Influence—Two Wisconsin Studies," Wisconsin Society of Farm Managers and Rural Appraisers (Milwaukee, 1980).

There are implications in this study that have profound significance for policy makers. This study offers a model that facilitates the identification of farmland subjected to urban land speculation pressures. It offers a technique to assist policy makers in differentiating complaints from farmers with legitimate concerns regarding urban-induced valuation increases from those farmers whose complaints mirror only inflationary increases.

Additional research will be required to verify the existence and extent of the dead ring and to predict the morphology of land rent cones around cities of various sizes and growth rates. Traditional models of land rent cones may need to be modified to include the dead ring as a standard element.

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Table 1
Measuring the Land Rent Cone

(1)	(2)	(3)	(4)	(5)
Parcel No.	Distance from City	Ag Value $	Market Value $	Market as % of Ag Value
1	3.5	606	1402	321
2	3.75	404	1233	305
3	4.0	520	1346	258
4	4.5	614	1355	220
5	5.0	700	1354	194
6	5.0	684	1358	198
7	5.0	244	1242	509
8	5.25	612	842	137
9	5.5	396	1334	336
10	5.75	344	945	274
11	6.5	616	1556	252
12	6.5	580	936	161
13	6.75	644	517	80
14	6.75	736	518	70
15	7.0	1066	362	34
16	7.25	678	921	135
17	7.25	434	556	128
18	7.5	534	955	178
19	8.0	1074	317	29
20	8.25	902	257	28
21	8.25	536	471	87
22	9.0	698	525	75
23	9.25	616	418	70
24	9.75	546	363	67
25	10.0	874	149	17
26	10.25	542	507	93
27	11.0	524	498	98
28	11.0	636	289	45
29	11.0	682	461	67
30	11.5	322	530	101
31	11.5	554	560	100
32	11.5	484	590	122
33	12.0	554	349	63
34	12.75	546	481	88
35	12.75	540	444	82
36	13.25	254	404	159
37	13.75	472	371	78
38	15.0	834	500	60

Column (1): Assigned parcel number. Location of sample is listed in Table 2

Column (2): Straight line distance measured from the pole of high rent—Port Plaza Mall in downtown Green Bay—to each parcel. Distance has been rounded to the nearest one quarter mile

Table 2
Location of Farmland Sample

(1) Parcel No.	(2) Public Land Survey System Location
1	NW1/4,NW1/4,Sec.3,T23N,R21E
2	SW1/4,SE1/4,Sec.34,T24N,R21E
3	NE1/4,SE1/4,Sec.9,T23N,R21E
4	SE1/4,NE1/4,Sec.10,T23N,R21E
5	NW1/4,SW1/4,Sec.11,T23N,R21E
6	SW1/4,NE1/4,Sec.35,T24N,R21E
7	NE1/4,SW1/4,Sec.15,T23N,R21E
8	NW1/4,NW1/4,Sec.14,T23N,R21E
9	NW1/4,NW1/4,Sec.1,T23N,R21E
10	W1/2,SE1/4,NE1/4,Sec.22,T23N,R21E &W1/2,NE1/4,NE1/4,Sec.22,T23N,R21E
11	SW1/4,NE1/4,Sec.12,T23N,R21E
12	NW1/4,SE1/4,Sec.23,T23N,R21E
13	SE1/4,NE1/4,Sec.13,T23N,R21E
14	NW1/4,SW1/4,Sec.7,T23N,R22E
15	NW1/4,NW1/4,Sec.18,T23N,R22E
16	SE1/4,SW1/4,Sec.24,T23N,R21E
17	NW1/4,NW1/4,Sec.25,T23N,R21E
18	SW1/4,SW1/4,Sec.19,T23N,R22E
19	NW1/4,NW1/4,Sec.17,T23N,R22E
20	NW1/4,SW1/4,Sec.8,T23N,R22E
21	NW1/4,SW1/4,Sec.30,T23N,R22E
22	SE1/4,NE1/4,Sec.16,T23N,R22E
23	SE1/4,NE1/4,Sec.31,T23N,R22E
24	NE1/4,SW1/4,Sec.32,T23N,R22E
25	NW1/4,SE1/4,Sec.21,T23N,R22E
26	NE1/4,SW1/4,Sec.15,T23N,R22E
27	SW1/4,NE1/4,Sec.27,T23N,R22E
28	SW1/4,NW1/4,Sec.4,T22N,R22E
29	NE1/4,SE1/4,Sec.33,T23N,T22E
30	NW1/4,NW1/4,Sec.26,T23N,R22E
31	NE1/4,SW1/4,Sec.34,T23N,R22E
32	NE1/4,SW1/4,Sec.23,T23N,R22E
33	NW1/4,SW14,Sec.35,T23N,R22E
34	SW1/4,NE1/4,Sec.25,T23N,R22E
35	NW1/4,SW1/4,Sec.2,T22N,R22E
36	NW1/4,SW1/4,Sec.11,T22N,R22E
37	SW1/4,NE1/4,Sec.1,T22N,R22E
38	SE1/4,SW1/4,Sec.13,T22N,R22E

Column (2) Real estate tax roll of Brown County

A parcel number listing by political jurisdiction follows:
City of Green Bay: 1, 2, 3, 4, 5, 6, 9, 11
Town[ship] of Bellevue: 7, 8, 10, 12, 13, 16, 17
Town[ship] of Hobart: 14, 20.
Town[ship] of Eaton: 15, 18, 19, 21, 22, 23, 24, 25, 26, 27, 29, 30, 31, 32, 33, 34
Town[ship] of New Denmark: 28, 35, 36, 37, 38

Table 3
Calculating Annual Net Income Per Acre

To determine the values for the variables in the formula (I = G - E) the following calculations were performed:

(1) Determine gross income (G):

a) Identify and measure the area of each soil;

b) Ascertain the recommended crop rotation cycle for each soil;

c) Determine the potential yield of each soil;

d) Ascertain sale price of corn, oats, hay, straw, and a dollar value for pasture (note: soils in other areas may support different crops and/or crop rotation cycles);

e) Calculate gross income per acre by multiplying c) by d).

(2) Calculate expense (E) for crop production per acre based on operating expenses of the dominant soil of each parcel. Expense could be calculated for each soil, but the dominant soil determines the long-term plan for both fields and farms (rotation plans, etc.) Using the dominant soil both reflects the "way things are done" and provides an estimate at a level of precision appropriate to the purpose (Luening [29, 30]). The cost of crop production was calculated as follows:

a) The expense of producing corn is the sum of seeding, plowing, disking, harrowing, planting, cultivating or spraying, picking, and management plus the costs of fertilizer, herbicides, insecticides, taxes;

b) Oats lists similar costs with drilling added and cultivating and planting deleted;

c) Hay requires seeding, mowing, raking, conditioning, baling, fertilizer, herbicides, insecticides, management, taxes;

d) Straw requires raking and baling costs;

e) Pasture requires fencing, mowing, fertilizer, and taxes.

(3) Calculate net income (I):

a) Costs per crop per acre (E) are subtracted from gross income (G);

b) Net income from each rotation cycle is summed and then divided by the number of years in each cycle to yield net income per parcel;

c) Divide b) by parcel acreage to yield annual net income (I) per acre of the parcel

Data used in the income capitalization process were obtained from the *Soil Survey of Brown County* [48], soils and their location, recommended crop rotations; from the *Land Capability Classification* [28], potential soil productivity; from the *Wisconsin Farm Reporter* [57], prices paid for corn, oats, hay, and straw; from "Short Run Crop Budgets for the 1978 Crop Year" [46], the costs of seed, fertilizer, herbicides, and insecticides; from the real estate tax roll of Brown County, Wisconsin [42], property tax paid; from the *1978 Wisconsin Custom Rate Guide* [55], costs of plowing, disking, harrowing, planting, cultivating, picking, drilling, combining, mowing, raking, conditioning, and baling; from Luening [29, 30], costs of management, percentage added to reported costs to compensate for underreporting by farmers who do custom work part time, costs of straw, fencing, and pasturage; from Tlachac [50], additional information about the price of corn planting, oat drilling, hay crushing, and hay baling.

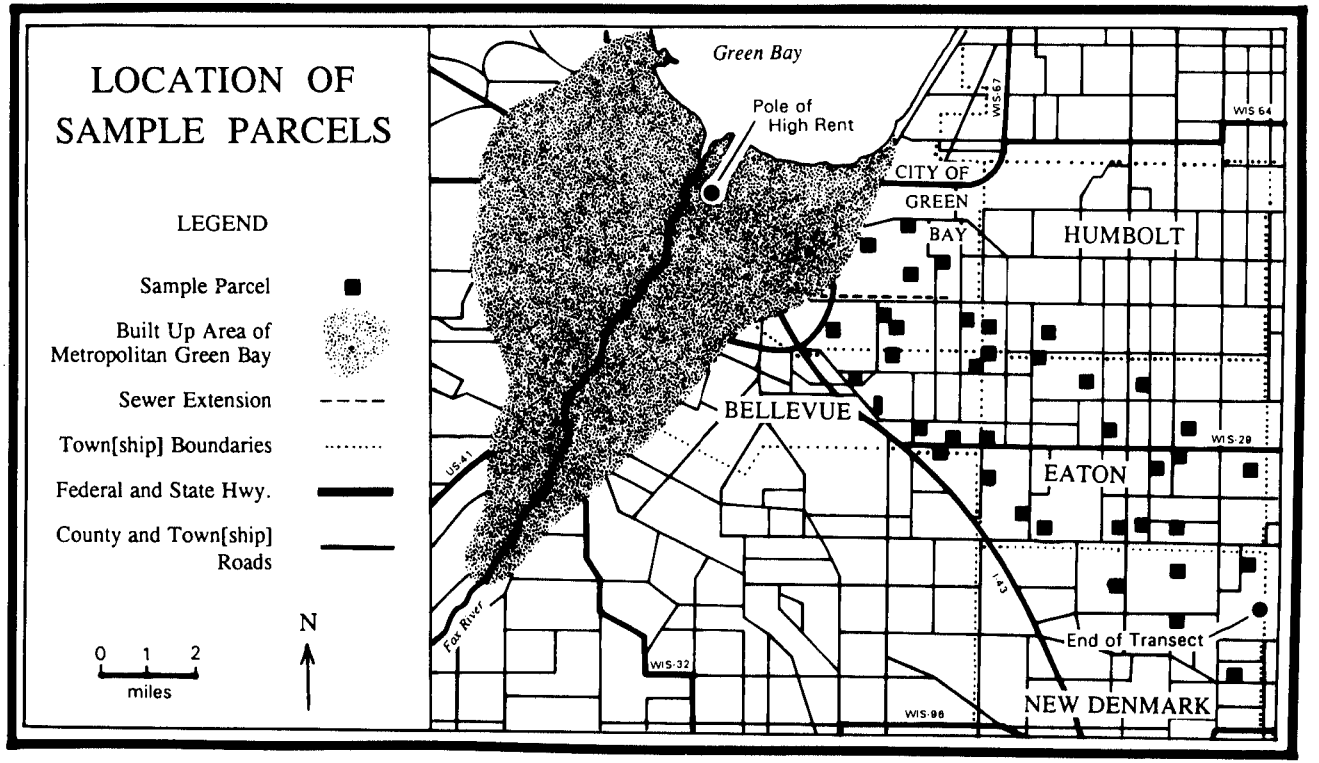
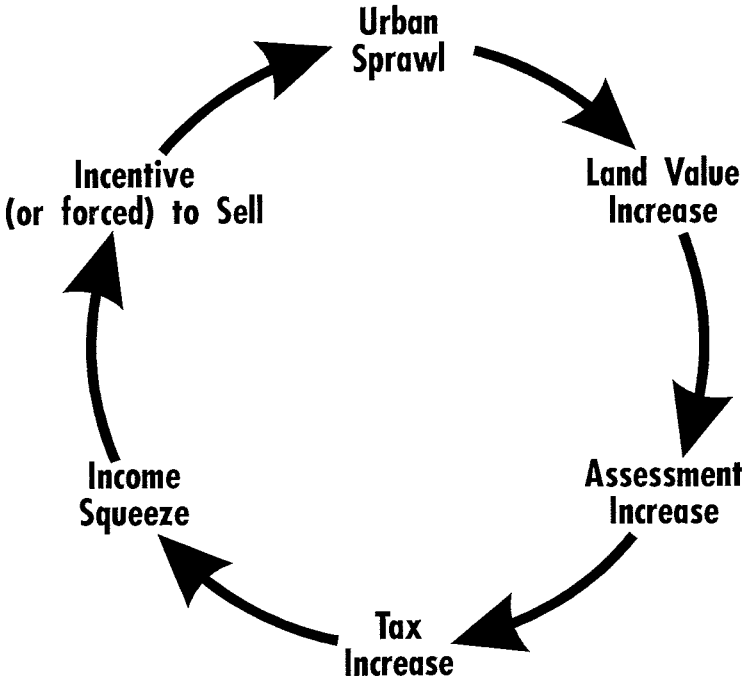
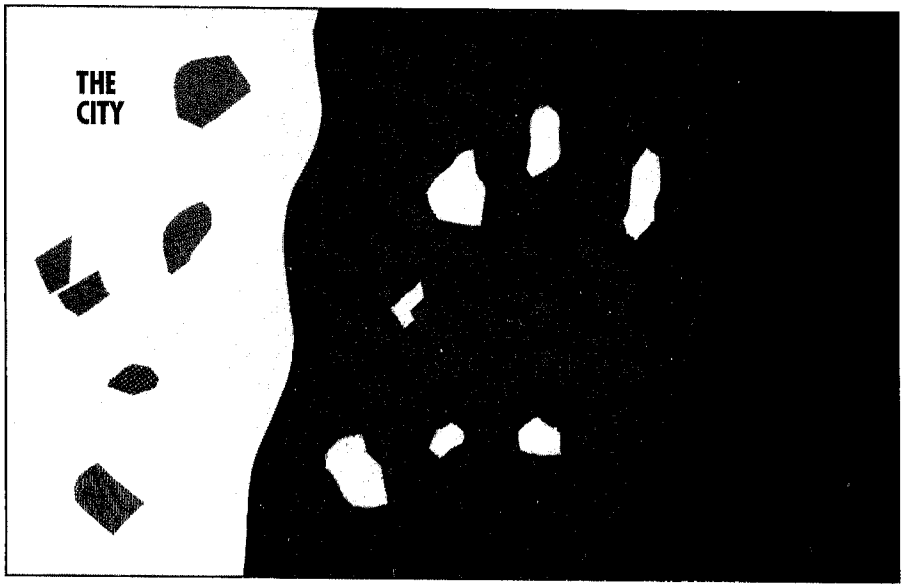

LOCATION OF SAMPLE PARCELS
LEGEND
Sample Parcel
Built Up Area of Metropolitan Green Bay
Sewer Extension
Town[ship] Boundaries
Federal and State Hwy.
County and Town[ship] Roads
0 1 2
miles
N
Green Bay
Pole of High Rent
CITY OF GREEN BAY
HUMBOLT
BELLEVUE
EATON
NEW DENMARK
End of Transect
Fox River
US-41
WIS-32
WIS-96
WIS-29
WIS-64
WIS-57
I-43

Figure 1
The Vicious Circle



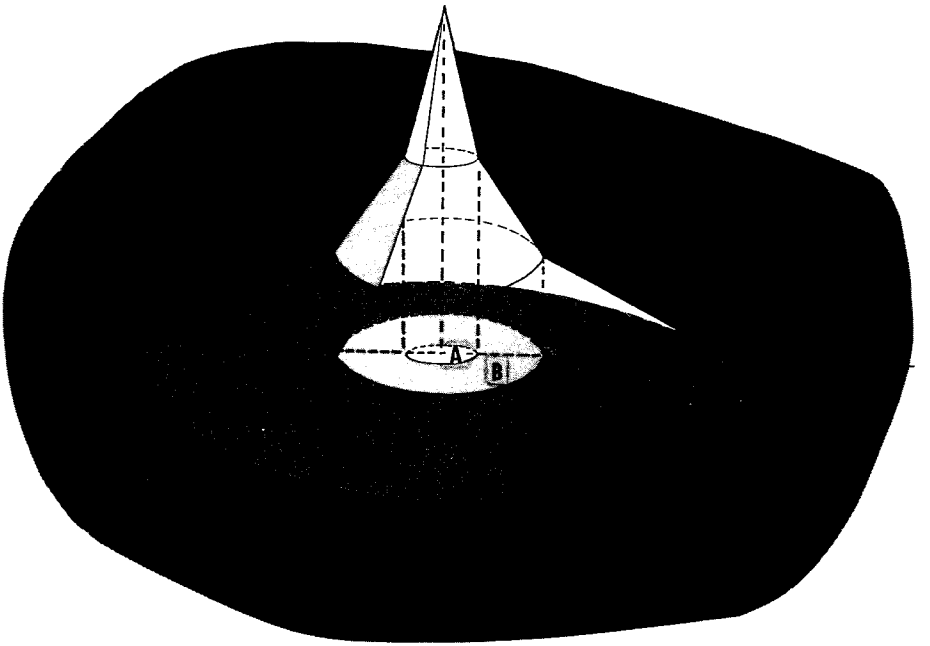
The vicious circle or cycle illustrates the process of change that occurs for farmland adjacent to a growing city (Barrows [5, p. 3])

Figure 2
Locus of the Study Area



The *zone of speculation* is defined as follows: land used mostly for farming; contains some urban uses; market value of land contains both agricultural and urban use value; both urban use and urban-induced land values decrease with distance from the city. This zone is surface C in the diagram of land rent cones (Figure 3). The City, shown here, is part of cone surface B. It is characterized by urban land use—and urban land values continue to rise toward the pole of high rent. The Country exhibits agricultural land use and agricultural land values. It is illustrated by plane surface D. The boundary between the city and the zone of speculation is easy to see. Although not precise, it is characterized by an intermingling of farmland and urban buildings and uses. In contrast, the boundary between the zone of speculation and the country is invisible—it is located somewhere within a scene of continuous farmland

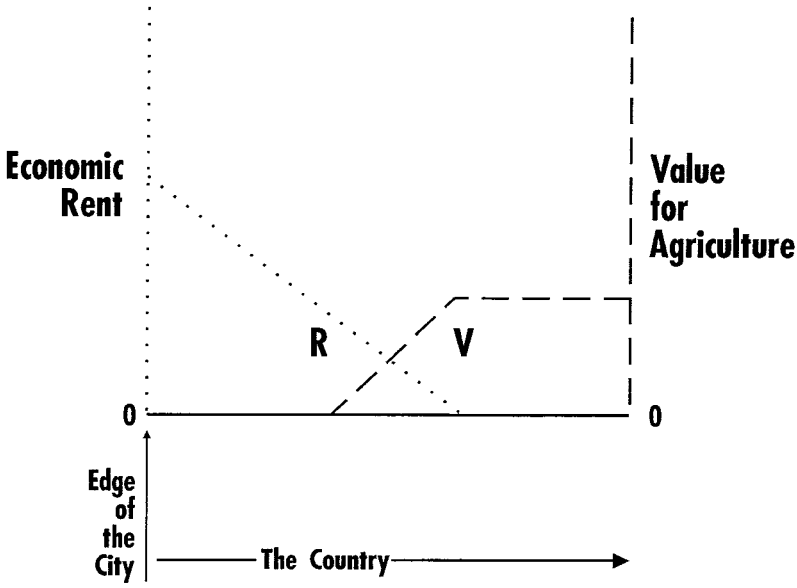
Figure 3
Land Rent Cones



"Use of land rent cones to illustrate relative levels of land rents or land values associated with the highest and best uses of sites located at different distances from the central markets" (Barlowe [3, Figure 9-3, p. 229])

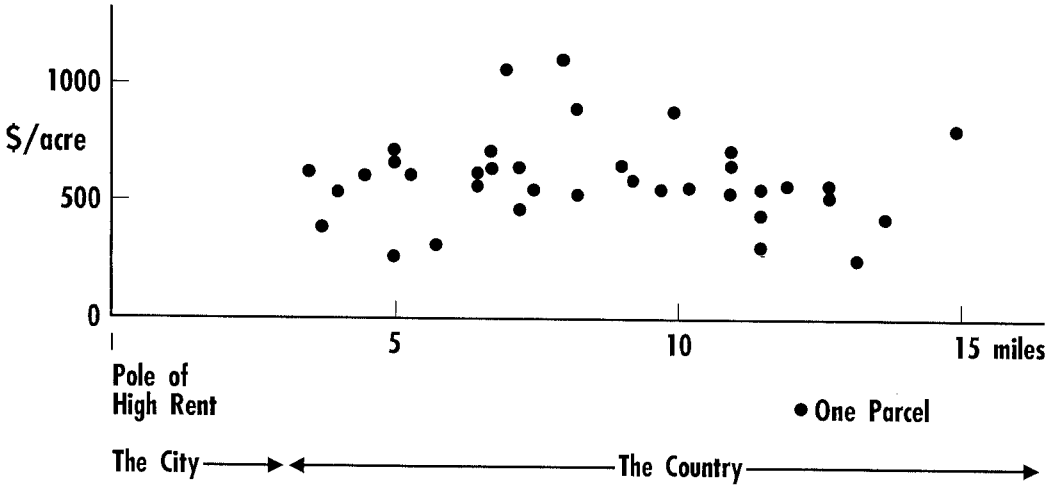
Author's note: the cones of all central markets or cities (surfaces A, B, and C) rise above a limitless plane of value for agricultural use (surface D)

Figure 4



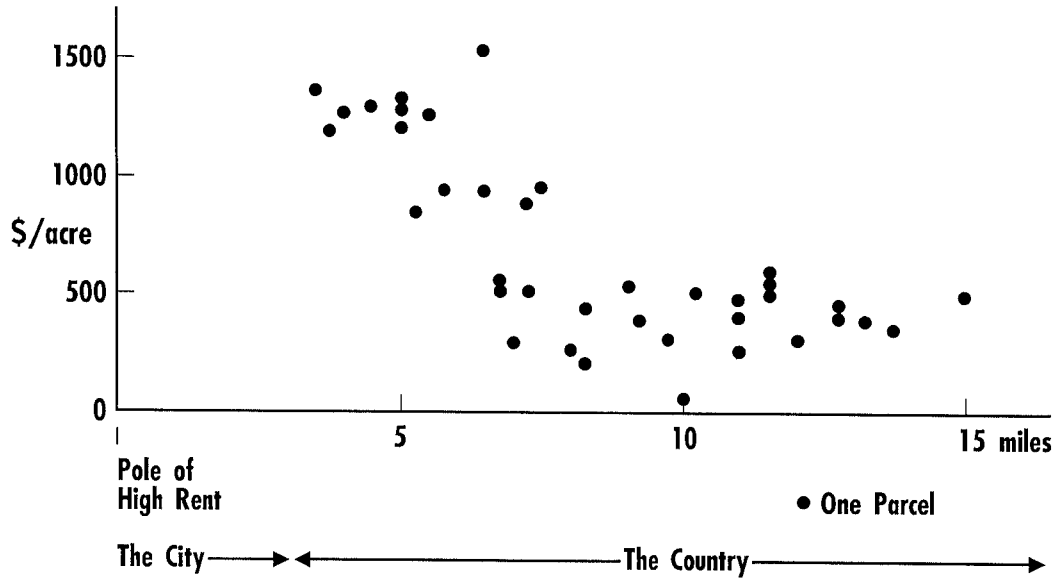
Sinclair's [47] Figure 1, "Economic Rent and Distance from the City" superimposed on Figure 5, "Value of Agriculture and Distance from Urban Area." The depression of market values illustrated at the intersection of lines R and V, if it exists, should appear on Barlowe's illustration in Figure 1 where cone surface C intersects the plane of agricultural land values. Sinclair's speculation that lines R and V may intersect in this way appears on page 79, note 17

Figure 5
The Dairy Use Value of Farmland



Source: Table 1, Column (3)

Figure 6
The Market Value of Farmland



Source: Table 1, Column (4)

Figure 7
Hypothetical Scatter Plot
Market Values of Farmland as a Percent of Dairy Use Value in a Rural Area

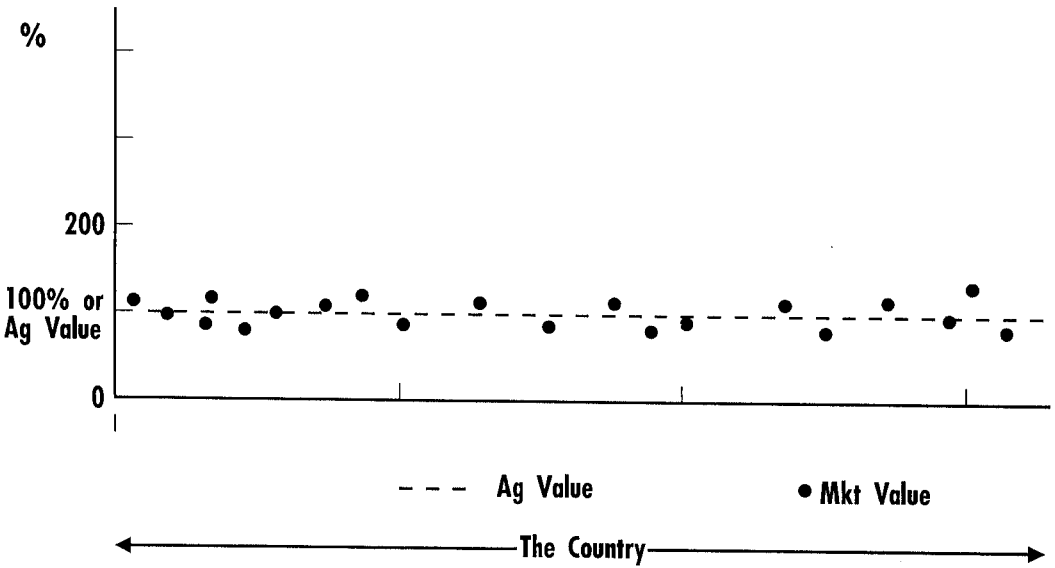
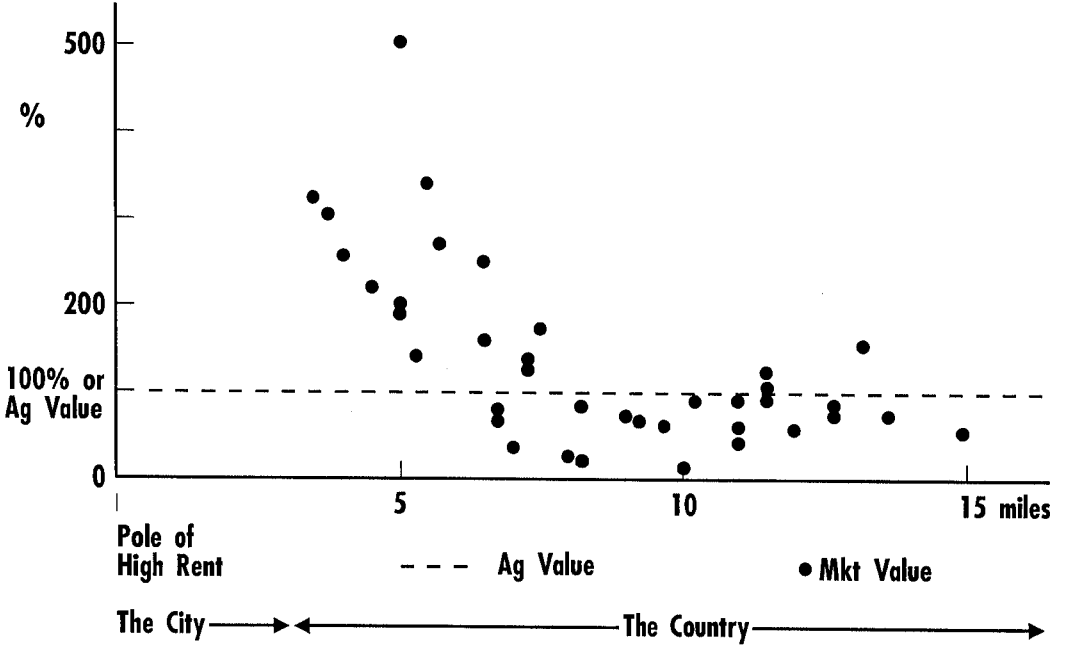
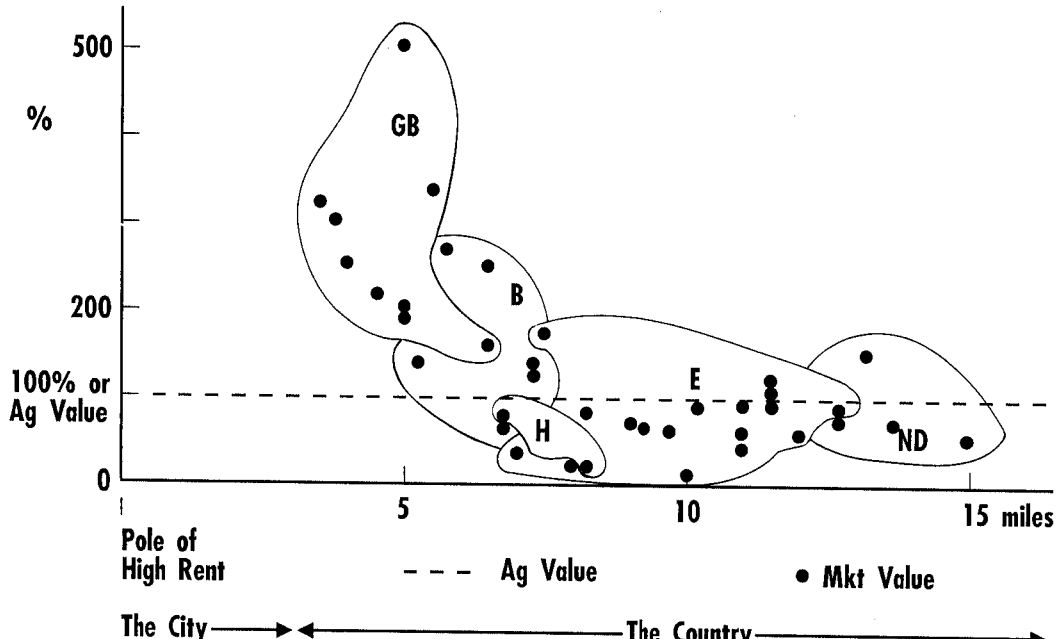


Figure 8
Market Values of Farmland as a Percent of Dairy Use Values in the Green Bay Study Area



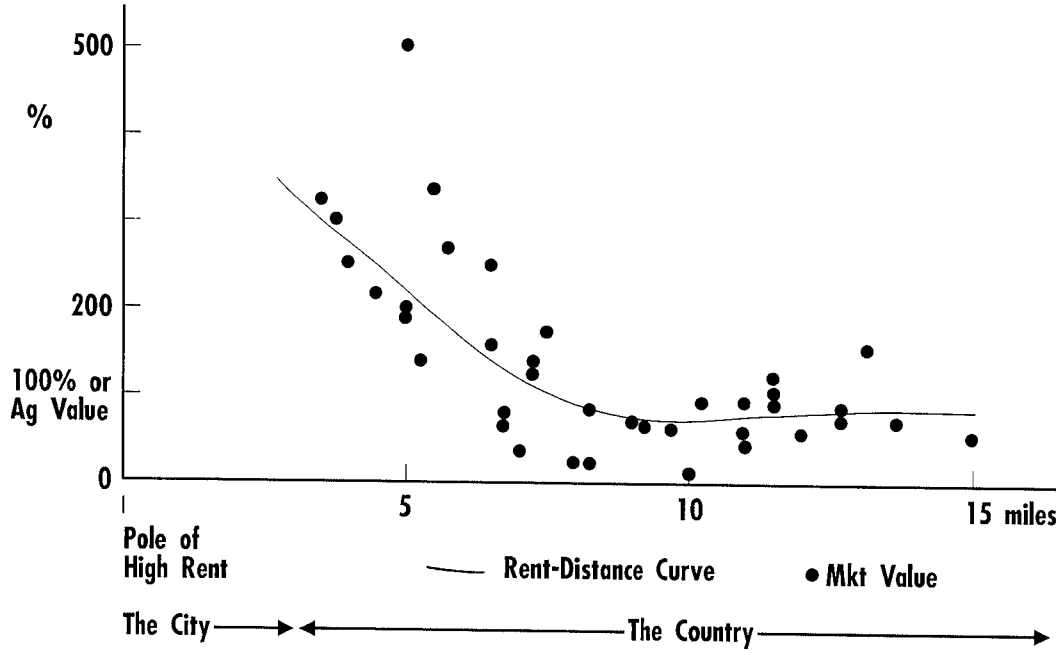
Source: Table 1, Column (5)

Figure 9
The Political Jurisdiction of the Sample in Relation to Market Values as a Percent of Dairy Use Values



Sources: Table 1, Column (5), and Table 2

Figure 10
The Surface of the Land Rent Cone



Source: Footnote 19 and Table 1