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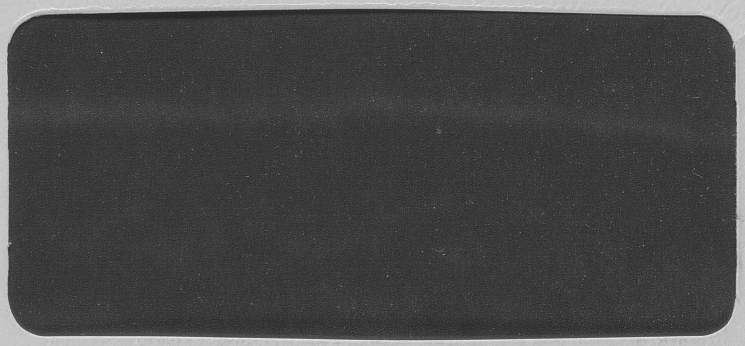

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BREAK-EVEN LAND PRICES: A NORMATIVE ANALYSIS OF THEIR DETERMINANTS*

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Abstract

Break-even land prices are derived for various factors affecting disposable net income per acre. The analysis includes a frequently overlooked consideration - the repayment capacity of the existing stock of assets. In addition, the effects of alternative cropping patterns with varying degrees of riskiness in net income are determined.

The determination of prices for agricultural land has long been a perplexing problem. It is confounded not only by the potential production characteristics and capabilities of the land, but also by the individual characteristics, desires and expectations of both buyers and sellers.

The break-even or maximum offer price for agricultural land is often computed as (Suter, pp. 247-252):

$$V = \frac{NI_{AT}}{I} \qquad (1)$$

where: V = the break-even price for land ($ per acre),

NI_{AT} = the expected net income after tax ($ per acre), and

I = the effective rate of interest.

At the outset, it is important to note that the demand for land services by itself does not determine the price of land. It only constitutes one side of the market. Notice also that if the rate of interest used in the above calculation refers to the "going interest rate", the land is treated as a consul. No provision is made for paying off the principal amount unless adequate savings can be generated from other sources. In addition, note that the demand for land is a derived demand - derived from the <u>marginal</u> value of land services to the farm under consideration.

This study analyzes the break-even price for good quality (class 1 and 2) grain land in western Canada, <u>at the margin</u>, for farmers differing in after tax net income expectations, managerial ability, inflationary expectations, and aversion towards risk. A supplementary question concerns the effect of size of land purchase and repayment capacity of the existing unit on the break-even land prices.

Without explicitly deriving the demand for land services from the

firm's profit maximizing conditions, the following function can be proposed. It follows from arguments made by Harris and Nehring and by Lee and Rask.

$$D_L = f(NI_{AT}, I, R, INF^e) \quad (2)$$

where: D_L = demand for land services ($ per acre),

R = measure of risk aversion,

INF^e = expected rate of inflation in after tax income per acre, and

NI_{AT} and I are as defined above.

The expected net income after tax can be determined as:

$$NI_{AT} = (P_y Y - \sum_i P_i X_i)(1 - T) \quad (3)$$

where: P_y = price of the output,

Y = quantity of output expected,

P_i = price of input i,

X_i = quantity of input i used in production, and

T = marginal rate of tax on net income.

Thus, $NI_{AT} = f(P_y, P_i, M, W, T)$ (4)

where: M = level of management proficiency,

W = an index of yield variability, perhaps signifying weather, and all other symbols are as defined above.

Method of Analysis

Two representative farm situations from the Dark Brown soil zone of south-central Saskatchewan were used for the analysis. One farm was 900 acres in size; the other farm was 1500 acres. Both were basically one-man operations with the larger farm having an inventory of larger machines (see Table 1). Spring wheat, barley and flaxseed could be grown on each of these farms (Table 2).

TABLE 1. VALUE OF INVENTORY FOR FARMS IN SOUTH-CENTRAL SASKATCHEWAN

Inventory Item	900 Acre Farm	1500 Acre Farm
Machines	$ 58,119	$ 81,997
Buildings	7,617	13,590
Land	247,800	413,000
Cash (including grains)	24,675	37,012
Debts	53,456	86,420

TABLE 2. SUMMARY OF HISTORICAL GRAIN YIELDS FOR SOUTH-CENTRAL SASKATCHEWAN (1960-1975)

	Summerfallow		Stubble	
	Mean	Standard Deviation	Mean	Standard Deviation
	bushels per acre			
Spring wheat	24.33	5.664	17.07	4.638
Barley	40.26	11.070	29.43	8.425
Flaxseed	13.69	3.558	9.87	3.185

Somewhat in concert with Patrick and Eisgruber the effect of the current stage in the family cycle on the break-even price of land was also included. It was assumed that each of the above farms was operated by:

i) a young family with three small children, and

ii) an older family with no dependent children.

This permitted four farm situations to be used in the analysis.

The stage of the family cycle will have an effect on the break-even land price through a different amount of after tax net income (because of the different income tax exemptions[1]), and through a differential ability to pay

[1] All persons residing in Canada in 1976 are entitled to a personal exemption from tax of $2090 for the household head and $1830 for the spouse providing the net income of the spouse was less than $360. The exemptions for a child under 16 years of age who had no net income was $390.

for land (because of a difference in consumption withdrawals from the farm business). The consumption function[2] for the young family was:

$$C = 3182 + .6454\ Y_t \qquad (5)$$

where: C = total consumption ($ per year), and

Y_t = net income after tax.

The consumption function for the older family was:

$$C = 2296 + .5684\ Y_t \qquad (6)$$

The income which was exempt from taxation amounted to $5090 annually for the young family and $3920 for the older family.

A farm level model of crop production, as reported by Zentner, was used for the analysis. The model contained production alternatives for various crop types, rotations, machine and tillage operations, machine replacement policies, etc. that are feasible in the study area. The model was used to determine the optimal production alternatives for each farm situation over a six year planning horizon. All costs associated with production were representative of 1976 conditions. Net incomes, accumulation of net worth, levels of personal consumption, and taxation were calculated for each case.

The analysis was divided into three stages:

i) the marginal value of land services under average conditions was estimated for each of the four farm situations together with the effects from:
   a) higher and lower product prices,
   b) lower level of managerial ability,
   c) higher and lower levels of expected annual inflation, and
   d) lower provincial income tax rates;

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[2] The consumption functions are taken from Hassan and Johnson. The functions, although derived from family expenditure patterns in urban areas, are considered to be applicable to the farms used in this study.

ii) the marginal value of land services was estimated at average and lower product price conditions for two farm situations under alternative quantities of "add-on" segments and repayment horizons; and

iii) the marginal value of land services for each of the farm situations from different degrees of risk aversion.

In the first stage of the analysis, the capitalized value of land under each of the conditions noted in Table 3 was determined for three interest rates. It was based upon the addition of one-quarter section (160 acres) to each of the existing farm situations. These values thus represented the break-even prices for land, approximately at the margin.

TABLE 3. LEVELS OF VARIABLES USED IN THE FIRST STAGE OF ANALYSIS

	Price for			Index of	Expected Annual	Prov. Income
	Spring Wheat	Barley	Flaxseed	Managerial Ability	Inflation Rate	Tax Rate
	---- $ per bushel -----				%	% of Fed. tax
Average situation[1]	3.00	1.87	5.74	100	0	42
High product price situation[2]	4.17	2.59	7.98	100	0	42
Low product price situation[3]	1.83	1.15	3.50	100	0	42
Low managerial ability situation[4]	3.00	1.87	5.74	85	0	42
High expected inflation situation[5]	3.00	1.87	5.74	100	+2	42
Low expected inflation situation[5]	3.00	1.87	5.74	100	-2	42
Low income tax situation	3.00	1.87	5.74	100	0	26

[1] Represents the approximate farm prices in Saskatchewan for the period 1971-1975.

[2] Represents the approximate farm prices in Saskatchewan for the period 1973-1975.

[3] Represents the approximate farm prices in Saskatchewan for the period 1951-1975.

[4] This refers to a lower level of efficiency in field operations. Therefore, labor and machine use are greater for each acre of land worked.

[5] The inflation rate affected all the variable costs associated with production.

The expected net farm income above taxes and consumption expenditures is required to repay the principal amount of the land being purchased. In the second stage of the analysis, the effect of this repayment capacity on the break-even land prices for various amounts of land purchases and repayment periods was estimated.

The third stage of the analysis involved estimating the expected returns-risk trade-off for each of the farm situations. The expected after tax net incomes and the standard deviations of these incomes on the 160 acre "add-on" segments were estimated for alternative cropping patterns. Linear programming was used to estimate a frontier function, which related the net income to the standard deviations of net income, for each of the farms.

The Results

The break-even prices for land under the situations outlined in the first stage of the analysis are presented in Table 4. They are, of course, very dependent on the interest rate. The break-even price for land under average conditions varied from $368 to $412, $263 to $294, and $204 to $228 per acre at interest rates of 5, 7 and 9 percent, respectively.

The results indicate that the 900 acre farm has a higher break-even price for land than does the 1500 acre farm, ceteris paribus. In addition, the young family has a higher break-even price for land than does the older family, ceteris paribus. Both results follow directly from the smaller farm and the younger family having lower income tax rates at the margin.

The choice of product prices used in the analysis had a very dramatic effect on the break-even land prices for each of the situations. The higher product prices (i.e., those associated with 1973-75 price levels) resulted in an average increase in the break-even price for land of 43.0 and 45.6 percent (over the average condition) for the 900 and 1500 acre farm situations, respectively. The lower product prices (i.e., those associated with 1957-75)

price levels) resulted in an average decrease in the break-even price for land of 36.7 and 46.3 percent for the 900 and 1500 acre farms, respectively.

TABLE 4. BREAK EVEN PRICE OF LAND AS INFLUENCED BY SIZE OF FARM, AGE OF FAMILY AND OTHER DECISION VARIABLES

	900 Acre Farm		1500 Acre Farm	
	Young Family	Older Family	Young Family	Older Family
	$ per acre			
	5% interest			
Average conditions	412	398	374	368
High product prices	586	573	545	535
Low product prices	268	245	208	191
Low management ability	384	372	322	318
High expected inflation (2%/yr)	405	391	366	362
Low expected inflation (-2%/yr)	418	408	380	372
Lower income tax	427	414	388	384
	7% interest			
Average conditions	294	285	267	263
High product prices	418	409	389	382
Low product prices	191	175	149	136
Low management ability	274	265	230	227
High expected inflation (2%/yr)	289	280	262	258
Low expected inflation (-2%/yr)	299	292	271	265
Lower income tax	305	296	277	274
	9% interest			
Average conditions	229	221	208	204
High product prices	325	318	303	297
Low product prices	149	136	116	106
Low management ability	213	206	179	177
High expected inflation (2%/yr)	225	217	203	201
Low expected inflation (-2%/yr)	232	227	211	206
Lower income tax	237	230	215	213

A 15 percent lower managerial ability (i.e., lower labor and machine use efficiency) also had an effect on the break-even prices for land. The lower managerial ability resulted in the break-even price for land declining by 6.8 percent for the 900 acre farms and by 13.5 percent for the 1500 acre farms.

Continued inflation or deflation in the price of production inputs did not have a large effect on the break-even prices for land. A 2 percent annual rate of inflation decreased land prices by 1.7 and 1.9 percent for the 900 acre and 1500 acre farms, respectively. A 2 percent rate of deflation increased the break-even prices for land by 2.1 and 1.4 percent, respectively, for the 900 and 1500 acre farms.

The lower provincial income tax rate (leaving the federal income tax schedule unchanged) increased the break-even prices for land by 3.8 and 4.1 percent for the 900 and 1500 acre farms, respectively.

The second stage of the analysis involved calculating the break-even land prices for various quantities of "add-on" segments for the 900 acre farm situations, assuming alternative repayment horizons. If the existing land base cannot repay the principal, the balance must come from the newly purchased land. Therefore, larger "add-on" segments and/or shorter repayment schedules will cause the break-even price to become smaller.

The break-even prices for land for the two 900 acre situations for various quantities of "add-on" segments are illustrated in Figure 1. Both average and low product prices were used in the calculation. The figure indicates that the young family can initially afford to pay more for land than the older family, but the repayment capacity does not permit as many acres to be purchased at this price (assuming a 20 year repayment schedule in both cases). If the younger family is permitted a 30 year repayment period while the older family is restricted to 20 years (as assumed by Lee and Rask), then the younger family can pay more for all quantities of land.

Notice that under the low product price scenario, the break-even price per acre drops much more rapidly for larger purchases.

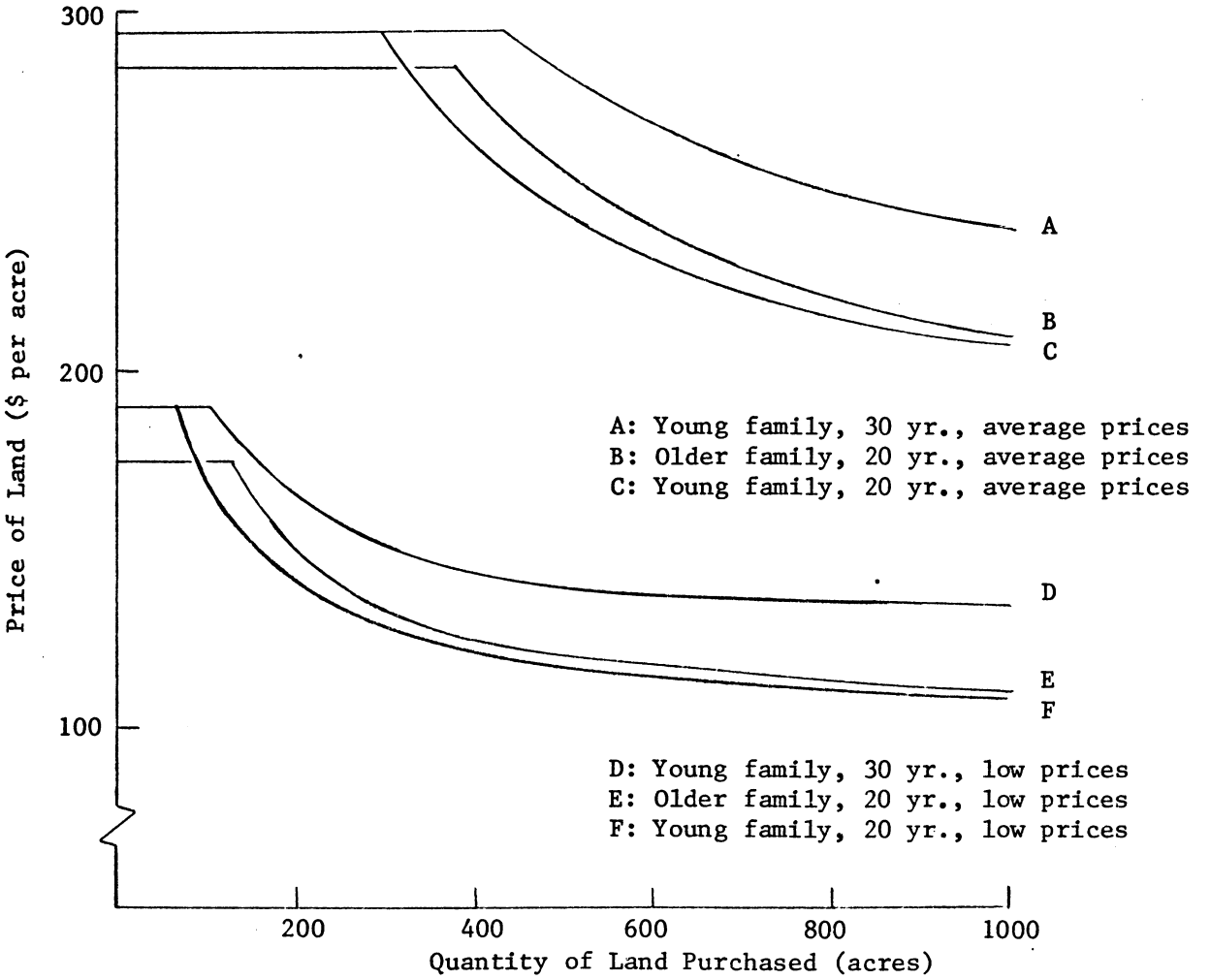

FIGURE 1. BREAK EVEN LAND PRICES FOR VARIOUS QUANTITIES OF LAND PURCHASED, 900 ACRE FARN

The third stage of the analysis consisted of estimating expected after tax net income - standard deviation of income functions for each of four farm situations. The functions were estimated as follows:

i) 900 acre, young family

$$\Pi^e = 11.10s^{.5613} \quad (7)$$

ii) 900 acre, older family

$$\Pi^e = 7.50s^{.3053} \quad (8)$$

iii) 1500 acre farm, young family

$$\Pi^e = 6.24s^{.6235} \quad (9)$$

iv) 1500 acre farm, older family

$$\Pi^e = 7.10s^{.5329} \quad (10)$$

where: Π^e = expected net income after tax ($ per acre), and

s = net income after tax ($ per acre) for yields that were one standard deviation below the means.

Each of the estimated relationships displays the familiar pattern of increasing riskiness for each level of expected net income. (Since each of the estimated exponents is less than one, it must be the case that s increases more rapidly than does Π^e.) The equations can be used to calculate the trade-off between expected income and risk for each farm situation.

The break-even prices of land based upon alternative levels of risk aversion are summarized in Table 5. Flax has the highest net return per acre but it also has the largest variation in net income over time. Wheat, on the other hand, has a lower expected net return but it is much more stable. Therefore, cropping practises having high proportions of flax have higher expected incomes; those with high proportions of wheat have lower expected incomes.

The break-even land prices for the cropping pattern most generally observed (i.e., 75 percent wheat and 25 percent barley) were 6 to 8 percent below those calculated upon the maximum expected net income. The 100 percent wheat alternative produced break-even land prices of 8 to 11 percent below those calculated from maximum net income.

The apparent risk aversion by farmers, as inferred by their observed cropping patterns, produces risk premiums similar to those estimated for the 3 medium qualities of land in Iowa by Harris and Nehring.

TABLE 5. NET INCOME AND PRICE OF LAND, ALTERNATIVE LEVELS OF RISK AVERSION

Crop Production Alternatives			After Tax Net Income		Price for Land
Flaxseed	Barley	Spring Wheat	Mean	Standard Deviation	at 7 percent Interest
-- percent of seeded acreage ---			------- $ per acre -------		---- $ per acre -----
---------- 900 Acre, Young Family ----------					
25	75	0	20.58	6.73	294
0	25	75[1]	19.36	5.63	277
0	0	100	18.90	5.19	270
---------- 900 Acre, Older Family ----------					
25	75	0	19.92	6.79	285
0	25	75[1]	18.73	6.19	268
0	0	100	18.33	6.01	262
---------- 1500 Acre, Young Family ----------					
25	75	0	18.70	5.95	267
0	25	75[1]	17.19	5.11	246
0	0	100	16.68	5.00	238
---------- 1500 Acre, Older Family ----------					
25	75	0	18.38	5.96	263
0	25	75[1]	16.99	5.16	243
0	0	100	16.46	4.96	235

[1] Represents the approximate combination of crops produced in south-central Saskatchewan over the period 1960 to 1974.

Conclusions

The results indicate that the largest farms do not necessarily have the highest break-even prices for land. This agrees with the findings of Harris and Nehring. The reason for the lower break-even prices for land is the higher income tax rates for the larger farms at the margin. It was also determined that the younger family farms have higher break-even prices for land than the older family farms. This is also due to the lower marginal income tax rates from their higher personal exemptions.

The repayment capacity of the existing land base and the aversion toward risk can decrease the price per acre where a farmer can break-even. This is in accordance with *a priori* expectations.

The break-even land prices, as calculated, bear a satisfactory relationship to recorded land prices. Land prices in this region of Saskatchewan in 1967-68 averaged $150 per acre (low product price regime) and in 1975 averaged $230 per acre (Albasser and Farm Credit Corporation). This is somewhat lower than calculated values but would be expected when comparisons are made with a normative model.

This analysis demonstrates that a normative procedure can be effectively utilized to determine the various influences on the marginal value of land services. As emphasized at the outset, the marginal value of land services at any level are not necessarily coincident with observed market clearing prices. An analysis of the supply side of the market must undertaken to develop equilibrium land prices.

References

Albasser, Gottfried, "Farm Real Estate Sales in the Prairie Provinces, 1963-1967", Economics Branch, Canada Department of Agriculture, March 1969.

Farm Credit Corporation, "Federal Farm Credit and Related Statistics, 1975".

Government of Saskatchewan, "Acreage, Yield and Production of Principle Grain Crops", various issues.

Harris, Duane G. and Richard F. Nehring, "Impact of Farm Size on the Bidding Potential for Agricultural Land", American Journal of Agricultural Economics, Vol. 58, No. 2, May 1976.

Hassan, Zuhair A. and S. R. Johnson, "Family Expenditure Patterns in Canada", Economics Branch, Agriculture Canada, Pub. No. 7613, June 1976.

Lee, Warren F. and Norman Rask, "Inflation and Crop Profitability: How Much Can Farmers Pay for Land?", American Journal of Agricultural Economics, Vol. 58, No. 5, December 1976, Proceedings Issue, pp 984-990.

Patrick, George F. and Ludwig M. Eisgruber, "The Impact of Managerial Ability and Capital Structure on Growth of the Farm Firm", American Journal of Agricultural Economics, Vol. 50, No. 3, August 1968, pp 491-506.

Statistics Canada, "Quarterly Bulletin of Agricultural Statistics", various issues.

Statistics Canada, "Handbook of Agricultural Statistics", Part 1, Field Crops, 1921-1974.

Suter, Robert C., The Appraisal of Farm Real Estate, Dunville: Interstate Printers and Publishers, 1974.

Zentner, R. P., "The Simulated Effects of Cropping Rotations and Fertilizer Use in the Brown Soil Zone", unpublished M. Sc. thesis, University of Saskatchewan, June 1975.